SURGICAL

AFTER-TREATMENT

A MANUAL OF

THE CONDUCT OF SURGICAL CONVALESCENCE

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PREFACE TO THE SECOND EDITION

THE gratifying reception which has been accorded this book has encouraged us to undertake its revision. We have attempted to modify and add to the presentation of each subject as the shift of medical opinion and the advance of surgical knowledge have required. As a result, the volume has been largely recast; some chapters have been entirely rewritten and others nearly so; several illustrations have been replaced by better ones, and many new ones have been added.

We have received great help from the kindly criticisms of our friends, and we believe that we here present a book which may be taken, as it were, to the bedside with full confidence in the assistance it will afford in the recognition of the complications of the postoperative period, and reliance on the specific directions as to treatment which it offers.

We wish to thank Dr. Lewis P. Felch, of Boston, for assistance in compiling the chapter on Massage. For other assistance, intelligent and tireless, in the work of revision, we have to thank Miss Mary Clancy.

L. R. G. CRANDON,
ALBERT EHRENFRIED.

BOSTON, MASSACHUSETTS,
April, 1912.

PREFACE TO THE FIRST EDITION

THESE suggestions for After-treatment of Surgical Cases are written for two classes of practitioners: house surgeons in hospitals and general practitioners in communities which are not surgical centers.

Hospitals develop traditions of treatment; the graduating house surgeon is an oracle to the beginning junior officer; the visiting surgeon leaves most of the postoperative detail to the house surgeon, and if the latter has good sense in addition to his academic knowledge, he is able to use the traditions of treatment which he has inherited from his predecessor in office wisely, and matters of after-treatment in the wards go on serenely. Traditions and customs, however, may be bad, and it seems unnecessary, if it is avoidable, that each succeeding house officer should have to learn all details of after-treatment empirically and at the patient's expense. It must be admitted that the danger of an arbitrary printed page may be greater than that of a verbal tradition of treatment, but if these pages can serve to show that successful after-treatment, like successful primary treatment, depends first on common sense, that each case should suggest its own after-treatment to some degree, that an arbitrary rule is dangerous, the book will have served its purpose.

When the metropolitan surgeon operates in the smaller towns, he leaves the case after operation in the hands of his consultant, who may not be a man of recent hospital experience. For such a man a manual of elastic but detailed directions should be of value.

Every procedure herein advised has stood the test of practice and will safely do for the reader until, from his own experience, he develops his own methods. The fact that each surgeon eventually grows into a technique peculiar to himself, and that many differing ways are successful, should make us liberal in spirit and constantly alert for new truth. No surgical life is so brief but that it has seen new methods appear, vaunted as perfect, pursued for a time, only to fade away.

Statistics are given little place, therefore, in this work. It is little comfort to a patient that ninety out of a hundred with his malady get well. Such a statement contains no assurance that he is not of the ten. Furthermore, we must acknowledge some truth in Christopher Heath's remarks (Brit. Med. Jour., 1892, i, 1243): "Of course, we hear of one case that did recover, but do not hear of the ninety and nine cases that did not. When a man has a case of that kind which gets well, he puffs it tremendously, and you always hear of it; but those who have unsuccessful cases are content to leave them alone and keep them out of the Journal; therefore, you must not believe too much in statistics. As soon as a gentleman begins to work up his statistics, his moral faculty appears to become relaxed."

Finally, I wish to quote from an admirable letter written by Gustavus Richard Brown, January 2, 1800, to Dr. Craik, concerning the last illness and death of General Washington:

"We were governed by the best light we had; we thought we were right, so we are justified.

"Dr. Rich is a most sensible man. He uses his common sense instead of the books as his guide in his profession, and he is no bigot. He says our professional practice needs great reform, and that can be brought about only by each individual becoming a practical reformer himself. He is disposed to put up his lancet forever and turn nurse instead of doctor, for he says one good nurse is more likely to assist nature in making the cure than ten doctors will by their pills and lancet." (Lossing's Hist. Rec., ii, 501.)

I wish here to thank Dr. Albert Ehrenfried, of Boston, for continuous and enthusiastic assistance in the preparation of this manual—assistance which has amounted to collaboration.

Dr. George P. Sanborn, of Boston, a leading disciple of Sir Almroth E. Wright in America, has written the chapter on Vaccine Therapy, a contribution I was very fortunate to get. He also prepared the section on Intubation, based on an experience of three hundred cases.

Dr. Frank B. Granger, of Boston, has contributed the section on Electrotherapeutic Technique, to my great satisfaction.

Such a manual as this must be, to a degree, a compilation. I have used the literature freely, meaning in each instance to give full credit and exact reference.

Thanks are due, and are herewith gladly given, to Doctors John H. McCollom, John Bapst Blake, Frederick J. Cotton, John H. Blodgett, Nathaniel R. Mason, Allen G. Rice, John T. Williams, Walter M. Boothby, and Miss Mabel R. Harris, for suggestions, criticism, and other material assistance.

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SURGICAL AFTER-TREATMENT

PART I

CHAPTER I

SICK ROOM, NURSE'S CHART, POSTURE

As a rule, the end of the operation marks the beginning of the surgeon's care and anxiety. In operating, the surgeon consumes from fifteen minutes to one hour—rarely longer—in performing a piece of surgical technique with which he presumably feels quite at home. When the patient leaves the table, however, he goes over into strange hands for an indefinite period of convalescence, with all its discomforts and all the possibility for mishap. The surgeon must now depend, in a large measure, upon others to carry out his plans for after-treatment and to keep him informed of the changes that may develop from hour to hour and the emergencies that may arise. For the time being, he must relegate a portion of his authority and responsibility to the person in charge—the nurse in a private family, or the house officer in a hospital. Skilful after-treatment has pulled through many a forlorn hope, while neglect in the after-care will negative the skilful effort of the best surgeon. Success in after-treatment means the successful mastery of a mass of details.

SICK ROOM

The room in which the patient is to pass his convalescence should be large, airy, well ventilated, and capable of being adequately heated. If in a private house, it should be situated apart from the living rooms and cooking, and near to a bath-room. The walls should be painted with washable paint in plain colors, without figures. The floor should be of polished wood, linoleum, or concrete, and without carpets.

The bed should be light, easily movable, with low head- and foot-pieces, best made of enameled iron, so that it may be readily and thoroughly cleansed. It should be narrow, and stand so high above the floor that the patient can be easily dressed and attended. It should be so placed that the nurse can readily get around all sides of it, and so situated that the patient does not have to look directly at a window or have the sun strike his face. It is well to have blocks, which may be placed under the head or foot casters of the bed, and to have boards to be placed across the middle of the frame to support the spring if it sags and gives the patient a backache.

Two small and rather hard feather pillows will suffice. One may be encased in rubber for use if the patient vomits. Sometimes several pillows of different sizes are handy to place under the small of the back or under the knees of the patient, as after an inguinal hernia operation, or to place against the foot of the bed for the patient to brace his feet against, in case the head of the bed is elevated.

FIG. 1.—CHANGING THE BED.
A blanket is thrown over the whole bed, and the bed-coverings are pulled out from beneath.

A small enamel or wooden table may be useful, placed at the right side at the head of the bed. Otherwise, save for a chair or two, there should be no furnishings in the room. Ornaments, pictures, hangings, and bric-a-brac are out of place. There should be a convenient hook or nail to be used in hanging up a fountain syringe.

The bed should be provided with a firm, level, horsehair mattress. A water-bed may be employed in case the patient is paralyzed, enfeebled, or emaciated, to prevent bed-sores; its use should be restricted, for it sometimes imparts a sensation akin to sea-sickness. Over the mattress comes the sheet; a narrow rubber "draw-sheet" is placed across the middle of the bed to protect the mattress. A full-sized sheet, once folded end-to-end, is also placed across the bed to cover the rubber sheet. This is of great convenience, because it can be

FIG. 2.—CHANGING THE BED.
Patient wrapped in blanket is turned to left side. All the under bed-clothes on right side are rolled up toward the middle of the bed.

readily changed when soiled by discharges, dressings, irrigations, or the bed-pan, without disturbing the under sheet.

FIG. 3.—CHANGING THE BED.
Clean under sheet and rubber draw-sheet are laid on right side of bed and tucked under mattress.

In changing the draw-sheet a nurse stands on each side of the bed. One nurse gently turns the patient toward the side nearest her, while the other rolls up the soiled sheet, wipes off the rubber draw-sheet, and lays on the clean sheet, which has been folded and rolled up, and tucks her end in under the mattress. Then the patient is allowed to turn on

FIG. 4.—CHANGING THE BED.
Clean draw-sheet similarly applied.

his back and is gently rolled on the other side, while the other nurse pulls out the soiled sheet, wipes off the rubber sheet on her side, unrolls

FIG. 5.—CHANGING THE BED.
Patient rolled over on his right side. Soiled under bed-clothes are removed from left side of bed, and rolled up portion of clean ones pulled through and tucked in.

the clean draw-sheet from under the patient, and tucks her end in, taking care that it is tightly stretched and smooth. This procedure may be easily carried through by a single nurse, provided the patient can be turned without danger.

The under sheet may be changed in the same way. The under sheet should be changed every morning and the draw-sheet as often as necessary. The bed should be kept free from crumbs and food particles, which will cause irritation of the skin or may even lead to bed-sores.

Over the patient all that is necessary is a sheet, a blanket, and a coverlet; extra blankets may be added when necessary.

The nurse should see that she has at hand a 4-quart fountain syringe and connections, hot-water bags, a rectal tube and glass female catheter,

Fig. 6.—Changing the Bed.
Clean top bed-clothes applied, temporary blanket pulled out, counterpane tucked in.

a hard-rubber oil enema syringe, bed-pan, towels and bed linen, toilet-paper, basins, hypodermic syringe with strychnin, morphin, and atropin, feeding-glass, feeding-tube, thermometers, and temperature charts. In private practice she can depend upon the surgeon to supply or order the other instruments and drugs necessary.

NURSE'S CHART

A surgeon at his visits will rely largely upon the nurse's chart. This should be accurate and explicit. It should record the temperature, taken twice daily (10 A. M. and 4 P. M.) or every four hours, as the case demands, and at the same time the pulse, and the respiration if the surgeon wants it. The frequency and nature of bowel movements should be stated, as well as the occurrence and the quantity of urination. For the first few days after operation, especially in stomach and other abdominal cases, it is well to keep a detailed diet-chart (Fig. 7), recording the occurrence of vomiting and the stimulation,

THE BOOTHBY SURGICAL HOSPITAL

Name .... *Date* ....

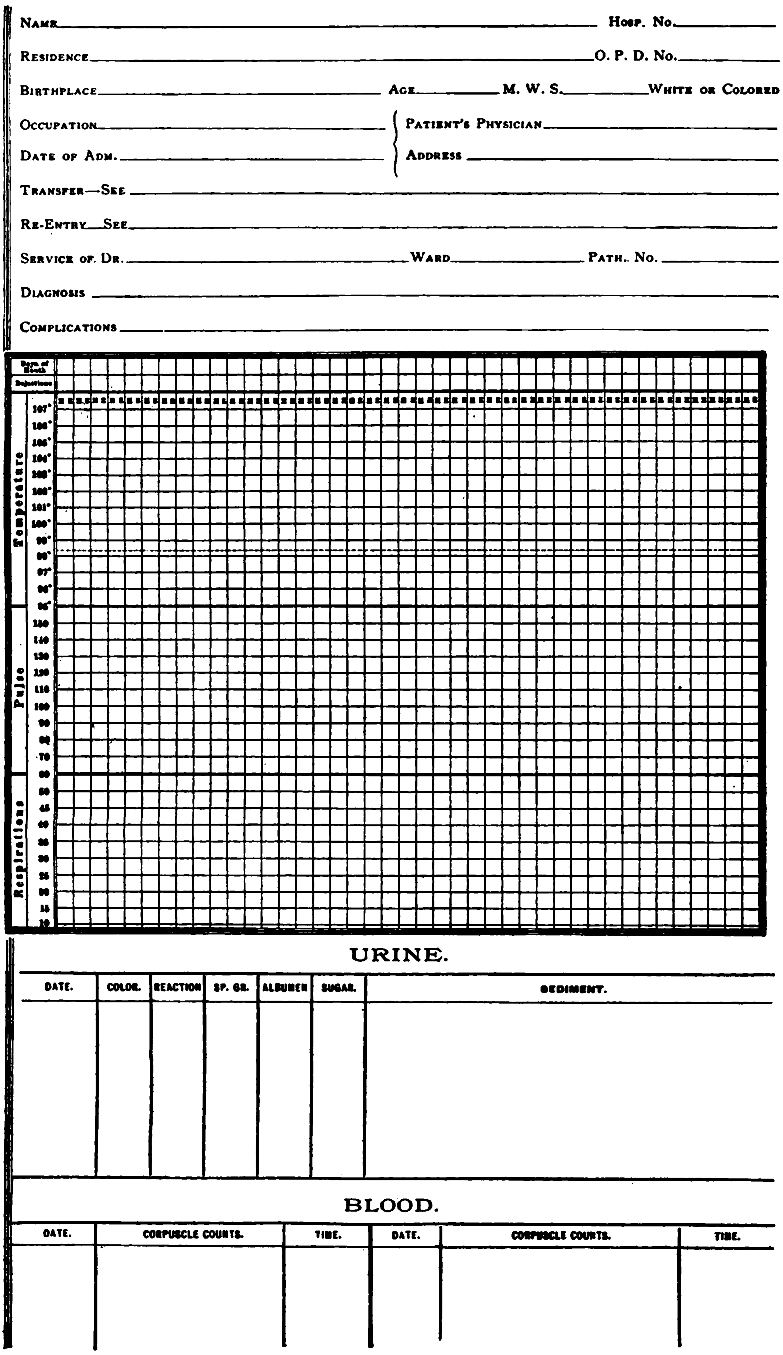
Patient of Dr. ....

A.M.	P.M.	Temp.	Pulse	Resp.	FOOD	Medicine	Sleep	Urine	Bd.	REMARKS
7.30										

Day Report	*Night Report*
Signature of Nurse	*Signature of Nurse* ....

FIG. 7.—A CONVENIENT TYPE OF DETAILED CHART. (*Reduced one-half*)

nourishment, enemas and their retention, catheterization, sleep, etc. It is valuable also for future record to enter briefly on the temperature chart such items as the date of operation, wicks out, stitches out, the date of sitting up, and final discharge.


NAME ____ HOSP. No. ____
RESIDENCE ____ O. P. D. No. ____
BIRTHPLACE ____ AGE ____ M. W. S. ____ WHITE OR COLORED
OCCUPATION ____ PATIENT'S PHYSICIAN ____
DATE OF ADM. ____ ADDRESS ____
TRANSFER—SEE ____
RE-ENTRY—SEE ____
SERVICE OF DR. ____ WARD ____ PATH. No. ____
DIAGNOSIS ____
COMPLICATIONS ____

Days of Month
Dejections
Temperature: 107° 106° 105° 104° 103° 102° 101° 100° 99° 98° 97° 96° 95°
Pulse: 150 140 130 120 110 100 90 80 70 60
Respirations: 50 45 40 35 30 25 20 15 10

URINE.

DATE.	COLOR.	REACTION	SP. GR.	ALBUMEN	SUGAR.	SEDIMENT.

BLOOD.

DATE.	CORPUSCLE COUNTS.	TIME.	DATE.	CORPUSCLE COUNTS.	TIME.

FIG. 8.—BEDSIDE CHART USED AT THE MASSACHUSETTS GENERAL HOSPITAL (reduced).
With the exception of "Diagnosis" and "Complications," which are filled out only after discharge, this chart contains no data undesirable for the patient and his friends to read.

The nurse is expected to be fully informed as to the pulse and temperature, state of the bowels and bladder, distention, vomiting, pain, delirium, sleep, amount of discharge or hemorrhage if it soaks through the dressing, and the occurrence of menstruation or vaginal discharge. A nurse of experience can be of help in other ways, but these things she must know. Moreover, she must have sufficient judgment to be able to decide whether to summon the surgeon and when to do so. Upon her devolves the responsibility of informing the surgeon of any change or emergency, otherwise it is a matter of waiting upon the patient and of following explicitly the orders of the surgeon in charge.

POSTURE

The patient should be allowed to assume in bed the position of greatest ease and comfort, provided this position is not harmful. Comfort and sleep are important after a serious operation, and any-

FIG. 9.—DORSAL POSTURE.
Pillow under knees to relax abdominal muscles.

thing which will tend to induce them—avoiding opiates—is to be diligently sought after and practised. It has been generally held that the only proper posture for a patient after an operation of any severity is the supine, with the patient flat on his back, and sometimes, in spite of increasing discomfort, he will not be allowed to turn for some days. The cases where this rule need be enforced are few, and ordinarily, in celiotomies which have been sewed up tight and wear a firm swathe, there is no reason why a position of greater comfort may not be allowed. In the supine posture backache is frequent, though this may be relieved by flexing the knees at 45 degrees on pillows, or by placing a small pillow under the hollow of the back (Fig. 9). Few persons sleep on their backs, and turning the patient gently on his side in the natural resting position, supporting his back with a pillow, may often induce sleep.

Many women are unable to empty the bladder lying upon the back, and residual urine collects and may develop into a troublesome cystitis, which could have been obviated by turning the patient on her side to micturate. Some patients appreciate being turned face downward in bed, and drainage from an abdominal wound may often be

Fig. 10.—Right Semiprone Posture.

appreciably assisted by this position. Others will take comfort in being allowed to assume the semiprone posture.

It is frequently advisable so to prop up the upper half of the mattress that the patient is in a semireclining posture—for instance, in elderly persons, in cases of cardiac asthma, bronchitis, hypostatic pneumonia, and after thoracic and gastric operations. The sitting posture is of distinct value in preventing postoperative pulmonary complications, especially in fat patients, after celiotomies for conditions such as gall-stone disease, gastric troubles, or umbilical hernia. It is a good practice in patients who are old or feeble, or who have pulmonary emphysema or bronchitis, to set them up soon after they have recovered from the anesthetic. Hypostatic congestion of the bases of the lungs is not then likely to occur, and the liability of pneumonia is lessened. If the patient is held upright without any effort on his part, there is no increased strain on the abdominal wound. As this position takes the pressure off the bony prominences of the back, patients are in less danger of bed-sores. In distention this position is advantageous, in the first place, because the diaphragm and abdominal muscles compress the viscera more powerfully, and, in the second place, because in this position the action of the heart is less impeded by upward pressure of the distended intestines. Sitting up a distended patient always causes an improvement in the pulse. When sitting up such patients can breathe better, they take food and liquids better, the tone of vascular system is better preserved, and they are not so liable to dizziness and swelling of the feet when they finally walk.

R. H. Fowler,[1] analyzing 69 cases of diffuse septic peritonitis operated upon in St. Luke's Hospital in ten years, refers to the article by G. R. Fowler[2] on the advantages of the elevated head and trunk position. He concludes as follows: "Early institution of postural drainage is of great aid in preventing septic material from reaching the diaphragmatic peritoneum. The manner of instituting postural drainage matters but little, provided that the pelvis is sufficiently low for gravitation to take place and the patient is comfortable. A wooden frame may be used with a folded pillow beneath the knees to prevent the patient from slipping."

This posture has been universally adopted in the treatment of general peritonitis. Experimentally, H. T. Buxton[3] has shown that there is an almost instantaneous rush of bacteria into the lymphatics of the diaphragm whenever infectious material comes in contact with it. If the head and trunk are sufficiently elevated, septic matters drain into the pelvis, where absorption is much slower. R. C. Coffey,[4] by means of an ingenious cast of the peritoneal cavity, has shown that it is necessary to elevate a person's body as high as 45 to 50 degrees to insure drainage of the lumbar depressions of the abdomen. The Fowler position, to be at all effective, must be maintained all the time.

Many devices have been described for maintaining a position upright in bed. Elevating the head of the bed and placing a pillow under the knees is ineffectual because the support is too yielding. J. F. Baldwin[5] advises the use of an ordinary rocking-chair; J. E. Allaben[6] describes a back rest on the principle of a double-inclined

[1] Ann. Surg., 1908, xlviii, 828.
[2] Med. Rec., 1900, lviii, 617.
[3] Jour. Med. Research, 1907, 17, 25, 251.
[4] Jour. Am. Med. Assoc., 1907, xlviii, 937.
[5] Ibid., 1907, xlix, 1043.
[6] Ibid., 554.

plane; and D. T. Gilliam[1] advocates the use of a steamer chair. S. McGuire[2] elevates the head of the bed and uses an adjustable seat to keep the patient from slipping downward. W. D. Gatch[3] describes an apparatus consisting of an oblong frame of stout boards, to the upper surface of which are hinged three movable flaps, which can be arranged so as to give a sitting posture. An efficient way to maintain Fowler's position is shown in Figs. 169, 170, and 171, pages 518 and 519.

[1] Jour. Am. Med. Assoc., 1908, li, 1133.
[2] Ibid., l, 1019.
[3] Ann. Surg., 1909, xlix, 410

CHAPTER II

AFTER THE ANESTHETIC: NAUSEA AND VOMITING, HEMATEMESIS, RESTLESSNESS, SWEATING

In the ordinary operation of election, the major incident, so far as the patient is concerned, is the anesthesia. With no well-defined appreciation of the so-called horrors of the operating-room, but with an innate dread against resigning himself to the fumes of an overpowering drug, sharpened by the harrowing recitals of acquaintances who have been through it, the patient usually goes to the table in a state of anxiety and suppressed excitement which has an important bearing upon the course of the anesthesia and the recovery therefrom. If such a patient is unskilfully handled, he will come out of the ether in a state of collapse, he will be distressed for hours by nausea and vomiting, the operative recovery will be retarded, and the whole incident will constitute a nightmare which he will carry through life, with the leading part taken by a professional person who is throttling him nonchalantly, and is bellowing in his ear, "Now take a long breath," with, as support, a grim surgeon in a white gown, who hisses through his teeth, "Get him under" or "Give it to him."

The surgeon does wrong to himself as well as to his patient if he neglects the anesthetic. A considerate, even etherization, competently conducted, will see the patient to bed almost recovered, with the minimum of shock, and with little or no gastric disturbance. The experience has not been disagreeable to the patient, and he starts his convalescence with a better spirit and a higher resistance than the person who has been fagged out and distressed by an irregular or hurried anesthesia, and its subsequent nausea and vomiting.

If an expert anesthetist can be obtained, this should be done. A well-trained nurse who specializes in this field is as satisfactory as most male anesthetists, and is distinctly safer and better than the average doctor. As has been said elsewhere,[1] a perfect solution of the problem of giving anesthetics would be a medical man of high grade of intelligence, with a well-grounded medical and surgical education, and especial education in anesthetics, supplemented by a natural inclination in this direction as against any other. Are the

[1] J. M. Baldy, Boston Med. and Surg. Jour., 1909, clxi, 262.

attractions of anesthesia sufficient to overcome the disadvantage of the scientific narrowness and lack of opportunty for distinction and income to hold a sufficient number of men of this type, or even of great worth, in this field? The answer seems apparent. To the nurse, anesthesia would prove a stepping-stone to something better than she had originally chosen, a higher and more dignified position, and appeal in its own way to her ambition and pride, just as does the superintendency of a training-school. With the nurse anesthetist is eliminated the inattention to the anesthetic, with its attendant annoyances and dangers, there being no desire for, or chance of, an assistantship or future chiefship.

An element in humane and successful anesthesia, where time and other conditions permit, is for the personal physician, if he be at all competent, or the surgeon himself, to start the anesthesia. By this means no new individual is introduced to the patient at the last moment, with a possible unpleasant psychic effect.

Most important, first of all, is that the anesthetist should, by preliminary conversation with the patient, by air of self-confidence, deliberation with no suggestion of hurry, by constant spoken reassurance as the anesthesia proceeds, gain and keep the entire confidence of the patient. If at first the patient asks for a little more air, he should have it. Unless the patient is likely to harm himself by his struggling, *no one should touch any part of the patient as he goes under.* In the midst of the weird dreams of ether intoxication the mere restraining hand of a bystander on the patient may convert a fantasy into a wild delirium, a quiet patient into a temporary maniac. Successful etherizing is half hypnotic in its method.

In the hands of the slightly skilled or the average anesthetist, as well as the expert, the drop method of giving ether is the safest and best. Twelve to twenty layers of gauze, cut rectangular in shape, 7 by 9 inches, are laid over nose and mouth and tucked under chin. The patient gets used to breathing through the gauze, and then, so slowly that he may get used to the smell, ether is played over nose- and mouth-area of gauze from a single pin-puncture in the top of a 250-gm. tin ether can. The patient thus gets constantly ether-laden air, which is at the same time always fresh.

Certain advantages are claimed for various methods of inducing anesthesia. Nitrous oxid gas, anesthol, ethyl chlorid, and chloroform are all less unpleasant to most patients for beginning anesthesia than ether; they go under more rapidly and quietly, there is less swallowing of ether-laden mucus, and as a result the after-effects are far less disagreeable, as a rule. But all these methods complicate the problem of anesthesia, and they must be used with care and discretion. Nitrous oxid gas, the safest of those mentioned, requires a special apparatus and a trained administrator, and it should not be used in patients with valvular disease or myocardial degeneration. Chloroform, ethyl chlorid, and anesthol are dangerous in increasing ratio: death from the two latter is extremely sudden, and in the majority of cases occurs within five minutes of the beginning of inhalation.[1] These agents will give good results only in the hands of trained anesthetists of wide experience in their use, and with cognizance of their disadvantages.

Similarly, some surgeons employ as a routine, preliminary to ether or chloroform, morphin (gr. $\frac{1}{8}$ to $\frac{1}{4}$) and atropin (gr. $\frac{1}{150}$ to $\frac{1}{100}$), or morphin and scopolamin (gr. $\frac{1}{150}$ to $\frac{1}{100}$), by subcutaneous injection or by mouth, a half-hour or one hour before the anesthetic is started. The advantages of this procedure are, a smoother anesthesia, more readily induced, with decreased salivation, economy of the anesthetic, and lessened nausea and vomiting. On the other hand, their action is variable with individuals and they sometimes fail to act, they are likely to be followed by dryness of the mouth and thirst, and by prolonged sleep, and they depress circulation and respiration, and may cause death. The routine use of these combinations should be deprecated; they should not be employed in severe cardiac conditions or in operations about the mouth and throat on account of the interference with expectoration.[2] Their use is sometimes indicated in the case of alcoholics, dyspeptics, and the nervously unstable. Nitrous oxid with oxygen, which has been gradually growing in favor in major surgery in this country within the last five years, is noted for the mildness of its after-effects. Crile[3] reports only 139 cases of nausea (of which 9 were severe) after 1000 major operations in which gas and oxygen were used. The effects on the kidneys and liver are equally mild, as compared with ether, and particularly chloroform. When ether vapor is added to the combination, as it frequently has to be to overcome spasm of the abdominal muscles and rigidity of the legs when the lithotomy position is used, these beneficial effects are more

[1] H. C. Wood, The Comparative Danger of Ethyl Chlorid as an Anesthetic, Jour. Am. Med. Assoc., 1910, lv, 2229.

[2] R. A. Hatcher, Scopolamin and Morphin in Narcosis and Childbirth, Jour. Am. Med. Assoc., 1910, liv, 446; C. V. Collins, Scopolamin and Morphin as a Preliminary to General Anesthesia, Jour. Am. Med. Assoc., 1910, liv, 1051.

[3] Jour. Am. Med. Assoc., 1910, liv, 1907.

or less neutralized, however. This form of anesthesia is as expensive as regards materials, it requires special and complicated apparatus, and a professional anesthetist.

AFTER THE ANESTHETIC

Immediately after the operation the patient is wiped dry, the dressing or bandage is adjusted, wet clothes changed for dry, and he is wrapped in blankets and transferred to a warm bed, to be carefully watched during his recovery from the anesthetic. In hospitals there is usually set apart a special room called a recovery room. This should be high-posted and airy, maintained at a constant temperature of about 70° F. It should be quiet, with a subdued light, and so isolated from the general wards that any disturbance or loud retching may not upset other patients in a critical condition. The room should be barely furnished, the walls painted in a plain color, and windows should be barred. In a private house these conditions should be approximated as closely as may be.

During the recovery the patient should have the undivided attention of the nurse detailed for the purpose. Vigilance is necessary, not only to prevent the unconscious patient from swallowing his tongue or choking in mucus or vomitus, but also from injuring himself in delirium, or from removing or displacing his dressing. Rarely there may be necessity for restraining a patient by means of a folded sheet passed across the body and made fast to the bed-frame on either side (Fig. 11), as, for instance, when a delirious, muscular man is in the care of a little nurse who is alone. But usually, with the patient in a semiconscious state, restraint of any kind has a tendency to cause him to struggle and to increase the violence of the delirium. It is only rarely that delirium goes farther than random or irresponsible talk or an attempt to sit up, and it lasts, as a rule, not longer than ten minutes, so that a competent attendant will not often find use for restraint. Extra heaters and hot-water bottles, well covered beyond the possibility of burning the patient, should be at hand to distribute about the patient as necessary.

Recovery from anesthesia occurs, roughly speaking, with a rapidity in inverse proportion to the length of narcosis and the amount of anesthetic employed. Other facts enter into the matter, however. Recovery from chloroform is more rapid than from ether. The recovery will be shorter if the administration has been even; if a good quality of ether has been used; if the patient has been at all times allowed sufficient oxygen; if the air-passages have not been plugged with mucus; if the circulation has been well maintained during the anesthesia; if the patient has not vomited during the administration, or any

FIG. 11.—APPLICATION OF RESTRAINT.
Feet tied to foot of bed by sheet in a clove-hitch; wrists tied to side of bed by gauze bandage over a towel; chest held to bed by a folded sheet tucked tightly around side-irons.

emergency has arisen necessitating the use of tongue-forceps or of artificial respiration. A skilful anesthetist will, at the end, have his

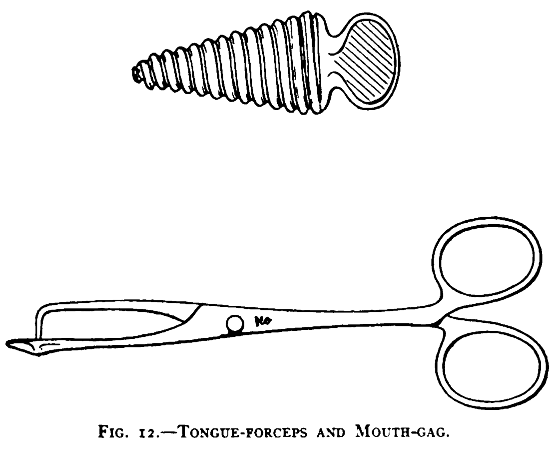


FIG. 12.—TONGUE-FORCEPS AND MOUTH-GAG.

subject so lightly under the influence of the anesthetic that signs of recovery appear immediately upon transference from table to bed. Some operators, indeed, demand of their etherizers that the patient vomit before he leaves the table; this is of particular advantage in private-house operations, where the surgeon is usually loathe to leave until he is assured that recovery is well under way.

The anesthetist should in every case see the patient to bed, and stay by him until distinct signs of recovery are evident—until the patient is able to dispose of his vomitus. He should remain until some semivoluntary action takes place—until the patient turns his head, opens his eyes, moans, or talks. In certain types of cases temporary obstruction of respiration is likely to occur, and there must be some one at hand who is competent to use the mouth-gag and tongue-

FIG. 13.—FROM OPERATING-ROOM TO BED.
Patient protected from exposure and properly attended.

forceps in an emergency, who will hold forward the jaw, wipe away the frothy mucus, and clear the mouth of vomitus if necessary. Neglect of this precaution may be serious, either as regards immediate strangulation or subsequent pneumonia. When a patient responds in any way to the question "Feeling better?" he may be safely left with a nurse.

If a patient who has not had preliminary morphin or scopolamin remains for a long time after the operation in a state of deep narcosis, it means that an unnecessarily large amount of anesthetic has been used. Accompanying this prolonged stupor there will be a deterioration in the pulse and duskiness of the face and lips. Sometimes, however, even if an excessive quantity of the anesthetic has not been used, there will appear a slighter degree of duskiness and some flagging of the pulse, independent of length or seriousness of operation, which is probably due to the presence of mucus in the air-passages and to the deprivation of the stimulating action of the anesthetic.[1]

Both chloroform and ether act as cardiac stimulants in feeble subjects, and as soon as their administration is stopped the circulation will flag. During the interval of lowered vitality the patient should be kept dry and warm. As soon as retching and vomiting occur and the air-passages have cleared themselves of their accumulations, the normal

FIG. 14.—FROM OPERATING-ROOM TO BED.
Exposure and neglect of patient; vomiting unattended.

color will come back to the face and lips and the pulse will be restored to its former strength.

The best position for a speedy and satisfactory recovery is with the patient on his side. When conditions allow this—and the exceptions are rare—it will be found that the tongue gravitates to the side of the mouth, a free air-way is established, stertor disappears, mucus and saliva will find their way out without being sucked into the air-passages, and coughing ceases; if there is vomiting, the vomitus will escape freely. The patient, having no pillow under his head, may be bolstered

[1] J. B. Blake (Boston Med. and Surg. Jour., 1896, cxxxv, 492): "Oxygen shortens the time of returning consciousness and diminishes unpleasant after-effects of ether. It is a good cardiac and respiratory stimulant, and is indicated in threatened collapse. Insert a soft-rubber catheter gently through the nares until the eye is approximately opposite the opening in the trachea."

up if turned on his right side by putting a doubled pillow behind his left shoulder, taking the precaution of making sure that he is not lying upon his right arm. When the patient cannot be turned, his head should be held to the right.

NAUSEA AND VOMITING

The occurrence of nausea, retching, or vomiting in some degree is characteristic of the after-effects of ether. It comes on suddenly, and for the time being it may be violent, but subsides rapidly and leaves the patient half awakened to clear-headed consciousness, or is succeeded by quiet, normal sleep. Vomiting after ether practically always is temporary; as a rule, it occurs while the patient is unconscious, and has spent itself before the patient has been brought to a state of realization of his distress. It may, however, recur in repeated attacks, and this depends on certain factors which should be mentioned.

If solids or liquids are present in the stomach at the beginning of the administration, there will not only be difficulty in maintaining a deep, even, quiet anesthesia, but the after-symptoms may be severe. The quality of ether used is important—it should be made from pure grain alcohol, free from methylic ether, sulphuric acid, alcohol, or water; it should be freshly opened, for ether exposed to the air develops acetic acid.

If during the operation much blood, mucus, or saliva passes into the stomach, it will be bound to find its way up in the post-anesthetic stage. The after-symptoms are likely to be more severe in constipated persons, after handling of the stomach or intestines, if the anesthesia is protracted, or if the patient is jolted about during recovery. Some surgeons make it a practice to wash out the stomach after the operation is over while the patient is still on the table; this often is advantageous, especially in cases where proper preparation has not been possible, in that it forestalls what may prove to be an uncomfortable period for the patient. As a routine its employment is unnecessary.[1]

[1] Ochsner (Clin. Surg., 1902, 108 *et seq.*): "The fact that the patient is suffering from nausea or vomiting is the strongest indication for the use of gastric lavage, because the nausea is caused by the presence of decomposing material in the stomach, and its removal must result in the greatest benefit to the patient. It frequently happens that these patients lose their anxious expression and restlessness, which we have observed in this case, and that the skin becomes warm and moist, and they begin to sleep directly after the gastric lavage has been practised. . . .

"It is possible that there may be more material of the same character in the small intestines, but, if so, it will soon regurgitate into the stomach and make its presence known by the recurrence of nausea. Should this occur, the gastric lavage will be repeated at once. If no food is given by mouth, I have never been compelled to irrigate the stomach more than two or three times in the same patient, and usually one careful, thorough irrigation

Chloroform in this respect acts differently from ether. The transient nausea, with retching, ending in the expulsion of a small quantity of whitish or yellowish stringy fluid, rarely occurs, owing chiefly, perhaps, to the smaller quantities of mucus which are secreted under the stimulation of chloroform. If the chloroform anesthesia has been maintained evenly and deeply the recovery, as a rule, is rapid and satisfactory—a single cough or act of retching will suffice to clear the larynx of any mucus-plug, the dusky hue will depart from face and lips, the pulse will rapidly restore itself, and the patient, if not disturbed, will usuall pass off into a quiet sleep. When, however, vomiting does come on after chloroform it is much more likely to prove distressing to the patient and intractable to treatment; indeed, fatal cases have been reported. It is apt to occur at intervals for hours and sometimes days,

will suffice. It will be wise to direct attention to the method employed in such cases. The patient is turned upon the right side in order to add the weight of the intestines to the support of any adhesions which may exist in the vicinity of the appendix. The head and shoulders are slightly elevated by means of pillows or a head-rest, then the pharynx is sprayed with a 4 per cent. solution of cocain in order to prevent gagging when the stomach-tube is passed, because this might disturb the adhesions in the vicinity of the appendix. It is well to spray the pharynx repeatedly for a period of about five minutes, permitting the patient to swallow a little of the saliva mixed with cocain in order to anesthetize the esophagus to some extent at the same time. After holding the cocain in the pharynx a minute it is expectorated with the saliva which has accumulated and a fresh spray is applied. As most of the cocain is thus thrown out, there is no danger from poisoning. After about five minutes a fairly large stomach-tube is inserted and the contents of the stomach siphoned out. The stomach-tube should have one or two lateral openings aside from the opening at its end. These openings should be within 1 to 2 inches from the end which is inserted in the stomach. This will prevent the end of the tube from becoming closed by drawing into it a portion of the mucous lining of the stomach.

"Whenever there is any interruption in the flow, this may be overcome by pouring a little water into the tube and thus dislodging any substance which may have become fixed therein.

"After the accumulation which is present in the stomach has been siphoned out it is well to introduce into the stomach 1 pint of normal salt solution at 100° F. and then siphon it out. This may be repeated until the fluid returns clear.

"The patient will now be placed in bed, with the shoulders somewhat elevated, so as to favor gravitation toward the pelvis. She will receive absolutely no food and no cathartics by mouth. Every four hours she will receive an enema of 1 ounce of one of the concentrated predigested foods dissolved in 3 ounces of normal salt solution. I am confident that she will not require any anodyne, her pain will disappear spontaneously, since we have removed the cause of irritation by performing gastric lavage. . . .

"There are two classes of patients in whom this form of treatment is not so satisfactory as it is in all other classes—namely, the very old and the very young. Very old patients do not bear confinement in bed well, no matter what their condition may be, and they do not prosper generally on rectal feeding. In these cases one is compelled to choose between two evils, and whichever is chosen, one usually wishes it had been the other.

"In children it is difficult to perform gastric lavage; they are likely to struggle and injure themselves while this is being accomplished."

even after the stomach has emptied itself beyond any possibility of doubt, which leads to the inference that it is due to some not clearly evident reflex mechanism, or, in severe cases, to derangement of the general metabolism, from the effects of the anesthetic upon the liver. As against the brisk but transient gastric disturbance of ether, the more rare but persistent retching of chloroform is far worse.[1]

It must not be overlooked that the vomiting following operation may have a significance of its own, apart from the anesthetic. It may be a symptom of intestinal obstruction or peritonitis, in which case its character and appearance are of importance; it may be an early manifestation of pneumonia or uremia, or represent an acetonemia. Sometimes vomiting will apparently be continued as a reflex from the pressure of gauze drainage or of a glass or rubber tube, and will cease with its removal; sometimes it will be kept up by improper food supplied by injudicious friends. After anesthesia, if the vomiting is protracted or violent and there is danger of the slipping of a ligature or of too much strain being placed on a long abdominal wound, it is advisable, if none has been given for three or four hours, to administer a suitable dose of morphin hypodermically.

Recovery Room.—To aid an unconscious person to vomit the head should not merely be turned over, but the patient should be lifted by the shoulder over on the side until the thorax is well turned. If, then, with the chin pulled forward, reflex expulsive effort is not sufficient to drive the vomitus out of the pharynx and mouth, inspiration involuntarily follows, and the vomited matter is pulled back toward the trachea. The first danger from vomiting after ether is that the vomitus shall enter the trachea and acutely interfere with respiration—in short, choke the patient. Should a patient, therefore, be seen to make a vomiting effort, little or nothing come out of the mouth, and cessation of breathing with cyanosis appear, the air-passages above the larynx must be cleared at once by the deep-reaching

[1] Blanlaret (Presse Med., 1909, xvii, 481, "Vomissements Chloroformiques"): "Vomiting from chloroform is annoying, threatens the solidity of the suture, weakens the patient, and by inhalation of solid or fluid particles causes postoperative pneumonia and bronchitis. The patient should be kept under the influence of the anesthetic until he is safely returned to bed, because movement of the body, especially when the anesthesia is not complete, increases the tendency to vomiting. Of equal importance is the maintenance of an even temperature of the body and the removal of the patient from an atmosphere charged with chloroform. Lavage of the stomach before the patient regains consciousness may be advisable if there has been much secretion and swallowing of saliva. If vomiting occurs, cold applications to the stomach or injections of ergot or of picrotoxin, 1 cc. of a 2 per cent. solution, are indicated."

finger or swab. Obstruction may be due to the tongue being sucked backward into the pharynx—a matter quickly remedied.

If the vomited matter has been inspired deeper than the larynx, and the reflex coughing is not sufficient to clear the trachea, tracheotomy must be done at once.

As a rule, a patient vomits most easily with head low, that is to say, without a pillow. It is said that lying on the right side diminishes the tendency to vomit, as the contents of the stomach move over toward the right orifice and will not so easily be ejected. It should not be forgotten, however, that during anesthesia ether is excreted by the stomach, and hence the stomach-contents must contain a certain amount of irritative ether.[1] Some vomiting, therefore, is desirable.

The treatment of *protracted vomiting* is sometimes unsatisfactory, but ordinarily after ether comparatively simple measures will give relief. It is fair to say that a patient adequately prepared for operation by rest in bed and thorough emptying of the alimentary tract vomits the least after ether, but it should not be forgotten that excessive nausea after ether may be an individual peculiarity that no amount of preparation will counteract in a given case. Frequent rinsing of the mouth with cold water should be tried, but ice increases the tendency to vomiting. Five to 15 minims of cocain hydrochlorid, 2 per cent. solution, in 1 dram of hot water every half-hour for three or four doses, will sometimes allay a most persistent case.

By far the best and simplest procedure is to give the patient, three or four hours after operation, or as soon as he asks for it, a glassful of hot water ($\frac{1}{2}$ pint). This will promptly make him sick, and he will vomit it, together with the mucus and saliva and the ether which he has swallowed as vapor, or which has been reëxcreted by the gastric mucous membrane. This is, in short, an effectual form of gastric lavage; the stomach, which has been ineffectually retching in an effort to bring up a small quantity of thick, slimy, irritating material, now successfully exerts itself in getting rid of a larger bulk of more dilute fluid. Later another drink may be given, and it will usually be retained. This procedure is contraindicated only in certain operations involving the stomach and duodenum.

If the vomiting is still persistent and prolonged—that is, after

[1] A. Graham (Jour. Am. Med. Assoc., 1909, liii, 2094) recommends the administration of 1 ounce of pure olive oil just as soon as the patient can swallow. He reports that in 29 out of 30 cases there was no vomiting after this procedure. The oil is supposed to dissolve the ether within the stomach. The oil may be poured into the stomach through a tube before the patient leaves the operating-table.

five or six hours, and is not then definitely becoming less frequent—the stomach should be washed out with hot water containing sodium bicarbonate, 2 drams to the quart. This lavage may be repeated every four hours if vomiting persists. Although an uncomfortable procedure for the patient, it is brief and most efficiently relieves the symptoms. The tube should be passed rapidly well into the stomach, and as much sodium bicarbonate solution as the stomach will comfortably hold is passed in. This is forthwith siphoned out, and the stomach is so filled and emptied three times. Just before the tube is withdrawn a small amount of the alkaline solution is left in. This method is better than any of the medical remedies.[1]

Charged waters and champagne seem to exert a quieting effect upon the stomach. Essence of peppermint, 5 to 10 drops on a lump of sugar or in water, may often be of benefit, as well as tincture of capsicum or tincture of iodin, 2 or 3 drops in water. Hot fomentations or, much less commonly, the ice-bag over the epigastrium may relieve the stomach spasm. The inhalation of vinegar is said to have a sedative effect in vomiting after ether.

If the vomiting does not yield to these milder measures after a reasonable time, it is likely to prove troublesome. The patient should be kept in a quiet, darkened room, propped up in a sitting posture in bed (to reduce the sensation of nausea), and all food and drink by mouth stopped. Any residue in the stomach should be gotten rid of by means of gastric lavage. Thirst should be satisfied by saline enemata, and nourishment should be administered only by way of rectum. Hot poultices or a mustard plaster should be applied to the epigastrium, or a hot-water bag should be applied and frequently renewed. Morphin will be of service, or a cup of black coffee to which 10 gr. of sodium bromid has been added may be given, or an enema of bromid and chloral, if there is violent retching. Milk of bismuth in ounce doses may be repeated frequently. Cocain, gr. $\frac{1}{10}$ (5 minims of a 2 per cent. solution), may be given every half-hour. Cerium oxalate gr. 5 to 10; chloroform, 1 minim in a teaspoonful of water; dilute hydrocyanic acid, 1 or 2 minims in water, have all been recommended. The urine should be examined for albumin and acetone.

Emergency tracheotomy must be performed rapidly to be successful. The head is dropped into the Rose position—that is to say, backward over the edge of the bed or table. Standing on the patient's right the surgeon, with the left thumb and forefinger, grasps the cricoid and upper trachea, holding it firm in the middle line. With

[1] For the technic of gastric lavage, see page 148.

the right hand an incision is made with a pocket-knife or any cutting instrument which it is possible to get, from just below the cricoid, 1 to 1½ inches downward, if possible at once to the depth of the trachea itself. Bleeding is absolutely disregarded. The knife, now turned edge toward the patient's chin, slipped into the trachea at the bottom of the wound, cuts upward about three tracheal rings. The knife turned at right angles will hold open the tracheal wound while artificial respiration helps the patient to breathe.

When this operation is started, some bystander should at once go for the tracheal dilator and two or three tracheal cannulæ, and when they arrive, one of the tubes may be inserted, a tube sufficiently long to well enter the trachea, but not long enough to cause pressure deep in the trachea where it is in relation to the arch of the aorta. The tube at first rapidly fills with blood or mucus. This is best cleared by rotating a hen's feather down through the tube. The head should be kept low until all bleeding has ceased, so as to allow the blood to run from the mouth. If a tracheotomy tube is not at hand, a piece of bent wire or rubber tubing may be used temporarily to hold the edges of the trachea apart. When respiration is well established, any part of the wound extending above and below the tube may be closed with sutures.

HEMATEMESIS

The vomiting of blood after operation, where no lesion in the gastro-intestinal tract exists to explain its occurrence, was first noted forty years ago,[1] and it has never yet been satisfactorily explained. Cases are not frequent in the literature, but they have been recorded by A. v. Eiselsberg,[2] C. W. Mansell-Moullin,[3] A. W. Mayo-Robson,[4] J. H. Croom,[5] W. E. Lee,[6] G. E. Potter,[7] and others. Busse recorded 96 cases occurring up to 1905.

Hematemesis occurs practically only after celiotomy. The operation need not have been performed on the gastro-intestinal tract, for it has followed cases of ovariotomy, hernia, pelvic abscess, peritonitis, and cholecystotomy. General anesthesia is not a necessary antecedent, nor does the presence or absence of frank sepsis seem to have any bearing upon the etiology.

[1] Fox, Diseases of the Stomach, 1872, p. 205, quoted by McKay.
[2] Archiv. f. klin. Chir., 1899, lix, 832.
[3] Lancet, 1900, ii, 1125.
[4] Ibid., 1901, i, 375.
[5] Brit. Gyn. Jour., 1902, xviii, 59.
[6] Ann. Surg., 1908, xlviii, 632.
[7] Jour. Am. Med. Assoc., 1910, liv, 872.

Von Eiselsberg considered that the condition was the result of torsion or ligature of the omentum, causing multiple gastric hemorrhages. McKay suggests that a common factor in all cases is shock, and that shock may produce portal engorgement, and, secondarily, venous congestion of the walls of the stomach, and that diapedesis or even rupture of the capillaries may result. Others have suggested that the hemorrhage is the result of operative trauma to the gastro-intestinal tract, that it is caused by thrombosis,[1] or that it is the result of multiple infective emboli from any source of infection, such as the appendix or gall-bladder, set free by the manipulation attending operative procedure and distributed by the blood-stream. Winiwarter,[2] who studied 30 cases occurring in von Eiselsberg's clinic within five years, asserts that there are two important etiologic factors: retrograde embolism in the vessels of the stomach-wall caused by detached thrombi from ligated veins in omentum or mesentery, or by direct extension of thrombosis, and, second, paralysis of the vessels from toxins set free in the blood after major operations on any part of the body, and in the formation of which the anesthetic, vomiting, and predisposition may be factors.

Autopsy on fatal cases is likely to show the stomach filled with thin, chocolate-colored fluid, with its vessels engorged, and its mucous coat exhibiting occasional minute extravasations and frequent small shallow ulcers scattered over its entire surface. Sometimes evidence will be found of retrograde embolism or extending thrombosis from ligated veins in the neighborhood of the stomach.

It is not uncommon to note that a patient who has just undergone a severe operation, particularly one who has taken his ether badly, while coming out will vomit a small amount of brownish, frothy fluid. This is always transient, and it represents the small amount of blood which is swallowed during the operation and digested in the stomach. Postoperative hematemesis may come on a few hours after the patient has recovered from the anesthetic, or its onset may be postponed a day or two. The blood may be bright red in color, but it is more likely to present some degree of decomposition, varying in shade from light brown to black, and it tastes intensely bitter. The fluid contains brown, flocculent masses, resembling coffee-grounds, and responds to the tests for the recognition of blood. The vomitus is, as a rule, small in quantity, and occurs at intervals of an hour or two; the patient may

[1] Schwellbach, Postoperative Gastro-intestinal Hemorrhage After Appendix Operations, Deutsch. Zeit. f. Chir., 1908, xcv, 141.

[2] Magen-Darmblutungen nach Operationen, Archiv. f. klin. Chir., 1911, xcv, No. 1.

vomit but once or twice in considerable quantity—from a pint to a quart at a time. Sometimes the vomiting is accompanied by the passage of blood per rectum. The general condition resembles that of profound collapse. The pulse is small and rapid, the skin becomes cold and clammy, and the temperature may be subnormal.

The prognosis in all cases is poor. As stated by Lee (*loc. cit.*), the mortality has been placed at 55 and 72½ per cent. If the hemorrhage is in small quantity and digested, rather than in larger quantity of fresh blood, the pulse is more likely to maintain its tone and collapse is less to be feared.

Treatment promises little. Morphin should be administered to keep the patient, and particularly his gastro-intestinal tract, quiet, and an ice-bag should be applied to the epigastrium. Nothing should be given by mouth. Saline solution and a nutrient enema when indicated should be given by rectum. Saline with adrenalin should also be given subcutaneously if there are signs of collapse. Hot gastric lavage has been recommended; saline solution or 2 per cent. sodium bicarbonate at a temperature of 115° F. should be used. After this comes back clear, 15 minims of adrenalin in 1 pint of normal salt solution can be poured in and left. Winiwarter recommends washing out the stomach with silver nitrate solution.

RESTLESSNESS

Restlessness is due most often to the mild delirium from ether and to petty discomforts; next, to pain. It is always present after serious loss of blood and is frequently present in shock. The restlessness of hemorrhage and shock is considered elsewhere; that due to pain will be discussed later.

The restlessness due to ether is usually mild and soon passes off. It may occasionally closely resemble a delirium; the patient acts wildly, is very talkative, sometimes screaming and thrashing about violently. If his attention can once be secured, he becomes quiet, and often confesses to acting queerly without cause. As a rule, this foretells the end of the delirium, but frequently it is necessary to hold the attention for a few moments. Sometimes he relapses into delirium, but is readily made rational by the same means.

The petty discomforts causing restlessness are numerous. Often the worry and anxiety incident to the operation are the cause. Whatever the result of the operation may be, assure the patient for the time being that everything is as favorable as could be expected; tactfully allay his suspicions and anxieties and encourage him not to talk.

The relief of nausea and thirst is generally followed by satisfaction of mind and body. A slight change in posture; a pillow under the small of the back or under the knees; a blanket less or a blanket more; the loosening of a tight binder, or the granting of a harmless whim, will often allay the restlessness. Not rarely a heater has caused a burn, slight but nevertheless irritating, proper attention to which is gratifying and restful to the patient. See that the patient is dry throughout, and that his wound is free from unnecessary pressure and strain. If the patient has recovered from his ether, and the simple measures described above have failed to quiet him, the cause of his restlessness is probably more serious, and should be found and treated accordingly.

SWEATING

In most cases ether, by dilating the superficial capillaries, induces sweating. This commonly occurs early in anesthesia, and ceases as the circulation regains its equilibrium. In strong, healthy patients it rarely has any untoward significance. This sweating may be called physiologic, in that it is eliminative and harmless, provided the body surface is guarded from sudden chilling. Therefore, in the recovery room even profuse sweating in itself need cause no alarm in the case of a vigorous person, or in cases where the operation has been short. Toward the end of a long operation, or when the patient has been some little time in the recovery room, sweating occasionally appears. This is a cold, rather scanty, and clammy sweat, of far different aspect and graver significance than the other variety. It is a sign of weakness, and should call attention at once to the patient's general condition. Shock and hemorrhage are both to be looked for, and measures taken at once to support the patient. It is an early danger-signal of considerable value, and while it may not be followed by a serious condition, it is by no means to be disregarded.

CHAPTER III

THIRST, ITS SIGNIFICANCE AND RELIEF

THE sensation of thirst which is commonly complained of after operations, especially laparotomies, sometimes assumes troublesome proportions. Thirst is partly symptomatic; the inhalation of ether or chloroform seems to exert a postanesthetic inhibitory action on the secretion of the mucous glands of the mouth and throat, and anesthesia, especially if there is any manipulation of the stomach and intestines, seems to be followed by a reflex decrease in the secretion of saliva, so that, as a result, the patient suffers from a dryness of the mouth and fauces and begs for water. This same condition, moreover, may be due in part or chiefly to the action of morphin or atropin administered before, during, or after the operation. Thirst may, without doubt, result also from an actual loss of body fluids—by a purge before operation, by increased secretion of mucus and saliva under the anesthetic, and by vomiting, sweating, or hemorrhage during or after the operation.

Operations involving the peritoneum are practically always followed by the symptom thirst, due to loss of body fluids, as shown by an increase (which has been demonstrated experimentally) in the specific gravity of the blood; intense thirst usually also characterizes the condition of shock, and occurs generally in peritonitis and to a less degree in febrile temperature from any cause. Thirst ceases as soon as the body tissues have been provided with their proper complement of fluid.

The condition of thirst may be met by the use of drinks, washing of the mouth, by enemas, by leaving water in the abdomen before sewing up after celiotomy, and by the use of water subcutaneously.

By mouth, as already stated, there is very rarely any contra-indication to giving water in considerable quantities. If the patient is nauseated after the anesthetic, and water in copious draughts seems temporarily to increase his vomiting, it must be borne in mind that the water is serving to wash out the stomach and to help it relieve itself of an irritating substance. If the patient is vomiting from any other cause, and it becomes important to supply fluids to the body, it will be found usually that the water is retained sufficiently long to allow a considerable portion of it to be absorbed. In either case the giving of small sips of water, frequently repeated, is to be condemned, for such a method is apt to provoke vomiting where it does not already exist, and is ineffectual either in relieving thirst or in diluting the contents of the stomach and so assisting in their expulsion. Hot water is better than cold, and drinks should not be repeated oftener than every fifteen minutes. Ice, for the purpose of slaking thirst, as well as ice-water, should be banished from the sick room. It does nothing toward reducing temperature which ice applied externally will not do. If it momentarily decreases the sensation of thirst, it in reality increases and stimulates it by causing a hyperemia of the mucous membranes of the mouth and throat.

Sometimes a patient will appreciate a drink of hot weak tea, the flavor giving a satisfaction which does not exist in plain water. In the same way, champagne or siphon soda may be used, or raisin tea, or a drink made up of the juice of a lemon, 1 ounce of glycerin, added to a pint of water. If the patient has lost blood, or is still oozing, there will be advantage in giving dilute gelatin solution, with lemon added for flavor. If a patient complains of thirst, and it is not desired to give water by mouth, much satisfaction will be afforded by allowing the patient to suck the end of a towel moistened in water or to chew gum.

Washing of the mouth is always appreciated by a patient after anesthesia. It removes the disagreeable sensation of dryness and stickiness, the foul taste following vomiting, and bits of vomitus themselves. If Dobell's solution is used, or glycerin and rose-water equal parts, there is substituted a pleasant taste and an agreeable sense of cleanliness and coolness. Patients are rarely too weak to rinse out their mouths. If this condition arises, the nurse can wash out the mouth and scrub the furred tongue with her forefinger wrapped in absorbent cotton and dipped in the solution. For this purpose glycerin with a few drops of lemon-juice added is good.

Proctoclysis.—In serious conditions, where water in sufficient amount by mouth is impracticable, the simplest method for its administration is by means of enema. If the need is anticipated before the operation is over, an enema of normal saline solution (a teaspoonful of salt to a pint of warm water) may be given while the patient is still under the influence of the anesthetic, otherwise the enema may be started as soon as the patient has been put to bed, and a quart may be given and repeated in two hours if necessary. As in giving fluids by rectum in bulk there is a likelihood of a considerable proportion not being retained and absorbed, especially with a patient not fully recovered from the anesthetic or weakened by hemorrhage or shock, it is often of advantage to administer saline solution by the drop or Murphy method.[1] For this purpose the fountain syringe is hung at a moderate distance above the bed (page 519), in a position where it or the tube will not be disturbed by the patient. On the tube a clamp or hemostat is adjusted, so that the water comes away drop by drop at the rate of about a drop a second (which is equivalent approximately to 16 ounces per hour). To the end of the tube is attached a small-caliber soft-rubber catheter, which is introduced 6 inches into the rectum, or a small-sized vaginal hard-rubber syringe tip may be employed. The water in the syringe should be hot, so as to allow for cooling in the tube. If the instillation is accurately regulated, the question of maintenance of heat in the reservoir is relatively unimportant, because the amount of heat abstracted from the rectum during so slow an introduction is practically negligible. If the flow becomes too rapid, the fluid does not absorb as fast as it comes in, the rectum becomes flooded, and the temperature falls. Instead of saline solution, Ringer's solution (see p. 50) has been recommended,[2] as well as Trunecek's serum,[3] and Brünings[4] suggests from personal experience the advantage of the occasional substitution of coffee, diluted to half strength, and without sugar, for stimulation as well as the relief of thirst.

FIG. 15.—SAXON'S APPARATUS FOR MURPHY METHOD.

Several forms of special apparatus have been recently devised to keep the supply-tank warm during the long administration, and to allow for the expulsion of flatus. Thus, G. J. Saxon[5] describes an

[1] Jour. Am. Med. Assoc., 1909, lii, 1248.

[2] Rosenstern (Deutsch. med. Woch., 1911, xxxvi, 54) employed Ringer's solution (see p. 50) in 4 cases of pyloric spasm, and found that it induced relaxation of the pyloric sphincter, as evidenced by cessation of vomiting.

[3] d'Amico (Gaz. degli Osped., 1910, xxxi, no. 132) has seen remarkable results in 100 cases of uncontrollable vomiting follow the injection of diluted Trunecek's serum (see p. 50 for formula).

[4] Münch. med. Woch., 1911, lviii, no. 24.

[5] Ann. Surg., 1909, xlix, 404.

apparatus which maintains the temperature of the solution to be given by rectum, and which controls the flow in a manner which will not interfere with the quick passage of flatus or the sudden expulsion of salt solution back through the tube. The fluid enters the rectum at a temperature ranging from 100° to 115° F. He uses a copper bucket with legs, handle, and lid; inside of this is placed a glass percolator, to be used as a reservoir, and about this is placed a warming fluid (Fig. 15). The technique in the application of the Murphy treatment is so perfected by Dr. Saxon's apparatus that the solution can be kept at a temperature of from 105° to 115° F. without any interference for a period of two hours or longer; it is easily renewed for prolonged application; rapidity of flow is under accurate control; a thermometer interposed near distal end permits easy reading of temperature near the exit.

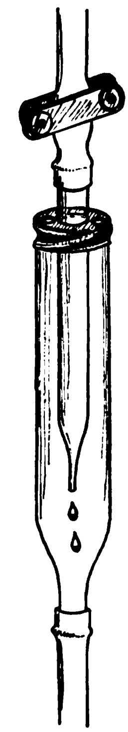


FIG. 16.—MODIFICATION OF DEWITT'S APPLIANCE FOR REGULATING FLOW, AND ALLOWING ESCAPE OF FLATUS.

W. A. Dewitt[1] describes a simple and efficient means of estimating the rapidity of flow and of allowing for expulsion of flatus (Fig. 16). He removes the plunger from a large glass irrigating syringe with a metal cap, and punches three or four holes in the cap. Through the hole for the plunger he inserts the glass tube of a medicine-dropper. The upper end of the dropper is connected with the reservoir, which may be an ordinary fountain syringe, by a short length of rubber tubing, carrying a screw clamp. The tip of the glass syringe is connected with the rectal tube. By this means one can watch the rapidity of flow, and an outlet is provided for flatus.[2]

Some surgeons make it a practice in celiotomies, when the patient

[1] An Efficient Inexpensive Enteroclysis Apparatus, Surg., Gyn., and Obstet., 1911, xii, 166.

[2] Other references on this subject are: D. N. Eisendrath, Jour. Am. Med. Assoc., 1908, li, 406.

S. E. Newman, Jour. Am. Med. Assoc., 1909, lii, 1250, Continuous Enteroclysis.

B. B. Wechsler, Jour. Am. Med. Assoc., 1909, lii, 1251, An Apparatus to Keep Enteroclysis Solutions Hot.

J. B. Murphy, Jour. Am. Med. Assoc., 1909. lii, 1248, Proctoclysis in the Treatment of Peritonitis. Shows apparatus for maintaining the heat of the solution by electricity, gas, or alcohol flame.

Kemp, New York Med. Jour., 1909, xl, 298, A New Container for the Preservation of a Constant Temperature of Saline Solution for Rectal Irrigation or Infusion. An is in a serious condition from shock, or when the operation is being done on a patient in extremis, say, from intussusception or strangulated hernia, to leave a quart or so of hot normal salt solution in the peritoneal cavity on sewing up. This maneuver takes no time and sometimes acts effectually in forestalling shock and thirst. In localized septic conditions, as appendix abscess, pyosalpinx, or localized peritonitis, its employment is, of course, contraindicated, as the fluid tends to disseminate the infection. In diffuse peritonitis, where the infec-

FIG. 17.—SUBCUTANEOUS SALINE INFUSION.
Needle under the breast, reservoir vessel held aloft.

tion is already widespread, and in such conditions as bullet wounds of the intestine or rupture of a gastric or duodenal ulcer, operated on immediately, where material which is presumably strongly infective

application of the vacuum bottle to proctoclysis, enteroclysis, hypodermoclysis, and infusion.

E. A. Babler, Jour. Am. Med. Assoc., 1910, liv, 870, A Satisfactory, Inexpensive, and Portable Proctoclysis Apparatus.

A. McLean, Jour. Am. Med. Assoc., 1910, liv, 1134, A New Apparatus for Proctoclysis.

E. C. Hill, Jour. Am. Med. Assoc., 1910, lv, 2233, A Simple Method of Rectal Feeding or Proctoclysis.

W. S. Sutton, Surg., Gyn., and Obstet., 1911, xii, 166, A Speedometer for Proctoclysis Apparatus.

is spread about generally through the abdomen, the water which is allowed to remain after washing out the peritoneal cavity acts beneficially in diluting the infective material and in exciting a secretion of bactericidal serum from the peritoneum.

Saline Infusion.—Finally, the method for supplying fluid to the body, which, of all the artificial means, is probably the most commonly employed, is the administering of sterile salt solution by subcutaneous injection (hypodermoclysis). For this purpose a thoracentesis or salt infusion needle of medium size is used. It should be sterile and attached to a sterile rubber tube, which in turn may be connected with the nozzle of the container of the salt solution. In the technique of administering a subcutaneous injection all care with regard to asepsis of the operator, the field, the instruments, and the solution should be exercised in order that the danger of submammary or other abscess be reduced to a minimum. The field usually chosen is the breast, the injection is made (with the needle full of water and the tube pinched) in the outer lower quadrant, upward and inward under the mammary tissue, or upward under the pectorals and into the axilla. Sometimes the injection is made into the inner aspect of the thigh or in the loin.

The needle should be inserted its full length, and as the tissue begins to bulge with fluid, the unengaged hand of the operator, anointed with sterile oil, should massage the parts, to assist the tissues in taking up the solution. As the fluid runs in and the parts become white and tense, the needle may be gradually withdrawn, or its point shifted from time to time in various directions, to open up new avenues of absorption. A quart of fluid is the ordinary limit in one place. If more is to be given, it is better to give a quart under each breast. Undoubtedly in men the best site of injection is upward under the pectorals, for here there is all the loose tissue of the axillary space to take up the fluid rapidly. After the injection, the needle is quickly withdrawn, a finger placed over the puncture to prevent oozing, the surrounding skin wiped dry, and a small wad of sterile absorbent cotton is applied and held in place by collodion. The dangers to be avoided, after sepsis, are puncture of a vein, injection of air, puncture of the pleura. The salt has no injurious effect, as shown by the experiments of Henkel,[1] and it may be given unreservedly even in cases with edema, heart affections, or nephritis.

The *intravenous infusion* of salt solution (see p. 100) is reserved for cases of shock or hemorrhage, where immediate relief to the vascular

[1] Einfluss der Kochsalzinfusion, Münch. med. Woch., 1910, lvii, 2505.

system is necessary, and where absorption from beneath the skin would be too slow.

Ringer's solution has the following composition (Jour. of Phys., London, 1885, vi, 361):

℞.	NaCl	0.07 per cent.
	KCl	0.03 per cent.
	$CaCl_2$	0.026 per cent. (crystals).

Locke's solution is made up as follows (Jour. of Phys., London, 1895, xviii, 332):

℞.	$CaCl_2$	0.024 per cent. (crystals).
	KCl	0.042 per cent.
	$NaHCO_3$	0.03 per cent.
	NaCl	0.9 per cent.
	Dextrose	0.1 per cent.

The formula for Trunecek's serum is as follows (d'Amico, Gaz. degli Osped., 1910, xxxi, 1393):

℞.	Sodium sulphate	0.44 gm.
	Sodium chlorid	4.92 gm.
	Sodium phosphate	0.15 gm.
	Sodium carbonate	0.21 gm.
	Potassium sulphate	0.40 gm.
	Distilled water to	1000.00 gm.

CHAPTER IV

PAIN AND SLEEP

THE amount of postoperative pain seems to bear no relation to the seriousness of the operation. Some patients after minor procedures will suffer agony, while others, who have endured a serious or protracted abdominal operation, make no complaint except perhaps of a backache. The personal element seems of much importance here, for the better the mental control, or the deeper the faith in the surgeon, the less is the likelihood of the patient's magnifying discomfort into pain.

If in a celiotomy there have been found extensive adhesions, or if the occasion has made necessary much handling of the intestines, pain is pretty sure to follow. The most common cause of pain in abdominal cases is distention of the bowel. From one cause or another there is induced a paresis of the intestines, then distention with gas, and the patient, unable to pass it himself, suffers from colicky pains, which are the more trying because the relief ordinarily afforded by pressure and movement in bed is not at his disposal. In this case the relief of the distention by measures to be discussed later is to be sought.

Another cause of postoperative pain is pressure from packing or from drainage, either by gauze wicks or glass or rubber tubing. Wounds are packed for different purposes, such as to control hemorrhage, or to absorb pus or serous fluid. To accomplish these purposes it may be essential that the packing should be tight, and any pain which results must accordingly be endured if it cannot be relieved by some other means. The most that can be done is to make certain that the packing is rightly placed and is no tighter than is necessary to serve its purpose. It usually becomes unnecessary after twenty-four hours. Relief can be obtained at the time of redressing. Gauze wicks rarely exert enough pressure to cause trouble. Rubber tubing, however, and glass tubing may exert considerable pressure on the intestine or rectum, and, if disturbed by the restlessness of the patient, may even slip through the wound into the abdomen. In placing rubber or glass drainage-tubes one should be sure that their edges are well protected, that they are so placed that they exert no pressure upon the gut, and that they are so long that there is no danger of their slipping into the abdominal cavity. Until the proper time for their removal any pain which they cause must be treated by means of morphin.

Pain developing some hours after operation is not to be dismissed with the administration of an anodyne, but its cause should be carefully sought and removed. Often a simple change of posture, the cutting of a tight bandage, the removal of pressure on some bony prominence, straightening out the clothing, and such little attentions will give relief. A safety-pin passed through the patient's skin in fixing the bandage may cause the trouble.

Another common cause of the complaint of pain is splints. As usually constructed, splints are rigid and unyielding. Whenever they are applied to unconscious patients, one can never be sure, no matter how generously they are padded and how carefully they are put on, that some point is not unduly pressed upon. As soon as consciousness is regained, every splint should be subjected to detailed inspection and careful readjustment. No complaint on the part of the patient referred to the splinted limb, however trivial it may seem, is to be neglected; particularly is it important to see that the circulation and the sensation of the part is not interfered with; coldness, blueness, edema, or numbness of the finger-tips, for instance, must be instantly relieved by loosening the splints. In applying splints, one must remember that a certain degree of swelling follows every trauma, and that due allowance must be made for this. Plaster bandages make the best-fitting and most effective splints, but they can easily cause a great deal of discomfort and serious damage on account of their unyielding nature and their intensive pressure as swelling takes place. Instant relief is obtained and all danger averted, without sacrificing efficient fixation, simply by splitting the bandage itself full length down one or both sides. Operations involving bones and joints are peculiarly liable to give rise to pain; still, morphin should never be given to a patient wearing a splint until it is certain that the splint itself is not at fault.

Every wound is surrounded by localized muscular spasm. This is nature's method of maintaining the part at rest. It is most apparent in fractures. If the muscles become tired and relax, pain then occurs from the fatigued muscles and from the wound, which is no longer kept at rest; spasm then becomes noticeable because it is painful. The way to prevent painful spasm, or to treat it if present, is to immobilize the wounded part. A firmly applied bandage is often sufficient. If the wound is near a joint, a properly fitted splint to fix the joint is essential. Wounds of the trunk are readily immobilized by adhesive plaster strapping or tight swathes.

It is only a poorly applied bandage that causes pain. A bandage serves two purposes—it keeps the dressing in place and gives firm, even pressure. Several layers of sheet wadding beneath a bandage give the whole dressing elasticity and help to distribute the pressure evenly. A bulky dressing gives the most comfort. Every bandage should be applied from an extremity toward the trunk, steadily lessening the pressure while advancing. Too tight a bandage causes pain from congestion; too loose a bandage causes discomfort and even pain by allowing the dressing to slip about. One should watch particularly the limits of the bandage, for it is here that painful chafing readily occurs.

If properly applied, the dressing itself is rarely a source of pain or discomfort for the first twenty-four hours. However, there are two evils which may be due to the dressing in this early period, therefore it is unwise not to investigate complaints. The dressing may have

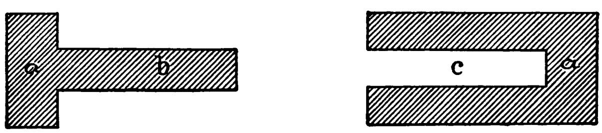


FIG. 18.

slipped, owing to its insecure retention or to the patient's movements, leaving the wound partially or wholly uncovered; or the sharp end of a suture may be pricking the skin. Relief is easily obtained. After twenty-four hours the dressing becomes hard and caked from the dried secretions. This serves as a splint and rarely causes distress. The removal of the dried gauze is all that is necessary if there is real discomfort.

Pain from stitches is due—(1) to tying the suture too tightly, thus putting the parts under too great tension; (2) to imperfect immobilization of the wound; and (3) to sharp ends of the sutures pricking the skin. The last has already been spoken of and its treatment indicated. If the wound is immobilized, as described above, the stitches in themselves cause very little discomfort. Even if the sutures have been too tightly tied, one dislikes to cut them at the risk of having the wound gape open. Relief can be obtained by the use of adhesive straps, so applied that the tension on the stitches is lessened. The method is as follows: Cut two pieces of adhesive plaster, shaped as in Fig. 18, and fasten the broad ends, *a*, *a*, on opposite sides of, and at some distance from, the wound, so that the narrow ends cross the wound, the tongue, *b*, lying in the space *c*. While an assistant presses the sides of the wound together, the narrow ends are drawn taut and stuck fast to the skin. If the tension is still painful, the stitches are probably cutting their way out. Only when this is actually seen to be the case is it advisable to cut the sutures and trust to the strapping to hold the wound together.

Every septic process is accompanied by pain, varying all the way from the nagging discomfort of a furuncle to the intense throbbing, excruciating pain of bone infection. Incision and drainage, by reducing tension, generally afford immediate relief to such an extent that opiates are not required. If, however, sufficient relief is not obtained by satisfactory incision and drainage, it is far better to give morphin than to let the patient lower his powers of resistance through suffering.

Rest and sleep are not compatible with pain. As rest and sleep are requisite elements of a safe and speedy convalescence, they should be encouraged after operation by all safe means. Most often the occurrence of pain can be estimated in advance, and, if no contra-indication exists, the patient's comfort can be assured, after setting or wiring the fracture, after amputation, after a dilatation and curettage, by injecting subcutaneously a dose of morphin before the patient has recovered from the anesthetic. After operations about the anus or male urethra morphin may be administered similarly, in the form of suppositories. Giving morphin in this fashion before coming out of ether often works strikingly; the patient awakens from a quiet sleep, two or more hours after the operation is over, with a sense of well-being and no memory of the discomforts of nausea or vomiting. As many patients dread the postoperative pain more than the idea of the operation itself, this relief will assure the surgeon of their gratitude.

In operations upon the abdomen surgeons are of two minds as to the propriety of employing morphin at all. Lawson Tait was the first to argue strongly against its use after celiotomies, on account of its effect in decreasing intestinal peristalsis, and its action, accordingly, in favoring the production of distention. It is known that distention and intestinal paresis favor the occurrence of peritonitis, especially after operations involving infected matter, such as for salpingitis and appendicitis. Over against these theoretic considerations other men have placed the comfort and quiet which come from morphin properly used, and have favored the use of morphin after celiotomies as a routine.

Gibbon[1] says: "Abdominal operation produces more pain than others because of the aggravation and discomfort caused by the movement of the diaphragm, especially such excessive actions of this muscle as take place in retching and coughing. It is a good rule always to administer a hypodermic of morphin and atropin before the patient has recovered consciousness. The patient passes from the sleep of the anesthesia to the morphin sleep, gets comfortably over the most distressing hours after operation, and never knows the morphin has been given. It is seldom that a second dose is necessary, and postoperative vomiting is infrequent."

Perhaps the safest rule to follow in this regard is to use morphin after celiotomies where much pain is anticipated, provided there has

FIG. 19.—TECHNIQUE OF HYPODERMIC INJECTION.
The skin is pinched up in a fold into which the needle is inserted at *right angles* to the skin. The injection is thus truly subcutaneous and not intracutaneous.

been no infected material let loose into the abdomen. In cases of peritonitis, or where peritonitis is imminent, it will be wise not to allow one's self to use morphin until the bowels have moved for the first time after operation.

Sometimes it will be found that heat in the form of fomentations, stupes, or poultices, applied locally, will be efficacious in relieving pain of local origin. In the same way cold may be employed advantageously, especially after operations upon joints. As the weight of a heavy ice-bag or hot-water bag might in itself cause considerable pain, it is well to have such a bag slung from a cradle, or in some other way suspended so as to take the weight off the wound. It will easily

[1] Postoperative Treatment, Ann. Surg., 1907, xlvi, 298.

be found that if pain is relieved by one or the other of the methods which we have suggested, sleep will naturally follow. When it becomes necessary to resort to drugs, morphin is by far the most reliable where no contraindication exists. Sometimes trional, paraldehyd, hyoscin, or codein will be found to work equally satisfactorily. If the patient is kept awake by pure nervousness, rectal enemata of sodium bromid (gr. 50 to 80) or chloralamid (gr. 30) act advantageously. By whatever means effected, sleep must be induced as essential to the patient's well-being.

Headache.—Headache is a symptom which the surgeon is frequently called upon to treat in the course of convalescence from operations. It is just as bad practice to order drugs to relieve pain without looking into the underlying cause during this period as at any other time.

In general the treatment of headache may be outlined as follows:

1. Discover and remove the cause.
2. Local applications: heat, cold, menthol, wintergreen, etc.
3. Drugs: aspirin, bromids, acetphenetidin, morphin.

The two last named drugs are to be used only after everything else has failed, and morphin only in acute cases.

Causes of Headache.—According to R. C. Cabot[1] the position and character of the headache have little significance. Exceptions to this are pain due to inflammation of the antrum or frontal sinus, migraine, trigeminal neuralgia, and periostitis.

A. D. Wilmoth[2] divides headaches into two classes with regard to cause:

1. Those secondary to conditions not located in the head.
2. Those in which there is a definite pathologic process at the site of the headache.

Under Group 1:	Under Group 2:
Ether.	Periostitis.
Constipation and indigestion.	Sinusitis.
Excitement and fatigue.	Trigeminal neuralgia.
Elevation of temperature.	Migraine.
Menstruation.	Meningitis.
Eye strain.	Brain tumor.
Alcoholism.	
Nephritis.	
Toxemias (as eclampsia).	
Psychoneurosis.	

[1] Differential Diagnosis, 1911, p. 35.
[2] Kentucky Med. Jour., 1910, viii, 2022.

Sometimes the diagnosis will be obvious. A headache on the afternoon after operation is usually due to ether, or when the bowels have not moved for several days it may be predicted with a fair amount of certainty that the headache is due to constipation. If the patient complains of headache and the face appears flushed, the temperature should be taken at once, even though it has been taken a few hours previously and found normal. In such instances the headache is due to elevation of temperature which may be due to some local cause, as suppuration of the wound, or to a general cause, as the supervention of an acute disease—influenza, pneumonia, typhoid, etc. Excitement and fatigue, perhaps from receiving too many visitors, may cause headache. In this instance there is likely to be also a slight elevation of temperature and an increase in the pulse rate. Menstruation should be inquired about in any obscure case in a woman, and eye strain from too much reading in the latter part of the convalescence. Alcohol is rather rare as a cause of headache following a surgical operation. A high-tension pulse and enlargement of the heart should suggest nephritis and call for an examination of the urine. In the pregnant or parturient woman headache demands an immediate examination of the urine, whether there are other signs and symptoms of toxemia—headache, edema, disturbance of vision—or not. The diagnosis of nervous headaches will depend largely on previous history and the exclusion of other causes.

Periostitis is to be suspected whenever there is syphilis, and whenever there is severe local tenderness not situated over an accessory cavity of the nose or a branch of the trigeminal nerve. Potassium iodid is the best analgesic in this condition. Pain from a frontal sinus or an antrum is to be diagnosticated from its location, especially if there is tenderness over the cavity and an unnatural nasal discharge. The diagnosis of trigeminal neuralgia or migraine is usually easy, however. As Cabot has pointed out, headache from nephritis, infection, brain tumor, and other causes may be unilateral. In severe headache of acute onset, with elevation of temperature and pulse, stiff neck, Kernig's sign, squints or other paralyses, meningitis should be suspected. In more chronic headache with vomiting the eye fundus should be examined upon the possibility of brain tumor.

Finally, in any puzzling case the following tests laid down by R. C. Cabot[1] should be made:

[1] Differential Diagnosis, 1911, p. 37.

"1. Thorough examination of the eyes (including retinoscopy), the pupils, and the testing of the intraocular tension (glaucoma).

"2. Temperature record (infections).

"3. Blood-pressure measurement (nephritis, tumor).

"4. Urinalysis (albumin, sugar, acetone).

"5. Palpation of the insertion of the nape muscles at the occiput.

"6. Examination of the nose and its accessory sinuses."

CHAPTER V

PULSE, TEMPERATURE, AND RESPIRATION

THE temperature *chart* may be considered the barometer of the patient's condition. It is one of the few means of accurate observation which we have at our disposal, and should never be neglected. Some surgeons of wide experience will sometimes studiously ignore the chart and pass their judgment of a patient's condition upon his general aspect, his posture, the appearance of his tongue, and all these aided by intuition. Their deductions may often appear brilliant, but their example is a dangerous one for the younger man to follow.

When one has studied many charts representing the same condition, he is usually able to prognosticate with some degree of accuracy in the case of any individual patient. If one considers the pulse alone, however, or the temperature alone, he is likely to be led astray. The firmest conclusions can be drawn only from a study of the pulse and the temperature and the respirations and their relation to each other. For instance, a falling temperature in itself is usually of good omen; when combined with a rising pulse, it may mean serious trouble. A surgeon may argue that a patient cannot be badly off when his pulse and temperature are both normal, but a normal pulse and temperature after a celiotomy, combined with an increased respiratory rate, is very likely to mean peritonitis.

PULSE

The most importance is usually, and properly, placed upon the observation of the pulse. Although the rate is the only quality which is usually recorded upon the chart, the surgeon should also take into consideration the rhythm, volume, and tension. Moreover, if he would save himself the possibility of some needless anxiety later, the surgeon should have become familiar with any peculiarity of the patient's pulse before operation, as, for instance, the irregular rhythm and the constantly increased or diminished pulse-rate which one sometimes comes across in otherwise normal young individuals, which apparently have no pathologic significance. In this study of the pulse, from the point of view of the surgeon, we will confine ourselves to a consideration of the variations dependent upon and following surgical procedure, it being understood that cardiac lesions, angina, and arteriosclerosis have been ruled out by a previous examination, or that due allowance is made when they exist.

The normal *pulse-rate* may be considered to be 72 beats per minute. The excitement preceding an operation and attending the administration of the anesthetic usually increases this rate, except in the most phlegmatic, about 20 beats. If the operation is short and involves little loss of blood, and the anesthesia is well conducted, the pulse recovers somewhat from this preliminary rise as soon as the patient has cleared himself of mucus. During the recovery the rate will probably drop still farther and its normal quality will be restored, to continue normal, unless complications arise, throughout the convalescence. After any prolonged or serious operation, or one attended by a loss of blood, the patient may be put to bed with the pulse-rate increased anywhere from 25 to 40 beats.

Most celiotomies show a rise of 10 to 20 beats after the patient has fully recovered from ether. This rate gradually drops off, unless complications arise, to reach normal on the second or third day. If the pulse-rate rises suddenly on the third or fourth day, we have to consider the onset of peritonitis or some intercurrent affection, as bronchitis, pneumonia, la grippe, tonsillitis, malaria, or an acute exanthem. Distention alone is apt to send up the pulse-rate, and is likely, also, to cause it to become irregular. If the pulse goes up for the first time at the end of a week after operation, there is likelihood of a stitch-abscess or pelvic abscess. A sudden and rapid increase in pulse-rate at any time, coupled with dyspnea, usually means pulmonary embolism.

After hemorrhage the increase in frequency will depend not so much upon the amount itself, as upon the rapidity with which a considerable amount is lost; for instance, the loss of blood during 4 or 5 beats from a medium-sized trunk seems to send up the pulse-rate much more effectually than the loss of the same amount of blood from a small vessel. It may be considered that in the former case the heart is wearing itself out by pumping against a suddenly and enormously decreased peripheral resistance—to be compared to a fighter who puts his whole force in a blow, fails to meet his object, and exerts his energy on empty air. Unless the hemorrhage is checked, the rate rapidly and progressively rises, the pulse finally becomes uncountable, and the patient dies.

Intense pain will frequently send up the pulse-rate from 10 to 20 beats, and sometimes in nervous women the pulse will suddenly increase to 120 or over without apparent cause. In the former case a subcutaneous injection of morphin will relieve the pain and restore the pulse to normal. The nervous crises are probably related to pseudo-anginal attacks which the patient has had when in her normal state. The use of bromids by rectum is indicated as soon as the diagnosis is made sure.

Rarely the pulse-rate will fall below normal. The slow full pulse is the accompaniment of increased intracranial pressure from hemorrhage, clot, abscess, or tumor. The pulse-rate is usually restored to normal within a few seconds after decompression has been practised. Elderly persons with good heart muscle and more or less thickened vessels are apt to exhibit ordinarily a slow pulse. The pulse is commonly

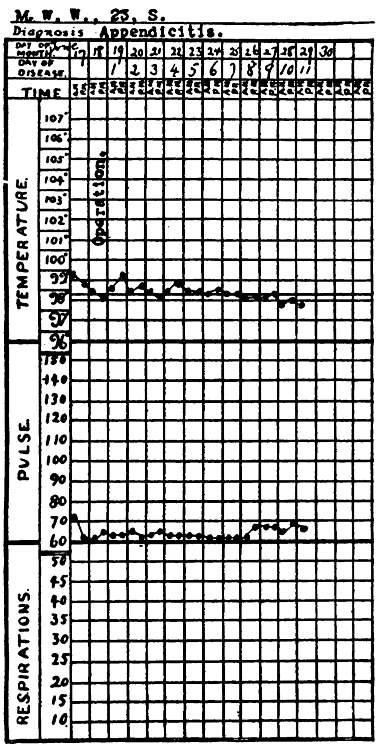


Fig. 20.—Normal Reaction After Aseptic Operation.

slowed during convalescence from erysipelas, pneumonia, or typhoid. If the chart records a slow pulse where it is not readily accounted for, one must not be satisfied until he listens at the apex, for, in conditions of marked debility, it will sometimes be found that, on account of the weakness of the stimuli, the arterial contraction-wave expends itself before it reaches the peripheral arteries, and the radial pulse records only every second or third beat—thus an entry of 60 on the record may have to be corrected to 120.

The pulse may be irregular in *force* and *rhythm*. If irregular in rhythm alone, and of well-sustained force, and the radial pulse registers every contraction of the heart, the condition is apt to represent a temporary vasomotor derangement, such as may occur in persons of a high-strung or hysteric disposition. In other words, the heart (from excitement) is skipping an occasional beat. Such a condition, other things being favorable, is sure to disappear as soon as the patient is restored to her normal state of nervous equilibrium.

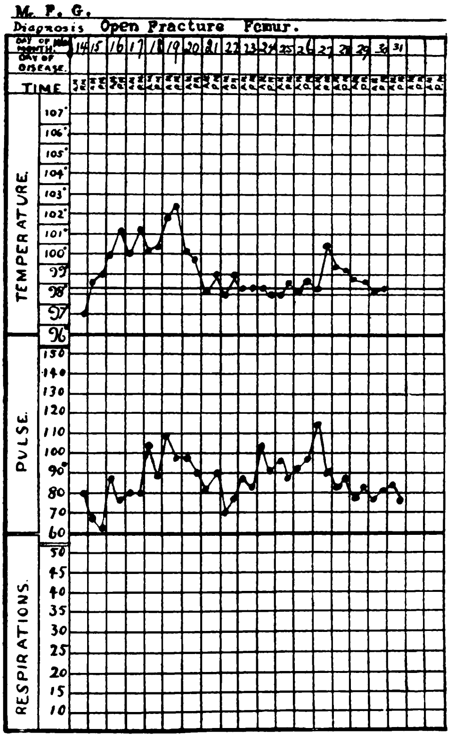


FIG. 21.—OPEN FRACTURE OF FEMUR.

Postoperative rise in temperature and pulse simulating sepsis, but due, in fact, to absorption from lacerated soft parts. Primary healing.

If, on the other hand, the irregularity of the pulse means that a certain proportion of the cardiac contractions are lost before reaching the peripheral arteries—even if the cardiac rhythm itself is normal—or if irregularity in the force of the beat exists, or if the pulse is irregular both in force and in rhythm, we have a condition of the gravest significance, which can result only from a played-out, overworked heart-muscle. A pulse may be ever so weak or so rapid, but so long as it is regular in force and rhythm there is hope; the heart in such a case preserves its power to recuperate, to respond to stimulation and the treatment of the underlying condition. If, now, such a pulse suddenly becomes irregular in force and rhythm, it may be considered that the nervous and muscular mechanism of the heart are wearing themselves out under the strain—that is to say, that the heart is going to pieces.

Irregular pulse occurs in shock, hemorrhage, and overwhelming septic intoxication or other forms of toxemia, such as thyrotoxicosis.

The *volume* of the pulse represents the quantity of blood which

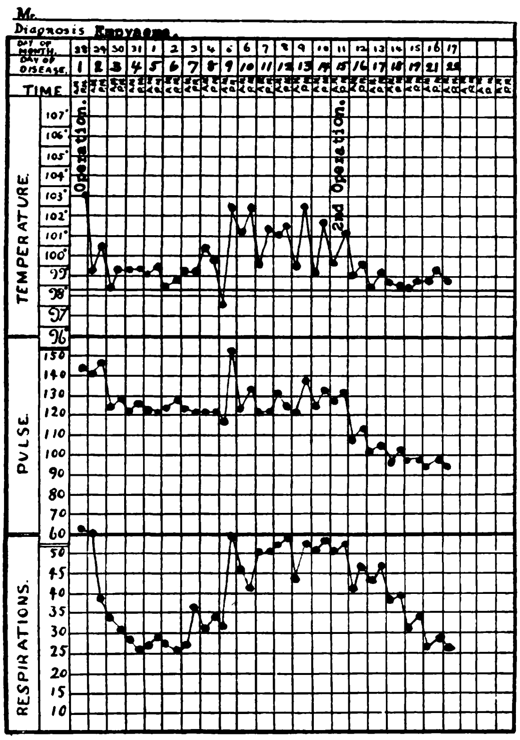


FIG. 22.—EMPYEMA.

On the eighth day drainage became inefficient, and a week later a second operation was done, after which temperature, pulse, and respiration again fell to normal.

passes under one's finger; that is, the arterial content. The volume is small after loss of blood from hemorrhage and in conditions where the systemic tissues have been depleted of fluids from any cause. Thus, volume decreases with increasing hemorrhage or progressing septic infections.

Volume is closely associated with *tension*. Tension represents the pressure within the artery; it expresses the degree of blood-pressure. It is measured by the amount of compression which must be exerted to shut off the transmission of the pulse-wave. A reliable appreciation of arterial pressure, apart from volume, can be acquired only after considerable education of the finger-tips. In making the observation one must not be led astray by the resistance offered by the thickened walls in arteriosclerosis. The use of blood-pressure apparatus generally after operation has not yet demonstrated its necessity.

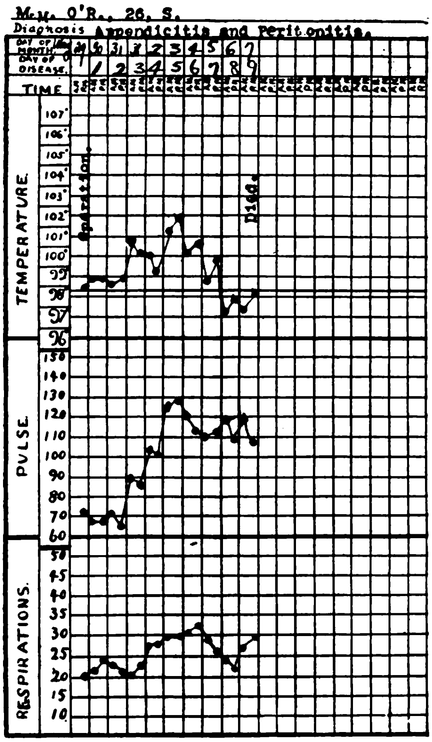


FIG. 23.—PERITONITIS.

Rise in pulse and drop in temperature, the so-called "closing of the jaws of death."

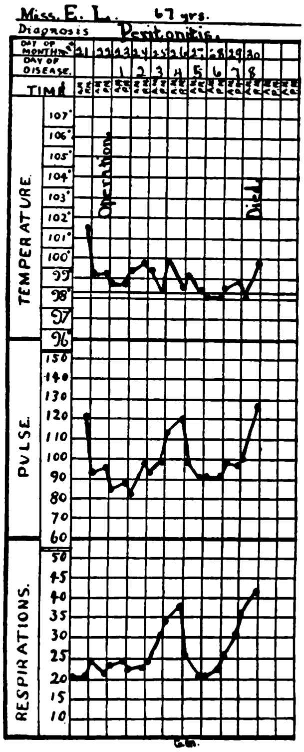


FIG. 24.—APPENDIX ABSCESS.

Gradual development of distention such as appears in a diffuse dry peritonitis. The graphic record in no way suggests the actual serious condition of the patient. Old people react less markedly and the chart is of less value as a criterion.

Changes in volume are not necessarily related to changes in tension, but the two qualities are often characteristically associated. Thus, the full volume and high tension give a large, hard, bounding pulse; with the low tension, a full, soft, flabby pulse; low volume with high tension gives the small, hard, wiry, cord-like pulse, and with low tension the flickering, thready pulse—all of which have important clinical significance.

TEMPERATURE

Variations in temperature may be considered as due to the normal reaction after simple aseptic operations; to shock after prolonged operations or those attended by much manipulation of the abdominal contents or from loss of blood; to septic causes, in cases febrile at the time of operation, or those developing peritonitis, or pelvic or stitch-abscess; and, finally, to accidental and intercurrent conditions, such as thrombosis, phlebitis, or pneumonia.

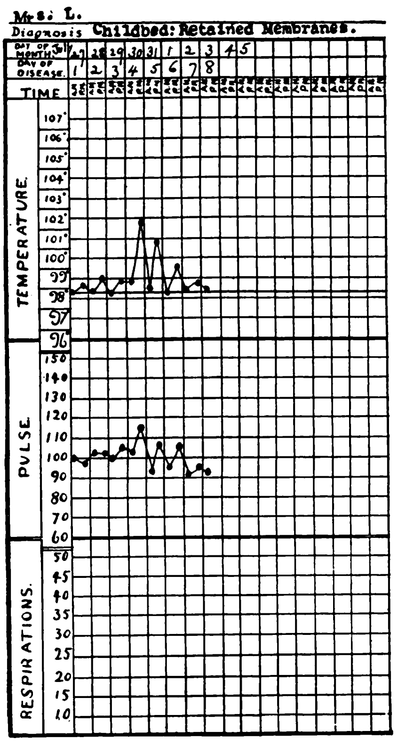


FIG. 25.—CHILDBED.
Rise of temperature and pulse on fourth day, aseptic absorption from retained membranes.

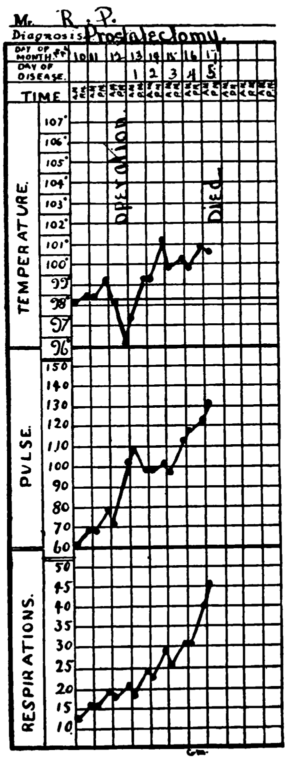


FIG. 26.—PERINEAL PROSTATECTOMY (weight of prostate, 12 ounces).
Marked shock shown by drop in temperature and rise in pulse; then temperature, pulse, and respirations all rise till the end.

Most uncomplicated aseptic procedures show a reactionary rise in temperature which reaches its maximum, about 100° F., twenty-four hours after operation, and strikes normal on the evening of the second day after operation. Sometimes there will be a lesser rebound of the temperature-curve on the third day (Fig. 20). The pulse, without altering its character, accelerates its rate simultaneously with and in proportion to the rise in temperature, usually reaching 99° or 100° F. In children and young persons, or after operations on bones, or about the anus, the pyrexia may go to 102° F. or higher. This rise in temperature, sometimes called aseptic fever, is usually to be expected, and, in so far as it represents the normal reaction in persons in good health at the time of the operation, it is a good sign and should not be confused with sepsis. There has been much theorizing concerning the mechanism of its production. It may intelligently be considered as due to absorption of

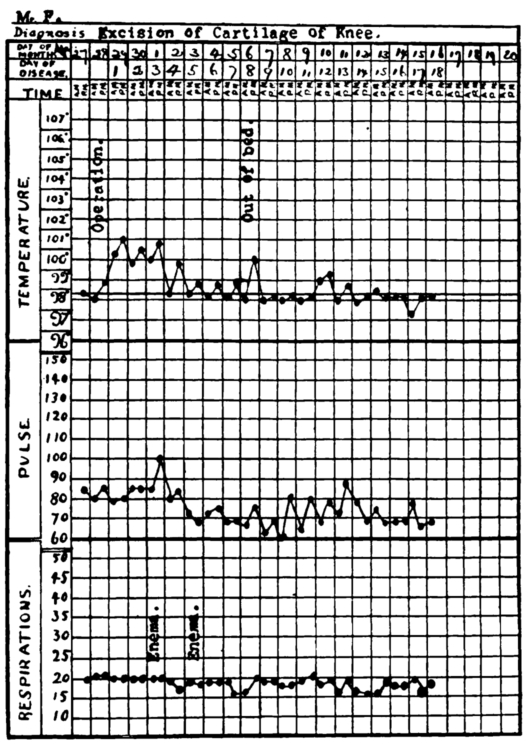


FIG. 27.—EXCISION OF CARTILAGE OF KNEE.

Sustained postoperative reaction in a neurotic individual. Typical rise of temperature on first day out of bed.

decomposition products, of liberated blood, and of matters set free by destruction of tissues.

After *hemorrhage* or in *shock* this reaction is delayed. The first effect on the temperature, if the shock is considerable, is a notable fall. The temperature often becomes almost immediately normal or subnormal, even in cases febrile before operation, and the pulse rises sharply to 130 or more. A falling temperature with rising pulse in the early hours after operation must always make us fearful of collapse and death. If the patient is successful in combatting the condition, a late reaction will occur; the temperature goes up to a degree proportionate to the pulse, and then pulse and temperature gradually subside, to reach normal some days later.

Sometimes there will be a condition of *continued* shock, immediately following operation, which lasts for twenty-four to forty-eight hours before it changes for better or worse. Then there is the condition of *late* shock, which puts in a rather unexpected appearance twenty-four

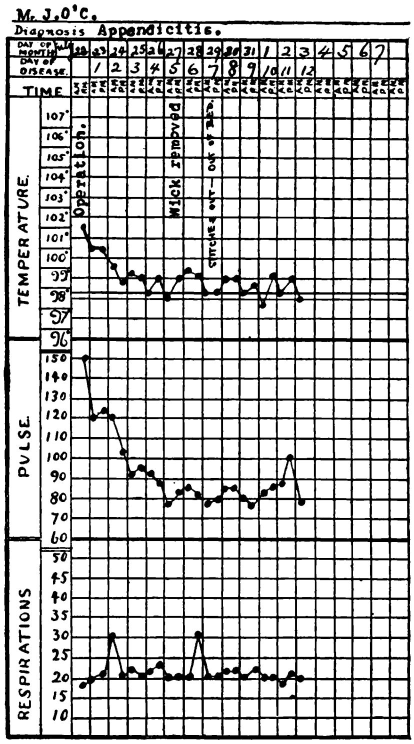


FIG. 28.—IMMEDIATE DROP IN TEMPERATURE AND PULSE AFTER RELIEF OF TENSION IN SEPSIS.

hours after the operation, the patient having apparently recovered normally from the operation. Often there is a low fever, about 101° F., and a pulse of 110, where no symptoms of shock are apparent in cases that have endured a long and severe operation. This condition is apt to be maintained for four to eight days, gradually working down to normal. It may be taken to represent not so much shock as a condition of exhaustion and a poor or delayed operative reaction. If pulse and temperature are approximately normal, or if the normal pulse-temperature ratio is maintained, it is rarely that death occurs from shock.

The onset of *sepsis* is usually marked by an immediate rise in pulse and temperature, unless the patient is septic at the time of operation. The only exception to this rule is the occurrence of sepsis in persons who have lost their powers of resistance through exhaustion; a patient may die, for instance, of peritonitis, with a normal pulse and temperature. If the patient is febrile from retained pus, and the operation consists in liberating this, the temperature chart is apt to show a short, sharp

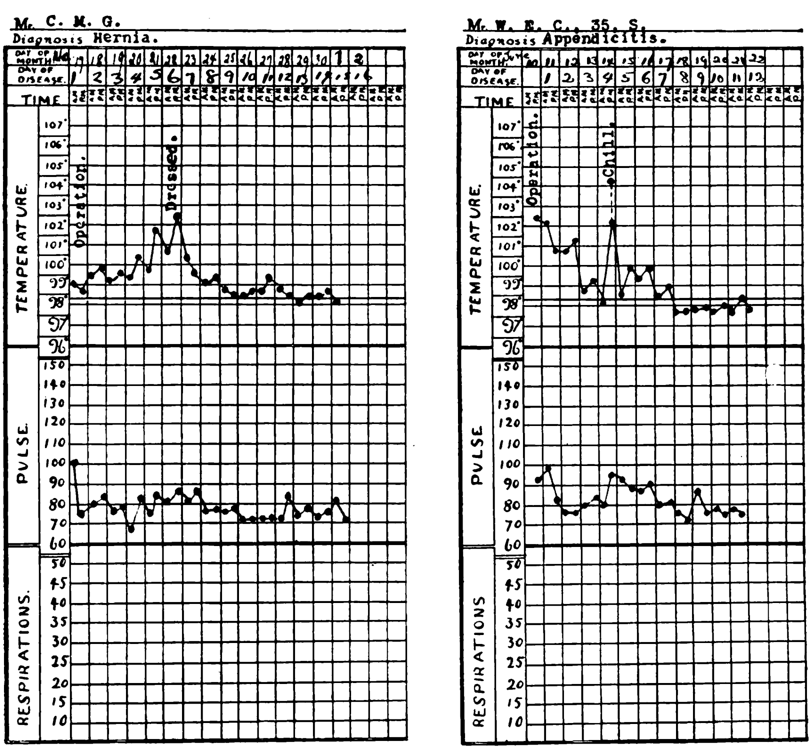


FIG. 29.—HERNIOTOMY.

Rising temperature; wound inspected on the sixth day, stitch-abscess found and relieved, immediate drop to normal.

FIG. 30.—APPENDIX ABSCESS.

Usual drop after drainage, sudden rise of temperature on the fourth day, due to backing up of pus, drop to normal when drainage is again made efficient.

reaction, and then a sure and progressive decline as the drainage effectively acts (Fig. 28). If the patient's temperature is about normal, and the operation discloses an abscess and some pus is set free in removal or drainage, there will be the regular reactionary rise in temperature, and the height of the curve will be maintained, with a tendency to morning remissions, until the system has successfully combatted the infection. On general principles, in an aseptic operation a rise in temperature, occurring on or after the third day after operation, should be considered, until proved otherwise, as due to sepsis—from infection of the wound, peritonitis, decomposition of retained blood-clot. In a septic condition it means blocked drainage, residual abscess, peritonitis, septicemia. A late rise—after the fifth day—frequently means stitch-abscess (Fig. 29). One should look for sepsis, then, whenever the reactionary rise in tem-

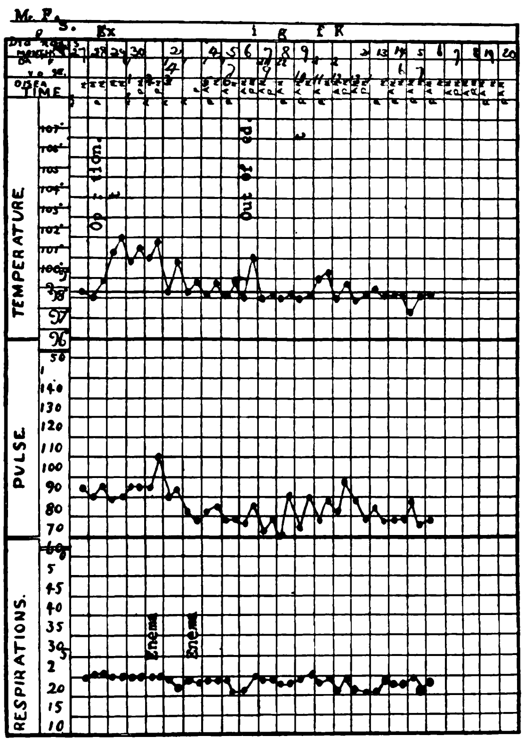


FIG. 31.—PHLEBITIS ON THE EIGHTH DAY.
Sharp reaction in temperature and pulse.

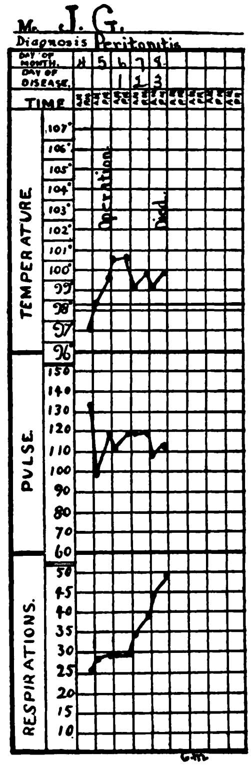


FIG. 32.—GENERAL PERITONITIS OF SUBDIAPHRAGMATIC ORIGIN.
Temperature and pulse not so significant as the practically continuous rise of respirations.

perature fails to drop, whenever the temperature rises on the third day or later.

It must not be forgotten that complications may arise during convalescence which will affect the appearance of the chart without any respect for the arbitrary rules which we have laid down above. Common among these are tympanites, menstruation, tonsillitis, erysipelas, the acute exanthems, pneumonia. Less common, but not to be overlooked when other causes fail, are malaria, la grippe, tapeworm, phlebitis

(Fig. 31), pylephlebitis, thrombosis, and embolism. When the temperature rises from these so-to-speak accidental causes, one should make his diagnosis with extreme care. They will be considered in detail later.

RESPIRATION

The record of the respiratory rate is apt to be neglected. A good working rule is to take the respirations whenever the patient is doing poorly, or whenever the diagnosis of his condition is in doubt.

In peritonitis the respirations are practically always increased and may run up to 48 per minute (Fig. 32). The abdomen is kept tense in an effort to guard and "splint" the inflamed and acutely painful areas; there is no longer the normal rhythmic rise and fall of the abdominal wall. In advanced cases the movements of the diaphragm even are inhibited and the respiration becomes entirely thoracic.

In tympanites, without peritonitis, these same phenomena are to be noted to a lesser degree. The advantage of having a record of respirations in case there is question of the onset of pneumonia goes without saying.

In severe hemorrhage the respiration is quickened and sighing, the chin is elevated, the nostrils dilated, and the arms thrown over the head. In pulmonary embolism the respirations are rapid, shallow, and gasping, the mouth is held open, and the patient tries to sit up in bed.

CHAPTER VI

POSTOPERATIVE HEMORRHAGE: PRIMARY, DELAYED, SECONDARY; TRANSFUSION

POSTOPERATIVE hemorrhage may be defined as primary, delayed, and secondary.

PRIMARY HEMORRHAGE

Primary hemorrhage is that form which comes on during an operation. The indication in this form of hemorrhage is, clearly, to find the bleeding point and secure it. The after-treatment may be considered the same as that for shock. This condition is one of the best indications for the use of salt solution subcutaneously and the employment of transfusion if necessary. These are dwelt upon in detail elsewhere.

DELAYED HEMORRHAGE

Delayed hemorrhage may be taken to be that form of hemorrhage which comes on after the patient has recovered from the anesthetic after the lapse of anywhere from a few hours to six days.

Causes.—(1) A wound may be left apparently dry—on account of feeble circulation and the consequent low blood-pressure no bleeding may be apparent from some smaller cut vessels or from torn tissues or omentum. Later, after the operative depression passes off, blood-pressure increases as the circulation improves, and hemorrhage results.

(2) Small vessels may occlude by clot; as pressure increases or the patient moves about, the clot may be displaced and bleeding ensues.

(3) Trifling bleeding may not be noticed, but reliance may be placed on pressure from the dressings. A small vessel may be cut by the needle in sewing up. This forms a hematoma, which increases, especially in soft tissues, as about the scrotum and lower abdomen, by stripping up skin or fascia.

(4) Catgut ligatures may soften or absorb. If the vessel the ligature is holding is near a main trunk, the pressure behind the thrombus may be so great as to force it out of the stump, and so cause late hemorrhage.

(5) The untied distal end of an artery may bleed when collateral circulation has been established.

(6) A ligature may slip if it is not tied tight enough; if the knot is poorly done; if the distal tissues have been severed too closely to the ligature. If in the removal of a pedunculated tumor of any sort the ligature is applied with the pedicle on the stretch, and this is then cut off close to the ligature, the traction on the elastic arteries being relaxed they have a tendency to retract behind the ligature, whereupon they may give rise to serious bleeding. Hemorrhage may occur as a result of the gradual shrinkage of the tissues which a ligature surrounds and the consequent loosening of the ligature, as in the uterus after Cesarean section or a fibroid enucleation.

(7) If the vessels are thin-walled and delicate, as the veins of the omentum, or if the tissues are soft and friable from inflammation, as about a pus-tube, a ligature tied tightly may cut through the vessel. Also, if the arteries are atheromatous, as in the amputation of an arteriosclerotic uterus, a ligature, especially of silk, may cut through them.

The **symptoms** of internal concealed hemorrhage vary with the amount of blood lost and the rapidity. It is not the loss of blood alone which causes trouble; there is an element of shock in the dynamic insult to the heart-muscle of pumping against much decreased peripheral resistance. It is said that a loss of from 4 to 10 ounces will suffice to bring about the typical picture of hemorrhage.

The onset may be fulminating in character. If a ligature slips from a large artery, the patient will start up suddenly, cry out from pain as the blood rushes into her peritoneal cavity; the pulse rises in a moment to 130, temperature drops to subnormal, respiration becomes hurried and gasping, the face becomes pinched and ashy pale, and death ensues inside of half an hour.

Usually the story is longer, but no less typical. The patient, apparently doing well, at ten to thirty hours after operation begins to show a slight increase in the pulse-rate. At the same time, she becomes nervously aware that all is not well, she can feel her heart beat, and she has harder work in breathing. She calls for a glass of water, and asks to be fanned or to have the windows opened. Then she has a sensation of pain referred to the abdomen from the presence of blood. The symptoms increase at the end of an hour. The pulse has reached 100 and the respiration 26. A yellowish pallor is spreading over her face and her lips are blanched; the pupils are somewhat dilated; the hands and feet become cold and clammy, and a cold sweat appears on her forehead. By the end of the second hour the pain and anxiety increase, she becomes restless, tosses about in bed, and throws her arms over her head to help her now labored respiration. Her temperature is subnormal. Her pulse by this time has reached 140 and the respirations are 30. She begs constantly for water and tries to get relief in sitting up, but this makes her head swim round uncomfortably. Soon, exhausted by her struggle, cold, with dilated pupils, an uncountable, thready pulse and rapid, embarrassed respiration, she dies.

Although shock is an important element in the cause of death from hemorrhage, the two conditions of shock and hemorrhage are distinct clinical entities and should rarely be confounded. The patient suffering from protracted shock, or delayed shock, often is apparently most phlegmatic, lying quiet and motionless in bed, stupidly comfortable, taking a patronizing interest in what is being done for him. The patient with hemorrhage, on the other hand, is nervous and restless, panting for air.

The **diagnosis** of abdominal hemorrhage is always made certain by signs of free blood in the peritoneal cavity. If it remains fluid, there will be dulness in the flanks, shifting as the patient turns upon one side and the other. If it clots, it presents the sensation of boggy fullness and resistance and dulness which does not change. If blood accumulates in the pouch of Douglas, it may be felt through the vagina. If the hemorrhage is between the folds of the broad ligament—that is to say, extraperitoneal—a definite mass may be made out *per vaginam*, pushing the uterus forward and to the other side of the pelvis. An examination of the wound dressings should never be neglected. If the wound is sutured tight, there may be no blood upon the dressings. If the wound has been drained, the gauze of the dressings is apt to be saturated, and a slight loosening of the drain is apt to be followed by a flow of blood.

Operative Treatment of Superficial Hemorrhage.—Etherize, reopen the wound, clear out the clot, and snap and tie the bleeding vessel. If the patient is *in extremis*, the wound should be opened immediately without anesthesia, a hemostat or clamp applied and left *in situ*, and steps taken to restore the patient. If the bleeding has ceased when the surgeon arrives on the scene, and a large subcutaneous clot is in evidence, the wound should be opened, unless the patient's condition contraindicates, and the clot evacuated, because there is danger of renewed bleeding as soon as the patient recuperates, and the presence of a mass of blood-clot will materially delay repair and interfere with first intention healing, if it does not serve as the nidus for secondary infection. If the bleeding is venous and occurs in a limb, care should be taken that it is not maintained by congestion dependent upon tight bandage or dressings proximal to the wound.

Operative Treatment of Internal Hemorrhage.—If, after due consideration, it has been decided that operation is necessary, or if, in cases of collapse, the patient has revived sufficiently to make etherization feasible, the abdominal wound is reopened and a search instituted for the source of hemorrhage. Some surgeons make it a rule not to open up the entire wound at once, but remove only a few of the stitches at one end, and through these enter the peritoneal cavity. If the procedure is followed by a gush of blood, then the entire wound is immediately thrown open. If no blood follows, a large, soft-rubber catheter is introduced and a glass syringe attached, to be used as a sucker. If there is any free blood, this apparatus is sure to locate it. If none is found, it is decided that there is an error in diagnosis, or that the bleeding has arrested itself, and the patient is sewed up again.

Most men, however, after having made a definite diagnosis of hemorrhage, open the wound from end to end, and if this does not give enough room, may enlarge the old incision. The free blood and clots are now rapidly scooped out, and, if the bleeding point does not present at once, a search is made over the field of operation. Sometimes the wound of an artery may be accidental, and is found at some distance from the operative site. The bleeding vessel once found is tied off, the abdomen washed free of clots with sterile salt solution, some of which may be left in the abdomen, and the abdomen sewed up. If the patient is in a critical condition and time is an object, a long-handled clamp may be applied to the artery and its handle left projecting through the wound, to be removed at the end of forty-eight hours. If the bleeding is of such nature that it cannot be controlled by ligature or suture, the region can be packed firmly with gauze strips, the ends of which are left hanging through the wound. Oozing from a denuded surface will sometimes respond to hot water.

SECONDARY HEMORRHAGE

The term secondary hemorrhage is applied to that form of hemorrhage which makes its appearance some days after the operation, and is dependent upon erosion of a vessel by the extension of a septic process. This condition is less frequently met than in the old days when sepsis was the rule, and when a rubber tourniquet was hung over every bed and the ninth day awaited with trepidation. It is to be feared now in widespread and deep sepsis of a limb treated without amputation.

Secondary hemorrhage may occur through the ulceration of an artery from pressure of a drainage-tube. Caraven and Bassett[1] report a case of ulceration of the external iliac artery from pressure

[1] Rev. de Chir., 1910, xxx, No. 12.

of a drain in appendix abscess, and refer to 4 similar cases, and Moschcowitz[1] reports secondary hemorrhage from ulceration of both external iliacs caused by pressure from rubber drainage-tubes in a case of bilateral ureterolithotomy, following removal of the tubes, which necessitated the liagation of both external iliac arteries.

Secondary hemorrhage, when it occurs, comes furiously and practically without forewarning. In the older hospitals there are still traditions of patients being left for a few moments, to be found exsanguinated in a pool of blood.

A man of twenty-six suffered a homicidal large-caliber bullet wound of the abdomen. At the operation it was found that the bullet had entered at the left of the navel from above, had made seventeen wounds of intestine, and had then buried itself in the region of the right psoas muscle. Blood and intestinal contents were free in the abdominal cavity. Several wounds of intestine were sewed and two resections were made. All mesenteric hemorrhage was stopped by ligature. The cavity was washed out, drains were left in, and the patient was put to bed. Convalescence was uninterrupted. Some mild suppuration persisted, however, from the region of the pelvis, into which the bullet had apparently disappeared. A wick was in this sinus.

On the twenty-third day, at 6 A. M., the patient called the nurse and asked to be fanned. One glance showed the patient to be deathly pale; the bedclothes were pulled down, and the patient was discovered to be lying in a bed literally full of blood. He died in twenty minutes, and autopsy revealed a suppurative process which had eroded the right common iliac vein.

Any *treatment* to be efficacious must be immediate, and here the tourniquet and digital pressure proximal to the wound are to be relied upon until the vessel can be found and tied or clamped. If the sloughy nature of the wound makes this difficult or impossible, the wound may be packed, or the old-fashioned methods of the actual cautery, acupressure, or tying the vessel through the skin by using a curved needle some distance above the wound, must be practised.

Sometimes the condition of recurrent hemorrhage is complicated by the presence of one or another **constitutional diathesis,** as hemophilia, leukocythemia, jaundice. In this case the bleeding does not come from a single vessel which can be tied off, but is in the form of a general ooze, and the above rules do not apply. This form of bleeding may occur from the moment of the operation, or may not come on for some days afterward; it may continue interruptedly, or it may stop for some hours and then start afresh. The flow of blood is not copious, but the amount lost is often considerable, and the patient may soon be reduced to a

[1] Ann. Surg., 1911, liii, 547.

dangerous condition. Such hemorrhage is not readily amenable to treatment, and, on the whole, when it occurs, is one of the most trying of all complications which the surgeon has to face.

If the diagnosis of any of these conditions is made before operation, and the operation cannot be postponed, the patient should be given the benefit of the administration of large doses of calcium lactate for a few days before as well as after the operation, in order to increase the coagulability of the blood.

Calcium lactate occurs in white, granular masses, powder, or in crystals, is odorless, and has scarcely any taste. It is soluble in water (1:15), less so in hot water, slightly soluble in alcohol, and insoluble in ether. The solubility of different specimens of calcium lactate varies considerably and is affected by age. Calcium lactate is given before operations in doses of 1 or 2 gm. (15 or 30 gr.). The ordinary dose is 0.5 to 4 gm. (10 to 60 gr.). It is much less irritant than calcium chlorid, and may be injected subcutaneously. The large doses now given may be suspended in water, or, as this salt is permanent in the air, dispensed in powders or in cachets. Calcium lactate should be fresh, that is, it should form a clear or nearly clear solution in water. If there is a white precipitate, it should not be used. It may be given as follows:

℞. Calci. lact. 10.0
Tinct. capsici 0.3
Aquæ chloroformis .... ad. 150.0.—M.
Sig.—Tablespoonful in water three times a day, one hour before meals.

The lactate should be given on an empty stomach, otherwise it is likely to be precipitated by the phosphates of the food. Saline aperients are contraindicated for the same reason, and to relieve the constipation which the calcium salts usually induce other cathartics should be employed.

The intravenous infusion of concentrated salt solution is known to be followed by a temporary increase in the coagulating power of the blood. As a means of prophylaxis in operative cases where parenchymatous hemorrhage is expected, or where the blood coagulates more slowly than normal, von den Velden[1] accordingly advises the injection of 3 to 5 cc. of a 5 per cent. salt solution into a vein before operation, to be repeated, if indicated, every half-hour.

The use of animal sera before as well as after operation has been followed by good results. For the technique of their administration see Hemophilia (Chapter XXVIII).

Locally, the wound, if it can be reached, may be packed with gauze soaked in adrenalin, and this packing renewed frequently. Other styptics, such as Monsell's solution, may be used in the same way. A styptic is useful only when applied while the bleeding is temporarily

[1] Centralblatt für Chir., 1910, xxxvii, No. 21.

arrested. The clot formed by the styptic must be actually in the mouth of the vessel and not on the surface of the wound. Pressure alone is rarely of much assistance, but long-continued digital pressure on the artery or arteries supplying the part, or even ligation of these arteries, when feasible, has been practised with success. The patient should be kept quiet by opiates, he should be given gelatin lemonade and ice to drink, and stimulation by brandy or digitalis administered as necessary. Vasodilators and salt solution should not be given.

Gelatin when injected subcutaneously has long been known to exercise a beneficial effect in promoting coagulation of the blood. It has frequently been a source of tetanus infection (see p. 293); sterilization is difficult, and overheating is said to destroy its therapeutic property. Given by mouth or rectum it is considerably less active. Ciuffini[1] has noticed effectual results from a combined treatment with gelatin and ferric chlorid. The non-sterilized gelatin is given by mouth or rectum, and ferric chlorid mixed with a concentrated solution of acacia (both previously sterilized) is injected subcutaneously. His investigations show that by this method coagulation is notably increased, and the effect persists for twenty-four hours or longer.

Constitutional Treatment.—The treatment of these conditions after the hemorrhage has been securely stopped is mainly that of shock, but before it is certain that there is no chance of further bleeding, great care must be taken that the arterial tension is not increased either by the use of vasoconstrictors or of much fluid by mouth, by rectum, subcutaneously, or by transfusion. The use of vasodilators is clearly contraindicated. Sometimes the patient is too low to allow of operation for the control of bleeding. The condition of collapse, with its state of lowered tension, favors clot formation, and during collapse hemorrhage may be stayed; thus the expectant is sometimes the best treatment in slow forms of internal hemorrhage with the patient in collapse.

When this course is decided upon, the patient should be given $\frac{1}{4}$ gr. morphin, to be followed by $\frac{1}{16}$ gr. every half-hour, and nothing else. If the loss of blood is overwhelming, and the surgeon has no question but that it comes from a large radical and interference will be necessary, a patient in collapse may be stimulated temporarily by the use of adrenalin subcutaneously, by brandy, strychnin, strophanthin, digitalis, or camphor, to a state where she can stand ether and a hurried operation. It is to be remembered that in collapse ether inhaled

[1] Policlinico, 1910, xvi, Medical Section, p. 525.

acts as a temporary stimulant within certain limitations, and also that in collapse but little vapor in proportion to air is necessary to keep the patient anesthetized. Ether should not be started, however, until all is ready for the operation Chloroform should not be used. The surgeon should plan out his course of action before he starts. He should work rapidly and, if time is precious, should not hesitate to leave in gauze packing or a clamp. After the operation is finished, treatment for shock should be instituted (Chapter VII, page 91).

In general, the following directions apply to all forms of hemorrhage:

(1) Lift the foot of the bed by means of bed-blocks or a chair. This determines the flow of blood to the medulla, where resides the vasomotor center.

(2) Open the windows and allow a free current of air to aid in the ready oxygenation of the blood.

(3) Apply heaters to the extremities and blankets to the body to aid in the maintenance of body heat.

(4) Apply ice locally—the coldness decreases pain and constricts the capillaries.

(5) Give morphin if necessary to keep the patient quiet in bed.

(6) Give normal salt solution intravenously or subcutaneously, or normal salt solution with adrenalin, or employ transfusion of blood from another individual *after the bleeding has ceased.*

(7) Stimulate by means of enemas, which may be composed of black coffee and contain ammonium carbonate, brandy, or strophanthin.

(8) Stimulate by means of subcutaneous injections of strychnin, ether, adrenalin, strophanthin.

TRANSFUSION

The **transfusion** of blood has recently come into prominence in the treatment of hemorrhage. It is indicated in acute hemorrhage from any cause. Cases which have been exsanguinated, so that the infusion of salt solution to increase the blood volume does not suffice to maintain life, may be saved by transfusion. This not only makes up for loss of fluid, but provides red blood-corpuscles, which can serve temporarily as oxygen carriers. It is of the greatest value in internal hemorrhage preceding operation (as in extra-uterine pregnancy), postoperative hemorrhage, hemorrhagic disease of the newborn, hemophilia, and illuminating gas poisoning.

Transfusion is of interesting and ancient origin.[1] It was known to the Egyptians of old and is referred to in the works of the Romans. The earliest known authentic case is that of Pope Innocent VIII, who was operated upon in 1492 by his Jewish physician, whose name has not come down. The blood of three boys was passed into the veins of the prelate, but without marked benefit. The discovery of the circulation by Harvey gave a new impetus to the discussion of the subject, and research was instituted upon animals. Lower, in 1666, wrote the first detailed account we have of the method of performing transfusion, and in the same year Jean Denys, in France, carried on similar experiments. He also performed the operation three times successfully upon human beings. Following his report, transfusion was carried on extensively, sometimes from animal to man, and sometimes from man to man, either by direct communication of vessel to vessel or through the mediation of a quill or cannula of silver or of bone, or indirectly by a syringe or pump. Other successes were reported, but the method aroused fierce opposition, and, as a result, in France the procedure was forbidden (1668) except by express permit of the Faculté of Paris.

For a while the procedure fell into disuse, to be revived from time to time only in discussion, until about the year 1800, when it was again revived and given an important position in experimental physiology. Blundell,[2] in England, did important research upon the subject. About this time also it was first noted that the blood of an unlike species would be liable to cause distressing and even fatal symptoms in the person in whom it was injected. About 1835 Bischoff experimented with defibrinated blood, and the use of this became an established procedure up to about the middle of the century.[3] In 1863 Blasius[4] collected 116 cases of transfusion which had been performed during the preceding forty years, and found that there had been 56 successful results. All these cases were cases of indirect transfusion, and in 2 the source of the serum was an animal.

From this time on a great deal of attention was paid to transfusion, and claims of a highly exaggerated nature were advanced

[1] See Landois, Transfusion des Blutes, Leipzig, 1875; Oré, 1876, quoted by Crile, Hemorrhage and Transfusion, 1909, 151.

[2] Medico-Chirurgical Transactions, 1818, ix, 56.

[3] Cheever, of Boston, in his interesting reminiscences (Boston Med. and Surg. Jour., 1911, clxv, 485), says: "I did it, in old times, drawing blood by venesection, whipping out the clot, warming and infusing it into a vein through a funnel and glass-tube. The entrance of clots, or of air, was the peril."

[4] Deut. Klinik.

and new and complicated methods originated. The transfusion from animals to man was reintroduced, but after Landois' discovery that the serum of one animal may have the property of destroying the red corpuscles of another, the use of heterogeneous blood was given up. It was found also that defibrination of the blood created a source of danger, inasmuch as it contained a fibrin ferment which might cause intravascular coagulation. These limitations, together with the general introduction of intravenous injection of normal saline solution, about 1875, brought about a gradual disuse of transfusion,

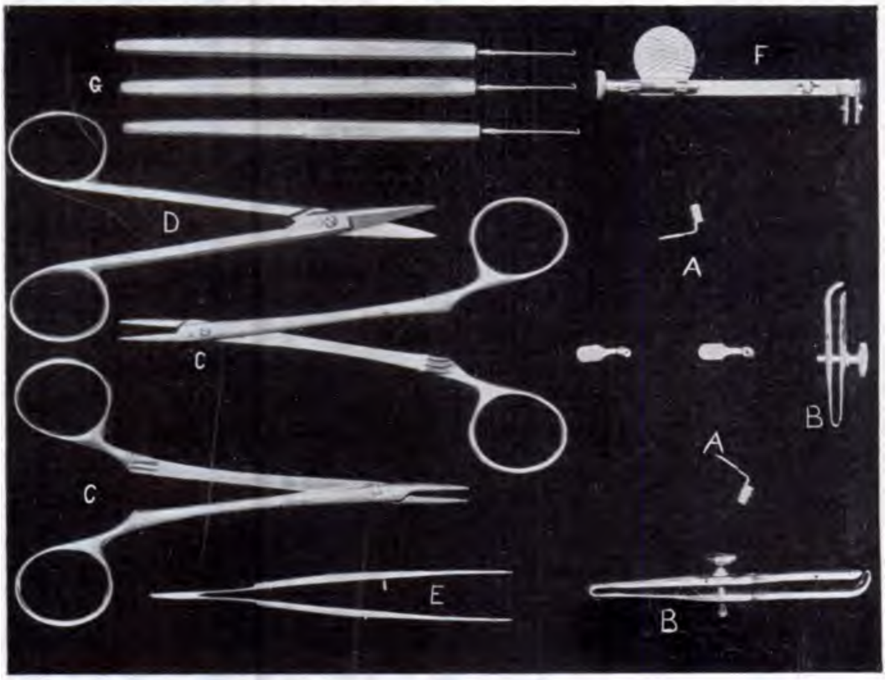


FIG. 33.—TRANSFUSION INSTRUMENTS.

A, A, Crile cannulæ, four views; B, B, Crile clamps; C, C, mosquito forceps; D, fine scissors; E, jeweler's forceps; F, Elsberg cannula; G, Elsberg hooks.

which lasted until some time in the 80's, when it was taken up with renewed enthusiasm.

There were three methods of transfusion ordinarily employed—the intravascular, the intraperitoneal, and the subcutaneous. The work of Carrel and Guthrie was the foundation for a great advancement in the use of the intravascular method. As a result of their experiments a practical method of end-to-end suture of vessels was perfected. Crile[1] simplified this technique by the use of a cannula

[1] Hemorrhage and Transfusion, New York, 1909.

adapted from that which had already been introduced by Queirolo and Payr. Modifications of the Crile cannula have recently been introduced by Elsberg,[1] Bernheim,[2] Curtis and David,[3] and Janeway.[4]

For a complete exposition of the subject of transfusion, both experimental and clinical, as well as his own technique, the reader is referred to Crile's book; from it we quote freely, with Dr. Crile's kind permission.

Technique.[5]—"The following instruments (Fig. 33) and materials have been found to be most helpful: (1) Scalpel; (2) blunt dissector; (3) small, sharp-pointed straight scissors for dividing the vessels, snipping off fragments of the adventitia, and so forth; (4) ordinary dissecting forceps; (5) minute tissue-forceps, with exact approximation at the points (those used by the watchmakers have been found to be useful); (6) half a dozen mosquito hemostats, to use in securing the minute branches of the radial artery and the small venous branches; (7) a pair of small "Crile" artery clamps; (8) a set of "Crile" cannulæ; (9) sterilized vaselin; (10) the ordinary means of closing a wound, and dressings.

"The vessels to be anastomosed are exposed (the details will be described later), and, after selection of a cannula of size suitable to the size of the vessels, the end of the vein is either pushed *through* the needle end of the cannula, with the help of fine-pointed forceps, or pulled *through* by means of a single fine suture inserted in its edge, the needle being left on the suture and passed through the cannula ahead of the vein. The handle of the cannula is then tightly seized by a pair of hemostats (the fingers are too clumsy) (Fig. 33), three mosquito hemostats or small fine-pointed forceps, such as oculists use, are snapped at equidistant points on the end of the vein, taking care not to have the tips extend up into the lumen more than is necessary to get a firm hold. The end of the vein is then cuffed back over the cannula by gentle, simultaneous traction on the three hemostats, and tied firmly in place with a fine linen thread in the groove nearest to the handle. The cuffed part is next covered with sterile vaselin, being careful not to get any into the open end. This facilitates slipping the artery over the cuff. The hemostats are removed from the full edge and the artery may then be put in place.

[1] Jour. Am. Med. Assoc., 1909, lii, 887.
[2] Ann. Surg., 1909, l, 786.
[3] Jour. Am. Med. Assoc., 1911, lvi, 35.
[4] Ann. Surg., 1911, liii, 720.
[5] Crile, Hemorrhage and Transfusion, 284 *et seq.* (Copyright, 1909, by D. Appleton and Company.)

"Owing to the elasticity of the arterial wall, it usually shrinks considerably when the pressure from within is removed, as it is at the free end. To obviate this, it may be necessary to dilate the end very gently by inserting the closed jaws of a mosquito hemostat covered with vaselin and opening them for a short distance. The three hemostats are then applied to the edges, just as with the vein, and the artery is gently drawn over the cuffed vein on the cannula and tied in place with another fine linen suture applied in the remaining groove. The mosquito hemostats are removed, and, finally, the large hemostat

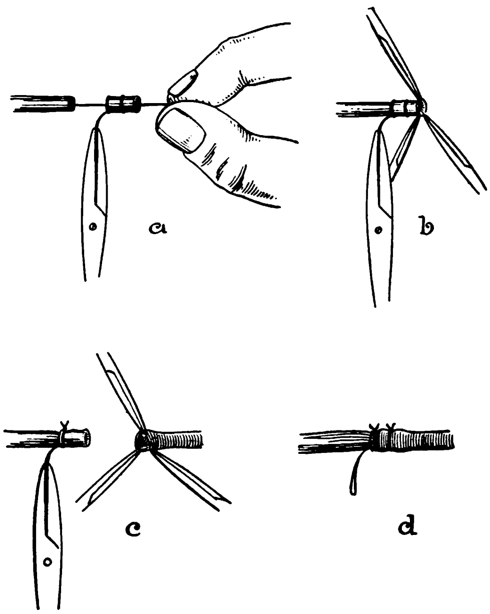


FIG. 34.—TRANSFUSION. (After Crile.)
Transfusion by Crile cannula: *a*, Threading the vein; *b*, making the cuff; *c*, pulling artery over cuffed vein; *d*, the artery tied in place.

which has been snapped on the handle of the cannula during all this time is removed. The process is then completed. After the transfusion the cannula is removed, both artery and vein are ligated, and the wounds are sutured.

"In making a cannula anastomosis experience will show what size cannula is suitable for the given vessels. As large a size should be used as possible, without injuring the intima of the artery by stretching it too large. Usually there will be no difficulty in obtaining a large vein, but the artery may be very small. If too small a cannula is used, the amount of the flow will be diminished. Moreover, too large a vein will take up too much room in the cannula and the amount of flow will be diminished.

"In using the cannula two facts should be particularly remembered. The first is that the long axis of the tube should coincide with the long axis of the lumen of the vein and artery. A little experimenting will show how easily the cannula may be made to slant so that the opening in it will come almost in contact with the artery wall and shut off the flow in great part or completely. Actual experience has shown the necessity of placing the cannula accurately.

"The second and less obvious fact is that, unless the right amount of tension is maintained on the vessel which passes through the cannula when the blood is flowing across, particularly with a small cannula, the flow will be diminished or shut off altogether by the elasticity of the vessel wall on tension in cannula, pushing the outside part of the vessel in and blocking the way.

"The exposed vessels should be kept moist and warm with normal saline solution. Not only is drying harmful, but the flow is increased through gradual relaxation of the arterial wall.

"Experience has shown that if anything goes wrong in carrying out this technique, it is best to start again from the beginning, and not to try to get around any of the details by substitution."

Of the other forms of cannulæ which have been devised, the most ingenious is that of Elsberg.[1] He employs a cannula "built on the principle of a monkey-wrench, which can be enlarged or narrowed to any size desired by means of a screw at its end (Fig. 33). The smallest lumen obtainable is about equal to that of the smallest Crile cannula, and the largest greater than the lumen of any radial artery. The instrument is cone shaped at its tip, a short distance from which is a ridge with four small pin-points which are directed backward. The lumen of the cannula at its base is larger than at the tip. The construction of the cannula can be easily understood from the following description of the method of using it:

"The radial artery of the donor is exposed and isolated in the usual manner. The cannula, screwed wide open, is then slipped under and around the vessel. It is then screwed shut until the two halves of the instrument slightly compress the vessel. The artery is then tied off about one centimeter from the tip of the cannula. Before the vessel is divided, three small-eye tenacula are passed through the wall of the artery at three points of its circumference, a few milli-

[1] *Loc. cit.*

meters from the ligature. Small mosquito forceps may also be used. These are given to an asistant, who makes traction on them while the operator cuts the vessel near the ligature. The moment the artery is cut the stump is pulled back over the cannula by means of the tenacula or forceps, and is held in place without ligation by the small pin-points. There is no bleeding from the artery, even though no hemostatic clamp has been applied, because the cannula itself acts as a hemostatic clamp. The vein of the recipient is then exposed (but not freed); two ligatures are passed around it; one is tied peripherally in the usual manner. A small transverse slit is made in the vein, the cannula with the cuffed artery inserted into the vein, a ligature tied around the vein and cannula screwed open, and the blood allowed to flow. The rapidity of the flow can be varied as desired by the size to which the instrument is screwed or unscrewed, and the lumen of the artery is never diminished.

"It will be noticed that the artery is cuffed instead of the vein; this method I believe to be more correct. The vein is the larger vessel, and can, therefore, be more easily telescoped over the artery. The vein is only exposed, not freed, and the artery is intubated into it.

"With this cannula I have been able to make the anastomosis in less than four minutes after the artery had been isolated, and have found the entire procedure a simple one. The advantages of the instrument are the following:

"(1) One cannula will fit any vessel.

"(2) The cannula is applied around the vessel instead of the vessel being drawn through the cannula.

"(3) No ligature of the cuffed vessel is required.

"(4) The cannula itself acts as a hemostatic clamp.

"(5) The cuffing of the artery is easily accomplished without stripping back the adventitia, and, therefore, the traumatism to the artery wall reduced to a minimum.

"(6) The vein need only be exposed, not dissected out and cut.

"(7) As the cannula is unscrewed the blood will flow, the flow can be regulated at will, and lumen of the artery is not diminsihed."

The Elsberg technique is simpler than that of Crile, is more rapid in execution, and requires fewer assistants. The one cannula will serve for vessels of any diameter, and it can be employed between two of marked discrepancy in size. In the hands of some men it has supplanted the Crile instrument in favor.

Some surgeons prefer the Carrel method of suture of vessels over the use of cannulæ.[1] The advantages claimed are that the anastomosis is not covered in by a mechanical device, which prevents massaging of the vessels at the point of junction if the flow is too slow, and that the caliber of the vessel is not diminished by such a device. But on the other hand, arterial suture requires a considerable experience with the technique in lower animals. "The chief difficulties to suture in transfusion are the inequality in size of the vessels, their difference in texture, and the possibilitits of tension under which the operation is performed."[2] The disadvantages are sufficient to deter all but men of special training from employing the technique, when the cannula will do the work as well.

General Management of a Transfusion.[3]—"*The Donor.*—First of all, a suitable donor must be obtained. Both men and women are suitable. In cases in which no immediate hurry exists, the best subject is selected from among the relatives and friends who are willing to serve. After the donor has been selected, he is subjected to a full cross-questioning as to his family and personal history and a thorough physical examination. This is for his own benefit as well as for the benefit of the patient. The regeneration of the blood lost by the donor is uninterrupted and rapid. From the donor's standpoint *the duration of flow* is an important consideration. The best way of determining when to stop the flow is by watching his symptoms. At first he will show loss of color in his mucous membranes, pallor of the skin, slight uneasiness, slight quickening of the pulse and respiration, lowering of the blood tension, and beginning of shrinkage in the skin of the face.

"*The Recipient.*—As far as the recipient is concerned, transfusion is a problem in mechanics as well as in therapeutics. There are few, if any, operations in which more factors must be considered and in which more care must be exercised.

"From the mechanical standpoint, the chief danger to be feared is acute cardiac dilatation and subsequent cardiac failure, caused by transfusion in excessive amount or at excessive rate of flow. Fortunately, a certain amount of dilatation may occur and pass rapidly away without causing either immediate or subsequent harm. It may be necessary to shut off the flow altogether, with gentle pressure of the fingers, for short intervals, giving the heart a chance gradually to

[1] For the technique, see Pool and McClure: Transfusion by Carrel's End-to-End Suture Method, Ann. Surg., 1910, lii, 433. Ehrenfried and Boothby: The Technic of End-to-End Arterial Anastomosis, Ann. Surg., 1911, liv, 485.

[2] Ehrenfried and Boothby, *loc. cit.*, p. 494.

[3] Crile, *loc. cit.*

assume its added burden by allowing only small amounts of blood to cross at a time.[1]

"The principal symptoms of acute cardiac dilatation are dyspnea, distress, or pain in the upper cardiac region, cough, and cyanosis, the pulse increases in rate and may be very irregular in action, tension, and volume. When acute dilatation has once occurred it must be promptly recognized, the transfusion must be stopped, the operating table tilted so as to raise the patient to the head-up position, and rhythmic pressure made on the chest over the heart. If recovery is not complete in a short time, transfusion should be given up and the patient put to bed in a head-up position, given carefully graded doses

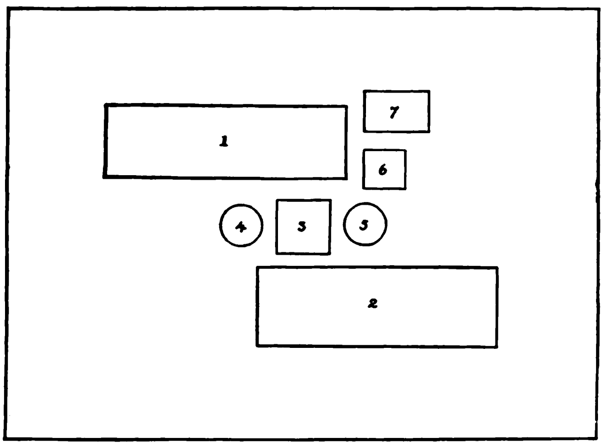


FIG. 35.—TRANSFUSION. (After Crile.)

Diagram to show arrangement of operating room: 1, 2, Operating tables for recipient and donor, respectively; 3, table for arms of recipient and donor; 4, 5, stools for surgeon and first assistant, respectively; 6, instrument table; 7, table for dressings, sutures, etc.

of nitroglycerin to insure peripheral dilatation of the vessels, and digitalin hypodermically *in very small doses* to stimulate the heart-muscle directly.

"The treatment is a question of therapeutics when reduced to its final analysis. The surgeon takes the place of the internist when he gives a 'dose' of blood. The question of dosage may be very important, especially when there is hemolysis of the recipient's red corpuscles by the donor's serum; therefore, in all but emergency cases, prelimin-

[1] To avoid the danger of acute dilatation of the heart, Dorrance and Ginsburg (Jour. Am. Med. Assoc., 1910, lv, 569) recommend the employment of transfusion from vein to vein. They claim that the operation presents fewer technical difficulties than does arteriovenous anastomosis.

ary hemolysis tests should be made in order to handle a given transfusion more intelligently and protect the recipient more fully."[1]

"*The Operation.*—It is a great advantage to have a thoroughly trained corps of assistants. Two operating-tables are necessary (a single large bed in a private house will do). Two small square tables of the same height as the operating-tables are needed—one for the instruments and the other to support the arms of the patients. Two low stools, one for the surgeon and one for the first assistant, complete the list.

"From twenty to thirty minutes before being brought to the operating-room the donor and recipient each receive morphin sulphate, gr. ¼, hypodermically, unless there is some special reason for its being contraindicated.

"When each is in place on his respective table, the tables are so arranged that the left arm of each will rest comfortably on the small table, placed for the purpose between the operating-tables (Fig. 35). The patients are told that there will be no pain beyond the first needle-prick. The nurse who is detailed to care directly for the patients relieves the monotony of waiting by bathing the forehead, giving water to drink if desired, and, in short, doing anything permissible to afford comfort.

"The next step is the dissection of the blood-vessels. Experience has shown that it is best to use a radial artery of the donor and any superficial arm vein of the recipient near the elbow. Usually the median basilic vein is the best one, on account of its size and easily accessible position."

In infants and children the median basilic or median cephalic vein is, as a rule, too small to allow of easy handling; the femoral vein is to be preferred. With the thigh abducted and rotated outward, it will be found to run along a line extending from just external to the spine of the pubes to a point just behind the internal condyle of the femur. In adults, where for any reason a vein of the arm cannot be used, the saphenous vein may be taken in the lower leg or at the ankle.

"Local anesthesia is obtained by injecting cocain in $\frac{1}{10}$ of 1 per cent. solution with a few drops of 1:1000 adrenalin chlorid solution. Several hypodermic syringes should be ready, so that there need be no

[1] For the technique of these tests, see Crile, *loc. cit.*, 313. Ordinarily, transfusion cases are emergency cases to the surgeon. A blood relative should be chosen wherever possible, parent, child, brother, or sister; next to that, husband or wife. In 8 personal cases in private practice, where no opportunity was allowed for hemolysis tests, but where care was exercised in selecting the donor, no untoward effect was observed.

delay on account of having to stop to refill a single one. The injections are first made in the skin and then more deeply around the vessels.

"In making the dissection it is necessary to have good light. Mosquito hemostats are used to catch every vessel that shows even a drop of blood. The vessel should be kept absolutely clean. The donor's radial artery is isolated for a distance of about 3 cm. at the point of election in the wrist. Here there are a number of small side branches which must be carefully isolated and tied with a No. 1 Chinese twist silk before being cut. The artery is then tied at its *distal* end, and a Crile clamp is gently screwed in place over the approximate part, as near to the place where it comes out of the undissected tissues as convenient. The clamp should be screwed up with great care. Just enough pressure should be used to control the flow of blood without causing injury to the vessel wall. The artery is severed with sharp scissors a short distance from where it is tied off, the end cut squarely across, the adventitia pulled down and cut off, and is then ready for the completion of the anastomosis. The result should be that the operator has about 2½ cm. of the exposed radial artery free from branches, the cut end open, and the blood prevented from coming out of it by the clamp.

"The next step is the dissection of the vein. It is exposed for the same distance as the artery, the branches are tied off in the same way, and the ligature is also applied at the distal end. The second Crile clamp is applied just as before, the vein cut near the ligature, and it in turn is ready for the completion of the anastomosis."

It requires a certain amount of experience to tell just how long to allow the flow to continue. No stated time can be set, although with vessels of equal size, about that of the radial, and with an uninterrupted flow, a half-hour is long enough. The best guide is the condition of the recipient, as estimated from his pulse and color, though, of course, the donor should not be neglected. Oftentimes it is difficult to tell whether the blood is flowing through or not; in this case it will be wise, before disconnecting the anastomosis, to dissect the vein up to a small branch, and cut this, to see if the blood flows. One should be careful that the vessels do not dry up, that they are not twisted, that they are not relaxed so that they pucker up inside the cannula, and that they are not stretched, for in either case the flow will cease. If there is evident a marked pulsation in the vein at some inches from the anastomosis, the flow is too rapid.

Interesting work is being done on the fate of the transfused blood.

It is evident (Boycott and Douglas) that the red cells survive only temporarily in the circulation of the recipient. Sooner or later, probably within a few days, they are disposed of just as effete cells are normally taken care of, through destruction and assimilation by phagocytes.[1]

Mrs. B., seen (Dr. Crandon) in consultation with Dr. C. N. Cutler, in Chelsea, Massachusetts, was a former patient who had been operated on for left extra-uterine pregnancy six months previously. Forty-eight hours before was taken with collapse, pallor, gasping respirations, low abdominal pain, and tenderness. *Diagnosis*, ruptured extra-uterine pregnancy. Her condition, which at first was too poor for operation, improved slightly, and *operation* was done, with the assistance of Drs. Cutler, Ehrenfried, and Osgood. A median celiotomy revealed free blood and clot. On right parovarium ruptured pregnancy mass was found; a fetus size of thumb-nail floating free among intestines. Tube was removed, abdomen cleaned of clot and blood, salt solution was poured in, and abdominal wall closed by mass sutures. Meanwhile 1 quart of adrenalin salt solution (1 : 50,000) had been given under breast. Total duration, sixteen minutes. Patient cold, no radial pulse, respirations 40.

Transfusion was at once performed, using the Crile technique, from left radial artery of patient's brother into her left median basilic vein, and continued twenty-five minutes. The vessels were large and the volume of the brother's pulse was full. At the end of twenty-five minutes the transfusion was stopped. The patient had a fairly good pulse at the wrist, rate 156, the skin had changed from cadaveric yellow to a more natural color, and there was a distinct pink in the lips; the gasping respiration ceased entirely and the patient slept quietly.

Uneventful recovery.

B. B., aged eight, seen (Dr. Crandon) in consultation with Dr. Provandie, in Melrose, Massachusetts. The patient had had his tonsils removed by guillotine about nine hours before, had apparently been bleeding down his throat all day, and at 6 P. M. collapsed, with pulse 160, temperature 97.2° F., respiration 42, slight cyanosis.

A Crile transfusion was done, using the mother, under cocain, as the donor, the boy being etherized. The flow was carried on fifty-six minutes, at the end of which the boy was nearly normal in color, pulse better volume, but still 140 in rate. It seems likely that he had too large a dose of blood, though no increased cardiac area could be made out. The next day, to bear this out, there were some signs of congestion of the lungs, but recovery was uneventful.

[1] See also Hopkins: Phagocytosis of Red Blood-cells After Transfusion, Arch. of Internal Med., Sept., 1910.

Mr. C., seen (Dr. Ehrenfried) in consultation with Dr. F. C. Whitehouse, in Bedford, Massachusetts, had suffered from pernicious anemia for six years. For some weeks he had shown marked anemia (red count about 500,000), with depression of all vital functions. A few days before his condition had become worse, with collapse and stupor. When seen he was yellowish and pasty, with a radial pulse that could be made out with difficulty. Under the excitement of the operation he became more or less alert.

Transfusion was done, with the assistance of Dr. W. M. Boothby, by the Elsberg technique, under cocain, using the wife as donor. Extreme difficulty was experienced in finding a vein, and it took nearly an hour's search before one was located in the doughy fat of the patient's arm large enough to employ. Although the vein was much smaller than the artery, the Elsberg cannula worked well. The blood was allowed to run forty minutes on account of the small size of the vein.

Report from the attending physician showed immediate slight improvement. The red count twelve days after operation was 1,632,000, and a week or so later the patient was up and about, working in his garden. He continued happy and well until about six months later, when he died suddenly, within a few hours.

Mrs. F., seen (Dr. Crandon) in consultation with Dr. F. A. Mahoney, in Chelsea, Massachusetts, had missed two periods, and had thought that this might be due to beginning climacteric. Thirty hours before she had been suddenly taken with abdominal pain and dizziness, which had increased constantly. She was a large and obese woman, pale and sweating. The pulse, which could not be found at wrist, was 158 by stethoscope; respirations 36; abdomen distended, and in a state of spasm. Operation was performed with the assistance of Drs. Mahoney and E. J. Powers. Median celiotomy revealed a right tubal pregnancy ruptured at proximal end of tube. This was tied off and removed, together with a large amount of clot and fresh blood, and the abdomen was closed full of hot salt solution. Time, thirty minutes.

Immediate transfusion, using the Elsberg cannula, was done, the patient's brother was donor, and both were under ether. At time of starting transfusion the recipient's pulse was 180 by stethoscope and she was, to all appearances, dying. The flow of blood began thirty-five minutes from the beginning of transfusion operation, this great time being due to the fact that the vein was hard to uncover in a very fat arm. The artery had to be massaged to start the flow. The transfusion continued for nineteen minutes; at the end of this time the recipient's pulse was 120, respiration 22; she was pink in the face, and the nose, which had been cold, was warm.

The dose of blood in this case again seems to have been too large. For three days the patient had some distress in left front of chest and crackling râles in both backs. Recovery was otherwise rapid and uneventful.

CHAPTER VII

SHOCK: CAUSES, SYMPTOMS, TREATMENT

SHOCK is a condition of reflex depression of the vital functions which occurs after serious injuries and operations, but may, apparently, result also from mental excitement induced and accompanied by comparatively slight bodily injury. Every operation of any severity is accompanied by some degree of shock. It may vary in intensity, from a transient state of weakness, which reacts readily to stimulation, to the most profound condition of vital depression which resists all efforts at alleviation and is the cause of death. Races with less stable nervous organization, the American, Hebrew, and Irish, are said to be more susceptible than the more phlegmatic peoples, the Scotch, German, and Chinese.

We may consider the exciting causes of shock to be psychic, as profound emotion, fear, or sorrow; irritative, such as might follow the irritation of peripheral sensory nerve-endings by extensive skin wounds, superficial burns, and destruction by caustics; toxic, as from the influence of anesthetics; and, finally, mechanical, either from trauma or operative handling and exposure of tissues, nerves, and viscera. Thus, shock will follow severe blows upon the head, larynx, abdomen ("solar plexus"), testicle, or spermatic cord, abdominal wounds and visceral injury, gunshot wounds of the intestines, and perforation of the bowel in typhoid or appendicitis. Hemorrhage causes collapse and not shock, although the clinical distinction between the two is often difficult.

Postoperative shock may be the result of any one or more of the factors mentioned, but particularly the two last. It most frequently follows procedures involving the abdominal contents and visceral peritoneum; next, the visceral pleura; third, the male generative organs. In abdominal operations the state of shock seems to bear some proportion to the amount of manipulation the visceral peritoneum receives, or the amount of exposure of the viscera. In abdominal surgery the tendency to shock is least after operations upon the pelvic organs, and greatest in operations on the stomach and duodenum. In operations on the extremities the amount of shock seems to bear a proportion to the sensory nerve supply of the tissues exposed or injured. Pain is an important factor in causing or prolonging shock.

The **etiology** of shock is still under discussion. One theory has it that cardiac exhaustion is the prime cause, another holds that shock is due to a reflex inhibition of the activity of the centers of the cord. The hypothesis which is receiving the widest acceptance among surgeons to-day is that originally enunciated in 1864 by W. W. Keen, S. Weir Mitchell, and C. W. Moorehouse,[1] which explained shock as due to vasomotor exhaustion. This theory has been elaborated and apparently confirmed by Crile[2] and Romberg,[3] who independently observed that during shock the blood-pressure in the peripheral arteries fell. Crile states the doctrine essentially as follows: As the result of the cumulative effect of excessive or unusual stimulation of afferent nerves the vasomotor center becomes depressed and, finally, completely exhausted, and as a consequence of this exhaustion there occurs a paralysis and dilatation of the peripheral vascular system, with the accumulation of blood in the venous trunks. The output of the heart diminishes and the circulation gradually fails.

This theory has been recently disproved by the experimental researches of physiologists. W. T. Porter[4] says: "The hypothesis which constitutes the hitherto generally accepted definition of shock declares that the vasomotor cells are depressed, exhausted, or inhibited by excess of stimulation of afferent nerves. The fall in the blood-pressure and the accompanying symptoms are the result of this depression. The experiments cited in this paper demonstrate that the vasomotor cells are not thus depressed or inhibited, and experiments show also that stimulation of afferent nerves does not materially lessen the blood-pressure. The present hypothetic basis of shock is thus removed." And Seelig and Lyon[5] have advanced definite experimental data to prove that the peripheral vascular system is not paralyzed and that no inhibition of the vasomotor center exists, even in profound shock.

To replace this doctrine there has been recently advanced, by

[1] See Circular 6, Surgeon General's Office, 1864.

[2] An Experimental Inquiry into Surgical Shock, Philadelphia, 1899; Blood-pressure in Surgery, Philadelphia, 1903.

[3] Deutsch. Archiv. f. klin. Med., 1899, lxiv, 652.

[4] Porter and Quimby, Amer. Jour. of Physiol., 1908, xx, 500; also Porter, Harvey Lectures, 1906, 1907.

[5] Jour. Am. Med. Assoc., 1909, liii, 45; Surg., Gyn., and Obstet., 1910, xl, 146.

Yandell Henderson of Yale, the theory of acapnia as the underlying cause of shock. Haldane[1] has stated, and it is now generally accepted, that the carbon dioxid in the blood is the chemical regulator of the respiration (except in states of anoxemia, when certain acid radicals, products of incomplete tissue combustion, act to assist the carbon dioxid in stimulating the respiratory center). In other words, the respiratory activity is adjusted to maintain a uniform carbon dioxid content in the blood; for example, if the proportion of carbon dioxid in the air inspired is increased by .2 per cent., the respiratory activity is doubled. Henderson confirms, experimentally, this theory, but he goes further and asserts that the carbon dioxid in the blood may be nearly as important in the regulation of the circulation as of the respiration, postulating a hitherto unrecognized venopressor mechanism.

Stated in brief, Henderson's explanation of the mechanism of shock is as follows: Voluntarily forced respiration in man induces symptoms of shock. Emotion, pain, ether-excitement, irritation of sensory nerves without conscious suffering, and other conditions known to produce shock, involve excessive respiration (hyperpnea). The result of this overventilation of the lungs is a fall in the proportion of carbon dioxid in the blood (acapnia). Another source of loss of carbon dioxid is by evaporation from exposed intestines during operation. The primary result of this withdrawal of the natural stimulus of the respiratory center is a cessation of respiration (apnea), which, if sufficiently prolonged (about eight minutes), will cause death from oxygen starvation of the heart. This is respiratory failure.

A no less important secondary effect of acapnia is an increase in the rapidity of the cardiac contractions. This quickening of the heart-beat occurs at the expense of the diastole, which is thereby shortened, and as a result time is not allowed for complete filling of the auricles. The output of the heart accordingly diminishes, which causes a fall in blood-pressure. Simultaneously the venous pressure falls and the blood stagnates in the veins. The failure of circulation in shock is, therefore, fundamentally a venous stasis, and the underlying cause of this stagnation is diminution of the carbon dioxid content of the blood.

Acute acapnia diminishes the volume of available blood as effectively as does an extensive hemorrhage, says Henderson. The apparent failure of the heart is due to a diminution in the venous stream to the

[1] For a recent exposition of the physiology of respiration see his article in Encyclopedia Brit., 1911, xxiii, 187.

right auricle. Clinically, an increasing pulse-rate and a rise in diastolic pressure indicates the approach of shock.

This theory opens up definite therapeutic possibilities, which will be considered later.

Whatever hypothesis as to the fundamental cause of shock we accept, if we may accept any, there are certain essential factors which we can at this time take for granted. In shock the blood-pressure falls, but not from paralysis of the peripheral arterial system and the consequent abolition of peripheral resistance, nor directly from the stimulation or irritation of afferent nerves. The peripheral arteries are contracted in an effort to maintain the circulatory equilibrium. Irritation or excessive stimulation of the afferent nerves, with or without conscious pain, may induce shock. No exhaustion or inhibition of any sort occurs in the vasomotor nervous system. On the contrary, this is active to compensate for the lessened blood-stream. The pulse accelerates. The blood accumulates in the venous trunks and the output of the heart diminishes; the force of the heart-beat lessens. The heart is not weakened primarily.

Symptoms.—Clinically, shock may be *immediate*, coming on during or immediately after an operation; *deferred*, six to twenty-four hours after operation; and *continued*, coming on soon after operation and lasting twenty-four to forty-eight hours or even three or four days. The two latter varieties are uncommon. What is called deferred shock may sometimes be the collapse of secondary hemorrhage. Continued shock is like ordinary shock, except that the symptoms are slower in developing and that it runs a longer course. It is apt to occur after prolonged operations, in cases accompanied by severe mental shock or pain, and in anemic women.

The symptoms are analogous in all forms and extremely typical. Rarely the onset of shock will be so sudden and its development so rapid that the patient will die on the table. This fulminating form is not to be confounded with asphyxia due to the anesthetic. Usually the condition develops gradually as the operation proceeds, the pulse-rate increases, and soon the volume and tension decrease, the surface temperature drops, the respiration becomes faster and less deep, the face and lips become pallid, and the pupils dilate. The immediate indication is to end the operation and treat the patient; patients in this stage may be expected to react. As the condition proceeds the pulse becomes irregular and thready, the skin cold, pallid, and covered with a cold sweat, the lips become blue, and the respiration shallow and irregular. The patient is put to bed in a state of dull torpor, which gradually develops into coma. The pupils are dilated and the eyes half-closed and staring. There is loss or impairment of surface sensibility, and the phlegm which collects in the throat is audibly churned with the respiration. Occasionally there is hiccough, nausea, and even vomiting; there is loss of muscle control; there may be incontinence of feces, lessened secretion, and retention of urine. Rarely, instead of the commonly expected picture of mental inactivity and apathy, we find excitation and maniacal delirium, which exhausts itself rapidly and develops into coma.

If the patient responds to treatment, there will be a gradual development of consciousness, often preceded by vomiting, and the patient in a husky voice will ask for water. The corneal and cutaneous reflexes will be reëstablished, the pulse become stronger and slower, the skin become warmer and lose its clammy appearance, the respirations become slower and deeper, and the kidneys begin to secrete urine. If there is no pain the patient will often sink into normal sleep, to awake in a few hours much improved.

Treatment.—In treatment the matter of *prophylaxis* has an important place. Before operation the bowels should be empty, although overfree saline catharsis causes depletion of tissues and should be avoided. Starvation should not be practised; the patient should be well fed, and may even have a cup of bouillon or coffee and a cracker an hour before ether is started if she feels the need of it, or a nutrient enema may be given one-half hour before the operation. The patient should be in a quiet frame of mind, and should have a good night's sleep, otherwise, if she is restless or in pain, morphin, gr. $\frac{1}{4}$, and atropin, gr. $\frac{1}{120}$, should be administered one-half hour before operation. On the whole, it is wise to avoid the routine preoperative use of drugs to prevent shock; drugs should be withheld until a definite indication for their use appears. Gas-oxygen and, second to that, ether are always the anesthetics of choice if shock is feared.

If the patient is brought to the surgeon in a state of severe shock, as, for instance, from a mutilating trauma, he will have to decide whether to superimpose upon the existing condition the shock of ether and operation or to temporize and combat shock before operation. There seems to be among active surgeons a growing tendency in favor of the latter course. Many a forlorn hope has been rushed to the table to expire during the operation or soon after its close, where the operative risk might have been lessened in cases that could wait if a few hours were given first to the treatment of shock.

During the operation much may be done to forestall shock; if shock is expected, all precautions should be taken. In the first place, the operation should be rapid, even to going through the abdominal wall with one stroke of the knife if indicated. All preparations should be made and everything well planned before the anesthetic is started. It is vastly important that the period of anesthesia be as short as possible. Everything should be made ready for the treatment of post-operative shock while the operation is going on, and, if the occasion demands, hypodermoclysis of normal salt solution may be carried out beneficially while the operation is under way.

All measures should be taken to prevent the loss of body heat. The room should be warm, about 72° F., and an operating-table heated by steam or electricity may advantageously be used. The body and limbs should be well wrapped in blankets; hot-water bottles should be used freely if necessary, and especial care should be taken that the patient is not lying exposed upon uncovered cold glass plates or that the blankets or towels are allowed to become wet without being changed. The room should be well ventilated, especially in operations of any length, so as to allow the patient a proper supply of oxygen.

Loss of blood should be scrupulously avoided, especially in anemic, cachectic, or exsanguinated persons. All unnecessary exposure or manipulation of intestines should be guarded against; coils of intestine should be replaced with considerate gentleness as soon as practicable, and, if exposed necessarily, should be kept covered with sterile towels or large pads, hot with sterile salt solution frequently renewed. The omentum is much less sensitive to handling than the intestines. In a limb the cocainization of the sensory nerve-trunk supplying the part—"blocking" the afferent track—before any gross mutilation or rough handling is to be performed, as in cleaning up and repairing an ankle after a bad crush, will forestall or lessen shock. If shock is imminent, the lowering of the head by the assumption of the Trendelenburg posture will relieve cerebral anemia.

With the condition of shock established, certain indications for treatment present themselves. These we shall consider in the following order:

(1) Fall in blood-pressure.

(2) Venous stagnation and the withdrawal of blood from the active circulation.

(3) Anemia of the brain and of the vasomotor center from lessened blood-supply and consequent poor oxygenation.

(4) Cardiac exhaustion from progressive weakening of the heart-muscle, resulting from its attempt to maintain the circulation.
(5) Acapnia.
(6) Pain as an element in causing or prolonging shock.
(7) General measures in the care of patients.

It may be accepted that one of the main factors in shock is a general fall in the *blood-pressure* in the peripheral arteries, with a coincident stagnation of blood in the venous trunks. Leaving the abdomen full of sterile salt solution after a celiotomy will temporarily, at least, create a positive pressure which will partially counteract or prevent dilatation of the splanchnic vessels, and will, by absorption of the fluid, increase the volume of the circulating blood. It is here also that the usefulness of the vasoconstrictors is apparent, and of these we shall consider adrenalin, caffein, and strychnin. On the whole, the results of drug treatment of shock are not encouraging.

Adrenalin is the most active member of this group, and perhaps its best indication for use is in shock. It induces a prompt and marked rise in blood-pressure by acting directly on the muscle-tissue of the arteries to cause contraction of the peripheral vessels. The ordinary dose is 5 to 15 minims of the 1 : 1000 solution. It must be given subcutaneously or intravenously, as its vasomotor action is absent when given by mouth.[1] Adrenalin may conveniently and rationally be given in salt infusion, 15 minims to the quart (1 : 50,000 solution). Its action is very transitory,[2] lasting only about ten minutes, so that if the desired effect is not obtained, it must be repeated. Its effect in increasing the blood-pressure may be so marked as to lead to acute dilatation in a diseased or weakened heart from the suddenly increased amount of work thrown upon it.[3] For this reason, as well as on account of the occurrence in animals of an arteriosclerotic condition[4] if

[1] The administration of drugs by mouth should be avoided in shock, as patients do not react normally to sensory stimuli, and the reflexes connected with the act of swallowing are dulled, so that the irritating fluid may readily pass into the larynx.

[2] D. D. Jackson (Prolonged Persistence of Adrenalin in the Blood, Amer. Jour. of Physiology, 1909, xxiii, 226) says adrenalin does not persist in the blood after its visible effects in the rise of blood-pressure have disappeared. In the dog adrenalin disappears in about one minute.

[3] Merkens (Zentral. f. Chir., 1910, xxxvii, No. 42) reports a fatality in a man of fifty following closely upon the injection of 10 drops of adrenalin in 1 liter of normal salt solution.

[4] N. Waterman (Arteriosclerosis after Injections of Adrenalin, Virchow's Archiv, 1908, cxci, 202) says that research shows that the arteriosclerosis induced in animals after injection of adrenalin closely resembles ordinary arteriosclerosis in man.

the use of adrenalin is long continued, the drug must not be given in too large doses or over long periods.

Caffein is a vasoconstrictor of rapid action, which causes a rise in blood-pressure that is maintained about one and one-half hours. It is said to act better when the heart structure is diseased or weakened, as in acute infectious diseases, than when it is normal. It is useful in an emergency, and may be given in the form of strong coffee by way of the rectum, in doses of 2 to 4 ounces. Caffein is otherwise given subcutaneously in 2- or 3-gr. doses. On account of the poor solubility of the alkaloid in water (1 in 45.6 parts), the form ordinarily used for hypodermic medication is the freely soluble caffein and sodium benzoate (N. F.), which contains 45 per cent. caffein, and should be given in doses of 3 to 6 gr. It may be repeated in two to four hours.

Strychnin is the least dependable of all the vasomotor drugs of this class. From recent investigations it appears that its action at best is inconstant, and that a rise in blood-pressure, through direct stimulation of the vasomotor center, is produced only when the drug is given in quantity approximating the toxic dose. A comparatively safe active dose is $\frac{1}{10}$ gr.; this may be followed in fifteen minutes by $\frac{1}{20}$ gr., and then $\frac{1}{20}$ gr. given every two hours. It must be borne in mind that, though no toxic symptoms appear during shock, the patient may be taken with convulsions, if larger doses are given, as soon as the condition of shock disappears, as the result of the cumulative action of the drug, which, in the state of shock, has not been eliminated.

Alcohol must be considered here, for though it is ordinarily classed as a vasodilator, recent works seem to show that moderate amounts given by mouth or rectum induce, coincident with the peripheral dilatation, a constriction of the splanchnic vessels. These findings bear out the clinically often-observed stimulant effect of alcohol in shock. It may be given in the form of brandy diluted with an equal part of water—1 ounce by mouth or 2 ounces by rectum.

Animal investigations lead us to believe that the rapid action of the heart occurring in shock is not due—in the early stages at least—to exhaustion of the organ, but rather to the fact that the heart has an *insufficient quantity of blood* to work upon. The situation has its parallel in the damage which is done to the engines of an ocean liner going at full speed which suddenly has her propellor lifted clear of the water, and may be compared with the exhausting futility of working a pump with no water in the tube. Crile found that if salt solution or blood were supplied to take the place of the blood stagnant in the venous trunks, the heart at once began to work more slowly and forcibly. We shall consider four methods of supplying the needed fluids:

(1) Emptying the peripheral vessels.
(2) Salt solution infusion (hypodermoclysis).
(3) Intravenous infusion of salt solution.
(4) Transfusion of blood.

(Rectal absorption is too slow to make this route of any value in early shock. The drop method may be advantageously employed in continued shock or in connection with other methods.)

It has been clearly demonstrated that blood can be forced into the general—so to speak, vital—circulation from the extremities. The vascular content of the arms and legs is considerable, and elastic pressure exerted on the limbs will empty these peripheral vessels, cut them off in great part from the circulation, and force their content of blood into more vital channels. This is the fundamental principle of the *elastic suit of Crile*, an arrangement by which, pneumatically, measured elastic pressure could be exerted on the legs and abdomen. On account of its inconvenience and complexity this appliance has not generally been adopted, but the underlying principle can be met to a degree by simple elevation of the lower portion of the body, in the Trendelenburg posture, by massaging the limbs and abdomen, and by tight bandaging of the extremities with elastic rubber or fabric bandages from toes to groin and fingers to shoulder. A broad bandage of flannel applied over sheet wadding or absorbent cotton will distribute the pressure evenly, without risk of cutting off the blood-supply. The pressure may be graduated; if it is so great as nearly completely to shut off the circulation, the apparatus cannot be safely worn longer than five minutes. The bandages may be left in place, or a tourniquet may be put on at their upper limit, as the groin, and the bandages removed. Thus, after both legs have been emptied, a tourniquet may be applied about the abdomen, at the level of the umbilicus, and with a pad over the aorta. These measures are effective in raising the blood-pressure.

In cases of shock, and those due to hemorrhage particularly, the injection of *salt solution* is a valuable mode of treatment. When, however, the trouble is due to primary heart failure, the increase in the quantity of fluid means an added strain upon the heart, and is, therefore, contraindicated.

Hypodermoclysis is, on the whole, the most satisfactory method of supplying fluid to the circulation; the procedure has already been described in the chapter on Thirst (Chapter III). Fully twenty minutes should be allowed for the injection of 3 pints, at a temperature of 110° F. Care should be taken that the fluid does not become cooled below body temperature in transit through the tube. Extreme care should be exercised to preserve asepsis, and too large a quantity should not be given in one area, on account of the possibility of slough. There is usually to be noted a rapid improvement in the circulatory condition after its administration, as shown by a rise in blood-pressure. This improvement may, however, be only temporary, and show signs of wearing off at the end of an hour, so that one should be prepared to repeat the infusion if indicated. It is a mistake to give too large a dose; a safe and effective rule is 2 or 3 pints, repeated hourly if indicated. Hypodermoclysis—just as transfusion of salt solution and of blood—is most valuable when hemorrhage has been an element in the causation of shock. It is important, also, that no fluid be infused while there is actual bleeding, and care must be exercised that the volume and pressure of the blood-current is not raised too high or too suddenly where clotting has been relied upon to stop hemorrhage.

Intravenous infusion of salt solution is being largely superseded by hypodermoclysis. Its disadvantage is in its much slower and more difficult technique. Its advantage lies in the immediate relief which it gives to the vascular system. On the other hand, if the saline is too rapidly infused, the blood taken into the heart will be extremely diluted, imperfect aëration and dyspnea will be induced or acute dilatation ensue, and immediate death may occur. One of the larger superficial veins of the upper arm is usually chosen—the basilic or cephalic. This is made to stand out by a loose tourniquet applied above, and, aseptically, it is dissected out through a longitudinal incision about an inch long. Two silk ligatures are passed under it. The lower one is tied; between the two the vein is nicked, the end of the cannula attached to the tube from the salt solution bottle is introduced (taking care that there is no air in the tube), and the upper ligature tied once about its tip. Not more than 2 pints had best be given at one time. After the bottle is slowly emptied the cannula is slipped out and the upper ligature drawn taut, so as to tie off the proximal end of the vessel. The skin is sewed and a sterile dressing applied. There are disadvantages beyond those of technique, as shown in the following case:

A well-formed young woman, acrobat, was seen in a state of extreme collapse from some intra-abdominal condition. An immediate celiotomy was performed and simultaneously an intravenous infusion of salt solution made. The patient recovered, but the incision for the infusion became infected and left a small scar. She threatened to institute suit against the operator, on the ground that the infusion was performed without her permis-

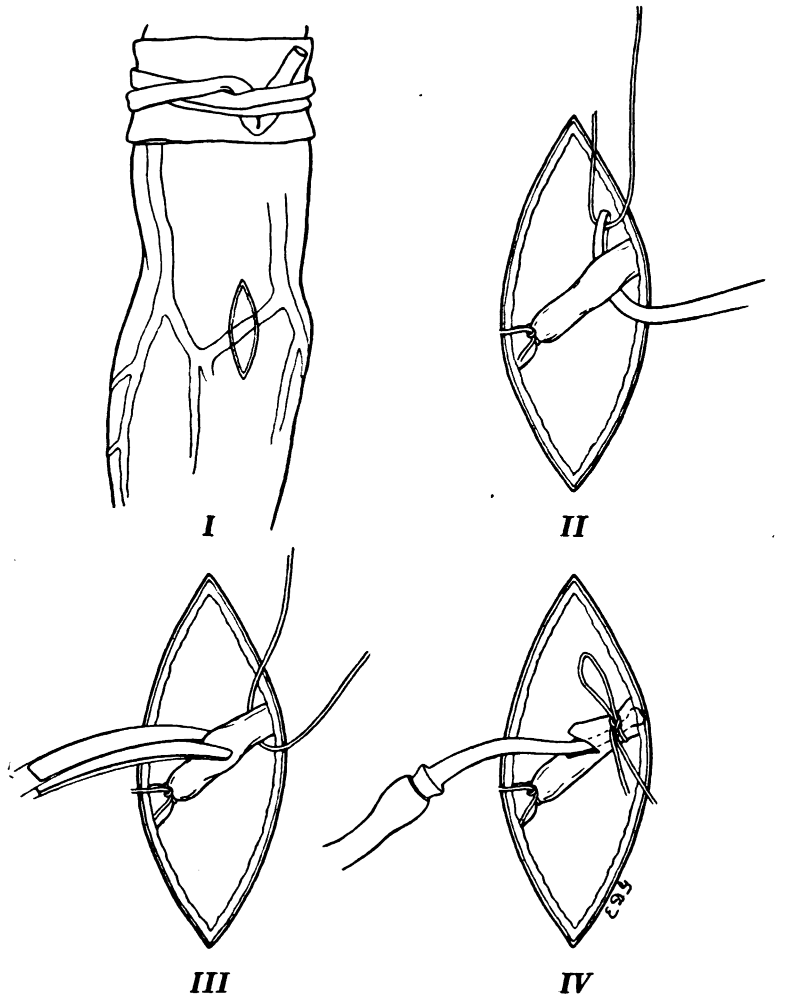


FIG. 36.—INTRAVENOUS INFUSION.

I, Exposure of median basilic vein; *II*, passing the upper ligature; the lower one is tied; *III*, opening the vein; *IV*, infusion cannula tied in place.

sion, and that the scar was unsightly and thus interfered with her earning capacity in her profession.

For the transfusion of blood, see p. 68 *et seq.*

Anemia of the vasomotor center will be combated by the measures already detailed for the purpose of equalizing and stimulating the circulatory system. It is rather important that the patient lie in bed without a pillow, and that the foot of the bed be raised on blocks. This position facilitates the return of the blood from the extremities and increases the quantity supplied the brain. Alcohol is of some use in dilating the cerebral vessels. If imperfect aëration of the blood is an element, as evidenced by cyanosis of the lips and under the finger-nails, inhalation of oxygen is indicated. If shock has developed before the patient has recovered from the anesthetic and the breathing has become rapid and shallow, oxygenation of the blood may be improved and elimination of the anesthetic assisted by the use of artificial respiration for a short period, or atropin may be given to stimulate the respiratory center.

The treatment of *intrinsic cardiac exhaustion* resolves itself practically into the consideration of the application of digitalis; the stagnation of blood in the vessels of the venous trunks and the resulting lowering of blood-pressure in the general circulation having been combated, so far as possible by the measures already suggested, a sufficient amount of fluid having been supplied by means of infusion or transfusion for the heart to work upon, and anemia of the cardio-vascular centers having been to some degree overcome by these and other measures. Digitalis induces, by direct action upon the heart, a slower and more complete emptying of the ventricles; this increases the volume of blood in active circulation, and consequently raises the blood-pressure, and, by inducing a better circulation in the coronaries, improves the nutrition of the heart-muscle itself. There is a secondary action on the vessels, consisting chiefly in the constriction of the splanchnic arteries and an accompanying dilatation of the peripheral vessels, including those of the brain.

Given by mouth, digitalis is slowly absorbed, taking from twelve to thirty-six hours before its action becomes evident. Moreover, it is cumulative in action, and for that reason it is liable to be poisonous when given in large doses. It is irritating also to the mucous membrane of the stomach. On account of its cumulative action, it should be withdrawn gradually after the indication for its use has disappeared. An overdose is shown by an abnormal slowing of the pulse. The digitalis of commerce varies markedly in strength and may be practically inert. One should use a standardized tincture of reliable origin:

the active, isolated parts and derivatives, of which there are many in the market (digitalinum verum, digitalin, digitoxin, digalen,[1] soluble digitalone, etc.), are clinically uncertain and are apt to be unstable. Insomuch as absorption by mouth is probably interfered with in shock, the drug had best be given hypodermically. This method enforces certain absorption, prompt action, and does away with gastric irritation.

A reliable preparation of strophanthin (Boehringer or Burroughs, Wellcome & Co.), given intravenously, is sometimes dramatic in its stimulating effect in profound cardiac exhaustion.[2] It is given from a hypodermic needle into a vein of the elbow-flexure in a dose of $\frac{1}{60}$ gr., to be repeated in an hour if necessary.

For acute cardiac failure, such as might occur in the course of an operation, more immediately active measures must be taken. Slapping the diaphragm and dilating the anal sphincter should be resorted to if necessary. The application of the faradic current to the diaphragm is indicated if apparatus is at hand. Atropin should be given subcutaneously to stimulate respiration. Amyl nitrite should be volatilized under the patient's nostrils. This increases the cerebral circulation. Rapidly acting stimulants, such as ammonium carbonate, camphor, ether, or aromatic spirits of ammonia, may be given subcutaneously.

If the patient collapses on the table during a celiotomy, especially under chloroform anesthesia, and other means of resuscitation fail to elicit any response, direct *massage of the heart* may be justified. The heart is grasped through the diaphragm, the left hand being inserted through an incision above the umbilicus, the ventricles are squeezed rhythmically between the fingers, or the heart is pushed against the front wall of the chest. The massage must be kept up for a long time, supporting the spontaneous contractions, or otherwise the heart's action will flag again. In some cases fifteen minutes elapse before the heart responds to the massage. Artificial respiration should be maintained simultaneously, with possible tracheotomy or intubation, to insure the rhythmic supply of oxygen to the lungs. The pelvis should be raised and the abdomen compressed to aid in increasing the blood-pressure by overcoming the paralysis of the vasomotor mechanism. This procedure, though rarely used in this country, has been applied with some reported success in Europe.

[1] Jour. Am. Med. Assoc., Sept. 11, 1909, liii, 869.
[2] A. K. Stone, Boston Med. and Surg. Jour., 1909. clxi, 586.

M. v. Cačkovič (Ueber direct Massage des Herzens als Mittel zur Wiederbelebung, Archiv. f. klin. Chir., 1909, lxxxviii, 910) reports a case of death under chloroform in a boy nine years old, in which the heart was exposed and massaged. He found 17 cases in the literature in which massage was practised for resuscitation, 9 of which completely recovered. In the rest the heart failed again after working for a longer or shorter interval. In all but 5 of the cases the syncope occurred under an anesthetic. The best results were obtained by massage applied from below the diaphragm. The outcome was better the earlier after the syncope the massage was undertaken. The first five minutes gave the most cases of success, while the massage failed constantly if ten minutes had elapsed after the onset of the syncope before the massage was commenced. The prospects are more favorable for direct massage of the heart when the syncope is of circulatory rather than respiratory origin.

Mocquot (La Réanimation du Coeur, Revue de Chir., Paris, 1909, xxix, 696; 924; 1184) reviews all cases on record and adds unpublished cases. Complete success in 9 cases out of 22. Two complete successes with massage through the chest-wall. Best mode of access is through the abdomen. The diaphragm may be too taut. In this case it should be relaxed by raising the pelvis. The heart is sometimes so flabby that it cannot be felt through the diaphragm, but after a few compressions it regains its consistency under the massage. It is probably not necessary to take hold of the heart itself to apply effectual massage. It is easier and more effectual merely to compress the ventricle against the wall of the thorax by means of the hand introduced flat under the diaphragm behind the heart, without incising it. While massage is being applied, artificial respiration should be kept up to relax the diaphragm. The Sylvester method interferes with the massage. The best technique is by direct insufflation through a tube. The rhythm of the massage should be about 60 a minute. The best success has been in chloroform syncope. The best chance exists when it is commenced not later than fifteen minutes after the arrest of the heart. Adrenalin is a valuable aid in stimulating the heart to contract, associated with massage.

The treatment of shock in accordance with the theory of *acapnia* consists in restoring carbon dioxid to the organism. Theoretically, this should give effective relief in all except extreme stages of the condition; this subject is so recent that reports of clinical results have not yet appeared in the literature. The theory seems to be supported by the report of Gatch,[1] who found no evidence of shock in several hundred anesthesias during which the patients were allowed to rebreathe some of their own carbon dioxid.

The means of supplying carbon dioxid are limited only by the avenues for absorption of the gas. It may be given as oxygen is, by connecting a funnel to the tank and hanging it inverted over the patient's face. A cradle can be placed over the patient's head and thorax and covered with a sheet to form a sort of tent, under which he can rebreathe his own carbon dioxid. It will be absorbed in the stomach from charged waters, siphon soda, ginger ale or champagne, and through the skin in a carbon dioxid bath. Normal salt solution saturated with carbon dioxid (by allowing the gas to bubble through it) may be injected intravenously (with some possibility of danger from embolism)

[1] Jour. Am. Med. Assoc., 1910, liv, 775.

into the peritoneal cavity, or instilled into the bowel by the drop method.[1]

The patient should be kept quiet, undisturbed by visitors, and, so far as possible, free from pain. His fears should not be aroused by the inadvertent talk or attitude of his attendants. Annoying routine measures in a hospital should be omitted, and the overuse of drugs avoided. The surgeon should give the impression of assurance, and the nurse should be agreeable and encouraging.

In shock persisting over any length of time it becomes important to administer nourishment regularly. Usually the rectal route is the one selected, and a nutritive enema (see Chapter XII) may be repeated every two hours. A good stimulating enema in practice is the following:

℞.	Black coffee	℥vj;
	Brandy	℥ij;
	Tr. digitalis	♏x;
	Ammon. carb.	gr. xx;
	Tr. opii	♏x.—M.

At the same time it must be seen to that the patient's comfort is looked out for, his tongue kept moist, and distention of the bladder avoided.

[1] It is too early as yet to allow anything to be said as to the ultimate adaptation of this theory to clinical surgery. It promises well in a field where previous doctrines leave much to be fulfilled. In Boston it is being tried out clinically by Dr. F. J. Cotton and Dr. W. M. Boothby, who will probably report later. We know personally something of their cases, and in some instances the effect of treatment has been striking.

CHAPTER VIII

COMA: DIABETIC, UREMIC; COLLAPSE; SUDDEN DEATH

THE development of coma after an operation is infrequent, but when it occurs it is usually of serious portent. It may follow so closely upon the operation that the patient never regains consciousness, or it may take some days to develop. We shall consider three forms—the diabetic, uremic (including puerperal eclampsia), and simple collapse. It must not be forgotten that a comatose condition may be due to scopolamin given antecedent to the anesthesia, to an overdose of morphin, or the action of a moderate dose upon a patient with an idiosyncrasy.

It was formerly one of the traditions of surgery that sugar in the urine was an absolute contraindication to anesthetization. Nowadays, unless we are dealing with an undoubted and progressing case of diabetes mellitus, it is generally considered that with the exercise of proper precautions the risk is slight.

The patient should be properly prepared by dieting during as long a period as the nature of the surgical indication will allow, so that the sugar content of the urine is diminished as much as possible. One should take care, however, that the patient is not starved. The anesthetic should be carefully and evenly administered. The period of anesthetization should be as short as possible. Chloroform is contraindicated on account of its effect on fat metabolism in the liver. Usually in the case of middle-aged glycosurics, who have been maintaining a more or less constant output of sugar for some years with only slight disturbance to health, with these precautions little need be feared, although, if the sugar percentage is high, a protracted etherization may disturb the metabolic balance and lead to fatal results.

In undoubted diabetes, especially in those cases where the sugar cannot be reduced by dieting, operations should be put off so far as possible, and their performance should be as rapid as the surgeon's technique will allow. Other things being equal, the proportion of casualties in diabetics under thirty is greater than in those over thirty. Carbohydrates should be administered after the operation with the hope of staving off coma. There is no question but that the postoperative administration of carbohydrates in reasonable amounts assists the healing of wounds in diabetics.

When the **diabetic coma** supervenes, it may come on shortly after operation, so that the patient who has been under ether for twenty minutes, to allow of the excision of a carbuncle, may be dead in from four to twelve hours. Usually it takes two, three, or more days for coma to develop, and the danger is past if it does not make its appearance within a week. The urine and the sugar percentage rapidly increase, the patient becomes restless and mentally disturbed, and the breathing and pulse-rate ascend. Then coma sets in, the face becomes pallid, the body and extremities cold, and the temperature falls to subnormal. There is deep sighing respiration, and the urine decreases in quantity and shows the presence of acetone.

Recovery from postoperative diabetic coma is rare. The usual treatment of coma in diabetes should be instituted. The patient's bowels should be emptied and injections of sodium bicarbonate (6 drams to the pint) should be given under the skin, and fluids, alkaline, if well borne, should be forced.[1]

Uremic coma after operation may be due to several causes. Among these we have to consider uremia in patients with chronic Bright's disease, anuria, dependent upon a tying in of the ureter by mistake, uremia, in cases where an only kidney has been removed or a non-functionating kidney left behind, and, for convenience, eclampsia in pregnant women.

Eclampsia rarely occurs primarily after an operation. Oftentimes the uterus may be emptied by operative means because of eclampsia, and in this case after operation there is a decided improvement, or else the eclamptic condition continues and the patient dies. Rarely after operations upon pregnant women primary eclampsia may be induced.

In middle-aged and elderly persons with impaired renal functions ether should always be used with circumspection. A prolonged anesthetization even in persons presumably normal may be followed by the exhibition of fats and albumin in the urine. In nephritic patients after an operation there may be a marked increase in the amount of albumin, renal excretion may gradually diminish in quantity and

[1] Becker (Deutsche med. Woch., 1894, xx, 359; 380; 404) reported 3 fatalities following anesthesia in diabetic patients, in which acetonuria was present at the time of operation. He reported other cases in which death followed anesthesia in diabetic patients. He was led to believe, therefore, that diabetic patients were liable, owing to some change in the process of metabolism, to pass into a condition of coma and death.

quality, and a comatose condition may develop. After a varying number of hours or days of semiconsciousness the patient dies. Not only is this to be feared in persons with Bright's disease, but it is especially to be guarded against in elderly prostatics who have been carried along for an extended period on catheterization. In these cases one is apt to find a small, thickened, corrugated bladder, markedly dilated ureters, dilated renal pelvis, all containing more or less pus, and a notably decreased secreting substance in the kidney. These cases after operation may react poorly, their urinary secretion may diminish steadily, and the patient sink from coma to death.

Rufus Hall[1] considers that patients with fatty hearts are liable to have suppression of urine after sections. In one of his cases, in which this condition was diagnosed, he performed hysterectomy. In the first nineteen hours after the operation she secreted 24 ounces of urine, heavily loaded with albumin. During the next seventy-four hours there was almost complete suppression. Coma became marked, but it was promptly relieved by steam baths and catharsis. At the end of seventy-four hours she was catheterized, and 1½ ounces of urine obtained. From this onward she improved.

Hall also operated on a patient, aged sixty-three, and performed abdominal hysterectomy for cancer of the uterus. Her arteries were atheromatous. Before the operation there was a diminished quantity of urine, but no albumin nor casts. Chloroform was administered. During the first twelve hours she secreted 5 ounces of urine, heavily loaded with albumin. The urine gradually decreased in quantity, until at the end of fifty hours there was scarcely any secreted. She remained in a condition bordering on coma for two days. She then commenced to secrete from 6 to 9 ounces of urine in twenty-four hours. This improvement lasted for more than a week; then there was a sudden suppression and she was profoundly comatose for ten or twelve hours. At the end of the third week following the operation she had suppression for the third time. It lasted two days. She recovered, and the albumin entirely disappeared.

Uremia may be the result of *anuria* caused by some surgical accident. A ureter may be cut or tied off accidentally, and cases are on record where both ureters have been accidentally divided during hysterectomy. Then, again, a nephrectomy may be performed without first ascertaining if the patient has another functionating kidney. In case the only secreting kidney is removed, the condition develops rapidly and death may occur within twenty-four hours. The temperature falls to subnormal, there may be profuse perspiration, but

[1] Am. Jour. Obst., 1898, ii, 679. Quoted by McKay, Section Cases, 1905, 486.

the skin soon becomes dry. There are vomiting and contracted pupils. There have been cases, however, that have lived for a week or ten days before coma ended in death. In all cases where there is suspicion of anuria being caused by ureteral obstruction the abdomen should be reopened and an attempt made to remedy the condition. The general treatment of these cases consists in sweating the patient profusely by means of hot air and a tent, by hot packs, the use of salt solution subcutaneously, or by rectum, or under the breast, and the administration of digitalis and potassium acetate; pilocarpin may also be used, as well as dry cupping, but pilocarpin should only be used in strong patients, gr. $\frac{1}{6}$ every four hours, three to six doses. Patients with nephritis should always be anesthetized with care, using a minimum amount of ether.

For *postoperative nephritis*, see Chapter XVIII, p. 198.

Sometimes a comatose condition after an operation will represent simple *collapse* on the part of the patient. In this case the coma is not attended by the symptoms which we should expect to find in diabetes and uremia. In cases where doubt as to the etiology of the condition exists, the urine should be obtained through a catheter and examined for albumin and sugar. The pulse is somewhat rapid and weak, but the temperature is about normal and the color is fair. Ordinarily, collapse and shock are carelessly classed together. Collapse may occur, however, in nervous patients particularly, on comparatively slight provocation. Under usual circumstances the milder methods of treatment suggested in the last chapter will be of avail in restoring the patient.

HEAT-STROKE DURING OPERATION

Three times in twelve years we have seen patients on the operating-table, or immediately after, show signs and symptoms of sunstroke or heat-stroke. The most important line of treatment, naturally enough, is preventive. At any time when the operating-room has a temperature over 90° F., a large ice-cap should be held by the etherizer on the patient's occipital region. If, however, the condition appears, with its very high temperature, rapid pulse, and delirium in sunstroke, or with its subnormal temperature, high pulse, and excessive sweating in heat-stroke, the appropriate treatment in the way of cold or warm packs and stimulation is given.

We append here a case of this sort observed by Dr. David D. Scannell:

"A boy twenty-three years of age had suffered three days from unrecognized appendix abscess, temperature 103° F., pulse 120. At the time of his sickness the heat and humidity were high. During the third day, indeed, the climatic temperature averaged 100° to 101° F. and the humidity was far in excess of normal. He left a seaside resort at 8 A. M. with a body temperature of 103.5° F. and climatic temperature of 100° F. He was conveyed five miles by steamer and in the city was carried over the hot streets to the hospital for immediate operation. The local conditions were merely those of a gangrenous appendix and a large abscess (½ pint of pus). The patient's condition on leaving the table was good except for sharply flushed areas on the cheeks. The temperature of the operating-room was 100° F. and the humidity was intense. I was exhausted at the end of the operation.

"One hour after operation the patient's temperature had gone up to 107° F., and his pulse to 180. The physical examination showed him to be still under the influence of ether and markedly irrational. I could not determine whether this mental state was due to ether or to the heat. The skin all over was intensely dry and reddened; the eyes were glistening, more so than with an ordinary ether recovery. The cheeks glowed and the tongue and lips were dry. The heart action was rapid and weak, but there was nothing about the abdomen to give surgical worry. The urine drawn by catheter was of very high color and small in amount (1 ounce).

"Under cold packs, electric fans, manual fanning, and the commoner cardiac stimulants the temperature gradually came down in less than twenty-four hours to 100° F., the greatest drop being in the first three hours. Subsequent convalescence was normal."

SUDDEN DEATH

It sometimes happens in the practice of the most experienced surgeon that a patient who is under ether, or who is apparently progressing favorably in convalescence, without complications, suddenly dies. Death may occur within a matter of minutes, no premonitory signs having appeared. Usually the diagnosis is made after death, and then, in default of an autopsy, with some degree of uncertainty. To the friends, explanation is usually difficult.

The causes which may lead to sudden death are considered under their respective headings. There remains a residuum of cases where the diagnosis cannot be satisfactorily made, even after an autopsy. The term status lymphaticus has been used loosely to cover some of this class. In their causation certain elements are involved, of which we have as yet no well-defined knowledge. The recent article on the subject by John Babst Blake[1] is worth quoting at length:

[1] Ann. Surg., 1908, l, 43.

"It is obvious (therefore) that emotion, exercise, and exertion are very frequently the exciting cause of sudden death, and a moment's consideration reveals the fact that these are precisely the conditions preceding and accompanying the average surgical operation. The apprehension and fright are very obvious, while the effect of the anesthetic upon pulse, respiration, skin, and kidneys is precisely that of moderate exercise; furthermore, the effects of long-continued and very serious surgical interference are again analogous to very severe exertion. We have, therefore, in the routine of modern surgery, reproduced with considerable accuracy the conditions under which a majority of sudden deaths occur. Is it not a fair inference that many of the all-too-frequent deaths said to be due to anesthesia are simply coincidental, and would have occurred with equal certainty under any other procedure which reproduced these precise conditions?

"Sudden deaths before, during, or immediately following operation are too common, and undoubtedly many occur that are not reported. The writer has been informed of 6 in the past year in which, with perhaps one exception, neither the anesthetic nor the operation seemed a sufficient cause. It is notorious to those who concern themselves with anesthesia that ether and chloroform are frequently blamed for catastrophies for which they are not wholly, or at times even in part, responsible.

"The more we know of the real nature of these deaths the better shall we be able to avoid them. Certain facts stand forth. We cannot yet predict with any certainty the individuals who are doomed to sudden death, nor the time of its occurrence, but we do know many of the pathologic conditions which predispose to it and the circumstances under which it most frequently occurs, In endeavoring to guard against it we must remember:

"(1) The comparative frequency of status lymphaticus. At least 8 cases have come to medicolegal autopsy as the result of sudden death in Boston within the past year, and in the experience of only two medical examiners. Another has been withheld from operation by the skilful diagnosis of a physician; another died shortly after a simple circumcision. It is believed that the diagnosis can often be made in advance by attention to the possible presence of a thymus, bowing of the femurs, a thick, short neck, and, in men, pubic hair of the female type. Of the 8 cases upon which autopsy was done, 6 died almost instantly and 2 some hours after a slight injury was received.

"(2) The invariable necessity for a more thorough and complete physical examination and personal history before operation even of a minor character.

"(3) The importance of diminishing to a minimum pre-anesthetic fright, apprehension, and intense emotion for the sake of the patient's safety as well as comfort.

"(4) The very great importance of complete histories and autopsies in every case of sudden death, an end which can be best attained by securing the active coöperation of medical examiners and coroners' physicians.

"(5) The necessity of the careful report of every case of operative sudden death, even if no autopsy is obtained, by the surgeon in charge of the case. It does not seem essential that such reports should be originally presented to the world at large, but they might well be made to a small committee of this Society, and by them examined and analyzed and the essential fact brought to the attention of the medical public."

Yandell Henderson, in a recent paper,[1] has, by his work in experimental physiology, done much toward interpreting the causes of sudden death under anesthetics. The majority of all deaths during anesthesia, he says, fall into one or the other of two general classes: those of primary respiratory failure and those in which cardiac standstill is the critical feature. Most surgeons blame the first on the anesthetic and the second on the patient, to whom they impute one or another of three defects—hypersusceptibility to anesthetics, heart disease, or status lymphaticus.

Henderson explains that the normal stimulus to the respiratory center is the carbon dioxid in the blood. In normal life the sensitiveness of the respiratory center varies extremely little, and the automatic rate and depth of breathing maintain the carbon dioxid content of the blood extraordinarily constant. Anesthetics, however, alter the sensitiveness of the respiratory center to an extraordinary degree. Ether-excitement, light and especially intermittent administration of the anesthetic, as well as fear, pain, and intense emotion, which may accompany the induction of anesthesia, increase this sensitiveness greatly, and accordingly cause rapid respirations, overventilation of the lungs, and a resulting diminution in the carbon dioxid content of the blood (which he calls acapnia). Full anesthesia restores the normal sensitiveness, while deep anesthesia renders the center less sensitive than normal.

[1] Heart Failure in Normal Subjects Under Ether, Surg., Gyn., and Obstet., 1911, xiii, 161.

Overventilation of the lungs, by withdrawing the normal stimulus to the respiratory center (carbon dioxid), is soon followed by a quiescence of this center. In this state breathing will stop when the respiratory center, becoming less sensitive as the anesthesia becomes deeper, no longer responds to the amount of carbon dioxid at that moment in the blood. The heart in these cases continues to beat for a time with undiminished force, and if artificial respiration is administered soon enough, spontaneous breathing can usually be restored and death prevented. So much for the respiratory type of fatality.

The cardiac type of death is just as readily explicable, Henderson says, on the basis of modern physiology. The condition of increased sensitiveness of the respiratory center and the resulting overventilation of the lungs induce deleterious effects upon the heart, so that a patient will become hypersusceptible to the anesthetic; that is, a dose of chloroform or anesthol which would be borne with impunity under normal conditions is liable to cause sudden cardiac failure in acapnia. Ether is far less toxic, but even it will cause death from primary cardiac failure in the case of hypersusceptibility induced by acapnia. Cases of this sort occur in the hands of inexpert anesthetists who are afraid to keep their patient sufficiently well under the anesthetic, and particularly during light and intermittent anesthesias, such as for operations on the tonsils and adenoids. Fatalities of this class occur rarely in evenly conducted and profound or prolonged anesthesia. When death does occur, it is not the happenings of the preceding five or ten minutes, but the treatment the patient received a half-hour or an hour before, which kills him.

CHAPTER IX

THROMBOPHLEBITIS; PULMONARY EMBOLISM; PYLEPHLEBITIS; SUBDIAPHRAGMATIC ABSCESS

THROMBOPHLEBITIS

THROMBOPHLEBITIS of the veins of the pelvis and extremities occurs from time to time after confinements and celiotomies. It is especially common after operations upon the uterus and adnexa and in operations about the rectum. Although thrombophlebitis in itself is a troublesome and not particularly serious complication, its occurrence must always be viewed with anxiety on account of the potentiality that exists in every thrombus to become an embolus. It commonly attacks the veins of the calf and thigh, and more usually the left than the right, and in cases of this sort, if the patient lies quietly in bed, the prognosis is good. After operations about the uterus, thrombosis is set up in the veins of the broad ligament. If the process extends along the uterine veins to the iliac or femoral vessels, or along the ovarian vein to the vena cava, the prognosis is serious, on account of the great facility with which clots may gain entrance to the vena cava and so be carried to the pulmonary vessels. Cases are reported following appendectomy,[1] as well as operations upon the female pelvic organs[2] and after delivery.[3] Thrombosis of the lateral sinus may occur following operations on the mastoid,[4] and in the orbit after attempts to sterilize the lacrimal sac.[5]

Klein[6] reports that he has met 70 cases of postoperative thrombosis in 5851 gynecologic operations performed in ten years. Over one-half of these followed celiotomies, and one-third followed myomectomies. In 20 per cent. of the cases fatty degeneration of the myocardium was found. Schweninger[7] states that 22 cases of femoral thrombophlebitis occurred in 1315 cases operated upon in four years at the

[1] Sartoli, Gaz. deg. Osp., 1909, 121.
[2] Bland-Sutton, Lancet, 1909, i, 147.
[3] Hofmeier, Cent. f. Gyn., 1909, xxxiii, 21.
[4] Wood, Lancet, Oct. 22, 1910.
[5] Lamm, Hygiea, 1910, lxxi, No. 12.
[6] Archiv. für Gynäk., 1911, xciv, No. 1.
[7] Monats. f. Geburtshülfe u. Gynäk., 1910, xxxii, No. 1.

Munich Hospital for Women's Diseases. It may be fairly stated, therefore, that the condition occurs in from 1 to 2 per cent. of all gynecologic operations.

Thrombosis occurs usually between the tenth and twentieth day. It is most apt to occur in cachectic or anemic subjects, those who have suffered from profuse and prolonged menorrhagia due to the presence of a submucous fibroid, the cancerous or tuberculous, those with infectious processes or heart disease, the corpulent and flabby, and those who have been subjected to prolonged operation. Klein[1] states that thrombosis may be expected in one-third of all cases of myoma of the uterus, especially those removed by celiotomy.

Its etiology has been open to differences of opinion, but the recent experimental researches of Kelling[2] have gone far toward clearing the matter up. It is generally the result of infection, and it represents a defensive action on the part of the organism. Sometimes in a clot which forms in the ordinary course of the obliteration of a vessel behind a ligature low-grade infections will start up, and the clot will disintegrate, and particles may be carried in the circulation to other points and there set up thrombosis anew, or in cases of stitch-abscesses infection may spread directly to the femoral and iliac vessels along branches of the superficial and deep epigastric veins. The phlebitis is usually secondary to the septic thrombus, which communicates infection to the wall of the vein in which it lies. Other factors in the causation are stasis and changes in the composition of the blood.

Large varicosities on the lower extremities afford a predisposing cause for thrombophlebitis. In a number of cases autopsy showed that an embolus in the pulmonary artery came from a fresh coagulum in a varicose vein of the leg.[3]

Embolism, a result of thrombosis, rarely comes on until the third week after the operation, and is not to be expected after six weeks have elapsed. This period represents the time during which the clot is brittle and likely to disintegrate. Separation of a portion of a clot is apt to be preceded by some unusual effort, such as getting out of bed for the first time after operation or straining during defecation.

Symptoms.—The blood-clots that ordinarily organize in the vessels of the broad ligament after pelvic operations offer no symptoms to attract attention so long as they remain sterile. If, however, a

[1] *Op. cit.*

[2] Studienüber Thrombo-Embolie, insbesondere nach Operationen, Arch. f. klin. Chir., 1910, xci, No. 4.

[3] A. Fränkel, Archiv. f. klin. Chir., 1908, lxxxvi, 531.

clot becomes infected, diagnosis will usually make itself evident on vaginal examination by the presence of tenderness and swelling on the affected side. In addition to this spot of tenderness in the iliac region the leg on the same side may be swollen and painful. The Mahler pulse, that is, a high, rather irregular pulse with a normal temperature, is sometimes observed, as a premonitory or initiatory symptom. Usually the pain will start in the calf of the leg, the pulse rise to 120, and the temperature to 101° to 102° F., and there may be a mild initiatory chill. The whole limb may become so swollen and excessively painful that the patient will not allow it to be moved. The infected vessels will stand out like cords on palpation, and their course will be marked by a red line upon the skin over them. The phlebitis may occur on the side upon which the operation was performed, on the opposite side, or upon both sides. The acute symptoms gradually subside, and it will be three weeks or a month before the patient will be able to set foot to the ground. She usually carries for many months after recovery evidences of the condition, in the shape of edema or varicose veins of the leg and ankle.

Infrequently, thrombosis may occur in the mesenteric vein after operation,[1] causing symptoms of intestinal obstruction. It may occur in the hypogastric vein, causing swelling of the nates and sometimes of the genitals, or in the azygos vein, causing edema of the back.[2] Rosenthal[3] reports a case in which thrombophlebitis following an operation for appendix abscess caused priapism, which was relieved by puncture of the right corpus cavernosum.

Prophylaxis against thrombophlebitis should always be an important consideration in the after-treatment, particularly in cases involving the female pelvis. In flabby persons of low cardiac and muscular tone, the operation should be preceded when practicable by a systematic attempt to prepare the organism for the ordeal it is to undergo. A fortnight of well-regulated regimen, diet, exercise, massage, and hydrotherapy, carefully supervised by the physician, will go a great ways to lower the incidence of phlebitis. Patients with poorly compensated vascular disease or myocardial insufficiency are better off for a preliminary course of treatment tending to restore the competency of the heart.

During operation much may be done to avoid thrombosis. When superficial veins are prominent, as in cases of ascites or abdominal

[1] Mann, Jour. Am. Med. Assoc., 1910, lv, 1922.
[2] Kelling, *op. cit.*
[3] Berlin. klin. Woch., 1910, xlvii, No. 4.

tumors, the incision should be planned so as to avoid them. Injury of the veins, by rough manipulation or sponging of the cut tissues, should be avoided. If large veins have to be divided, they should be snapped first, on either side as far away from the center of the operation as possible, cut, and each portion tied behind the hemostat. In this way long dead spaces in the veins, favorable foci for coagulum to form, are avoided, and the vein is less exposed to injury during manipulations.

With the patient in bed, frequent change of position should be encouraged. The dorsal decubitus continued for long intervals is harmful, in so far as it allows stasis in the pelvic veins. The patient should be turned to one side or the other, and even on her stomach, at intervals of an hour or two. When pelvic thrombosis is anticipated, it is advisable to raise the foot of the bed; this helps to prevent the stagnation of blood in the pelvis, and stimulates the vital centers in the medulla. Massage and systematic movements of the legs help to keep up the circulatory tone and to prevent thrombosis in the legs. The massage should be carried out three or four times daily, and should be accompanied by bending exercises of the ankle, knee, or hip. The pulmonary circulation may be assisted by breathing exercises; the patient should be taught to breathe deep, and once an hour she should be instructed to take ten or twelve long breaths. The intestinal functions should be started early.

Some virtue is supposed to reside in the copious drinking of water. The quantity of body fluids should not be allowed to run low, and deficiency should be supplied either by drinking, subcutaneous infusion, or rectal installation of salt solution. The latter method has the advantage of promoting circulation in the pelvic veins.

Much milk should not be allowed patients just operated upon, because the calcium which milk contains promotes coagulation. If, however, sodium citrate is added to the milk in the proportion of 2 gr. to the ounce, this disadvantage will be overcome. The following prescription may be employed, and one teaspoonful added to the ounce of milk:

℞.	Sodium citrate..	gr. xlviij;
	Oil of peppermint..	♏ij;
	Distilled water..	℥iv.—M.

Patients should be gotten up and out of bed early, but gradually. The activity of walking is the best preventive of stasis. In clinics where this practice is a routine, the proportion of cases of thrombophlebitis after operations on the pelvic organs has fallen decidedly. Cases of embolism occur, but probably less often than where early rising is not followed. Standing still, erect, is worse than lying down, and should be avoided.

Treatment.—Absolute rest in bed for at least five weeks must be enjoined. The patient must be moved as little as possible, and getting in and out of bed should be absolutely forbidden. This is on account of the grave danger of the detachment of a portion of the clot. For the same reason, an active purge should never be given, but enemas employed instead when called for. Over the region of the pain hot applications should be made. The foot and leg should be wrapped in a thick layer of absorbent cotton, the foot should be elevated upon a soft pillow, and movements of the foot and leg should be prohibited by means of sand-bags placed on either side. Belladonna ointment may give relief. Morphin will sometimes be necessary. Pressure from the bed-clothes should be relieved by means of a cradle placed over the leg. Massage of the limb in every sense should be strictly avoided. Operation has been performed for the removal of a thrombus.[1]

PULMONARY EMBOLISM

Pulmonary embolism following operation is usually consecutive to thrombosis in the deep epigastric or pelvic veins and in the veins of the lower extremities or in the mesenteric veins. Injury to the vessel or changes in the blood sufficient to cause clotting at any particular point may be followed by a dislodgment of the entire clot or of a small portion, which may be broken off and carried away in the blood-stream. When this happens, it is carried by the blood-current until it reaches a vessel which is too small for it to pass through. As postoperative thrombosis is practically always venous in origin, the stopping-place of the embolus is usually in the lung. If the emboli are of sufficient size or number to block the more important branches of the pulmonary arteries or the artery itself, immediate death will ensue. If the clot is broken up in its passage through the right heart, so that the block is just incomplete, death will be preceded by a more or less prolonged respiratory struggle. If the emboli are smaller, strong heart action may suffice to overcome the effect and the patient survive. When minute emboli lodge in the smaller branches of the pulmonary arteries, infarction of the lung occurs.

It is estimated that embolism occurs in about 20 per cent. of all cases of postoperative thrombosis. It comes on, as a rule, anywhere

[1] Lecene, Archiv. des Maladies du Coeur, March, 1909.

from four to ten days after the operation, but it may be postponed until two or more weeks. The fatality is variously stated at about 50 per cent.[1] Le Normant[2] found that embolism occurred after $\frac{1}{2}$ of 1 per cent. of all celiotomies, and Ranzi, in $\frac{8}{10}$ of 1 per cent. Almost invariably it has been known to follow some slight unusual exertion on the part of the patient. This may be as small a thing as a movement to accommodate himself in bed, perhaps during a change of dressing, or it may be due to getting out of bed for the first time, sitting up in bed, and particularly straining during defecation. Death may occur within a few minutes of the beginning of symptoms, or two days may elapse before the fatal termination.[3] In the cases of longer duration it is evident that the embolus gradually increased in size, by accretion of clot, or that there occurred a series of emboli. As a rule, there is an interval of three to six hours from the onset of symptoms to the fatal termination. Diagnosis is made during life in only a small proportion of cases. That fatalities are not uncommon are shown by the report of Fraenkel,[4] which stated that during 1906 in the Vienna General Hospital 18 deaths occurred from postoperative embolism of the pulmonary artery.

It is said to be more likely to follow operations in persons who are debilitated; nevertheless, it is known to happen in persons who are robust, and the patient may be apparently perfectly well and have entirely recovered from the operation. Young individuals are more or less exempt, and, if affected, may perhaps recover, presumably on account of the yielding elasticity of their vessels, which may allow the blood to push its way beside a clot.[5]

The onset is always sudden. The patient finds it difficult to breathe, soon becomes cyanotic, raises some bloody sputum, and cries out from a sense of suffocation. His face takes on an anxious look, his lips are livid, he becomes restless and complains of pain, he gradually becomes pallid, the pulse weakens and becomes intermittent, and the respiration becomes gasping and distressed. Unconsciousness develops and death ensues.

Recovery depends upon the size and situation of the embolus and the integrity of the heart and lungs. If only one branch of the

[1] Mauclaire, Archiv. Gén. de Chir., June 25, 1908.

[2] Postoperative Embolism in the Lung, Archiv. Gén. de Chir., 1909, 221.

[3] Ranzi, Postoperative Lung Complications of the Nature of Embolism, Archiv. f. klin. Chir., 1908, lxxxvii, 350.

[4] Postoperative Thrombosis-embolism, Archiv. f. klin. Chir., 1908, lxxxvi, 531.

[5] C. L. Gibson. Pulmonary Embolism following Operation, Med. Record, 1909, lxxv, 45.

artery is occluded, a strong cardiac action may tide over the individual. If the embolus is so situated that the collateral circulation through the pulmonary capillaries is sufficient, the patient will recover. The area of lung tissue which is cut off from the circulation then becomes an infarct.

Prophylaxis is a matter of importance in this condition. It is a good rule never to operate in the presence of varicose veins of the lower leg without first ligating or removing them. Operations should not be performed where phlebitis or anemia is known to exist. If the pulse is small or irregular, digitalis should be given for a few days before operation. "Varicose veins in the vicinity of abdominal tumors, such as are not infrequently seen in the female pelvis in connection with myomata of the uterus, should be extirpated with the growth or ligated as far as possible toward the pelvic wall to avoid the likelihood of thrombosis."[1] In operating, the veins should be handled carefully, and, especially, injury to the vessels in the epigastrium should be avoided, as well as friction on the femoral vein and manipulation of the spermatic cord. After confinements, operations about the rectum, and operations on the uterus and adnexa, particularly where the possibility of sepsis exists, and in other cases where predisposition to thrombosis might exist, all the precautions detailed under the prophylaxis of thrombophlebitis should be carried out.

Treatment.—In cases of large embolus and sudden and complete blocking of one of the main branches of the pulmonary artery, death may occur before the surgeon has time to arrive upon the scene. If the patient survives the first shock of the occlusion, or if the occlusion is incomplete, the opportunity for treatment should not be neglected. Stimulation should be supplied by means of hypodermic injections of quick-acting and freely diffusible agents, such as camphor, ether, and ammonium carbonate. A mixture such as the following,

Camphor	1;
Ether	3;
Olive oil	6,

is excellent for use in emergencies. Oxygen and artificial respiration are indicated where the patient is laboring for breath. So long as the heart's action is strong, hope for recovery should be maintained.

The body should be kept warm by means of water-bottles and the room should be kept absolutely quiet. Complete repose should be en-

[1] Bartlett and Thompson, Occluding Pulmonary Embolism, Ann. Surg., 1908, xlvii, 717.

joined. If the patient is restless, morphin should be administered in small doses until she rests comfortably. If she lives for hours, there is a possibility of collateral circulation about the block asserting itself, and everything should be done to assist in maintaining the circulatory equilibrium. The patient should be allowed plenty of fluids, but no milk, calcium salts, or carbonate of magnesia.[1] If the patient progresses favorably, the area of lung which has been shut off from the general circulation will organize and become a hemorrhagic infarct, which, after a few days, will reveal itself to physical examination of the chest as an area of consolidation. The infarct in itself may prove fatal, or secondary pneumonia develop as a result.

Operative Treatment.—Recently, under the leadership of Trendelenburg,[2] the possibility of relieving cases of pulmonary embolism by the bold procedure of cutting down upon the pulmonary artery and removing the embolus has been urged, and the operation actually performed with sufficient success as to promise some advantage in suitable cases.[3]

The advisability of operative interference depends upon the rapidity of the course and the accuracy of the diagnosis. As to diagnosis, the characteristic picture has already been described. In addition, there may be minor indications, such as a previous operation in which the larger veins were exposed or ligated, the presence of an evident thrombosis of the femoral or other veins, fracture of one of the lower extremities, or varicosities.

As to rapidity, death does not always result as suddenly as is generally supposed. Of 9 cases, Trendelenburg found that only 2 died suddenly in from one to two minutes. In the other 7, ten minutes to one hour elapsed before death occurred.

He operates by making a transverse incision on the left side over the second rib, and a vertical incision on the left side of the sternum. Three or four inches of the second rib, in addition to the adjacent sternum, is resected. A vertical incision is made through the pleura and into the pericardium at the level of the third rib. The vessels lie a little underneath the sternum; they are pulled forward and a rubber tube is passed behind the aorta and the pulmonary artery and afterward drawn up tight. Work must then be proceeded upon with the utmost celerity. He incises the pulmonary artery, pulls out the em-

[1] Bidwell, Pulmonary Embolus and Thrombosis after Laparotomies, Practitioner, Feb., 1909.

[2] Central. f. Chir., 1908, No. 35, Beilage.

[3] See Ann. of Surg., 1908, xlviii, 772.

bolus with a pair of forceps, and immediately closes the incision in the arterial wall with clamps, using no more than forty-five seconds. He then releases the compress and sutures the skin at leisure. He has operated three times—the first man died on the table; the second recovered, but died fifteen hours later from heart failure; the third survived the operation for thirty-seven hours, and then died from postoperative hemorrhage from the internal mammary artery.

The embolus is generally located in the main trunk of the artery or in one of its chief branches, so that, anatomically, there is no great difficulty in finding and removing it. The chief obstacle so far has been the failure to recognize the condition in time. Sievers, following the Trendelenburg technique,[1] removed an embolus in a pulseless patient, who survived the operation fifteen hours. Trendelenburg reported another case in a man of forty-five years,[3] and Murphy[3] successfully removed an embolus from the common iliac artery.[4]

HEART-CLOT

In a few rare cases autopsy has shown that sudden death after operation has been caused by the lodgment of a large clot in the heart itself. It is said that if the clot is small, it may cause no symptoms, or nothing more than transitory murmurs as the clot encroaches upon one or another of the valves of the heart. In some cases which recovered the diagnosis was made on the presence of a murmur, feeble and tumultuous action of the heart, and attacks of dyspnea. Such a symptom-complex may be followed in a few days by evidences of pulmonary embolism, which can be interpreted to mean that the clot, freeing itself from the heart, has been carried into the pulmonary artery, where it has lodged as an embolus, or that there has been an extension of clot formation into the pulmonary artery and subsequent embolism.

[1] Fall von Embolie der Lungenarterie nach der Method von Trendelenburg operiert, Deut. Zeit. f. Chir., 1908, 93.

[2] Operationen der Embolie der Lungenarterie, Deut, med. Woch., 1908, xxxiv, 1172.

[3] Jour. Am. Med. Assoc., 1909, 52, 1661.

[4] Busch (Ueber plötzliche Todesfalle mit besonderer Berücksichtigung der Iudikationsstellung für die Trendelenbergsche Operation bei Lungenembolie, Deut. med. Woch., vol. xxxv, July 22, 1909) states that of 878 fatalities in 9727 patients in Kôrte's surgical service in Berlin during the last four years, 22 of the deaths occurred suddenly, and the symptoms indicated pulmonary embolism. Of these 22 cases, in 12 death was instantaneous. Autopsy in 7 showed embolism in 4. One showed a thrombus which could readily have been removed by the Trendelenburg operation. In 10 cases the symptoms persisted ten minutes to three hours before death. Autopsy revealed embolism in 6, and conditions would have been favorable for operative intervention in 5. In 4 other cases the assumed embolism did not exist, death having been due to fatty degeneration of the heart.

In cases which end fatally, differentiation between heart-clot and pulmonary embolism cannot be made certain without autopsy. In the following case, which was diagnosed clinically as heart-clot, we regret that autopsy was not permitted:

Male, forty-eight years old. Operation two years before for acute appendicitis; right rectus incision, splitting fibers. Third day a subsequent sepsis in wound; a complete disorganization of the ligatures and sutures, and gradual development of ventral hernia at site of operation. Present operation for repair of hernia. Sac excised; found to contain most of omentum, transverse colon, and many coils of small gut. Omentum tied off in mass with interlocked sutures and intestines freed with difficulty from sac. Adhesions ligated, peritoneum closed, and fibers of rectus muscle brought together with mattress sutures. Rectus sheath closed in the same way. Good ether recovery, there being almost no vomiting. Subsequent convalescence up to the tenth day uneventful; normal temperature and pulse throughout; gas pains singularly absent, there being no necessity for enemas more than once or twice. On the tenth day climax of good subjective feeling; temperature and pulse normal, appetite good, and patient looking forward to sitting up; subcutaneous stitch had been removed two days previously. On the afternoon of the tenth day patient was awakened out of his sleep by intense precordial pain. The pulse could at that time be felt, but was weak, occasionally fluttering, with the rate at about 100; respirations were 40; patient was gray, as with the fear of death, but there was no cyanosis. A hot-water bag was put over the heart and hypodermic stimulants of various kinds given. He failed to rally, the distress remaining constant about the heart. There was no dilatation of that organ apparent; no cyanosis appeared even to the end. He died in about forty minutes from the first onset of symptoms.

FAT EMBOLISM

Fat embolism occurs chiefly after fractures, operations on bones, and occasionally after burns.[1] The condition is the result of small fat particles entering a wounded vessel and, finally, lodging in the vessels of the brain. The symptoms are those of cerebral embolism, usually beginning with a convulsion, and ending in paralysis of greater or less extent.

The treatment consists in absolute quiet, ice to the head, and morphin. A. Schanz[2] has recommended the intravenous or, in more subacute cases, the subcutaneous use of salt infusions with a view to washing the particles away from their site of lodgment. He has had 8 cases successfully treated by this method.

[1] G. Pacmotti, Gaz. degli Ospedali e. delle Cliniche, 1910, xxxi, 857.

[2] Centr. f. Chir., 1911, xxxvii, 43.

AIR EMBOLISM

Sudden death may follow the introduction of air through a wound in the jugular vein in the course of operation upon the neck, or the introduction of air into the uterine sinuses after parturition. Death is usually instantaneous, the air reaching the heart and interfering with its contraction.

L. V. Lesser,[1] working on animals, has found that after experimentally produced air embolism he can resuscitate the animal by injecting salt solution directly into the right ventricle. This is certainly worth attempting in such desperate cases.

PYLEPHLEBITIS

Ascending septic infection of the portal veins after appendicitis is by no means rare. Gerster[2] reports that it was found nine times in 1187 cases of appendicitis operated upon at the Mt. Sinai Hospital. Munro[3] reported a series of 9 cases.

The condition appears to originate in the thrombosis which naturally occurs in the appendicular veins after their obliteration. There is a direct line of communication open between these veins and the portal system through the superior mesenteric vein. The case need not be clinically a septic one, for the complication occurs after clean interval operations as well as operations performed during the acute stage and those complicated by abscess formation. Occasionally it occurs when no focus of infection can be found to account for the condition.

The pathology has been studied by Thompson[4] in a series of 8 cases. Septic, partly disintegrated thrombi are found at autopsy to extend from the veins draining the appendix region to the portal vein, and this is either filled with pus or occluded by thrombus. Small bits of septic clot, becoming dislodged from the mass in the portal vein, are carried up into the liver until they are arrested in the finer branches, and there they are found to set up multiple abscesses in the liver substance, usually by preference on the anterior superior surface of the right lobe.

The condition is not always readily or correctly diagnosticated, partly because of its rapid course. Occasionally a case will run for three or four weeks.[5] It is most likely to be confused with a secondary

[1] Centr. f. Chir., 1910, xxxvii, 313.
[2] New York Med. Record, 1903, June 27.
[3] Boston Med. and Surg. Jour., 1902, 81.
[4] Boston City Hospital Med. and Surg. Reports, 13th series.
[5] Moschcowitz, Ann. Surg., 1911, liii, 549.

peritonitis. It should always suggest itself whenever a patient, shortly after an appendectomy, develops chills, a high white count, and an irregular temperature, fluctuating from normal to 105° or 106° F. Other signs to be looked for are tenderness along the outer border of the right rectus muscle, painful enlargement of the spleen and liver, with, in most cases, jaundice and rapid and profound prostration.

The prognosis is poor because of the frequency of the occurrence of liver abscesses. A single abscess may be drained and the patient recover, but in the face of multiple abscesses, which is the rule, operation offers little hope for relief. Nevertheless, exploratory operation should always be performed and abscesses evacuated and drained, as in subdiaphragmatic abscess.

SUBDIAPHRAGMATIC ABSCESS

Subdiaphragmatic abscess may occur after operations, particularly about the stomach and appendix.[1] After stomach operations it may represent a local peritonitis following a leak in a posterior gastro-enterostomy; it may be the result of the extension of infection along the subperitoneal lymphatics from the appendix or of abscess of the liver following pylephlebitis. Any suppurative inflammation originating in or about any viscus in the upper half of the abdomen will tend to gravitate free pus, provided the patient is flat on his back, to the capacious hollows under and about the liver. It may result accordingly from suppurative cholecystitis, perinephritis, perforation of the diaphragm in empyema, or it may represent the last focus of a general peritonitis.

Generally speaking, abscesses following appendicitis and liver abscess occur on the right side of the suspensory ligament of the liver, those originating in the stomach, on the left. Pleurisy with effusion, either serous or purulent, occurs as a complication in over half of the cases. Gas in varying quantity, the result of bacterial decomposition, is present in about half of the cases; indeed, the cavity may contain but little else. When gas and pus are both present in sufficient quantity, shifting dulness may be demonstrated as the patient turns.

The symptoms are usually slow in developing, and are apt to be readily confused with those of pleurisy with effusion and empyema. The temperature is irregularly elevated, and there is often cough and shallow respiration. There is localized pain and tenderness and there may be chills. As the collection of pus increases the symptoms become

[1] See A. Lawrence Mason, Subphrenic Abscess, Boston Med. and Surg. Jour., 1893, cxxix, p. 217, for history. See also Catz and Kendirdjy, Les Abcès Sous-phréniques, Rev. de Gynec. et de Chir. Abdom., 1908, xii, 469.

aggravated. The lower edge of the liver is pushed down perceptibly and the intercostal spaces are likely to bulge. Some cases show local edema. The difficulty in diagnosis, where the history of the case does not give any assistance, is complicated by the presence of the pleural effusion, which nearly always accompanies a subdiaphragmatic abscess. The aspirating needle is always of service in locating the pus-cavity; to reach the perihepatic space the needle must pierce the chest-wall and then pierce the diaphragm. If the diaphragm is not paralyzed by the inflammation or pressure, the needle which has pierced it will move up and down with respiration. Pus from below the diaphragm flows on inspiration; pus above the diaphragm is expelled by expiration. If nothing but air or gas escapes, the probability is that it issues from below the diaphragm.

The *prognosis* is serious. With operation it is far better than without, although in rare cases the abscess resolves, or it discharges externally, into a bronchus, or through one of the hollow viscera. Unoperated cases sometimes drag on for weeks and months. The mortality of subdiaphragmatic abscess from all causes is generally stated at about 50 per cent. Two-thirds of the cases that recover get well with operation and one-third without.

The *treatment* consists in incision and drainage; aspiration is to be considered as a diagnostic method only. It is often wise to have the operation follow immediately upon the aspiration if this be positive. If there is bulging at any point, the incision is made over this area, otherwise it is preferable to go in through the bottom of the pleural cavity or just below the reflexion of the parietal pleura. About two inches of the ninth and tenth ribs are resected in the posterior axillary line. The pleura may be pushed up and the diaphragm incised below it, or the pleural cavity may be incised and the surfaces of the pleura sewn together above. If need be, an empyema and a subdiaphragmatic abscess may be drained through the same wound. Drainage should be ample and rubber tubing is usually more efficient than gauze.

CHAPTER X

ARTIFICIAL RESPIRATION; OXYGEN; ELECTRICITY

During the first half of the last century mechanical apparatus for maintaining artificial respiration had a popular vogue. Some depended on intralaryngeal tubes; some, on tracheotomy cannulæ, made of metal, rubber, or leather. Some had a simple bellows, others had compound bellows for alternately injecting and aspirating the air, which, in some of the apparatus, was warmed. They were to be found as part of the regular equipment of many hospitals, jails, fire and life-saving stations in England and on the Continent, and they were used without hesitancy in cases of asphyxiation from smoke or gas, in drowning, and drug poisoning. But the method fell into disrepute as a result of mishaps which depended upon rough use and too forcible pressure, so that when postural methods were introduced they were immediately accepted. These have enjoyed undisputed sway since, and it is only during the past few years that interest has again been aroused in mechanical appliances.

Artificial respiration has its chief place in surgery in relation to anesthesia. It must be resorted to whenever respiration fails while the patient is under the influence of the anesthetic, and again whenever asphyxia threatens a patient recovering from anesthesia. In the former case the patient has to be dealt with on the table. If the anesthetic is ether, removing the cone and exerting rhythmic pressure on the sternum two or three times will usually suffice to start up respiration. If chloroform is being used the outlook is more serious, as with this agent, in contradistinction to ether, the cardiac action may cease simultaneously with, or closely following, the cessation of respiration. In either case, where the respiratory failure is due to direct action of the agent, and not to mechanical causes, the value of artificial respiration will depend upon whether the heart has been so far weakened as to be unable to carry on the circulation. Practically, then, if the heart is beating rhythmically and a pulse can be felt, if the anesthetic is removed and artificial respiration be immediately instituted, it should invariably be successful. If, however, a highly concentrated vapor has been inhaled and the heart has been weakened thereby, and has ceased to beat or is feebly fluttering, the prognosis is not good.

In recovery from the anesthetic the proposition is somewhat different. Here the failure in respiration arises from some mechanical interference. Fatal accidents have resulted from such foreign objects as plates of false teeth, plugs of gum, or tobacco falling into the air-passages. The common causes of postanesthetic asphyxia are the aspiration into the larynx of vomited matter or accumulated blood or saliva in the mouth and the closing off of the larynx by the tongue, in a state of relaxation, falling back into the throat. The treatment of this form resembles that for asphyxia by drowning.

We shall consider two forms of postural artificial respiration: the supine and the prone. The supine is ordinarily better when asphyxia

FIG. 37.—ARTIFICIAL RESPIRATION ON THE TABLE.
One man at head holds jaw forward and exerts rhythmic traction on tongue; one man at each side manipulates an arm.

occurs on the operating-table; the prone is of advantage in cases where asphyxia is due to obstruction.

The supine method—named for Sylvester (1858)—attempts to imitate natural inspiration by increasing the capacity of the chest. This is effected by drawing the arms upward toward the head (Fig. 38). Expiration occurs as the arms are gradually lowered (Fig. 39) again to the sides, and is completed by exerting pressure on the thorax (Fig. 40). This maneuver requires three persons—one standdig on either side to manipulate an arm and one forcilby to hold forward the tongue by means of tongue forceps and to swab out the mouth if necessary. The two operators should work slowly and in unison and the rhythm should be that of normal respiration.

In cases of emergency arising after the anesthetic, especially where the attendant is alone and cannot get help, there are many advantages in the " prone pressure method " recently described by Schaefer.[1] In this method the patient is laid belly down upon the floor, face to

FIG. 38.—ARTIFICIAL RESPIRATION. SUPINE METHOD.
Arms extended. Inspiration.

one side, and arms at right angles to the body. The operator kneels at his side and places his hands over the lowest ribs of the patient, one on either side. Then, swinging slowly forward and backward, by

FIG. 39.—ARTIFICIAL RESPIRATION. SUPINE METHOD.
Beginning expiration.

allowing his weight to fall rhythmically on and off his wrists, he can compress not only the thorax, but also the abdomen against the ground, thus forcing the air from the lungs. As the pressure is relaxed the

[1] Jour. Am. Med. Assoc., 1908, li, 801.

elasticity of the parts causes them to resume their natural shape and air is drawn in through the glottis. The pressure is exerted gradually and slowly over a space of some three seconds. It is then removed for two seconds and again applied, and so on, at the rate of about twelve times per minute. This method does not tire the operator; it requires only one man; the tongue falls naturally forward and does not need to be held; mucus, vomitus, or blood drain readily from the mouth.[1]

Rough artificial respiration may be the finishing touch. The first should always be *expiratory*, not inspiratory. Rapid and violent efforts may lead to dilatation of the heart.

Laborde[2] introduced the method of reflex stimulation of respiration by means of *rhythmic traction on the tongue*. The tip of the tongue is

Fig. 40.—Artificial Respiration. Supine Method.
Completed expiration. Arms flexed, compression of chest by pressure on elbows.

seized in tongue-forceps, and it is pulled out its entire length rhythmically, at the rate of about eighteen times a minute. Sufficient force should be exerted to lift the glottis clear away from the trachea; the novice will be surprised at the extent of the tongue which appears when the procedure is properly performed. This method should always be carried on with the supine form of artificial respiration when some one may be spared to perform it. The extension of the tongue should be synchronous with inspiration; otherwise, before artificial respiration is commenced, a free airway should be insured by some means of holding forward the tongue, such as tying a silk thread through its tip and about the patient's ear.

[1] See also A. Keith, Mechanism Underlying the Various Methods of Artificial Respiration, Lancet, 1909, i.

[2] Les Tractions Rhythmées de la Langue, Paris, 1895.

The subject of artificial respiration by means of mechanical apparatus has been greatly enlightened by the recent work of Sauerbruch, Brauer, Willy Meyer, Robinson, Meltzer, and others, with negative and positive pressure as applied to thoracic surgery. The adaptation of positive pressure to artificial respiration requires only a source of air, such as a single bellows or pump, to which oxygen can be added if desired, a means of supplying this to the airways of the patient, which may be an intratracheal tube, an intubation tube, a tracheotomy tube, a face-mask, or a cabinet in which the head may be enclosed, and a valve for shutting off the air current at rhythmical intervals, to allow the lungs to collapse. The best-known American apparatus is that of Fell, which he introduced in 1887, and to which he accords the credit of saving 28 lives. The elaborate cabinet of Janeway and Green, operated by electricity, has the added advantages of being absolutely automatic, the frequency of respiration and the ratio of the duration of inspiration to expiration can be varied at will. No instrumentation of the larynx or trachea is required. The latest principle is that of intratracheal insufflation, evolved by Meltzer and Auer, which relies on introducing the stream of air directly into the lungs through a tube passed along the trachea to the bifurcation. A simple apparatus of this sort has been described by Ehrenfried.[1]

Oxygen may be used simultaneously with artificial respiration, either by introducing it mixed with the air in mechanical respiration, or through a catheter passed into the patient's nose, or by means of a funnel hung inverted over his face. Kuhn[2] advises passing the oxygen directly into the trachea through an O'Dwyer tube or a laryngotomy. Schmidt and David[3] warn against using too concentrated a stream of oxygen, on account of its injurious action on the bronchial and alveolar epithelium.

The use of *electricity* has been widely advocated. The faradic current acts beneficially by stimulating respiration. The current should not be strong, as cardiac action may be inhibited. The diaphragm may

[1] See Matas, History and Methods of Intralaryngeal Insufflation, Southern Surg. and Gyn. Trans., 1899, xii, 52.

Fell, Artificial Respiration, Surg., Gyn., and Obstet., 1910, x, 572.

Green and Janeway, Artificial Respiration and Intrathoracic Esophageal Surgery, Ann. Surg., 1910, lii, 58.

Ehrenfried, Intrathoracic Insufflation Anesthesia, Apparatus, and Cases, Boston Med. and Surg. Jour., 1911, lxiv, 532; Transactions Mass. Med. Soc., 1911.

[2] Resuscitation in Apparent Death by Means of Oxygen and Intubation, Therap. Monats., Nov., 1908, xxii.

[3] Münch. med. Woch., 1911, lviii, No. 1.

be excited to contraction by stimulation of the phrenic nerve. One pole should be placed over the pit of the stomach, the other at the angle of the jaw, near the anterior border of the sternomastoid.[1]

[1] See E. A. Spitzka, Resuscitation of Persons Shocked by Electricity, Jour. Med. Soc. of New Jersey, 1909, v. 549. Crile (Surgical Anemia and Resuscitation, Am. Jour. Med. Sciences, 1909, cxxxvii, 469) describes the following technique for resuscitation after the heart stops beating from chloroform: The patient in the supine posture is subjected at once to rhythmic pressure on the chest, with one hand on each side of the sternum. This pressure produces artificial respiration and a moderate arterial circulation. A cannula is inserted toward the heart into an artery. Normal saline, Ringer's or Locke's solution (see page 50), or, in their absence, sterile water, is infused by means of a funnel and rubber tubing. As soon as the flow has been begun, the rubber tubing near the cannula is pierced with a needle of a hypodermic syringe loaded with 1: 1000 adrenalin chlorid, and from 15 to 30 min. is at once injected. The injection is rapid, in a minute if needed. Synchronously with the injection of the adrenalin, the rhythmic pressure on the thorax is brought to a maximum. The resulting arterial circulation distributes the adrenalin and spreads its stimulating contact with the artery, bringing a wave of powerful contractions and producing a rising arterial pressure. When the coronary pressure rises to 40 mm., the heart is likely to spring into action. As soon as the heart-beat is established, the cannula should be withdrawn. Bandaging the extremities and abdomen tightly over large masses of cotton is very useful.

CHAPTER XI

DIET AFTER OPERATION

ETHER, rather more than chloroform, is apt to occasion nausea and vomiting during the period in which the patient is recovering consciousness and after. The degree to which this occurs seems to depend on the duration of anesthesia, the amount of anesthetic given, the evenness of its administration, the length of time consumed in going under, and the amount of food in the patient's stomach. The vomiting may, however, be considerable in cases where no reason can be assigned and in susceptible persons. Usually there will be no desire and no necessity for food until the effects of the anesthetic have passed off, and then if a tendency to nausea persists, the diet should be a fluid one, consisting of an ounce or two of milk, buttermilk, beef-tea, cocoa, tea, or coffee, according to the patient's desire, and so long as the gastric irritation remains.

If the operation has been a severe one, or if the patient is suffering from hemorrhage or shock, it may be of importance for him to receive fluid or nourishment immediately, and in this case it may be given by rectum or subcutaneously, even before he has fully recovered from the anesthetic.

In abdominal sections it may be wise to give the gastro-intestinal tract complete rest by abstaining from all food by mouth for twenty-four hours, and in operations on the stomach the patient may be sustained by rectal enemata for two or three days. The danger in these cases from the occurrence of vomiting, or of stasis fermentation and flatulence, is far greater than that of inanition from abstinence from food. In general it may be laid down as a good rule that if there is any operative lesion of any portion of the alimentary tract, that portion should be given as complete rest as possible for a reasonable length of time. After mouth-feeding has been started articles of diet should be selected which do not call for digestive action by the particular portion of the gastro-intestinal canal which has been involved in the operation.

In selecting the diet stress should be laid upon one other point, namely, not to include any food-stuff which in the process of digestion is likely to give rise to fermentation or formation of gas and so cause flatulence and distention. Certain staple articles of food, such as milk, are extremely likely, under the conditions of intestinal stasis which exist after a celiotomy, to be improperly digested by the stomach, and give rise to fermentation, and as curd it may pass a long way down the intestines and cause flatulence. Peptonized milk has not these drawbacks, but patients rarely like it; flavored with cocoa it may be relished. Sir A. E. Wright[1] observes that the time-honored milk diet in acute diseases and after operation is a direct stimulation to the onset of thrombosis, owing to the large amount of calcium present in such a diet increasing the coagulability of the blood. Thus, milk, even when peptonized, is not to be considered a proper food for mouth-feeding after abdominal operations.

An excellent substitute for milk—unirritating, easily digested without gas formation—is albumin-water, made by beating up the whites of three eggs in a pint of water. It may be flavored with lemon and sugar, and 2 pints may be taken to represent a fair amount of nourishment for twenty-four hours.

Another form of fluid nourishment which can often be made use of to great advantage is the homely drink, "raisin tea." This is made by pouring a glass of boiling water upon a half-cup of chopped raisins, stewing gently for an hour, and straining. The filtrate may be given full strength or diluted with water or albumin-water, hot or cold, as the patient desires. It is highly nutritious, representing a high proportion of grape-sugar, the most readily assimilable form of carbohydrate. To the patient it is palatable and refreshing.

Beef-tea, as ordinarily made, and so often added to the invalid's diet, must be considered only as a stimulant. Beef-juice, extracted from fresh, juicy beef-steak by means of a meat-press or lemon-squeezer, is nutritious, although it contains hardly more albumin than milk. It may be served slightly warmed, with a pinch of salt. Hericourt[2] extols the virtues of raw meat and raw meat juice in wasting diseases of whatever nature, in convalescence and after hemorrhage. The proprietary beef-extracts are hardly worth considering. All types of patent foods should be shunned, in spite of their exaggerated representations, as of relatively little value compared with natural foods, properly selected. Where acetonemia is anticipated, it should be forestalled by a diet rich in carbohydrates, such articles of food as baked potato, cornstarch pudding, gruels, and mush.

Ordinarily, one regulates with some care the quantity of food

[1] Folia Therapeutica, Jan., 1909.
[2] Lancet, Jan. 7, 1911.

consumed, and gives little heed to the food value of the separate items, except in so far as they are commonly accepted as simple, easily digestible, and nutritious. With patients in bed and on a liquid diet a knowledge of food units is of particular importance. One patient may be starved and another overfed, without intention, unless the available calorimetric value of the various elements of their diet is understood.

Franklin W. White[1] has recently published a suggestive table:

1 glass of milk equals 160 calories.

1 glass of ¾ milk and ¼ (4 tablespoonfuls) 20 per cent. cream equals 240 calories.

An egg-nog (1 glass milk, 1 egg, 2 teaspoonfuls sugar) equals approximately 300 calories.

A plate of cream soup equals 160 calories.

A glass of skimmed milk or buttermilk equals 80 calories.

An equal amount of gruel equals 75 calories.

A glass of albumin-water (white of 1 egg) equals 20 calories.

A cup of beef-tea or clear soup equals 5 to 20 calories.

"Let us take," he says, "a 150-pound patient in bed who needs, approximately, 1800 calories a day, and who receives ten feedings of a glass (8 ounces) of liquids a day. Some combinations of liquids allowing for agreeable variety will abundantly nourish him; other combinations mean partial starvation. For instance:

"Two glasses each of milk (320), gruel (150), thickened soup (320), egg-nog (600), milk and cream mixture (480); total, 1870 calories.

"Two glasses each of milk (320), buttermilk (160), gruel (150), albumin-water (40), beef-tea (20); total, 690 calories.

"It is easy to increase the food value of a liquid food. Take a glass of milk (160 calories); each addition of a tablespoonful of cream (20 per cent.) gives 30 more calories, each addition of a teaspoonful of sugar (preferably milk-sugar) gives 33 more calories, the addition of an egg gives 70 more calories.

"The great value of soft solids is easily seen. One tablespoonful (½ ounce) of milk equals 10 calories; a heaping tablespoonful of cooked cereal equals 35 calories; of custard, 55 calories; of ice-cream, 135 calories."

Recently, in part as the result of the investigations of Metchnikoff, buttermilk has come into some favor in the postoperative dietary. This is a wholesome, cooling, and diuretic drink, and is often fancied

[1] Boston Med. and Surg. Jour., 1911, clxv, 545.

by patients to whom whole milk is obnoxious. Its food value is about that of skimmed milk, and it consists, besides water, chiefly of albumin, finely coagulated casein, and sugar, which has been converted largely into lactic acid. It is, as a rule, readily digested, even in cases where the proteids and fats are not well borne, and there is said to be less gas formation and residue than with milk. It should be drunk fresh and cold, perhaps diluted with siphon soda. Buttermilk made by inoculating milk with strains of bacteria represented in the various forms of tablets now on the market has no advantage in this connection over fresh buttermilk obtained from a clean dairy.[1]

The stimulation value of *sipping* should be remembered. Sir Lauder Brunton[2] says:

"More people in this country shorten their lives by overeating than by starvation, and an unnecessary excess of animal food not only leads to physical disorders, but to an irritable and irascible frame of mind. Instead of trying to remove the depression between eleven and four by taking a glass of wine or spirits, a much better plan is to sip a glass of water or soda-water and eat a biscuit. If a greater stimulus than this is needed, a glass of hot *eau sucree* with a lemon squeezed into it may be taken. It is not a matter of indifference whether the water be drunk down at a draught or sipped, for the act of sipping has a very extraordinary effect upon the circulation, as my friend, Professor Kronecker, has shown; during the act of swallowing the power of the restraining nerves upon the heart seems to disappear, and if any one will count their pulse before they take a sip of water and while they are taking it, they will find that while they are swallowing the pulse becomes nearly twice as quick as before. It has long been known that while sucking ale through a

[1] "If the purest milk obtainable is used, the putrefactive bacteria which are always present in the milk—even of the best grade—will not develop because the normal lactic acid bacteria antagonize them. It is clear that if the same dairyman who, by observing cleanliness in his establishment, furnishes a good quality of sweet milk, will observe the same care in handling cream for making butter, his buttermilk also will be wholesome and clean. More criticism of a similar nature could be made in regard to the use of commercial preparations for fermenting milk. Where clean, certified milk can be obtained, the use of these various preparations seems unnecessary. Inasmuch as it is not always feasible to obtain certified raw milk, however, boiled or pasteurized milk is to be preferred. It is here that the artificial 'starter' is of value. After the first inoculation, the same product can be obtained by inoculating pasteurized or boiled milk with a small amount of the first lot inoculated, with proper precautions of cleanliness. Once started, this process may be continued for a long time without having to renew the 'starter.'" (Jour. Am. Med. Assoc., editorial article, Jan. 30, 1909, lii, 397, quoting the results of Heinemann; Lactic Acid as an Agent to Reduce Intestinal Fermentation, Jour. Am. Med. Assoc., 1909, lii, 372.)

[2] On Disorders of Assimilation, Digestion, etc., London, 1901, 108.

straw a person becomes drunk much more quickly than when the same quantity is taken at a single draught, and it is probable that this alteration in the circulation by the process of suction has had much to do with this curious result."

The healing of all surgical injuries is promoted by an abundant nourishing diet. When it can be taken, therefore, such a one of ready digestibility should be selected. Care should be taken, however, with a patient in bed to supervise the evacuations, or otherwise the channels for the removal of waste may be clogged and the object in view defeated. With this caution in mind there is no harm, as a rule, in allowing a patient suffering from some minor surgical disorder, or kept in bed during the healing of a wound or fracture, or after a slight operation, in the absence of fever or sepsis, to satisfy his appetite on the animal and vegetable diet to which he is accustomed. If, in a prolonged convalescence, the appetite flags, it will be of advantage to vary the diet, or it may become necessary to prescribe beer, sherry, or brandy and soda, to be taken with meals.

If, on the other hand, the patient has been *severely injured*, or has passed through a considerable operation and is suffering from shock or loss of blood, or is in pain, food is less desirable than rest and stimulation. In such a case overfeeding is attended by positive harm. Coffee, milk, and broths may be offered, but it is unwise to urge food upon the patient where there is nausea or indifference. It is better to utilize the rectum, when necessary, for feeding and even for medication, until the stomach recovers its tone.

In surgical *inflammatory conditions*, such as sepsis, the patient's strength should be supported, as in any fever, by a sufficient amount of readily assimilable food. In severe cases the patient should be made to take milk, or milk with one-half the quantity of hot water, or milk diluted by one-third with siphon soda, in quantities of 4 to 6 ounces. At an occasional feeding beef-juice or strong chicken or mutton broth may be substituted. If the pulse becomes feeble, stimulants, such as whisky or brandy, should be given. If the patient has any appetite, semisolids, such as gruels, custard, beef jelly, or a raw egg beaten in sherry, are to be recommended. As improvement occurs, rice, cream-toast, scrambled egg, macaroni, bread and butter, tenderloin steak, or breast of chicken may gradually be added. Water should be provided in abundance, and acidulated drinks, sour lemonade, and carbonated waters are useful, but on an empty stomach only. In *chronic purulent conditions* fresh fruits and green vegetables are serviceable, both for their antiscorbutic and their laxative effects. Thus lemonade, oranges, baked apples, and stewed prunes are recommended. Fats are also especially needed, and, when the patient is able to digest them, should be liberally provided in the form of cream, butter, olive oil, or cod-liver oil.

A work of this sort cannot go thoroughly into the matter of food—its preparation and administration—without opening the great subject of cookery and being led afield into the details of the nursing profession.

We believe it to be unwarrantable during convalescence for the doctor to undertake to prescribe with minute exactitude, irrespective of the patient's tastes, the kind and amount of food. Every patient who is to any degree reasonable knows what he likes, and knows what seems to digest without trouble in his particular case. Each individual is, in a sense, a specialist on his own digestion. He has information on the matter such as no other person can have. It seems reasonable, also, even more perhaps in sickness than in health, to give heed to appetite and desire, since it is probable that acquired or conventional tastes disappear under these conditions and rightful instincts are more likely to be exhibited. It is better, therefore, in late surgical convalescence certainly to let the patient suggest the way in the matter of food and drink, always modified and limited by the pathology in the particular case.

The Serving of Food.—There are many obvious and trite considerations which should be here set down. While the patient should, in a general way, be consulted as to what he wants, nevertheless the particular item which is to come at a given meal may well be served without immediate announcement—come, in a measure, as a surprise.

In judging the appetite of a patient it must be remembered that the apparent lack of desire for food may be due to poor cooking, serving meals unattractively or at inopportune moments, as well as to the selection of articles of diet not to the patient's taste. It is the function of the nurse to study the likes and dislikes of her charge, and to yield to them so far as her instructions will allow. If her orders are vague or insufficient to cover any condition which may arise, she should make it a point to have them made clear at the next visit of the physician. The doctor, though he should on his part be explicit in his directions as to the sort and quantity of food to be given immediately after an operation, should provide also that, on the one hand, the patient shall not starve for want of food which is agreeable to him, or, on the other hand, suffer from overindulgence in a diet which has been left to the nurse's discretion.

Meals should be served at regularly appointed intervals, for a patient who was eager to eat at the time appointed may lose interest if the meal is delayed. Food is better when concentrated; a patient easily tires of swallowing dilute victuals. If the appetite flags, the appearance of some new or unexpected article of food on the tray is very pleasing.

Food should be served either hot or cold; lukewarm food is unpalatable. The cooking and preparation of food should be done where the noise and odor cannot reach the patient. The tray should be neat and inviting, the china attractive, the linen clean, and the food fresh, for a person confined in bed becomes fastidious of details which might appear trivial to others. The quantity of food offered should not be in excess of the limit of his capacity; a patient may take half from a cupful of broth and reject the rest with disgust, where if he were offered a cup half-full he would drain it with gusto. The tray and the remnants of the meal should be removed at once after the patient has finished.

A person who has become accustomed to alcohol from excessive indulgence is very apt to develop delirium tremens (see Chapter XXX, p. 310) in the course of a few days after receiving a severe injury or undergoing an operation, even though he has indulged in no stimulation for some weeks previously. In cases where it is suspected that the condition is about to develop, it may be wise to forestall it by allowing a certain quantity of alcoholic stimulant. Some surgeons prefer to treat cases not acute by entirely withholding alcohol, but in cases of emergency alcohol should always be used.

Special diets are prescribed where indicated under Special Operations in Part II. In the Appendix are given a number of food recipes for convalescents.

CHAPTER XII

RECTAL FEEDING

THE use of the absorptive powers of the mucous membrane of the rectum and lower bowel in the nourishment of the weak and sick comes down to us from the days of Galen. It is comparatively recently, however, that the experimental investigations of Voit, Leube, Ewald, and others have established rectal feeding on a scientific basis. In rectal alimentation we now have a practical method: first, of supplementary feeding, in cases where the stomach is unable to digest enough food to maintain the equilibrium of waste and repair; second, of sustaining life independently of all other means of nourishment for a short time.

Rectal feeding may be indicated: (1) In conditions of great weakness, where but little food can be taken by mouth, or where food is not retained. In patients exhausted by a serious abdominal operation rectal feeding is a temporary expedient of great value. In prolonged reflex vomiting after an anesthetic, nutrient enemas may be our sole reliance. (2) In conditions of obstruction to the entrance of food into the stomach, such as paralysis of the muscles controlling deglutition, stricture of the esophagus, foreign bodies, new-growths, or inflammatory conditions of the mouth, pharynx, or esophagus, irritability of the alimentary canal from ulceration or corrosion. (3) In diseases of the stomach, such as gastric ulcer, gastric carcinoma with obstruction. (4) In conditions of shock, coma, or delirium. (5) In the after-treatment of operations on the stomach, gall-bladder, or small intestine, where peristaltic activity might interfere with repair. (6) After plastic operations on the face, where mastication might tear out stitches.

The technique of administering a nutrient enema is as follows: If the patient can be moved about, he is brought to the edge of the bed and placed with his knees drawn up toward his chest in an exaggerated Sims posture, upon his left side; otherwise he is to lie flat on his back, with knees flexed. In either case the buttocks should be elevated as much as is comfortable upon a small hard pillow or the foot of the bed should be elevated; in this way gravity is brought to aid in the retention of the enema. A long, soft rectal tube, about 32 French in diameter, with open end and two lateral eyes, is employed; in children an ordinary soft-rubber catheter may be used. The tube should be so soft that it will not damage the rectal mucosa, and yet it should be stiff enough so as not to be likely to kink or double upon itself inside the ampulla. Long soft tubes coil themselves up, press on the intestinal wall, and stimulate peristalsis and straining, thus preventing the successful administration of enemas. To its end, by means of a short piece of glass tubing which is to serve as a window, is attached about a foot of similar rubber tubing coming from a glass or hard-rubber funnel.

The tube should be lubricated sparingly with olive oil or vaselin; glycerin should not be used, as it excites peristalsis. The funnel is partly filled with the enema, and after this has run down the tube to expel the air, the tube is pinched and introduced through the anus. Air in the tube is likely to be driven into the intestines, where it will set up peristaltic movements and lead to the expulsion of the enema. If the tube is passed slowly and gently, it may readily be carried in 6 or 8 inches.[1] The higher up the fluid goes, the more extensive is the absorbing surface that it comes in contact with, and the less is the likelihood of its being rejected. (See also Chapter XV, p. 165.) The veins of the lower rectum, also, empty into the vena cava directly and do not drain through the liver. To prevent the tip of the tube from engaging in the valves of Houston, causing the tube to kink, the introduction should be slow and deliberate, the tube meanwhile being rolled or twisted slightly from side to side between the fingers.

The enema should be poured into the funnel slowly, and the funnel should be held at such a level (not over 2 feet) above the level of the outlet that it takes about ten minutes for the entire quantity to pass in. As the tube is withdrawn, a gauze pad is held up against the anus to prevent the enema from gushing out. The patient should lie quietly in bed for an hour or so after the injection and should be told to try to retain the enema. If it appears likely that the fluid will leak out, a pad should be held firmly pressed against the anus for fifteen or twenty

[1] Soper (The Colon-tube and High Enema, Jour. Amer. Med. Assoc., 1909, liii, 426) concludes that only in rare cases of abnormal development of the sigmoid is it possible to introduce a soft-rubber tube higher than 6 or 7 inches in the rectum without it bending or coiling upon itself. With the aid of the sigmoidoscope the middle of the sigmoid can be reached, but nothing further. He substantiates this by x-ray photographs. The short tube, 6 inches in length, is therefore best for all sorts of enemas: (1) When water, etc., is introduced for the purpose of causing fecal evacuations; (2) when retention of fluid is desired, as in administering saline solution, oil, nutrient material, etc. The attempt to pass the tube higher into the bowels is not only unnecessary, but because of the coiling that inevitably occurs such a manipulation tends to produce irritability of the bowel. This, of course, will very probably cause expulsion of the fluid.

minutes or longer. A patient is likely to reject enemas at first, but can soon be trained to retain them effectually.

In feeding by rectum it is important that the condition of the rectum be carefully watched, especially if it is likely that the administration of the enemas will have to be kept up for more than a few days. Patients have been maintained on rectal feeding exclusively for six months (Leube) and ten months (Riegel), but four to six weeks may be accepted as the ordinary limit, and, indeed, in most cases two or three weeks is likely to produce irritation and mucous diarrhea, which will interfere seriously with absorption. For this reason all sources of irritation should be avoided. The bowel should be cleaned of mucus and fecal matter by a daily cleansing enema, best given in the morning, some time before the first nutrient of the day. For this purpose 1 or 2 pints of saline solution or of soapsuds and water may be used at about 95° F. If the rectum is inflamed, 1 pint of boracic acid solution (1 dram to 1 pint of water) may be used once or twice a day or before each feeding; if there is much mucus, sodium bicarbonate may be used in the same dilution. The nutrient should not be given until all the wash-water has come away, otherwise the enema may be immediately ejected.

Opium, about 10 minims of the tincture, is frequently added to the nutrients as a routine measure to prevent peristalsis and thus favor the retention of the enema. If enemas are rejected at first, from nervous irritability of the rectum, it may be wise to use opium until the bowel is accustomed to the procedure, when it becomes unnecessary. Opium may, however, interfere somewhat with absorption, and for this reason, especially if the use of enemas will have to be continued for some days, its use should be postponed, if possible, until it becomes necessary on account of the irritated condition of the mucous membrane. In this case the opium acts better if administered alone or mixed with 2 ounces of starch-water one-half hour before the enema is due. Red wine is frequently employed on the Continent of Europe as a constituent of nutrient enemas. The small percentage of alcohol it contains is readily absorbed, and its astringency and slight acidity seem to favor retention of the enema. Thus, a little claret or Burgundy will sometimes act as efficiently as opium for this purpose.

Sometimes the presence of hemorrhoids will interfere seriously with rectal feeding. If this complication occurs, it will be wise to use a smaller, softer tube, well lubricated. In addition to local treatment it may become necessary, on account of pain, to apply a 2 per cent. solution of cocain to the hemorrhoids before each injection. The presence of wicks or glass or rubber drains in the pelvis or vagina may interfere materially with the use of rectal feeding. It should also be remembered that if any suturing has been done on the large intestine, enemas should not be started for at least forty-eight hours, for retroperistalsis may carry the fluid back with sufficient force to tear out the stitches.

Ordinarily, 6 ounces (175 cc.) of fluid is given every four hours. In some cases it will be necessary to lessen the quantity and increase the frequency of the enemas; 4 ounces (100 cc.) may be given every two hours. There is a distinct advantage, however, in favorable cases in giving a larger quantity less often. If given slowly, 8 or 10 ounces (250–300 cc.) may be retained, and the patient will suffer less from thirst and there will be less likelihood of inflammatory changes being set up in the rectum. Such an enema need be given only three or four times a day, which is of some importance in gastric cases, for it has been shown that each injection stimulates gastric secretion.

The sensations of hunger and thirst may be annoying to a patient who is being started on rectal feeding. They rarely persist after twenty-four hours; the thirst may be met by additional enemas of saline solution or of plain water once or twice a day if the patient cannot take water by mouth. All enemas, to be retained, should have a temperature of 95° F., or about body temperature. Fluids much warmer or cooler than this are likely to set up a peristalsis, which will lead to their ejection.

The material for the enema should be selected with a view to absorbability and absence of irritating qualities; substances which theoretically should be readily absorbed, like the peptones, may be so irritating that they are not retained; other substances, which are absorbed only in small proportion, if at all, may interfere with absorption of the other elements of the enema by causing irritation, as the starches, or by forming a coating over the mucosa, like unemulsified fats. Many extended metabolic experiments on human beings have been carried on with a view to determining the relative absorbability of the various classes of food-stuffs, and, although these show woeful lack of agreement, they may be summarized as follows:

Proteids are usually supplied in the form of egg-albumen, milk, beef-juice, and peptones. Egg-albumen and, indeed, all proteids not predigested are better absorbed if salt is added in the proportion of 15 gr. per egg. Milk, if peptonized and not too rich in cream, is very satisfactory, and is commonly used as a basis of nutrient enemas. Beef-juice raw is absorbed to a certain degree, but had better be peptonized. Leube has used meat chopped up with one-third its weight of fresh pancreas, on the theory that the meat is digested within the rectum and the products absorbed. Except in his hands, however, the method has not been found wholly satisfactory, and meat, if used, had better be predigested before introduction by the use of fresh extract of pancreas. A glycerin extract should not be used in any amount on account of the aperient action of the glycerin. Commercial peptone, 2 or 3 oz. in 8 or 10 oz. of water, will often be well absorbed, especially in the presence of a little alcohol. It has the disadvantage of being expensive and it may set up irritation. On the whole, proteids are but poorly absorbed, the proportion varying and depending apparently on individual peculiarity and not on the amount injected. Roughly speaking, it may be said that in favorable cases 35 per cent. of the amount injected is absorbed if predigested; if not predigested, about 20 per cent.

Fats are usually given as yolks of egg, milk, cream—natural emulsifications. Unemulsified fats are but slightly absorbed and are useless. Olive oil may be emulsified by saponifying a small portion and shaking all together. Fat is important, in that it seems to lessen the loss of tissue nitrogen. Emulsified fat, in small quantities, is slowly absorbed in direct proportion to the quantity injected—about 25 per cent.

Carbohydrates are supplied in the form of glucose (grape-sugar or dextrose), flour, or starch. Pure glucose, in 10 to 20 per cent. solution in water, forms a nutritious and easily absorbed element. The commercial glucose should be avoided, as it may contain traces of sulphuric acid and arsenic, either of which might give rise to irritation. About 80 per cent. is absorbed. Boiled flour or starch or raw starch is sometimes added in small quantity for its nutritive value and to thicken the fluid.

Alcohol diluted may be added in small quantity to any enema, both for its stimulant action and to promote absorption of the nutrient. Whisky, brandy, or any red wine may be used, being careful not to cause precipitation.

Salt, up to 1 per cent., facilitates absorption of the enema, especially if it contains proteids; a large proportion causes irritation. To any acid mixture such as is likely to result if peptones are used, enough sodium bicarbonate should be added to make the reaction slightly alkaline.

Drugs, as indicated, may be administered by rectum, by adding them to an enema, providing they do not cause precipitation.

Proprietary preparations have been variously recommended for purposes of rectal feeding. Among these may be mentioned liquid peptonoids, bovinin, malted milk, nutrose, somatose, maltine, plasmon, proton, eucasin, sanatogen, panopepton.

Rectal suppositories are now being supplied by manufacturers to replace the ordinary method of feeding by injection. They are made of predigested and evaporated milk or meat-juice and cocoa-butter. They are convenient on account of the readiness with which they are administered and retained, but where the patient is being fed by rectum alone, they are not practicable on account of the small amount of material they supply. Containing so large a proportion of fat, and being placed so low down in the bowel, it is probable that only a small percentage of the food-elements is absorbed. Alternate suppositories of meat and milk may be given every two hours.

Boas[1] considers nutrient enemas of little worth; various writers have placed the limit of absorption by rectum at from 200 to 500 calories a day, where the average adult in bed needs 1800 to 2000. Repeated three times a day, in conjunction with the necessary cleansing enemas, they are troublesome and sometimes distressing, and the necessary handling may use up strength which can hardly be spared. They may cause injury or inflammation of the rectal wall, formation of gas, colic or tenesmus, and require the use of narcotics. (If given by the drop method, as he advised in 1900, they cause less pain and spasm, there is less likelihood of the occurrence of colitis, and they are better retained.)

For three years, accordingly, Boas has substituted suppositories for nutrient enemas. He has made up a suppository about 2½ inches long by ½ inch in diameter. Its components are crystallized egg-albumen and dextrin, with about 2½ per cent. of salt, and cocoa-butter as an excipient; 5 drops of tincture of opium are added for cases of extreme sensitiveness. Each suppository represents 45 to 50 calories, and 5 are given per day, preceded early in the morning and followed late at night by a pint of salt solution by the drop method, to supply the necessary fluid. Apparently they are nearly completely absorbed in three or four hours. They are usually well tolerated, they are clean and handy, and patients are more comfortable and better kept than with enemata. They do not, of course, represent a sufficient nourishment, and they should not be given for longer than three to five days, but, on the whole, Boas considers that they will do all that enemas will do, and in a much better fashion.

In many patients the institution of rectal feeding is marked by satisfaction of hunger and thirst, mental relief, and apparent maintenance of general condition or even increase in weight.[2] Nevertheless,

[1] Ueber Nahrsuppositorien, Berliner klin. Woch., 1910, xlvii, 617.

[2] It is stated (Sternberg, Münch. med. Woch., 1910, lvii, No. 28) that if hunger and thirst are not satisfied, they may be subjectively abolished by the administration of small doses of cocain or chloroform water by mouth.

rectal feeding is at best a poor substitute for feeding by mouth, and in the most favorable cases the patient is being subjected to partial starvation, for it is now generally agreed that the limit of absorption per rectum is less than one-fourth the nourishment required to maintain metabolic equilibrium in normal persons. Gain in weight, where it occurs, is due to the rapid absorption of water to satisfy the marked depletion of the tissues which ensues after severe hemorrhage or protracted vomiting. Some of the beneficial effects of nutrient enemas may be assigned to the psychic influence of the procedure. Moreover, the water content of the enema serves as a vehicle for the elimination of the waste products resulting from the combustion of the body tissues, which if retained would cause auto-intoxication. Where rectal feeding is the sole source of nourishment, the composition of the enema, the technique of its administration, and the condition of the rectum should receive the constant and particular attention of the surgeon himself.

FORMULAS FOR NUTRIENT ENEMAS

The egg and sugar enema (Ewald) is efficient and commonly employed. Boil a teaspoonful or two of starch or wheat flour in a half-cupful of 20 per cent. solution of glucose (grape-sugar) and add a wineglassful of claret. After this has cooled sufficiently to prevent the coagulation of the albumin, stir in slowly two or three eggs which have been beaten up smooth with a tablespoonful of water.

Egg and milk:	3 eggs, beaten, in	
	Peptonized milk	3 oz. (250 cc.);
	Salt	2 or 3 pinches (2 gm.).
Sugar and milk:	Grape-sugar.	2 oz. (60 gm.);
	Peptonized milk	8 oz. (250 cc.).
Leube:	Milk	3 oz. (250 cc.);
	Peptone	2 oz. (60 gm.).
Riegel:	Milk	3 oz. (250 cc.);
	Egg	2 or 3;
	Salt	2 or 3 pinches;
	Red wine	1 tablespoonful
Boas:	Milk	8 oz. (250 cc.);
	Yolk of 2 eggs	
	Pinch of salt	
	Red wine	1 tablespoonful;
	Starch or flour	1 tablespoonful.

Boyd:	Yolks of 2 eggs	
	Pure dextrose	1 oz. (30 gm.);
	Salt	7 gr. (5 gm.);
	Peptonized milk to	10 oz. (300 cc.).

Baumgarten:	Dry peptone	
	Sugar of milk (of each)	1 oz.;
	Alcohol	1 oz.;
	Tincture of opium	10 drops;
	Water to make	9 oz.

The following formula is to be recommended:

Separate the whites and yolks of 3 eggs, add the whites to 200 cc. of milk, and peptonize it. Stir in the beaten yolks. Add 2 oz. of pure grape-sugar dissolved in 80 cc. of water, 20 cc. of red wine, and 2 pinches of salt:

Milk, 200 cc.	146 calories
3 eggs	200 "
2 oz. of grape-sugar	246 "
2 pinches of salt	
20 cc. red wine.	
	592 calories.

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CHAPTER XIII

GAVAGE AND OTHER FORMS OF ARTIFICIAL FEEDING

GAVAGE is the name given to the method of feeding a patient by pouring liquids through a tube into the stomach. It is not commonly used in postoperative treatment, but it may be indicated:

1. In infants or young children who persistently refuse food, or are too weak to take nourishment in sufficient quantity.

2. As an alternative for rectal feeding in persistent vomiting after an anesthetic, provided there is no stomach lesion.

FIG. 41.—LAVAGE, FIRST STEP.
Introduction of tube.

FIG. 42.—LAVAGE, SECOND STEP.
Tube in stomach. Wash-water being poured into funnel.

3. As a method of forced feeding in acute infections, coma, delirium, insanity.

4. Where swallowing is interfered with, as after operations on the head and neck, in diseases of the mouth, lockjaw, or postdiphtheritic paralysis.

The technique and apparatus are the same as for gastric lavage. A highly polished soft-rubber tube, about 30 to 32 French, should be selected, of medium flexibility, with a conic end—having two openings, one at the end and another on the side, about ¾ inch above. In children an ordinary soft-rubber catheter may be used, about 21 to 25 French, according to age. It should be attached by a short piece of glass tubing, which serves as a window, to a rubber tube coming from a glass or hard-rubber funnel. As a lubricant, glycerin, olive oil, butter, plain warm water, or ice-water may be used.

The patient should be sitting or lying in a comfortable position, the head not tilted back or inclined to one side or the other. He should be directed to breathe slowly and deeply. A child might better be wrapped in a sheet and held seated on the nurse's lap, with its head supported on her shoulder, or laid flat on its back on a table. The tube should be held some inches from the tip, and with one motion it should be passed rapidly over the median line of the tongue down through the pharynx into the esophagus. It is not necessary to hold a finger in the mouth; as soon as the tip strikes the posterior wall of the pharynx the patient will begin to retch and gag, but if he will make several rapid swallowing movements and can resist the impulse to seize the tube and pull it out, all will be well. If the tube is held too near the tip, the tip will be in contact with the pharyngeal wall while the operator is shifting his hold, and the tube will probably be rejected. In the unconscious or delirious, as well as in children over two years of age, it is advisable to use a mouth-gag. In the unconscious, also, one must be sure by the patient's respiration that the tube is in the stomach and not the trachea before fluid is poured in.

FIG. 43.—LAVAGE, THIRD STEP.
Suction and siphonage.

Some nervous patients will experience respiratory embarrassment the first time the tube is employed. This can always be controlled if the patient will but breathe deeply and slowly while the tube is being passed. Patients readily get accustomed to the tube. It should be used with caution in persons with cardiac disease.

The tube is passed to the point where liquid is found to flow in without obstruction, usually about 22 inches to the line of the teeth in the adult. If there is any gas on the stomach, it should be allowed to escape by elevating the funnel before the feeding is poured in. After the liquid, in quantity proper to the age of the patient, has passed in, the tube is pinched tightly and withdrawn rapidly with one sweep. A slow withdrawal of the tube, or the tricklings of the last drops of the fluid from the tube in its upward passage, may be sufficient to excite reflex vomiting. If the fluid is vomited, the feeding should be repeated.

The materials ordinarily employed in feeding through a stomach-tube are milk, eggs, meat-juices, or broths. If indication exists, the meat broth or milk may be peptonized. A common feeding through a stomach-tube in an adult is two eggs (beaten), stirred into 1½ pints of warmed milk, with a pinch of salt, administered four times daily, or alternated with beef-juices or chicken broth, thickened with tapioca or sago.

Care should be taken, first, that the fluid is not hot enough to burn the stomach; and, second, that the capacity of the individual stomach is not exceeded.

NASAL FEEDING

Nasal feeding is a substitute for gavage which is employed rarely except in children. It is indicated in those cases where the stomach-tube cannot be passed by mouth on account of ulcerative stomatitis, after operations about the mouth, after tracheotomy, where great nervous excitement is induced, and in children in general.

The simplest method is that of pouring the fluid nourishment from a spoon into the nostril. This is employed in comatose states, and it obviates the necessity of opening the mouth. A teaspoonful should be given at a time, making sure the dose is swallowed before it is repeated. If the patient is lying back, the fluid will trickle down the posterior pharyngeal wall and excite the reflex of deglutition. Any excess of fluid will be regurgitated through the other nostril and the likelihood of choking is slight.

It is usually better, however, to use the distal half of a small-sized soft-rubber catheter attached to a small glass funnel. This is lubricated with olive oil or vaselin, introduced gently into one nostril, and held in place while the fluid is poured in. Just sufficient is poured in at a time to allow the child to swallow. The patient should be wound in a sheet, so that he may not struggle, and held firmly on his back. In either of these methods there is some danger of setting up irritation or inflammation of the middle ear by way of the Eustachian canal.

It is safer, therefore, to pass the tube through the nose into the esophagus and stomach. If the patient is lying flat, with his head in the median line, there will be no difficulty in passing a soft, small-sized stomach-tube, well lubricated, along the floor of the nose into the esophagus. Before pouring in the feeding it must be seen that the patient is breathing freely and that the tube is not in the larynx. This is the method used and advised by Dr. John H. McCollom at the South (Infectious Diseases) Department of the Boston City Hospital.

SUBCUTANEOUS FEEDING

The method of introducing fluid nourishment into the system by subcutaneous injection has not yet been generally accepted, although it has been practised since 1850. In desperate emergencies, where conditions have been such that nourishment could not be administered either by mouth or rectum, solutions of food substances have been injected under the skin, directly into the veins of the arm, or into serous cavities with some apparent success. In animals, olive oil has been used in this way, as well as diluted milk and solutions of sugar or albumin, and absorbed without ill effects.

The food material selected must be a fluid which, first, needs no digestion, and, second, which can be sterilized by boiling. The more closely it simulates blood in osmotic tension, the less irritation will there be at the site of injection. Pure glucose in 5 per cent. solution in distilled water fulfils these conditions well and may be given under the skin freely, in case the stomach will not retain food. Olive oil has been recommended in doses of 100 cc. injected in divided portions into various parts of the body. It should be sterilized by heat. It absorbs slowly and causes some pain, and the danger of fat embolus must not be overlooked. Milk and peptone solution have also been used in doses of 6 or 8 oz.

The injection must be made with all precautions as to asepsis. A sterile glass syringe, such as is commonly called an antitoxin syringe, is adaptable for the purpose. The injection should be made slowly, and once or twice a day is sufficient. The fluid should be at blood heat.

In view of the well-known efficacy of the subcutaneous method of supplying water to the system where the tissues have been deprived of this constituent, in persistent vomiting, in shock from loss of blood, in cholera, as well as in toxemias, it seems probable that the successes reported by some of those who first used this method of feeding were due in large part to the introduction of fluid without reference to its food value.

Berendes[1] recommends a 5 or 7.5 per cent. solution of grape-sugar in 0.9 per cent. salt solution, representing 200 to 300 calories to the liter. He has used it subcutaneously or intravenously in 40 cases, without pain or inconvenience. Slight glycosuria may appear after several days' use. D'Amico[2] is of the opinion that subcutaneous nutrient injections are, next to the natural route, the only rational and effective means for supplying nourishment. The most efficient food material, in his mind, for this purpose is fresh fertilized yolk of egg. To the yolk he adds 5 gm. of a 1 per cent. iodized glycerin and 5 gm. of normal salt solution, and the mixture he injects into the buttock. He has had favorable results with this method during four years. Kausch,[3] after considerable investigation, has determined that grape-sugar can be given advantageously in 10 per cent. solution into a vein, or in solutions up to 5 per cent. under the skin, in a daily dose not exceeding 1000 cc. The method is to be commended in surgical after-treatment, inasmuch as it supplies fluid as well as nourishment.

FEEDING IN GASTRIC FISTULA

After a gastric fistula has been established feeding may be started, if necessary, within a few hours. For this purpose a glass funnel should be attached to the drainage-tube leading to the stomach and small amounts of liquid poured in. An egg beaten up in a glass of milk, with a pinch of salt, may be given every two hours. The patient should be kept upon mush and soft solids for about a week after operation.

If the operation has been performed for non-malignant stenosis, the digestive powers of the stomach suffer very little, and the patient can be given solid food, such as meat chopped into bits, which may be pushed down the tube with a glass rod. At the end of three weeks the patient may be put on his normal diet—potatoes, meat, bread and butter, vegetables—which he masticates, introduces into the tube or funnel from his mouth, and pushes along into his stomach with a rod.

In cases of carcinoma food should be given which makes the least demand on the digestive powers of the stomach and which is rapidly passed on. Peptonized milk may be used and solutions of peptone or glucose. The patient, however, is usually extremely desirous of being allowed to chew and taste his food, and for this purpose gruels, soft-boiled eggs, and toast may be given.

[1] Zentralbl. f. Chir., 1910, xxxvii, No. 37.
[2] Gaz. degli Osped., 1910, xxxi, No. 132.
[3] Deutsche med. Woch., 1911, xxxvii, No. 1.

AFTER LARYNGEAL OPERATIONS

Tracheotomy is performed for obstructions of various kinds, such as foreign bodies—a tin whistle or a piece of meat—edema of the glottis, new-growths, accumulation of diphtheritic membrane, Ludwig's angina. The presence of the tracheotomy tube is well borne, as a rule, and interferes in no way with deglutition after the patient has become accustomed to its presence, provided it be of the right size and well adjusted. We know, for instance, of one patient, a well-nourished negro, who has worn a tube for complete obstruction for twelve years. At first, apprehension on the part of the patient may be a factor in making the feeding a matter of some difficulty. If the patient be propped up by pillows to a sitting posture and liquids given by means of a glass or china "feeder," to the spout of which a rubber tube may be attached, the difficulty is usually readily overcome. Until he can begin to take semisolids, fluids should be given in small quantities at frequent intervals. Should the patient resist, or should his condition be such as to preclude any coöperation on his part, and feeding be imperative, nasal feeding should be used without hesitation or delay.

When intubation of the larynx has been performed, usually for diphtheria, the patient is apt to find trouble in swallowing without drawing food into the trachea. It is difficult to close the epiglottis with the tube in position, or to draw up the larynx beneath the root of the tongue to the extent which should occur in normal deglutition, and hence fluid food in particular is liable to trickle through the tube into the trachea, exciting violent dyspnea and spasms of coughing. Semisolid food or solid food, such as mush eggs, junket, cream, gelatin, rice, tapioca, ice-cream, is more liable to glide over the instrument without being sucked in through it during inspiration. Very young infants, who are dependent upon a milk diet, can swallow best if laid upon the back across the nurse's lap with the head downward, supported below her knees. While in this position the bottle is given. Regurgitation through the nose may occur, but that is of little moment compared with the accident of inhaling milk through the tube into the lungs. Older children and adults can usually learn to swallow well while wearing the tube with a little practice in holding the head and the avoidance of inspiration at the moment of swallowing. Otherwise, when necessary, the passage of the esophageal tube may be resorted to, though this irritates the throat and may spread the diphtheritic membrane along the esophagus. Where the dyspnea is not extreme, the tube may be removed while the child takes nourishment, or, indeed, it may be well to resort to rectal alimentation for a few days to avoid the necessity of swallowing while the tube is *in situ*.

CHAPTER XIV

CATHETERIZATION; CYSTITIS; CATHETER FEVER

CATHETERIZATION

DIFFICULTY with urination is frequently the source of much discomfort after operation. Sometimes the nature of the operation seems to be the deciding factor; operations about the rectum and for hernia are likely to be followed by retention. It frequently seems to be a sort of neurosis, and as such is particularly liable to occur in nervous persons, especially after celiotomy. Sometimes it is dependent, in women, upon a low-grade cystitis, anteceding operation. Oftentimes the position of the patient in bed accounts for the difficulty in urination, as any one who attempts for the first time to urinate while lying upon his back can testify. Retention is likely to follow pelvic and vaginal operations in women, and rectal and hernia operations in men. Post-operative urinary retention is very frequently the result of swelling and edema about the internal urinary orifice, say Jacobson and Keller.[1] A 2 per cent. solution of boric acid in sterile glycerin injected through the urethra into the bladder has been found of striking value, and it should be used as a routine in all cases of ordinary retention before the catheter is resorted to. When catheterization has become necessary, if 5 or 10 cc. of the solution are injected into the bladder, through the catheter after it has been emptied, there will usually be no further difficulty.

Everything which can be done to encourage the patient to urinate spontaneously should be tried before a catheter is employed. If the patient is conscious and intelligent, nothing should be done until he calls attention to his desire to urinate, then, if difficulty is experienced, simply turning the patient on his side, or allowing him to stand, supported, beside the bed,—if the nature of the operation has been such as to make this allowable,—is likely to give relief. After the patient has once urinated, there will be no necessity for calling the catheter into requisition.

Ordinarily the urinary secretion is inhibited to a certain degree by anesthesia, so that, as a rule, after celiotomy the patient may be allowed to go sixteen to twenty hours before resorting to the catheter. When

[1] Post-operative Cystitis, Jour. Am. Med. Assoc., 1911, lvii, 1980.

the catheter is being used as a routine, once every eight hours is frequent enough. This routine, once established, should not be continued indefinitely, but, on account of the danger of cystitis, the patient should be made as early as possible to realize that he must take care of his own bladder function.

If, during the operation, the bladder has been opened, or its coats weakened in any way, or if adhesions between the bladder and other organs have been separated, distention should be avoided. Accordingly, the catheter should be passed six hours after operation and every four or six hours subsequently, or else permanent drainage should be instituted by tying in a catheter.

A good nurse will be competent to pass a catheter through the normal urethra, male or female, and into the bladder, with skill and

FIG. 44.—CATHETERIZATION OF THE FEMALE.
Cleansing the parts.

gentleness. Lack of dexterity and of care in the performance of this responsible duty is shown immediately by the pain which is caused the patient, and later, possibly, by a cystitis. A surgeon should never order a nurse to pass a catheter until he is sure that she is able to do it without causing pain or injury to the urethra and in an aseptic manner.

In catheterizing women the female catheter of glass should be used. This can be readily washed clean and boiled. It should be sterilized before using, and should be handled only by the sterile hands of the nurse. The practice of passing a catheter under the bedclothes, by the sense of touch, is mentioned only to be condemned. It is unintelligent and dirty. The parts should be exposed and the meatus urinarius should be sponged with weak corrosive. Then, with the fingers of the left hand separating the labia, the catheter can be introduced painlessly, without fumbling, and without danger of carrying in infective matter from the bedclothes, anus, or vagina. Infection, when it occurs, is usually the result of allowing the poorly cleansed labia minora to fall against the catheter during its passage.

For the normal male urethra, the best catheter for routine use and in inexperienced hands is that of soft rubber. This ordinarily can readily be introduced if properly lubricated, and with it it is practically impossible to injure the patient. It is relatively easy of sterilization—by washing thoroughly in soap and water and then boiling for three to five minutes. It stands boiling very well, but gradually loses its

FIG. 45.—CATHETERIZATION OF THE FEMALE.
Passing the catheter.

resiliency, when it should be discarded. If it is thin walled and very flexible, it sometimes gives trouble. Size 22 or 24 French is convenient in the normal urethra. If difficulty is experienced at all, it is at the neck of the bladder, where spasm of the sphincter prevents the catheter from entering. If continuous light pressure is exerted on the catheter, the spasm will gradually yield and allow the catheter to proceed.

Catheters of metal are sometimes advantageous and even necessary, as, for instance, in prostatic cases. They are readily and completely sterilizable. A polished silver catheter is probably, in skilled hands, the most agreeable of all catheters to the patient. On account of the possibility of tearing the urethra, however, its use should never be allowed except by trained and competent persons. Ordinarily, the gum-elastic or silk-webbing catheters, which carry stilets and can be bent to maintain any curve after being immersed in hot water, or the "coudé" or elbowed catheter, may be employed instead in prostatics. The disadvantage of this form of coated catheter is that with it complete sterilization is difficult. The ordinary English webbing catheter is roughened and spoiled by boiling; some of the better grade of French webbing catheters can be boiled carefully a number of times without injury. The means of sterilizing the cheaper grades which is ordinarily employed is a soap-and-water wash, followed by a prolonged soak in an antiseptic solution. Another fairly adequate means of sterilizing these catheters is in the metal containers which have recently been placed upon the market in which pastils of formalin are burned. The previously cleaned catheter should be kept in contact with the vapor for twenty-four hours or longer; before using it should be washed off in sterile water or boric acid solution, that the urethra may not be irritated by the formalin.

Whatever catheter is employed, particular care should be taken that it is absolutely sterile. Aseptic precautions should be taken with regard to the hands of the physician or nurse and the penis. The foreskin should be drawn back and the glans penis and the meatus should be washed off with weak carbolic or corrosive solution. Boric acid solution is too weak.

For lubrication, one of the sterile and somewhat antiseptic commercial "artificial mucus" preparations should be used. They come put up in wide-mouthed jars, into which the tip of the sterile catheter can be inserted, or in squeeze tubes, from which a sufficient quantity of the lubricant may be projected on the tip of the instrument. With care in using the sterility can be maintained indefinitely. Ordinary vaselin does not long remain sterile when exposed, and, like all oily substances, it is injurious to soft-rubber and webbing catheters and is difficult to clean off. The excess of the lubricant should be wiped off on the meatus, so as to insure that none be carried into the bladder. If the catheters are to be boiled, some olive öil or vaselin can be poured into the sterilizer. The boiling ensures the sterility of the lubricant, which floats in a film on the surface of the water, and automatically gives a thin even coating to the catheter when it is lifted out.

CYSTITIS

Unless scrupulous care is exercised in employing the catheter—and sometimes apparently in spite of scrupulous care—a troublesome cystitis is likely to be set up which may last for many weeks. It does not appear ordinarily until a week or more has passed from the time the use of the catheter was begun. Cystitis may appear where a catheter has not been used; a woman with an atonic bladder wall who is restrained for a long period to the dorsal position in urinating will be unable to empty her bladder completely; the residual urine may decompose and start up an inflammation.

Cystitis following catheterization of the normal urethra is due to the introduction of infective matter into the bladder. Any pyogenic bacterium may cause it—most frequently the colon bacillus, next the staphylococcus or streptococcus. The gonococcus apparently acts to pave the way for invasion by some other organism, as it is found only in association with one of those already mentioned. The catheter may be clean and yet carry infection into the bladder, for the heathly urethra is the normal habitat of several species of bacteria which are capable of producing cystitis. The more frequent source is by contagion from contiguous organs. In the female particularly, as catheterization is commonly practised, it is extremely likely for the catheter or the fingers of the nurse to be contaminated by organisms from the rectum or vagina. Cystitis is especially likely to occur where retention of urine exists. In the female susceptibility seems to be increased during menstruation or the puerperium.

The earliest **symptoms** of acute cystitis are increased frequency and urgency of micturition and pain, which may be stabbing in nature, across the lower abdomen. The patient feels compelled to urinate immediately the desire arises, and the expulsion of the last few drops is accompanied by sharp, scalding pain. The irritable condition of the vesical sphincters and of the urethra may cause the passage of urine every few moments. Sometimes, on account of pain attending the passage of urine, there is retention. There is usually a continued low-grade fever, and the patient is restless and sleepless and loses his appetite. The urine is cloudy and contains pus and may contain blood in considerable amount. In acute cases the urine may be strongly acid or alkaline, depending upon the responsible organism. In the presence of the colon bacillus the urine is acid.

Sometimes the condition of *irritable bladder* will resemble cystitis so closely as to be confounded with it. This not infrequently arises in any condition attended by a highly concentrated urine, such as usually occurs just after anesthetization. The symptoms are probably induced by the hyperemia of the bladder wall which results from irritation by such a urine. The indication in this event is to increase the amount of body fluids by copious drinking, instillation of water by rectum or subcutaneous infusion, with, if necessary, the exhibition of such drugs as potassium citrate or acetate, hyoscyamus, or digitails.

The **treatment** of postoperative acute cystitis may be considered under the following heads: prophylactic, medicinal, local, and operative.

Prophylactic.—The catheter should be employed only when other expedients fail, and its use should be discontinued at the earliest opportunity. The importance of asepsis in all the details of catheterization needs no further emphasis. If an acute gonorrhea exists, a catheter should not be used, even if the only alternative is suprapubic puncture of the bladder. The danger of passing a catheter under a sheet, with its impossibility of asepsis and its danger uf traumatism to the urethra, has already been dwelt upon. The internal use of urotropin (hexamethylamin) before catheterization, to inhibit the growth of pyogenic organisms in the urine, is sometimes advisable.

General and Medicinal.—In order to avoid tenesmus the patient should be kept quiet upon his back in bed until the acute symptoms have mitigated somewhat. Ordinarily, patients find it comfortable to draw up the knees, as this relaxes the abdominal muscles and so diminishes pressure upon the bladder. The use of hot applications will usually be found efficient in relieving pain—hot suprapubic applications should be applied several times daily, stupes or fomentations should be applied to the perineum, hot water may be run through a rectal siphon plug, or, if the patient can be moved, he can be placed in a hot sitz-bath. If tenesmus exists, morphin should be given in moderation. It acts most efficiently if given in the form of a suppository, with extract of belladonna, of each, ¼ gr. For intense tenesmus the instillation of 10 minims of a 20 per cent. solution of cocain into the deep urethra by means of a Keyes-Ultzmann syringe should be tried. Anything which decreases the pain or tenesmus and helps to quiet the bladder in so far assists the cure.

Internally, the administration of urinary antiseptics is indicated, to render the urine bland and unirritating, and inhibit, as far as possible, the growth of the bacteria in the bladder. Urotropin (hexamethylamin, cystogen, helmitol) may be given in the dose of 5 or 7½ gr. every four hours for some days. As this group of drugs, whose activity depends upon the generation of formaldehyd, tends to irritate the kidneys, their use should not be maintained constantly for too long a time. If much water is being drunk, the drug is diluted and its irritating action is decreased. Salol is efficient in doses of 10 gr. If the urine is strongly acid, alkalis, such as bicarbonate of soda in 20-gr. doses, or potassium citrate or acetate, in doses of 10 or 15 gr., should be given. An acceptable method of administering these drugs is in lemonade, a pitcher to be kept constantly by the bedside containing the proper amount. If the urine is alkaline, its reaction may be modified by the administration of acids. Sodium benzoate should be given in 7- or 10-gr. doses every four hours in a glass of water. Benzoic acid is also useful in 10- to 15-gr. doses; it is given dissolved in water, with borax or sodium phosphate added to increase its solubility and cinnamon-water added to flavor.

The concentration of the urine should be combated by copious drinking of water. To avoid disturbance of rest during the night by the necessity for urination, the drinking should be confined largely to the morning and early afternoon. Ordinary water, bottled waters, carbonated or still, albumin- and barley-water, and toast-water may be given, but all stimulating and fermented beverages, tea and coffee, must be avoided. The diet should be simple and light, and in the early stages of a severe acute cystitis should be limited to milk. Rich and highly spiced or seasoned foods should not be allowed—particularly meats, fish, and salads. The bowels should be kept active by means of mild laxatives; purgatives and drastic cathartics should be avoided.

In cases of chronic cystitis, where the colon bacillus is demonstrable in the urine, the use of an autogenous vaccine is to be recommended. For the technique of its production and administration, see Chapter LII.

Local.—Ordinarily in acute cystitis irrigation of the bladder is not indicated, and as a routine measure should not be employed. If, however, the condition should fail to clear up under the régime just prescribed, or if the urine becomes foul and shows the presence of decomposing pus, intravesical irrigation is necessary. The washing should be begun with normal salt solution or the mildest of antiseptics, such as 2 or 4 per cent. boric acid solution. In the acute stage astringents and strong antiseptics should not be employed. If the condition does not improve under the boric acid irrigation, it will become necessary gradually to work up to the stronger antiseptics. Argyrol may be used in 1 : 1000 solution; silver nitrate, 1 : 8000, gradually increasing to 1 : 500; or potassium permanganate, 1 : 6000, gradually increasing to 1 : 1000. Of these, the most commonly employed is silver nitrate; when pain follows its use, it must be abandoned.

Irrigations should be practised every other day, daily, or twice a day, depending upon the urgency of the case and the character of the urine. All fluids must be distinctly warm at the time they enter the bladder. The urine is passed or withdrawn before the washing is begun, and the irrigation is maintained until the wash-water returns clean. The hydrostatic pressure obtained by hanging the bag so that its contents are 2 or, at most, 3 feet above the level of the bladder is sufficient. In order to avoid instrumentation it is preferable to irrigate without the use of the catheter. A patient with a little effort can learn to relax his abdominal muscles, and the pressure of the fluid will overcome the natural resistance of the sphincters; 6 or 8 ounces may ordinarily be introduced, when the irrigating tip is removed from the urethra or the catheter and the fluid are allowed to come away. As soon as the patient announces a feeling of discomfort, the introduction should cease. As the natural tendency is for the bladder to contract in cystitis, sometimes the amount of fluid which can be retained is small. It is good practice to leave in an ounce or so of the irrigating fluid, or to inject an ounce of 5 per cent. argyrol solution, to remain until the next urination.

Howard A. Kelly[1] cites a case in which irrigation combined with progressive distention of the bladder gave good results in chronic cystitis. Each day the bladder was irrigated thoroughly with warm boric solution, which was followed by distending the bladder to three or four times its capacity with 1: 200 carbolic solution. On blotting paper a graphic record of the amount the bladder would hold was kept, and it was found that in seven weeks' treatment the capacity was increased from 40 cc. to 420 c.c

Operative.—In subacute or chronic cystitis permanent drainage sometimes becomes necessary. A catheter *à demeure*, or an ordinary soft-rubber catheter held in by adhesive plaster, will give rest to a contracted bladder and will allow for frequent irrigations. A cystoscopic examination will show the extent of the inflammatory process, and, if repeated, will serve as a guide to the efficacy of the treatment. Sometimes in the male it is necessary to afford drainage by means of a suprapubic cystotomy or a perineal urethrotomy, and in the female by dilatation of the urethra and suprapubic or vaginal cystotomy. Curettage of the bladder is rarely indicated.

CATHETER FEVER

It was observed for many years that instrumentation of the male urethra was not infrequently followed by an amount of constitutional disturbance. This was given variously the name of catheter chill, catheter fever, urinary fever, etc., but was never carefully studied until

[1] A chart to aid in the treatment of cystitis by distention of the bladder, Ann. Surg., 1910, lii, 664.

Thorndike[1] analyzed the condition and classified four forms, which he called urethral shock, acute urinary fever, chronic urinary fever, and septic infection.

Urethral shock, frequently called *catheter chill,* is a condition of nervous shock ordinarily manifested by the occurrence of a chill without fever directly or very shortly after instrumentation. This condition is common and may follow the simple passage of an instrument in a normal urethra. It is especially apt to follow the patient's first instrumentation—that is, if a patient does not exhibit these symptoms after his first instrumentation it is unlikely to follow repetitions of the instrumentation. Patients who have had chills are likely to have more. It is sometimes speedily fatal. The patient becomes faint and may completely lose consciousness. The chill is short and sharp, is of a few moments' duration, and, if not fatal, is followed by little if any constitutional disturbance.

Acute urinary fever, sometimes called *catheter fever,* comes on usually several hours after the instrumentation and generally shortly after the first urination following the passage of the instrument. The patient experiences a distinct chill. He looks badly, takes on an uncomfortable expression, and complains of pains in his head and back. The temperature rises sometimes as high as 108° F., and there may be vomiting. The fever lasts a few hours and is followed by exhaustion and perspiration. After twenty-four hours the patient has recovered his former condition. This complication will also follow operations upon the urethra, such as internal urethrotomy, particularly where there is contact of urine with the operated surface. It is probable that these febrile attacks are due to poisonous material of some sort, either chemical or bacterial, furnished by the urine and absorbed through the wound made by the operation, or through the mucous membrane of the urethra, which has been stretched and possibly torn by the instrumentation.

Chronic urinary fever comes on after catheterization in cases where destructive disease has preëxisted in some form for a long time and is particularly likely to follow the passage of a catheter for the relief of a more or less distended and atonied bladder. The catheter is passed and the residual urine is drawn off. A few days later the patient experiences chilly sensations and becomes feverish. He loses his appetite, suffers from thirst, and feels wretched. Evidences of a cystitis are present. This condition may persist for weeks and yet the patient

[1] Paul Thorndike, Disturbances Which May Follow Instrumentation Upon the Male Urethra and Bladder, Com. Mass. Med. Soc., 1892, v, 401; see also L. J. Hammond, Catheter Fever, Ann. Surg., 1909, xlix, 90.

recover. On the other hand, he may die. In the fatal cases autopsy shows advanced ascending disease of ureter and kidney, such as contracted bladder, dilated ureter, hydronephrosis, and pyonephrosis. Two conditions are essential to bring about this condition: one is a preëxisting degeneration of the secretory substance of the kidney; second, an alteration, from obstruction, in the intrarenal pressure, whereby the ureters, pelves, and calices of the kidneys become dilated. The sudden release of the increased pressure caused by long-standing urethral obstruction of some sort starts up a state of active congestion in the kidney.

Septic infection from an unclean instrument may cause merely a mild cystitis. The cystitis may be severe and extend upward and cause septic trouble in the kidney, or it may manifest itself as a true general septicemia or pyemia.

The **treatment** of these manifestations is a matter of intense importance to any surgeon who may be brought in contact with operative genito-urinary work. Much more can be done in the way of prophylaxis to prevent such complications from arising than in the way of treatment once they have arisen.

Urethral shock appears to be independent of absorption, because it shows itself immediately after the instrumentation and before sufficient time has elapsed for the effects of bacterial absorption to make themselves evident. The condition is apparently in the nature of an overpowering impression upon a susceptible nervous system. Fear, anxiety, and pain are strong contributing factors in the production of urethral shock, and if the patient is overwrought and apprehensive, so that shock in connection with urethral instrumentation is a probability, anticipatory measures must be taken. Freedom from pain and anxiety may be insured by the ample use of local and general sedatives and morphin, and the instillation of cocain through the Keyes-Ultzman syringe should always be employed preceding the first instrumentation in a nervous patient and before instrumentation in those who have had urethral shock before. The gradual education of the patient and urethra to the point of tolerance of instrumentation is an element in prophylaxis of no mean value. With the condition once established, the hypodermic use of morphin is indicated.

In the other forms absorption of bacteria and their products is the essential element, which must be attacked both for prophylaxis and relief. The importance of surgical asepsis need only be mentioned.

Absorption may be prevented, first, by neutralizing the injurious elements before their absorption, that is, by internal antisepsis; second, by washing them out of an involved urethra before or after instrumentation; and, third, by securing complete and effective drainage of the urethra. Internal antisepsis is furthered by the administration of urotropin, salol, and the other urinary antiseptics already mentioned. Digitalis is strongly supportive and stimulating to the renal secretion. Local antisepsis and asepsis are best secured by copious and frequently repeated irrigations of the urethrovesical tract with a solution of nitrate of silver, argyrol, boric acid, or potassium permanganate. It should be the rule to precede all instrumentation (such as the use of sounds after a urethrotomy) by the administration of hexamethylamin and to follow it by a urethral irrigation. With these precautions ordinary soundings need not be feared.

As a result of recent experience it has been amply demonstrated that extensive urethral manipulation may be carried on with impunity if coincidentally free and constant drainage of the bladder is provided. Thus, it has come to be the practice of conservative surgeons, especially in doubtful cases, to add external urethrotomy to operations for stricture, and perineal drainage in operations upon the prostate and bladder. Under these circumstances urethral fever, which was formerly the bugbear of genito-urinary surgery, is now rarely observed. In case this rule is not for any reason followed, a large calibered soft-rubber catheter should be tied in through the urethra for several days, or the urethra should be kept clean by frequent irrigations.

When urinary fever intervenes, in chronic or debilitated cases, the best method of maintaining bladder drainage is by means of a large double rubber drainage-tube or two soft-rubber catheters sewed back to back with silk, introduced through a perineal incision. In urgent cases a constant stream of warm sterile saline or boric acid solution may be maintained under low pressure through one tube, with the outlet by means of siphonage through the other.

CHAPTER XV

CARE OF THE BOWELS: CATHARTICS, ENEMAS, DISTENTION, FOMENTATIONS

In normal active adults nature makes ample provision for the regular evacuation of the intestinal residue. Peristalsis is excited reflexly and mechanically by the presence of food in the gastro-intestinal tract; mechanically, by coarse foods, rich in fiber and cellulose, and indigestible elements such as bran, seeds, and the skin of fruit. The presence of food in the stomach not only induces activity in the intestines, but stimulates also the colon and rectum to motion, provided a sufficient quantity of material has been collected in them. Bile is also an important element in natural purgation in a way not yet clearly understood, for obstinate constipation is frequently observed if the biliary secretion is prevented from reaching the intestines, and some of the drastic purgatives, such as rhubarb and podophyllin, fail to act in its absence. This biliary secretion is provided for by the massaging, so to speak, which the liver, gall-bladder, and its ducts receive during exercise, such as walking. Thus, in active persons nature provides mechanical and chemical stimuli to evacuation which, provided the fecal content of the intestines is not allowed to become hard from insufficiency of water, should suffice. To these may be added the psychologic stimulus of regular habit, such as having a movement of the bowels daily after breakfast, which is important but valueless after it has once been broken, for it has to be re-formed.

When a person, for one cause or another, is obliged to give up active life and keep his bed, all these agents are interfered with in their functioning—he is deprived of the beneficial effects of ordinary exercise, his habit is broken by the unaccustomed circumstances in which he finds himself, his diet is freed in great part from the coarser elements which exert a salutary influence in exciting peristalsis. In addition to these considerations is the purely mechanical one of position—the habit of defecation in the supine posture is sometimes difficult to acquire. As a result a patient may be allowed to become constipated, partly from oversight on the side of the surgeon, partly from lack of energy and of desire on the side of the patient, and it is not infrequent that the fecal content becomes packed so hard and so tight in the rectum as to require digital or instrumental removal. Constipated patients often develop anorexia and complain of headache and a feeling of weight in the lower abdomen, all of which may interfere with progress toward recovery. Frequently hemorrhoids develop, or, if already present, become aggravated and complicate treatment of the constipation.

In any given case the natural conditions under which the patient has lived should be approximated as closely as possible. If there is no contra-indication, the abdomen should be massaged for a few minutes morning and night, a trick which any competent nurse can be taught by one demonstration. The food should as closely simulate that to which the patient is accustomed as his condition will permit. There should be plenty of fluids and liquid foods, and farinaceous foods, jellies, jams, and marmalade, fruits, raw or stewed, prunes or figs. The patient should understand that he is to be expected to defecate at about a certain hour every morning. If it can be allowed, the patient should be permitted to get out of bed, with assistance, and move his bowels sitting upon a closet or stool; and, finally, the responsibility over the state of the bowels should never be left with the nurse or attendant; the surgeon, ignoring any sense of false modesty on his part or the part of the patient, should acquire the habit of automatically asking the patient directly, at the time of his morning visit, whether or not the bowels have moved during the past twenty-four hours.

It may be taken as a general rule that patients who are kept on their backs for weeks or months will require at some time medication of a sort to assist in maintaining intestinal activity. Whether the bowels should be moved daily or every other day depends partly on the patient. Some persons who have been accustomed to evacuate their bowels daily, or even twice a day, may develop considerable physical discomfort, along with mental irritability and inability to sleep, if they are obliged to go forty-eight hours without a movement. Others, of a more or less constipated habit, may go for some days or a week before they will call the attention of the doctor to the state of things. If a movement of the bowels be attended with discomfort or inconvenience, as, for instance, in a case of wired fracture of the hip, with more or less cumbersome apparatus, the rule should be a movement every other day. In other cases the surgeon will be governed by conditions, never, under ordinary circumstances, allowing the intestinal residue of a person on a fairly free diet to accumulate more than forty-eight hours.

CATHARTICS

A simple and not unpleasant measure to assist in moving the bowels is the employment of one or another of the numerous bottled laxative waters—natural or artificial; a wineglassful taken slowly before breakfast is usually just sufficient to prevent the fecal mass from becoming hard and dry and difficult to move onward; or a tablespoonful of olive oil, taken with each meal, may be just sufficient, by mechanically lubricating and preventing the intestinal content from becoming dry and impacted, to allow of one gentle movement daily. A small dose of castor oil, one-half or one teaspoonful, taken every morning, will often keep the bowels in excellent condition where other and more irritating drugs may fail. It can be used freely, because it is safe and has no bad effects. It may be agreeably taken in beer or tea, according to the taste of the patient. A pleasant way of serving it, so that the patient does not taste it at all, is to wet the inside of a wineglass, pour in a little water or peppermint water, float on top of this the castor oil, and then pour in a little brandy, which, being lighter than the oil, will cover it, forming a sort of "sandwich," which should be drunk at one gulp. A teaspoonful of the compound licorice powder, more or less, may be taken at night, stirred up in a little water; or cascara, the extract, in the form of pills, or, better, as the fluidextract, which may be made to taste more pleasant by the addition of aromatics. Some patients prefer the officinal A. S. and B. or the compound cathartic pill. Phenolphthalein,[1] in one or another of its proprietary forms, is agreeable to take and works, as a rule, gently and pleasantly in small doses. There is a considerable advantage in the occasional use of laxatives, in that it prevents straining at stool, with the uncomfortable effects this may have on hemorrhoids or hernia. Moreover, straining is attended by a considerable increase in intra-abdominal pressure, which, by causing a congestion in the vessels of the brain, may be sufficient to determine an apoplexy in elderly persons, or it may be the exciting cause in the setting free of an embolus.

If the bowels require stimulation stronger than that given by the laxative measures detailed above, it will become necessary to give these drugs in larger doses or to employ *purgatives*. These range from

[1] Berthoumeau and Daguin (Purgative Properties of Phenolphthalein, Presse Medicale, Paris, 1908, xvi, 378) review the literature on this comparatively new agent and report extensive personal experimental research. The results show that phenolphthalein increases, on direct contact, the contracting power and the secretion of the intestines. Beyond this action on the intestines the drug does not seem to induce any noticeable modification in the other functions. In the dose of from 0.5 to 0.8 gm. (7½ to 12 gr.) it purges without griping. The laxative dose is 4 or 5 gr. or less.

Epsom salt and calomel to the drastic croton oil or elaterin. Calomel in small doses gives soft stools, generally without pain or straining, apparently through acting as an intestinal irritant. Calomel has this peculiarity, that its cathartic action is not increased in direct proportion to the dose, for calomel itself is insoluble, only the portion which is changed to the gray oxid is active, and the major part of the large dose is thrown out unchanged in the stool, and for this reason the best effect is obtained by administering small doses (from $\frac{1}{10}$ to $\frac{1}{2}$ gr.) at half-hour intervals until a movement results. It is tasteless, and is not, as a rule, rejected by the stomach even when there is vomiting. If it fails to act, it should be followed by a Seidlitz powder, Epsom salt, or an enema.

The salines commonly employed are magnesium sulphate[1] (Epsom salt), magnesium citrate (effervescent), and the double tartrate of

[1] W. F. Boos (Boston Med. and Surg. Jour., 1909, clxi, 122) has shown that magnesium poisoning following the use of Epsom salt is probably more frequent than is generally supposed, the true cause of the toxic condition remaining unknown in most cases. Two of the 3 cases which the author had the opportunity to study were brought to his notice merely through the high specific gravity of the urine, in 1 case 1070 and in the other 1080. These 2 cases recovered, while the third case ended fatally. Fraser reports a case of his own, and discusses 6 others which he found in the literature; 5 of these ended fatally. In the author's 3 cases the intoxication was undoubtedly caused by the absorption of large quantities of magnesium sulphate from the gastro-intestinal tract.

The author finds that in the absence of hydremia the tendency of magnesium sulphate to be absorbed increases with the concentration of the solution, the dry salt being completely absorbed without action on the bowels. This fact was shown by Hay to be true also of Glauber salt. In hydremic conditions, however, the salt, even when it is given in very concentrated solution, is not absorbed. It appears, therefore, that the practice of giving very concentrated solutions of magnesium sulphate to deplete the system of excessive water is rational, but perhaps not without possible danger.

In the absence of edema or ascites to produce efficient catharsis without incurring the danger of intoxication from absorption, the salt is best given in solutions not exceeding 6 per cent. Above this concentration more or less magnesium sulphate is absorbed and is lost to catharsis, while its presence in the circulation is a menace to the patient's life. In the wards of the Massachusetts General Hospital the patients are now given $\frac{1}{2}$ oz. of Epsom salt dissolved in 3 oz. of water, to be followed immediately by a glass of water (6 oz.); this represents approximately a 6 per cent. solution.

Boos has made a further study of this subject (Jour. Am. Med. Assoc., 1910, lv, 2037), and concludes:

1. Magnesium sulphate in bulk or in concentrated solution is absorbed, in part at least, from the gastro-intestinal tract into the blood.

2. If a sufficient amount of the salt is absorbed at a given time, poisoning will result; of the 10 cases reported, 6 resulted fatally. The symptoms and autopsy findings in these cases agree very well with those obtained in animals after the intravenous application of magnesium sulphate.

3. On account of the slowness of its excretion from the system, magnesium sulphate, given repeatedly in concentrated solution, may produce poisoning by cumulation.

4. In normal conditions of the bowel, magnesium sulphate, in proper dilution, is a

sodium and potassium (Rochelle salt, usually administered as pulvis effervescens compositus or Seidlitz powder). These act, not by irritating the intestine, but, having a higher osmotic pressure than the blood, by inducing a secretion of fluids from the intestinal wall, until the weight of this, added to its own weight and bulk (being itself practically insoluble), induces increased peristalsis and the whole is evacuated. All these must be given in solution; if, however, the solution is weak, or if the blood and tissues are impoverished of fluid, evacuation is less likely to occur. As they act rapidly, they are best given in the morning. Many persons are nauseated by Epsom salt, and especially after ether is vomiting likely to occur; in either case the salt should be given cold and dilute. On account of the depressing action of magnesium sulphate it should not be used in case the patient is in a state of exhaustion, nor should any of the salines be used where the tissues have already been depleted of fluids.

Croton oil may be given in doses of $\frac{1}{2}$ to 2 minims on a crumb of bread, on a lump of sugar, or mixed with butter or olive oil. It is a powerful irritant, and in any but small doses acts as a poison. It acts effectually and without causing much pain or inconvenience after other drugs have failed. Elaterin is a powerful hydragogue cathartic, which acts rapidly by irritation. It is given in the form of the officinal trituration of elaterin, in the dose of $\frac{1}{2}$ gr. The disadvantage of employing the more powerful drugs is that their action is always unpleasanat to the patient and the evacuations are loose. Oftentimes the action of the drug may be continued over an hour or more, so that the patient is annoyed and distressed and may be considerably weakened by frequent watery movements of scanty amount.

As a result of the work of the English physiologist, Starling, it has become accepted that certain organs, during the performance of their normal function, elaborate as by-products substances which act to stimulate the functional activity of other organs. These substances have been named

valuable cathartic; Hunyadi water, for example, is practically a 3 per cent. solution of Epsom salt (magnesium sulphate 1.5 per cent., sodium sulphate 1.5 per cent.).

5. It is not wise to give magnesium sulphate indiscriminately in cases of so-called acute intestinal obstruction, because when peristalsis is much diminished or absent, and in cases of mechanical obstruction of the bowel, even dilute solutions will be absorbed, with consequent danger of poisoning.

6. In cases of suspected magnesium poisoning, large quantities of normal salt solution should be given intravenously. Dilute solutions of lime-salts given hypodermically may also be of benefit.

7. The subcutaneous use of magnesium salts to produce catharsis, as proposed by Wade, is not only absolutely irrational, but dangerous.

hormones. Zülzer[1] has demonstrated that the spleen is the repository of the hormone which stimulates intestinal peristalsis, and he has claimed that this active principle can be isolated and applied with success therapeutically to cases of constipation, tympanites, and postoperative paresis. Hormonal, as the marketed preparation is called, is given intramuscularly or, better, intravenously in doses of 20 or 40 cc. Occasionally its administration is followed by a slight rise in temperature and pulse-rate, and rarely by slight prostration.

It is not always necessary to excite peristalsis of the small intestine by means of drugs in order to clear out the bowel, because not infrequently the want of activity depends, not upon the small intestine, but upon the rectum, which, by training or habit, has become so accustomed to the pressure of fecal matter that it no longer irritates to the extent of setting up a reflex desire for defecation. In other cases, there is a distinct disadvantage in exciting intestinal activity. In either event we resort to the use of local measures—enemas or suppositories. One of the best means of ridding the rectum of accumulated feces is the employment of glycerin. This works immediately when it works at all. The stool which results is of ordinary consistency; there is but one movement, and that is unaccompanied by pain or colic. Its action depends largely upon its lubricating quality, partly upon its ability to excite a watery secretion from the mucous membrane with which it comes in contact, and chiefly by providing, through its irritant action, the reflex stimulus which was lacking. The glycerin should be injected low into the rectum, in a dose of $\frac{1}{2}$ to 2 teaspoonfuls. The more convenient mode of administration is in the form of suppositories, the officinal suppository being made up of 45 gr. of glycerin gelatinized by means of soap. These weaken with age as the glycerin tends to escape. An almost equally efficacious suppository is that made by whittling out a piece of Castile soap to shape. This should be moistened before introduction.

Digital Evacuation of Rectum.—If it becomes evident that there is impaction in the rectum to such an extent that these measures are inefficient, or result only in painful watery evacuations, it will be necessary to explore the rectum digitally. A rubber glove or finger-cot should be worn, well lubricated with vaselin. The exploring finger should break up the masses, if soft enough, and remove whatever is within easy reach. This procedure should be followed by a soap-suds enema. Often one will find the rectum filled with masses as hard as

[1] Die Hormontherapie. I. Das Peristaltikhormon, " Hormonal," Therapie der Gegenwart, May, 1911.

marbles, worn round by their play upon each other. If these cannot be broken up, the smaller may be removed entire by the finger; the larger will necessitate the introduction of a silver spoon or a gall-stone scoop. If this procedure is attended by much pain, it should be followed by a low enema of 6 oz. of starch containing 10 drops of tincture of opium.

ENEMAS

There has been a discussion of long standing as to the relative value of catharsis by mouth and of enemas in the treatment of postoperative constipation. It has been shown[1] that after abdominal operations involving the alimentary tract the enema is preferable. General peristalsis is excited only to a less degree, and the diseased part is maintained at rest. The large intestine is kept empty, and distention with gas, which is mostly formed in the colon, is rarely considerable. Hardened fecal masses cannot remain to block the exit of gas or attempts at evacuation. Straining at stool, with its pull on abdominal wound and on newly forming adhesions, does not occur, and such nourishment by mouth as the patient has been induced to accept is not unduly hurried along at a time when the patient needs all the strength he can acquire.

Mild Enemas.—When the bowel is filled higher up with fecal matter, it will become necessary to employ larger quantities of fluid, and to employ somewhat greater care and gentleness in making the injection, so as to insure the fluid being carried into the sigmoid without distending the rectum and thus exciting a desire to defecate. Ordinarily, a mild enema will suffice to induce the desired action, and of these, plain water, normal salt solution, and soapy water are efficacious, given warm, 95° to 100° F., in quantity about 1 pint for an adult; or an ounce of castor oil may be given in 12 to 16 oz. of thin starch solution. Another good enema is milk and molasses, equal parts, to make from a pint to a quart. Warm enemas cause no reaction and excite little peristalsis; cold water (about 70° F.) stimulates bowel peristalsis much more powerfully. Where there is no contra-indication, a half-pint of cold water may be injected into the rectum through a funnel, retained ten minutes, siphoned off, and the procedure repeated once or twice. The water may be gradually cooled. Large quantities of any solution should not be injected on account of the atony of the bowel which results. A quart should be the maximum employed, and if this amount is injected and does not come away

[1] Crandon, Catharsis in Abdominal Surgery, Boston Med. and Surg. Jour., 1901, cxliv, 639.

within a reasonable time, it should be withdrawn, particularly if another enema is intended to be administered.

More Drastic Enemas.—In abdominal cases not infrequently emergencies arise in which, on account of distention or intestinal paresis, evacuation of the colon becomes a critical necessity. In this event much more drastic enemas may be employed in conjunction with other means of exciting peristalsis—enemas so irritative that their use should ordinarily be avoided. Such an enema is that of suds and turpentine:

Turpentine	2 ounces;
Warm suds	8 "

This mixture must be stirred continuously while it is being given, otherwise the oil will float on top and the patient will get all the oil in the last few ounces. Shaking up the oil first with half its bulk of mucilage of acacia or white of egg will assist in holding it in suspension. Another combination which is commonly used is:

Turpentine,	
Glycerin,	
Epsom salt	āā 2 ounces;
Warm water	7 "

The turpentine here also should be emulsified with the white of one egg. In this enema the proportion of turpentine to water may be increased or diminished as the case demands. Before any enema containing turpentine is administered, the region about the anus, as well as the buttocks and sacrum, should be well oiled, to protect the skin from blistering. Heat seems to have an important influence in stimulating peristalsis, and for this reason some surgeons are in the habit of injecting into the colon 6 oz. of hot olive or cotton-seed oil or hot glycerin. The old-fashioned milk and molasses enema, of each one pint, if given high and hot, is usually followed by good results, and it is not so irritating as the enemas depending upon turpentine or glycerin for their action.

No enemas are of constant value, however, and if one mixture will not work, another should be tried. Ill success should not always be laid to the nature of the material used. In cases of fully developed paralytic distention, particularly if angulation of the bowel has occurred, enemas, which act primarily only on the colon, cannot be expected to be of much avail. They may be relied upon, however, if employed early, before these conditions have developed.

There is one precaution to be always borne in mind in the administration of an enema, and that is to see that due care is exercised in the *passing of the tube.* If the rubber rectal tube is pushed in carelessly or hurriedly, the tip is likely to catch on one of the valves of Houston, and the tube will coil up within the rectum and perhaps tear or injure the valve. For a high injection the tube should always be passed slowly and with great gentleness, upon the well-lubricated gloved forefinger of the left hand, inserted as far as it will go. If the patient lies upon his left side, gravity will aid in guiding the tube toward the sigmoid flexure. A valuable contribution to the question of the practicability of the high enema is that of Soper (see also Chapter XII, p. 141). It seems to be the belief of the majority of physicians that the soft-rubber tube can be passed beyond the sigmoid flexure, though this has been disputed by high authorities. Soper's experiments with the *x*-ray show that in most cases the soft flexible tube ordinarily used cannot be made to pass beyond the dome of the rectum, and that it is only in exceptional conditions of dilatation and hypertrophy of the colon that it can be successfully introduced beyond the sigmoid flexure.

The need of introducing the injection-tube beyond the rectum is probably in most cases an imaginary one. Soper has demonstrated the possibility of flushing the entire colon by using a large-caliber (½ in.) short tube. It is much easier to depend on an enema finding its own way beyond the flexures than to endeavor to carry it beyond them. A tube of sufficient rigidity to force its way would hardly be advisable for general use.[1] Soper[2] says, "I believe that it is only in those rare cases of abnormal development of the sigmoid that it is possible to introduce a soft-rubber tube higher than 6 or 7 in. in the rectum without it bending or coiling on itself. With the aid of the sigmoidoscope only the middle of the sigmoid can be reached. The practice of allowing liquids to flow through simultaneously with the introduction of the tube serves to smooth out the kinks and adds to the illusion that the tube is going higher. The short tube (6 in. in length) is, therefore, best for all sorts of enema (*a*) when water, etc., is introduced for the purpose of causing fecal evacuations, using the fountain syringe or funnel and long tube in the usual way. It is possible, as I have frequently demonstrated, thoroughly to cleanse the entire colon by using a large-caliber (½ in.) short tube. This is connected by rubber tubing with a large funnel, elevated from 3 to 4 ft. above the patient, pouring in the solution until he experiences a feeling of distention or desire to

[1] Editorial, Jour. Am. Med. Assoc., liii, Aug. 7, 1909.
[2] Ibid., 426.

evacuate, then lowering the funnel until the outflow has ceased, repeating this maneuver in exactly the same manner as in gastric lavage.

"The short tube is also best (*b*) when retention of liquid is desired, as in administering saline solution, oil, nutrient material, etc. The attempt to pass the tube higher into the bowels is not only unnecessary, but, because of the coiling that inevitably occurs, such a manipulation tends to produce irritability of the bowel. This, of course, will very probably cause expulsion of the fluid."

After any operation involving the lower rectum, as after a prostatic enucleation, a Whitehead or a Kraske, care must be exercised lest the thin mucous membrane be torn by the tip of a stiff tube, or the line of suture separated, and the enema be poured into the peritoneal cavity —which we have known to happen with fatal result. Likewise, after any operative procedure involving a suture of the intestines, especially if it be low down in the gastro-intestinal tract, enemas must be postponed until it is felt that the line of union is sound, and then they should be given gently and with little pressure. Even so, retroperistalsis may be set up, which will carry the fluid backward with considerable force along the gastro-intestinal tract.

DISTENTION

After any operation, but chiefly after celiotomies, we are accustomed to note the accumulation of a moderate amount of gas in the gastro-intestinal tract. This distention usually involves the intestines chiefly, but it may be limited to the stomach. The occurrence of distention seems to be about in proportion to the amount of exposure and handling which the intestines have received.[1]

Gas is normally present in some amount in both stomach and intestines. This normal quantity is added to after operation by the fermentation of such food as remains in the gastro-intestinal tract. If the patient has been well cleaned out before the operation, fermentation will be practically nil. In addition, there seems to be a failure on the part of the mucous membrane to absorb the gas. The flatus is sometimes increased considerably by air swallowing or "cribbing." With some persons this is simply a nervous habit; after operation a

[1] Henderson, whose investigations of acapnia have already been referred to, has shown definitely by experimental methods that the loss of tone of the gastro-intestinal track which follows celiotomy is due largely to loss of carbon dioxid by exhalation from the peritoneal surface during exposure. This exhalation is increased, he asserts, by the practice of keeping exposed viscera wrapped in towels moistened with hot saline. He suggests as therapeutic measures to combat the condition the bathing of the bowel in salt solution saturated with the gas, and its injection into the peritoneal cavity.

patient may swallow considerable air with the saliva which he is constantly gulping down to relieve the parched feeling in his throat. The gas accumulates in the intestines because the patient will not relax his sphincters to release it, because of failure of peristalsis to expel it, and because the abdominal muscles, if they have been injured by the surgeon's incision, cannot or will not contract to assist the intestines. As the volume of gas increases the intestines become inflated and stretched, offering less and less resistance to the expansion, and become paralytic, until they lose their tone entirely.[1]

Ordinarily, the accumulation of flatus is simply a matter of discomfort to the patient, and in cases other than abdominal usually responds to simple remedial measures. The hard-rubber rectal nozzle of a household syringe may be passed, well lubricated, through the sphincters, and worn an hour at a time, three times a day, usually with great relief. To encourage the belching of gas accumulated in the stomach, one should try one or another carminative, as peppermint water; Hoffman's anodyne, 20 minims, on cracked ice; or 5 drops of turpentine on a lump of sugar. Position seems to have an important influence on the accumulation of gas; allowing the patient to turn upon his left side and to draw up his knees will render easier the passage of flatus. Massage of the abdomen is an efficient aid in promoting peristalsis, especially in persons with flabby abdominal walls. As the first evacuation of the bowels usually carries off with it the gas which has accumulated since the operation, the bowels should be moved as soon as conditions indicate. For this purpose castor oil, calomel, or Epsom salt may be given by mouth, or an enema of soapsuds administered.

After celiotomies, distention may have a serious significance, and, besides being so frequently a forerunner of peritonitis, is always of itself a source of anxiety to the surgeon. The causes (leaving the consideration of mechanical obstruction to the next chapter) are sepsis (the result of disturbed innervation of the intestinal wall from septic absorption), atony (from general causes), and interference with innervation, direct, from handling the gut or from operative trauma, and reflex. In the latter case the theoretic sequence of events is about as follows: Operative handling of the peritoneum and viscera causes an irritation of the splanchnic nerves, which when stimulated exercise an inhibitory effect on the plexuses of Auerbach and Meissner, which

[1] It has been held that the Trendelenburg position favors the occurrence of postoperative distention, because the abnormal position in which the intestines are sometimes left interferes with the ready expulsion of gas. It is important that after the table is let down the intestines and omentum be replaced in their normal positions.

are located in the intestinal wall and control its muscular activities. As a result of the atony and diminished peristalsis, flatus tends to accumulate and the bowel becomes less able to expel the collected gas. Putrefactive changes go on in the small bowel, chiefly, as a rule, in the ileum, where the bacteria are most numerous, and distention progresses until the bowel is so stretched that it could not contract even if its innervation were not interfered with. This distention may prove fatal in itself, or a fatal termination may result from a kinking or angulation of the dilated intestine. The diaphragm is driven up, and may seriously impede the action of the heart and lungs.

In any abdominal case the surgeon should percuss the abdomen at each visit, until the bowels have acted, to satisfy himself that there is no overdistention. This can be satisfactorily done, as a rule, through the swathe; if there is any question, the swathe should be removed. If gas has not been freely passed within twenty-four hours after the operation, the simpler measures detailed above should be put into play. If these fail to act, or the distention increases, no time should be lost in bringing to bear every means of forestalling a possible fatal meteorism.

In *paralytic distention* purgation by mouth generally fails to act, and may aggravate the existing condition by stimulating the secretion of intestinal fluids. We should rely chiefly, therefore, upon drastic enemas, given high and frequently and in large amount. Of these, the best are the turpentine and suds, the turpentine, Epsom salt, and glycerin, the milk and molasses, the hot glycerin, and the ox-gall and water. Another enema which has a good reputation in the removal of flatus is the enema of asafetida:

Tincture of asafetida..............................	6 drams;
Warm thin starch-water............................	8 ounces.

These act to empty the large bowel of gas and so encourage more to descend from the small intestine. The rectal tube should be passed as high as it will go freely without kinking, and left in place to allow a free exit for gas. If there is no marked relief following the first enema, 6 oz. of hot cotton-seed oil should be injected through the tube every hour, and every fourth hour another enema administered.

In addition, peristalsis should be stimulated by external applications, either of heat, in the form of flaxseed poultices or turpentine stupes, covering the entire abdomen, repeated every two hours, or cold, in the form of ice-bags. As the distended abdominal wall is insensitive and seems particularly easy to burn, the skin should be greased with cold cream or vaselin before the application. Turpentine stupes are made by wringing out old flannels or squares of blanket in hot water to which turpentine has been added in the proportion of about a tablespoonful to the quart. Another maneuver, which is often followed by good results, is to run slowly a lighted wax taper or a Paquelin cautery tip heated to a dull red over the abdomen, just close enough to the skin to burn the hairs, beginning at the cecum, following up the ascending, across the transverse, and down the descending colon. Apparently the concentration of heat over a small area has some effect on exciting peristalsis; what part the mental effect plays cannot be definitely stated. In addition, strychnin may be given hypodermically, on the theory that it increases the activity of the alimentary tract.

Atropin is sometimes advocated, as it is given in various forms of colic to lessen spasm and to allow the passage of intestinal contents. Postoperative tympanites, however, is less often due to spasm than to paralysis, and atropin theoretically acts but to increase this paralysis. However, Lederer[1] reports 10 cases of grave paralytic ileus in which he got immediate benefit from the injection of $\frac{1}{60}$ gr. atropin, repeated up to $\frac{1}{20}$ or $\frac{1}{12}$ gr. Physostigmin salicylate is highly commended by some surgeons. It is ordinarily given during or after the operation in the dose of $\frac{1}{40}$ gr., and repeating every two hours for two or three doses. We have had no experience with it.[2]

There may arise an *acute postoperative dilatation of the stomach* and duodenum, apart from dilatation of the intestines. Its onset is sudden, with pain and vomiting, which is usually not fecal, and which frequently passes off as the condition progresses, and distention, which

[1] Med. Klinik, 1911, vi, No. 1.

[2] D. C. Craig, of Boston, has used this drug extensively and speaks highly of it (Am. Jour. of Obstet., etc., April, 1904; New York Med. Jour., March 13, 1905). If the patient is known to react readily to cathartics, he uses $\frac{1}{80}$ gr.; if she is of a constipated habit, $\frac{1}{30}$ gr.; when atony of the intestinal muscles exists, he gives up to $\frac{1}{20}$. The medium dose is $\frac{1}{40}$, to be repeated on the first indication that it is inadequate. It should always be given with atropin, which antagonizes all the undesirable actions of the eserin. The atropin should be given first, because it acts more slowly. The best time to give this is just before the operation, gr. $\frac{1}{150}$, subcutaneously. The eserin is injected under the skin after the abdomen is opened, as soon as it is evident that no contraindication exists, such as would demand absolute intestinal rest and quiet. It should be withheld, therefore, in cases where strong or numerous adhesions are encountered, until it is evident that the adhesions may be freed without damage to the intestinal musculature. Its use is contraindicated in cases of intestinal anastomosis or resection, and whenever we are led to suspect that some more or less septic material is being left behind in the peritoneal cavity, until healing is well established. Moennighoff (Jour. Missouri State Med. Assoc., Oct., 1908) uses eserin salicylate hypodermically in celiotomies as a prophylactic against distention, giving gr. $\frac{1}{40}$ immediately after the patient has returned to bed.

gives the succussion sound if any fluid is present in the stomach. The pulse and temperature rise and there is a rapidly developing collapse. The condition cannot be readily distinguished from acute obstruction; diagnosis is made, in suspected cases, by the succussion and the absence of any fecal quality to the vomiting. Chronic cases develop more slowly, but show the same signs. About 70 per cent. die if untreated, probably in many cases from pressure of the enlarged stomach upon the heart. In any case of tympanites accompanied by nausea a tube should be passed into the stomach to relieve it of accumulated gas and fluids, for in a given case it is usually difficult to differentiate distention of the stomach and intestines. (For treatment of this complication see Chapter XVI, p. 183.)

An unrelievable tympanites may represent a distention of the intestines behind a kink, which constitutes a true intestinal obstruction and tends to a fatal termination. Frequently distention is the initial sign of peritonitis. Sometimes patients die with distention and no peritonitis, or only a beginning peritonitis is evident at autopsy. It is clear in these cases that death is not the result of peritonitis. A theory has been put forward that death is the result of anemia of the centers at the base of the brain, due to the stasis of blood in the splanchnic area. Another theory attributes the lethal result to a reflex action on the central nervous system from irritation of the nerve-filaments in the intestinal wall, while some investigators hold it to be caused by auto-intoxication from some product of disturbed metabolism secreted in the affected intestine. But the researches of Murphy and Vincent[1] have demonstrated rather conclusively that death is due to a toxic substance which is found in the obstructed intestine, bacterial in origin, absorbed by way of the lymphatics. They assert, however, that interference with circulation of the obstructed intestine is the vital factor in the production of the typical symptoms of acute ileus, and the obstruction of the venous return is the most important element.

On account of the possibilities of obstruction, any case of postoperative tympanites which progresses in spite of treatment should be considered operative. So long as the abdominal wall remains soft, the patient being in good condition, there is hope of obtaining response to treatment. If the abdominal wall becomes tense and hard, and the general condition begins to fail, operative measures should not be delayed. The best method of procedure is to treat the case as one of acute postoperative intestinal obstruction along lines to be detailed in the next chapter.

[1] Boston Med. and Surg. Jour., 1911, clxv, 684.

There have been advocates, in the past, of simple puncture of the intestine by means of a fine trocar or long hypodermic needle shoved at random through the abdominal wall into the intestine for the purpose of allowing the escape of gas, and recoveries after this procedure have been reported. The method is unsurgical and the danger of setting up a peritonitis from leakage about the trocar is great. Moreover, the intestine must usually be punctured in several places and many times, because each puncture will relieve but one loop of gut, and the gut above and below will be shut off by kinking. The procedure is indicated practically only in moribund cases where an extreme distention is causing excruciating pain. It should be performed in the flank over the cecum, because this is a fixed point and will not give rise to kinking. A puncture here will relieve the colon, and may also relieve the small intestine gradually through the ileocecal valve. The trocar or needle may be left *in situ* for some while. If there is a leakage of intestinal contents at this point, it is less likely to spread over the peritoneal cavity and it may wall off.

It is far better, if the patient's condition will allow it, to perform an ileostomy under cocain, tying in a Paul tube by a purse-string suture. This can be done through a short incision, either in the middle line, above or below the umbilicus, or in the left flank. The immediate relief is usually great, the bowel, emptied of accumulated gas and liquid juices (which may have to be siphoned off), is allowed to collapse, and it recovers its tone. If the circulation reëstablishes itself, peristalsis is instituted and the patient is saved. Where, on account of angulation of the gut, only a portion of the intestine is drained, the relief will be found to be simply temporary, and another drainage site will have to be established. The small fecal fistulæ which persist frequently close spontaneously; if not, operative measures can be taken later. If it happens that the enterostomy be made high up in the intestinal track, there may result painful autodigestion about the fistula, and the patient may become greatly weakened from inanition.

CHAPTER XVI

ACUTE INTESTINAL OBSTRUCTION; ACUTE GASTRIC DILATATION

ACUTE INTESTINAL OBSTRUCTION

ACUTE intestinal obstruction is one of the most disastrous of the sequelæ which the abdominal surgeon has to face. Its occurrence is not infrequent and the mortality is high.[1] Several classifications of the various types of obstruction have been proposed. Two forms are ordinarily recognized, the mechanical and the septic.[2] Finney[3] speaks also of an adynamic type, but this we have already considered under the name of Paralytic Distention. It is simpler to consider all cases of acute obstruction as mechanical; cases in which exists no mechanical obstruction of the lumen of the gut should be classified as distention. The distinction is of importance, because the non-operative methods which can be relied upon in distention of the bowel usually are of no avail in obstruction. A distended gut may, however, become obstructed.

We shall consider here only early obstruction; late obstruction, occurring weeks to years after operation, will be considered under Adhesions (p. 332). Ordinarily, in early obstruction, the obstruction is or soon becomes complete; in late obstruction, partial and complete obstruction have to be differentiated.

Etiology.—The commonest cause of acute intestinal obstruction is an angulation or kinking of the intestine, a condition in which the gut doubles back on itself at an acute angle, so as to form a valve-like closure. This is most frequently due to paralytic distention; in this case, if the paresis is not too great, sometimes under the treatment already suggested peristalsis is set up and the angulation is overcome. It may be due to the adhesion of a loop of gut to an unusual situation, as deep in the pelvis, to another loop, or to the parietes. This occurs not uncommonly after appendectomy with drainage, where a few firm adhesions have united the cecum and an adjacent loop of small intes-

[1] Gibson, Ann. Surg., Oct., 1900, xxix, places it at 47 per cent.

[2] Forbes Hawkes, The Prevention of Intestinal Obstruction Following Operation for Appendicitis, Ann. Surg., 1909, xlix, 192.

[3] Ann. Surg., June, 1906, xliii.

tine. It may be due to the hernia of knuckle of intestine through an opening in the mesentery, or to a twist or volvulus. Distention behind an angulation acts to close it more firmly, by pressure of the inflated proximal limb upon the flattened distal portion. The lumen of the gut may be closed by a band or adhesions, particularly in cases of local or general peritonitis, or by pressure from a drainage-tube or packing.

Strangulation of the intestine implies an interference with the circulation of a loop of gut. It may be due to volvulus, intussusception, for instance, at the point of an intestinal anastomosis, to pressure from a band of adhesions, or to herniation. It is usually accompanied by obstruction, but the important factor is stasis of the blood-supply, which eventually leads to thrombosis and gangrene of the gut, and complicates the condition.

The term *septic obstruction* is one that is given to the condition which follows upon the development of general suppurative peritonitis. This form is likely to manifest itself immediately after any celiotomy which discloses a diffuse septic peritonitis. The formation of adhesions seems to take no part in the causation of this form of obstruction; the intestinal stasis can be referred partly to a disturbed innervation of the intestinal wall from septic intoxication, and partly to the formation of massive flakes of fibrin and the cohesion of coil to coil. This form of obstruction should be forestalled by instituting intestinal drainage at the time of operation in all cases of spreading septic peritonitis. Through a gridiron incision in the flank the ileum should be seized as low down as possible, incised, and drained through a Paul tube. If one waits for fecal vomiting before performing a secondary operation, the effort is usually wasted. Another cause of early postoperative obstruction in cases of extensive peritonitis, described by Woolsey,[1] is secondary abscess. He has found that without exception the obstruction was relieved by the evacuation of pus, and infers accordingly that the explanation of the condition lies in the pressure of the abscess upon coils of gut so restrained by adhesions that they cannot escape.

Diagnosis.—The onset of symptoms is usually late, from three to nine days after the operation. They appear suddenly in cases where the obstruction is primary and complete, or they develop more slowly where the condition is secondary to a paralytic distention. In the former event there may be sudden sharp pain, particularly

[1] Postoperative Intestinal Obstruction, Surg., Gyn., and Obst., 1910, x, 608; a comprehensive and scholarly consideration of the subject.

in volvulus or strangulation. Colicky pains of some degree are usually present, but they are less severe and persistent in cases due to atony. The passage of flatus ceases and distention develops. Distention occurs without peristalsis, and is more marked and uniform in the cases due to atony than in primary mechanical obstruction, where it is apt to be asymmetric, with visible peristalsis of the distended coils. There is obstinate constipation, and rectal enemas, after the lower colon is emptied, come back as they went in. Vomiting appears early, and rapidly becomes putrescent.

The diagnosis is often obscured by the conditions which preceded or occasioned the operation, and it may be confused with other post-operative complications, such as peritonitis. A differential diagnosis is frequently impossible, particularly as a spreading peritonitis is usually accompanied by a certain degree of paralytic distention.

The **treatment** may be considered under two heads, prophylactic and operative. Inasmuch as most cases are due to operative trauma, adhesions, or sepsis, conditions encouraging these factors should be guarded against. The bowel should be handled as little and as gently as possible, denuded surfaces and conditions inviting the formation of adhesions should be avoided. In the presence of peritonitis the operation should be simple and rapid, without trauma to the peritoneum, and the after-care, particularly as regards catharsis, should be strictly overseen. In any case of distention palliative measures of the sort advised in the previous chapter should be taken at once, with the purpose of forestalling an obstruction: gastric lavage, enemata, hot fomentations, physostigmin. Kappis[1] advises that a soft stomach-tube be passed through a nostril into the stomach and allowed to remain. After the stomach-contents are siphoned off, vomiting and hiccough stop, and the abdomen is relieved of the pressure of the filled stomach. The tube should not be worn more than twelve hours at a time, or esophageal ulcer may result. Generally speaking, if in marked distention palliative treatment does not show results within a few hours, operation should not be long delayed.

The question of *when to operate* in any form of postoperative obstruction is usually not easy to decide in the individual case. This difficulty may be referred entirely to the doubt that arises over the diagnosis. Frequently the surgeon puts off his decision from day to day, hoping against hope that the condition will clear up under palliative treatment, and by the time the symptoms have developed so that there is no question about the diagnosis, the chance of recovery is

[1] Münch. Med. Woch., 1911, lviii, No. 1.

small. If, after a fair and deliberate consideration of the symptoms, the probability of acute intestinal obstruction seems established, operation should be performed immediately. The following signs and symptoms are to be considered as incriminating evidence:

(1) Distention, with or without vomiting.

(2) Local pain or tenderness, which is extending.

(3) Increasing resistance or rigidity.

(4) Chills.

(5) An increasing pulse-rate, without a corresponding elevation of temperature.

(6) The peritoneal facies.

The question of *whether* to operate can be dismissed in a line. In the words of Sir Frederick Treves, "There is no avoiding the fact that acute intestinal obstruction if unrelieved ends in death." Delay is far more serious than operation, which is not to be considered as the last resort, but rather as the first resource.

The extent of the operative procedure will depend upon the condition of the patient. If the operation is undertaken early, with the patient in fair condition, without marked distention, particularly where a primary mechanical cause is suspected, an exploratory laparotomy should be performed, through a median incision or the opened-up wound, and a careful search should be made to unearth and relieve the cause of trouble. If the mechanical cause is found, it can be removed; if a collection of pus is brought to light, it can be drained; if no causative factor appears, an ileostomy should be performed by sewing in a Paul tube, using a purse-string suture and inverting the edges. On the contrary, with the patient in bad condition, particularly in the presence of sepsis, a rapidly accomplished enterostomy performed low down, under cocain anesthesia, may be the most radical course which can be considered. If, after some hours of relief, and without blocking of the drainage, the distention increases, it will be advisable to repeat the enterostomy in some other location.

ACUTE GASTRIC DILATATION

An acute dilatation of the stomach (gastrectasia, gastric paresis, gastromesenteric ileus) may follow operation. The condition is analogous to distention of the small intestine, which it frequently accompanies, and in the majority of the cases probably represents similarly a reflex paresis. Some investigators state that it is due to occlusion of the duodenum from the pressure of the mesentery which overlies it, and that the dilatation and ptosis of the stomach are secondary. As this condition (called duodenal ileus or gastromesenteric ileus) is usually to be definitely diagnosticated only at autopsy, it will remain difficult to determine finally in the individual case whether the dilatation and ptosis cause kinking and occlusion at the duodenum, or whether the weight of the small intestine dragging on the root of the mesentery causes the occlusion and secondary dilatation.

Occurrence.—The importance of this acute and serious complication of abdominal section has only come to be understood within the past ten years, and it is still more recently that we have begun to pay attention to its treatment. Recent discussion has convinced us that it occurs much more frequently than we formerly supposed, and that in itself it is very likely to cause death. The possibility of its occurrence must be borne in mind in the after-care of any case in which abdominal symptoms present themselves. Polak[1] found that it was recognized in $\frac{8}{10}$ of 1 per cent. of 1000 celiotomies. Laffer[2] has recently collected 97 cases after operation; 69 per cent. of these occurred after laparotomies. Of a series of 217 cases from all causes, 63½ per cent. died.

Etiology.—It is most frequent after operations on the biliary system, next after operations on the kidney, and less frequent after appendectomies, curettage, uterine operations, herniotomies, operations on the stomach, and on the extremities. Several cases are on record of its occurrence following the application of a plaster jacket for Pott's disease or fracture of the spine.[3]

The significance of anesthesia in its production is still undetermined. Laffer states that in 20 cases where the anesthetic was recorded, chloroform was used twelve times and ether eight. Attention has been called to the fact that it may follow prolonged narcosis. Woolsey[4] mentions that in the first case in his experience in which the condition was recognized, the patient had been under the influence of chloroform for two days before operation on account of pain. Lichtenstein[5] states that it may occur when no general anesthetic has been used.

It is said to be common in thin, weakly individuals, especially those

[1] Acute Gastric Dilatation as a Postoperative Complication, New York Med. Jour., 1909, lxxxix, 1184.

[2] Acute Dilatation of the Stomach and Arteriomesenteric Ileus, Ann. Surg., 1908, xlvii, 533.

[3] Hanssen, Norsk Magazin Laegevid, 1910.

[4] *Loc. cit.*

[5] Akute Magenlahmung, Central. f. Gyn., 1908, xxxiii, 615.

with general enteroptosis.[1] Abdominal trauma, errors of diet, the accumulation of gas due to fermentation of retained foods, as emphasized by Naunyn,[2] drinking a large quantity of fluids, especially carbonated waters, and tight abdominal binders, have all been blamed as the source of this complication. Haruzo Karu[3] advances the theory that certain classes of cases are due to a lack of adrenal secretion, which acts to regulate the action of the stomach, and he advises the use of this drug. Connor[4] makes the statement that obstruction of the duodenum by pressure of the overlying mesentery of the small intestine (first suggested by Rokitanski) must be regarded as a factor in the development of one-third to one-half of all cases of acute gastrectasia, and Polak[5] states that there can be no doubt but that the Fowler posture favors constriction of the lower end of the duodenum between the root of the mesentery and the vertebral column. Mathieu[6] holds that the underlying cause is air swallowing, aërophagia. An uneasy, nervous patient sucks air into her stomach while retching; the stomach walls, being weakened in some way not yet explained, yield, and the dilatation is started. The dilating stomach pulls down on the mesentery below the duodenum, thus tightening the pressure on the duodenum and giving rise to a vicious circle. To prevent air swallowing he advises that the mouth be held open by a cork between the teeth during retching or hiccough. Dilatation of the stomach may occur in paralytic distention and peritonitis, as well as in acute intestinal obstruction.

The onset of the condition is usually sudden, within twenty-four or thirty-six hours after operation; it may be more gradual, but it practically always appears within three days. We have twice known acute dilatation to occur before sewing up the abdominal wall—once in personal practice, once in a case of Dr. Torbert's,[7] both during Cesarean section. The dilatation was sudden and enormous, the stomach practically half-filling the entire peritoneal cavity. In the first case the stomach was emptied by gentle and persistent pressure; in the second by incision through the stomach wall. Both cases recovered without untoward symptoms.

The vomiting is the first *symptom* to attract attention. It occurs

[1] Borchardt, Akute Magenektasie, Berlin. klin. Woch., 1908, xlv, 1593.
[2] Mitteil. a. d. Grenzgebiet. d. Med. u. Chir., 1911, xxiii, No. 2.
[3] Ibid.
[4] Am. Jour. Med. Sci., 1907, cxxx, 345.
[5] *Op. cit.*
[6] Arch. des Mal. de l'App. Digestif., 1911, v, No. 8.
[7] Boston Med. and Surg. Jour., Aug. 12, 1909.

in 90 per cent. of the cases. The few cases in which no vomiting occurs are apt to end fatally. The vomitus is copious in quantity—apparently much in excess of the amount of fluid taken. It is usually continuous. It comes up in gulps, without strain or effort, in quantities of 8 to 12 oz. In nature it is yellowish green, or sometimes brown or black, sour smelling, but rarely ever feculent.

Signs of collapse begin to appear after a few hours, and they depend, among other things, on the loss of body fluids, toxemia, and interference with respiration and cardiac action by upward pressure of the dilated stomach.

Distention of the abdomen appears first in the upper half of the abdomen, soon becoming general. Sometimes in early cases the lower border of the stomach can be outlined by the peculiar quality of the percussion tympany, which may even replace to some extent the normal cardiac dulness. Splashing sounds in the stomach can frequently be elicited on rocking the patient from side to side. The distention may be so great as to tear out the abdominal sutures. It is usually unaccompanied by tenderness or rigidity, except toward the end.

Diffuse abdominal pain is usually present in a severe form, increasing with and depending on the amount of distention. Thirst is usually present and may be agonizing. The facies shows anxiety, and the patient exhibits restlessness. The temperature rises little or not at all, and as the signs of collapse increase, it may become subnormal. There is a steady increase in the pulse and respiratory rate as the distention increases; if this is relieved, the pulse and respiratory rate fall. The bowels are usually in a state of constipation and the urine is scanty. Enemata may result in the passing of some flatus.

The **diagnosis** is difficult only to the surgeon who has never recognized a case. It is usually confounded with peritonitis, paralytic distention, or acute intestinal obstruction. The persistent vomiting, in gulps without effort, of olive-green vomitus, which does not become feculent, is characteristic. The marked degree of distention, with no rigidity, little if any tenderness, and considerable pain, in the presence of the succussion splash, are pathognomonic. The normal or subnormal temperature accompanying signs of collapse serves to differentiate it from peritonitis. The diagnosis can be made absolute by the passage of the stomach-tube.

It must be remembered, however, that the condition may complicate paralytic distention, peritonitis, or acute obstruction. Hanssen[1] reports 2 cases in which the dilatation of the stomach was

[1] Nordiskt. Med. Arkiv., 1910, xliii, Internal Med., No. 2.

recognized and treated, but later investigation in both cases, in one by operation, in the other by necropsy, showed a coincident volvulus of the small intestine.

It is evident that *prophylaxis* assumes immediately a position of importance. Wherever dilatation of the stomach is known to exist before operation, and in any case in which the complication might be expected, particular care should be taken in the matter of postoperative diet. No large meals should be allowed while the patient is in bed. Water should be given in small quantities, and at first only subcutaneously or by enema. The patient should be made to assume a position upon the side or abdomen as much as possible.

Previous to any celiotomy, food should be restricted for forty-eight hours, especially with reference to weight and the amount of liquids, and purgatives should not be used immediately before operation. Handling of the stomach, and particularly pulling on the pylorus, as has been shown by Kennan,[1] favors shock and gastro-intestinal paralysis. Cooling of the viscera should be avoided in all celiotomies, as well as rough sponging and gauze packing. It is important that the quantity of anesthetic be limited to the least possible amount, because the ether which is reëxcreted in the stomach may be a factor of some importance. The swallowing of mucus should be avoided so far as possible by wiping out the mouth occasionally with gauze. The use of atropin before operation will usually limit the secretion of mucus. Sometimes it seems probable that the irritation from the presence of a drain in the neighborhood of the duodenum, such as might be introduced after operations upon the gall-bladder or its ducts, has some causal influence in setting up gastric dilatation. When suggestive symptoms occur, such a drain should always be loosened and removed.

Treatment.—Cases of acute dilatation of the stomach when uncomplicated and recognized early usually respond promptly and effectually to treatment. All food by mouth should be stopped and the stomach-tube should be put into service at once, no matter how badly off the patient seems. The stomach should be emptied completely and promptly, and it should be emptied repeatedly. Between the periods of gastric siphonage the patient should be made to lie on her abdomen, or, if this is impracticable, should be placed in the exaggerated Trendelenburg position.

Complete emptying of the stomach in its dilated condition is sometimes difficult. The fluid may be, and often is, down as far as the pelvis. It is a good plan to pass the tube so far in that we are sure

[1] Gastro-enterostomy and Pyloroplasty, Ann. Surg., 1905, 690

that it has reached the level of the fluid, and then place the patient in the knee-chest position and siphon off as much as will come away in this position, withdrawing the tube slowly, so as to allow all the fluid to run out. The abdomen should then be tightly bound in a swathe.

Some writers insist on the importance of the occlusion of the duodenum in maintaining the distention, and of the advantage to be gained by relieving it of the pressure of the overlying mesentery. Hardouin[1] states that in 3 cases he got immediate relief and cessation of all disturbances by turning the patient on to her abdomen, or placing her in the knee-chest position. Two cases, which were not recognized in time, died. Others (Rosenthal, Borchardt) have reported aggravation of the condition from postural treatment. Raising the foot of the bed, and placing the patient upon her left side, will facilitate the outflow of fluid through the stomach-tube.

Saline solution under the skin or by rectum should be given freely and stimulation as indicated. Morphin in small doses must be given when indications arise. Strophanthin, gr. $\frac{1}{60}$, may be indicated by a failing pulse. Some authorities speak highly in favor of the repeated lavage of the stomach with normal salt solution or sodium bicarbonate. Ordinarily this would seem to be contraindicated. Feeding should be by rectum. If the stomach can once be emptied by means of posture and siphonage through the stomach-tube, and is kept from filling through the agency of an abdominal swathe and the forbiddance of anything by mouth, as well as occasional repetition of the siphonage, the patient may be expected to recover.

Operative interference, drainage of the stomach through a gastroenterostomy, has been advised by some as a routine. This treatment is to be deprecated. Early recognition and prompt institution of the proper non-operative measures will generally afford the necessary relief. There has always been, however, a certain proportion of cases where the expected relief has not appeared, where the condition has progressed in spite of treatment, and death ensued. The possibility of the existence of volvulus or acute intestinal obstruction from other causes will always have to be considered in these cases, and the advisability of operating for the relief of the obstruction determined. Mathieu[2] records 8 cases in which the stomach was incised for this condition, all of which resulted fatally.

[1] Presse Médicale, 1910, xviii, No. 66.
[2] *Op. cit.*

CHAPTER XVII

BURSTING OF THE ABDOMINAL WOUND

THE accidental reopening of a celiotomy wound may result from infection of the wound or from purely mechanical causes. The accident is infrequent. It occurs usually after a median incision of some length and least often when the wound has been sewed up in layers. Instances are on record where a wound has reopened within a few hours of the operation, during a fit of coughing or vomiting or following an attempt on the part of the patient to sit himself up in bed. Sometimes the exercises of a patient in delirium will result in a bursting of some of the stitches in a wound which has been united by mass (through-and-through) sutures. Sometimes there is apparent lack of union between the layers of the abdominal wound, probably on account of faulty apposition, and in these cases the wound has been known to reopen, after removal of the sutures, as late as the eighth or tenth day.[1]

[1] Madelung (Ueber den post-operativen Vorfall von Baucheingeweiden, Archiv. f. klin. Chir., 1905, lxxvii, 347) states that bursting of the wound (postoperative eventration, secondary dehiscence of the wound, spontaneous postoperative evisceration) is more common than is ordinarily suspected, and it occurs even after the most approved technique of wound closure. He makes two classes, the immediate and the late. He cites in detail 157 cases of the immediate type, taken from the literature. Of these, 118 are given as occurring in women, and 25 in men. The patients were of all ages, and the occurrence was apparently independent of whether or not masses were removed from the abdomen. The incision was given as below the umbilicus in 124 cases, and above in 16; the majority of incisions were in the median line. It occurred in 5 per cent. on the day of operation, 20 per cent. from the first to the fifth day, 57 per cent. from the fifth to the tenth day, and in 18 per cent. after the tenth day. The critical days with celiotomies were apparently the eighth and ninth. Of the 148 cases of which the end results were given, 43 died.

Many causative factors are to be considered, such as poor catgut, anemia, and interference with healing of the wound caused by stitches too tightly drawn or too closely placed, insufficient apposition of structures in layer or mass sutures, and poor closure of peritoneum, allowing protrusion of omentum. Increase of intra-abdominal tension by reduction of massive herniæ has to be mentioned, as well as rapidly forming ascites, tympanites (Olshausen), sepsis in the wound (Kaltenbach), and trophic disturbances (Jareis).

Four of Madelung's cases occurred in patients having tuberculous peritonitis, and to this list Sarra Rabinova (Ueber das Aufplantzen der Bauchnarbe nach Laparotomie wegen Tuberculöser Peritonitis, Prag. Med. Woch., 1909, xxxiv, 315) adds another.

Madelung has found 18 cases of late dehiscence, occurring in the scar from five months to twelve years after celiotomy, with an average of four years. There were 16 women and 2 men. The rupture has usually been sudden, without premonition. except in a few cases

A woman of thirty had a median incision from umbilicus to pubes for a pelvic tumor. On account of poor condition at the end of operation the wound was closed by through-and-through sutures. The stitches were removed on the eleventh day, but no adhesive strips were put on afterward. Half an hour later a coughing effort split the whole length of the wound and the entire intestinal mass came out into the bed. The patient died of shock within the hour.

The element of sepsis may be important in preventing the firm adhesion of the wound edges. Sometimes simply the outer layers of the abdominal wound may separate. This will be followed by a hernia of the bowel covered with peritoneum and fascia. Reopening of the wound from sepsis is now fortunately uncommon. The use of the muscle-splitting incision and of the right rectus incision wherever these are practicable obviates to a large measure the possibility of the bursting of the wound in ordinary cases. Wherever a long median incision, however, has to be used, especially if the edges are held approximated only by through-and-through sutures of silk-worm gut, the possibiltiy of reopening of the wound must not be forgotten. The patient must be compelled to lie quietly, coughing and vomiting should be controlled so far as possible, and due care should be exercised in transferring the patient from one bed to another if this becomes necessary. The sutures should always in these cases be reinforced by strips of zinc oxid adhesive plaster, going across the abdomen from loin to loin.

In case the wound should accidentally give way and the intestines protrude, a dry sterile dressing should at once be applied. The nurse should then sit on the bed and so hold and control the hernia mass (covered by sterile dressing) that no more shall protrude till the surgeon arrives. If the parts are sterile and the wound has been covered by a sterile dressing since the operation, nothing should be done until the surgeon appears. Then, with aseptic precautions, the bowel should be returned into the abdominal cavity. Under cocain a few sutures should be inserted to close the wound, and reliance should be placed upon strips of adhesive plaster to prevent the accident from recurring. Sometimes this occurrence is accompanied by a con-

which showed thinning of the scar and a small hernial tumor. In some cases there may be a drainage site which is covered over with skin, and very little else. The rupture has occurred in bed, while straining at stool, and it has been induced by sneezing, coughing, heavy lifting, jumping from a wagon. The patient may show no signs of shock, and may even walk to the doctor. The omentum or gut which comes out is usually small in amount; in this series there was no fatality.

siderable shock to the patient, but the accident in itself need not be serious. If the parts are not sterile, great care should be exercised in seeing that the bowel is thoroughly washed with warm saline solution before it is replaced. If only a small tab of omentum protrudes, which sometimes happens, this may be tied off and the incision closed.

Failure of the carefully sutured abdominal incision to unite is sometimes referred to a local anemia of the healing line resulting from internal pressure, as in distention (C. H. Mayo), trophic disturbances (T. C. Witherspoon), as well as sepsis and constitutional dyscrasias, such as chronic nephritis and anemia (C. H. Wallace).[1] Failure of repair in wounds of the abdominal wall after stomach operations is explained by Morris[2] as due to trophic or neurovascular disturbance associated with sensory nerve disturbance in the stomach zone of Head.

[1] Jour. Am. Med. Assoc., 1910, liv, 148, 149.
[2] Ibid., 1911, lvi, 1798.

CHAPTER XVIII

SEQUELÆ OF THE ANESTHESIA: CONJUNCTIVITIS, ETC., PNEUMONIA, NEPHRITIS

Sore Jaw.—There are some minor inconveniences which a patient is liable to experience as a direct result of the anesthesia, which should be recognized and so far as possible alleviated. Sometimes he will complain of a soreness about the angle of the jaw, with pain on opening the mouth. This is due to the holding forward of the jaw which the anesthetist has found necessary, lest the tongue fall back against the glottis and impede or obstruct respiration. A flabby state of the tongue under anesthesia is not uncommonly found, especially in persons without teeth; sometimes holding the head turned to one side will prevent its sliding backward. The soreness usually wears off in two or three days; if severe, a menthol pencil may be applied over the articulation or chloroform liniment rubbed in.

Sore Tongue.—If it has been found necessary to resort to the use of the tongue-forceps, or to sew a silk thread through the tip of the tongue, in order to hold it forward, especially if Laborde's rhythmic traction has been performed, the tongue may become sore and painful. The forceps which induces the least traumatism to the tongue is the Carmalt, which has a single prong (Fig. 12, p. 32). Forceps which depends upon pressure for its grip, and especially hemostatic forceps used in an emergency, may cause some laceration and superficial slough. A tongue may be rather severely lacerated by being caught between the teeth and bitten in the state of spasmodic contraction of the jaw muscles, which is apt to precede attempts at vomiting during recovery from ether. Ordinarily rinsing out the mouth with a warm mild antiseptic, as boric acid or Dobell's solution, will give relief and conduce to the comfort of the patient. If there is any slough or ulceration, a 10 per cent. solution of silver nitrate should be applied and a potassium chlorid mouth-wash used.

Sore Chest.—Not infrequently a patient will call the doctor's attention to a soreness in the lower chest, or a pain in the sternum and lower ribs which is aggravated by deep inspiration. This may be due to violent retching during recovery or to artificial respiration resorted to during or after the operation. This soreness is likely to persist only two or three days, and some relief may usually be obtained by rubbing with liniment. If the pain is severe, a tight chest swathe may be applied. If a patient has been hung up in the Trendelenburg posture during a long operation, she may complain later of pains under the knees and in the calves, and there is probably an increased likelihood of a phlebitis of the calf occurring under these circumstances. If her weight has been resting against metallic shoulder supports, she will probably experience some soreness in her arms and shoulders.

Paralysis may appear as a result of pressure or of a strained position of the arms or legs during operation. The commonest form is musculospiral paralysis, which occurs if an arm is left hanging without support over the edge of the operating-table (Fig. 14, p. 34). There may be paralysis of the entire arm from pressure on the brachial plexus, if the patient is allowed to lie on his arm during operations on the kidney performed in the lateral posture. These paralyses are usually ephemeral, passing off in at most a few weeks; sometimes they persist for months after the operation. Strychnin, electricity, and massage are indicated in the treatment.[1]

Burns may be the result of using hot-water bags or bottles without adequate protection of the skin, or of using water for washing or irrigation which is too hot. These are sometimes severe and may be serious. Burns of slight degree may occur about the mouth and face from the action of liquid chloroform or ether. It is more likely to occur if the drop method is used, and, to prevent it, the face should be smeared with vaselin before the anesthesia is begun, and the ether should be spread over a sufficiently large evaporating surface and not allowed to drop on one spot.

Conjunctivitis should not occur with an experienced etherizer under ordinary circumstances. It is the result of strong ether vapor or of the ether itself getting into the eye. If the eyes are held closed, there will be no chance for the vapor to cause irritation; a drop of ether may accidentally be spilled if the patient is unusually refractive in going under, or in the flurry of vomiting or artificial respiration on the table. If there is any suspicion in the mind of the anesthetist that ether may have come in contact with the eye, he should, as a prophylac-

[1] A. E. Halsted (Wisconsin Med. Jour., 1908, vi, 511) gives a series of cases showing varieties of paralysis following and dependent upon the administration of a general anesthetic. He describes two forms, peripheral and central. The peripheral may be averted by proper handling through narcosis. The central cannot be prevented, though its danger may be avoided by limiting the quantity of anesthetic and by a preliminary hypodermic of morphin in ether anesthesia to control excitement.

tic measure, irrigate the eye thoroughly at once, if possible, with warm water, normal saline, or boric solution, whichever is at hand. This is done by dipping a gauze sponge into the solution, and, holding it a few inches above the eye, allowing the solution to drip gently on the conjunctiva. If, in the neglect of, or in spite of, this precaution, the eye on the second day begins to look injected and feel irritated, a drop of a solution containing one grain each of zinc sulphate and cocain hydrochlorid to the ounce of sterile water may be instilled, warm, into the eye every few hours, and boric acid irrigation carried on twice a day so long as any secretion appears.

Postanesthetic Pneumonia.—The occurrence of pneumonia and other lung complications after anesthetization has been a moot point in surgery. There is no question but that lung complications arise as a direct or indirect result of the use of a general anesthetic, especially after capital operations, although some of the cases reported are undoubtedly due to the coincident action of other causes. When they do occur, they are troublesome because of the discomfort and distress to which they give rise, and because of the possibilities of danger which arise in reference to the effect of the strain of coughing on ligatures and sutures; they are extremely likely to become serious, particularly in elderly and debilitated persons, because they come at a time when the patient's condition is already below par and his resistance lowered. The occurrence seems to increase directly with the length of anesthesia and inversely to the protection of the patient. This latter includes the maintenance of a proper temperature in the operating room, keeping the patient dry, and protecting from draughts during recovery. In private practice the occurrence is less than in public hospitals, where the patient is often trundled inconsiderately out of a warm operating room along a corridor for some distance to the recovery ward.

It is generally stated that the liability to lung complications is less after chloroform than after ether. Upon this statement is based the assertion that ether should not be the anesthetic of choice where there is present any disease of the lungs or air-passages, any condition which results by pressure or otherwise in a lessening of the lumen of the trachea or bronchi, or in any case where the Trendelenburg posture will have to be assumed and maintained for a considerable length of time, the pressure of the intestines against the diaphragm interfering with the free action of this organ. Ether acts as a local irritant in exciting a stimulating effect upon the glands of the bronchi so that the secretion of mucus is increased. The secretion may be so considerable as effectively to block some of the small bronchioles. The irritant action of the ether may set up a bronchitis or even a pneumonia. The irritating effects are less likely to occur if a dilute vapor is used and if the ether is fresh and pure, for ether decomposes if allowed to stand in contact with air in a warm or light place.

Chloroform may prove equally irritant if it is kept in a bottle containing air and exposed to the light. Chloroform vapors, moreover, are decomposed by an open flame into chlorin and carbon compounds, which are highly irritating when inspired. The prolonged use of chloroform in a poorly ventilated operating-room lighted by gas may induce serious respiratory conditions in the surgeon and attendants as well as the patient.

Of all the respiratory complications, *bronchitis* is the most frequent. It may be due to the lighting up, under the local irritant effect of the ether, of a previously existing or a chronic bronchitis. There can be no doubt, however, that it sometimes arises as a direct result of the inhalation of considerable volumes of cold and concentrated ether vapor, and from undue exposure or chilling of the body surface in persons not strongly resistant, as a result of age or general condition. It may, by extension, develop into a *bronchopneumonia.* It may be borne in mind that it is particularly improper to leave the patient wrapped in clothes which have become wet with irrigating solutions, for, because of evaporation, the loss of heat is greater in wet clothes than in no clothes at all. *Pulmonary edema* has been reported,[1] but this must be considered as dependent on cardiac weakness, associated, perhaps, with the fact that under the influence of ether the pulmonary vessels lose their tone and dilate and thus become more pervious.[2] The postoperative occurrence of *pleurisy* has been occasionally noted, as well as the lighting up of previously existing *tuberculous foci.*

The *occurrence* of postoperative lung complications varies widely in different clinics and in different countries, and it depends upon the nature of the operation, the anesthetization, and the after-care. They are less frequent in private than in hospital cases. They follow celiotomies five or ten times as frequently as other procedures, and of celiotomies, they follow stomach operations about twice as frequently as operations about the bile-passages, and about four times as frequently as herniæ.

[1] Nauwerck, Deutsch. med. Woch., 1895, xxi, 121.

[2] Lindemann, Centralbl. f. allg. Path., 1898, ix, 442.

Homans,[1] collating the statistics of 16,043 laparotomies reported from German clinics, including those of Czerny, von Mikulicz, Krönlein, and Trendelenburg, found an average mortality due to lung complications of about 4.4 per cent. The combined statistics of Munroe[2] (Carney Hospital), Risley[3] (Massachusetts General Hospital), and Graves[4] (Free Hospital for Women), covering 3089 celiotomies, show a mortality of 0.4 per cent. The apparent discrepancy is probably explained by the fact that the cases in the Boston series were carefully anesthetized, ether by the drop method being used in the majority of cases, that the preparation and after-care were rigidly followed up, and that the percentage of septic and desperately ill cases was low.

The morbidity of the Boston series was 1.8 per cent. (57 cases). There were 34 cases of pneumonia, 20 cases of bronchitis, and 3 cases of pleurisy; 6 cases were postoperative flare-ups in patients previously tuberculous. Graves is of the opinion that most of the cases of postoperative lung complications are caused by the lighting up or aggravation of pre-existing focal infection. Homans[5] classifies the pneumonias in three groups: ether pneumonias, hypostatic pneumonias, and embolic pneumonias. There seems to be general concurrence on the rarity of the lobar type of pneumonia. Hewitt (Anesthetics) and Prescott[6] go so far as to say that if it occurs the ether cannot be held alone responsible, and that it must be regarded as a coincidence.

Chapman[7] presents an account of experiments upon the irritant effects of ether, and states that surgical pneumonia may be divided into two classes: first, one in which infectious particles are drawn into the lungs by the violent inspiratory efforts incident to anesthesia; the other, in which organisms of particular virulence find in the postoperative state soil suitable to their growth and multiplication. He concludes that ether has a distinct irritant effect upon the lungs, causing a swelling of alveoli, congestion of the alveolar tissue, and even intra-alveolar hemorrhage, which increase with the length of etherization and with the amount of forcing or crowding of the ether.

Postoperative complications on the part of the lungs are, on the whole, more common than generally recognized. Many a slight increase in temperature in the first few days after aseptic operations is

[1] Johns Hopkins Bulletin, April, 1909.
[2] Jour. Am. Med. Assoc., 1909, liii, 425.
[3] Boston Med. and Surg. Jour., Jan. 20, 1910.
[4] Ibid., 1911, clxiii, 497.
[5] *Loc. cit.*
[6] Boston Med. and Surg. Jour., 1895, cxxxii, 304.
[7] Ann. Surg., 1904, xxxix, 700.

the result of minor pulmonary complications. They may disappear entirely in a few days without inconvenience, but they may provide the soil upon which pneumonia develops. The method of anesthesia, provided it be given carefully by a skilled person, has no influence upon the development of postoperative complications, which agrees with the rarity of pneumonia due truly to the inhaled anesthetic. An embolic process is evidently responsible for the postoperative pulmonary complications in the majority of septic cases, but hypostatic congestion must be accepted as the cause of a few isolated cases, particularly in the aged.

Among the contributing *causes*, apart from the anesthetic, may be mentioned previous tuberculosis, peritoneal trauma, general and local sepsis, old age, and poor hygiene of the mouth and pharynx.

Pasteur[1] considers that deflation of the lungs may be a predisposing cause of pneumonia, and that this deflation is prone to occur after abdominal operations, particularly such as involve the handling of the viscera above the umbilicus. Any extensive abdominal incision will tend to limit the excursion of the diaphragm, and pain or inflammation in its immediate neighborhood will fix it entirely, and as a result there is inactivity or even collapse of the lower lobes, with a greatly increased possibility of infection.

It is a significant fact, observed by Risley,[2] Spassokukotzky,[3] and others, that lung complications are more prevalent during the winter months, when windows and doors are kept closed. Spassokukotzky infers, accordingly, that one of the predominating factors is improper aëration of the lungs during convalescence, due either to insufficient ventilation and air-space, vitiation or contamination of the air by crowding of wards or by ministrations of nurses, visits of friends or students, or to the fact that during the first few days after celiotomies patients avoid normal breathing on account of the pain which it causes in the wound.

The *prophylaxis* covers preparation, etherization, and after-care. The preparation of the mouth and teeth should be thorough; the teeth should be scrubbed for ten minutes twice during the twenty-four hours preceding operation. The mouth and pharynx should be rinsed and the nasal passages douched with Dobell's solution. The anesthesia should be carefully conducted, preferably by the open or semiclosed method. If the Trendelenburg position is necessary, it should

[1] Lancet, 1911, i, 1329.
[2] *Loc. cit.*
[3] Mitteil. aus den Grenzgebiet. der Med. und Chir., 1911, xxiii, No. 2.

not be too extreme, nor should it be maintained for too long a period. Manipulation in the region of the diaphragm should be limited. The operating-room should be properly heated, without draughts, and the patient should not be allowed to lie in a pool of fluid, or in contact with wet sheets or blankets. He should be well wrapped, to prevent exposure during operation, with a blanket underneath to keep him from contact with the cold table-top. In the transference back to bed, he should have ample protection against the sudden change from the heated operating-room to the cool corridor. The convalescence should be conducted in a room with plenty of air space, well ventilated with clean air. Drugs, such as morphin, which depress respiration, should be avoided. Water should be given liberally to keep down thirst and prevent the dirty mouth that goes with lack of moisture. The diet should be as liberal as the circumstances allow and the patient will take. He should be encouraged to move body and limb, and, except in a comparatively few conditions, such as hernia, he should be propped up to a sitting posture in bed soon after he is out of ether. The old and feeble should be gotten up into an armchair after forty-eight hours, and all cases should be gotten out of bed as early as possible.

Bronchitis makes its appearance ordinarily on the day after operation, but it may be delayed, as pneumonia occasionally is, until three or four days or even a week later. The first sign of pneumonia generally appears in the form of a rise in temperature to 101° F. or over during the second twenty-four hours after operation. The patient generally suffers severely, and in some ways the condition resembles lobar pneumonia, although there is neither the profound toxemia nor the high temperature of the latter form. The treatment should be the ordinary treatment of pneumonia in the adult. The course is usually short and acute. Inasmuch as the patient is already in a state of more or less exhaustion as a result of the operation, there should be no hesitation in exhibiting cardiac stimulation from the inception of the disease without waiting for evidences of cardiac weakness to present themselves.

It is a serious complication and is the actual cause of a large percentage of the fatalities in old and debilitated cases.

Nephritis.—After anesthesia the urinary secretion is much lessened and continues abnormally low, though gradually increasing for a week or ten days. Thus, Penrose[1] showed that after laparotomy the average secretion in 111 cases during the first twenty-four hours was

[1] Ann. Surg., 1895, xxvi, 184.

13.4 oz., or about one-quarter the normal quantity. During the second twenty-four hours it was 14.6 oz., and the third, 19.6. Grieg Smith[1] observed 128 cases and got similar though higher results. The diminution, however, as shown by Buxton and Levy,[2] is chiefly in the water rather than in the solids, and depends largely on the lessened amount of fluids taken and retained, purgation, sweating, etc. Cases of complete suppression of urine and death have been reported as due to the anesthetic. They are rare, although the secretion may become very slight in case of severe shock or hemorrhage, and ordinarily in postoperative anuria some other cause may legitimately be sought, such as tied, cut, or kinked ureters, or Bright's disease. Good observers have reported cases where ether in elderly persons with Bright's disease or arteriosclerotic kidneys has been followed by gradual suppression and death, with no cause but the preëxisting nephritis demonstrable at autopsy. Primary acute nephritis occurring after anesthesia is extremely rare, if it occurs at all.[3]

In spite of this, abnormal urinary constituents are found after ether in a large percentage of all cases—particularly in one-quarter to one-third—immediately after operation; there are abundant casts, hyaline, fine and coarse granular and epithelial, and, somewhat less frequently, albumin. The occurrence after chloroform anesthesia is considerably less, although chloroform undoubtedly also acts as an irritant during elimination. These abnormal elements will have usually completely disappeared in from eighteen to twenty-four hours, but they may last forty-eight hours or longer in septic cases or cases doing badly, in case of complication arising, such as pneumonia, or in the case of a previously existing nephritis.

The cause of the " shower " of casts which is so likely to follow on etherization may be the renal congestion resulting from the chilling of the relaxed surface of the body, renal irritation from the anesthetic or toxic or septic products, or the concentrated state of the urine. If albuminuria or cylindruria exists before the operation, it is usually temporarily increased by ether, but more frequently by chloroform. It is the generally accepted opinion that ether does little or no lasting

[1] Abdominal Surgery, 1896, 137.

[2] Brit. Med. Jour., 1900, i, 833.

[3] Bovée (Amer. Jour. Med. Sciences, Jan., 1911) has observed that the renal function is greatly lessened while the patient is in the Trendelenburg position. In 16 cases, 8 under ether and 8 under chloroform anesthesia, it was shown that almost no urine was received into the bladder so long as the position was maintained. If this is borne out by further investigations, it will be demonstrated that the use of the Trendelenburg position involves an element of danger in arteriosclerosis, cardiac and renal conditions.

harm to the kidneys, even though renal disease is already present. Chloroform bears a bad reputation in nephritis, and if this exists, ether should be given the preference. Chloroform may bring about fatty degeneration of the kidneys, just as it sometimes causes fatty liver and heart.

Hirsch[1] states that the effect of chloroform and ether on the kidneys is merely one manifestation of a general intoxication of the system from the drug. Ether or chloroform can be used with the ordinary technique if the kidneys are known to be sound, but if the kidneys are abnormal, chloroform is absolutely contraindicated. Under all conditions the amount of the anesthetic used should be the smallest possible. As less of the anesthetic is used when administered drop by drop, the limit of tolerance is less rapidly reached by this method. Loss of blood, he says, should be combated in every possible way, as this favors the degenerative action of the anesthetic and contributes to the possibility of chloroform intoxication. It is also important to refrain from administering a general anesthetic several times to the same patient within a short interval. If the chloroform intoxication is superimposed on a preceding similar intoxication before the kidneys have had time to recuperate completely, there is liable to be serious trouble. The danger in the second anesthesia is far more imminent than in the first. The interval should be at least a week, and the second anesthesia should never be attempted until the urine is free from albumin.

Treatment.—As a prophylactic measure when nephritis exists, ether should always be used, and the least possible quantity of anesthetic should be employed. Carefully avoid dampness, draughts, and exposure. If suppression threatens, give water by the mouth, subcutaneously, and by rectum. Promote sweating by hot packs and hot-air baths. In case of emergency do venesection, and after bleeding give salt solution intravenously. In any case promote urinary and bowel secretion. Give digitalis and potassium acetate or citrate. Combat nephritis in septic cases.

[1] Centralb. f. d. Grenzg. der Med. u. Chir., 1908, xi, 929.

CHAPTER XIX

ACETONEMIA; ACID INTOXICATION; DELAYED CHLOROFORM POISONING; FATTY DEGENERATION OF THE LIVER

Soon after chloroform came into general use as an anesthetic it was noted that in some cases, especially in children under fifteen years of age, a profound intoxication, characterized often by incessant vomiting, would make its appearance from two to five days after the anesthetic. This was called delayed chloroform poisoning. In some cases sugar and acetone were found in the urine, and in these it was supposed that the symptoms were due to an unrecognized diabetes, especially as the patients frequently died in coma. In other cases, in which post-mortem examinations were made, nothing was found to account for death except a more or less general infiltration of the heart, kidneys, voluntary muscles, and liver with fat; the condition was usually especially pronounced in the liver, so that it resembled the liver of phosphorus-poisoning, and there were sometimes necrosis and contraction, as in acute yellow atrophy.

As more attention began to be paid to this condition, it was found that the urine in practically all the cases showing this symptom-complex exhibited an excess of acetone. It was then felt that the symptoms were due to an acidosis or acid intoxication as a result of some acute disturbance of metabolism.

Acetone was first discovered in the urine in 1857 by Petters in a case of diabetes. Further investigation demonstrated (Müller) that it is to be found often in minute quantities in the urine and blood of normal individuals, and in increased amount if the patient is subjected to temporary starvation. Then it was determined that the amount of acetone in the urine became regularly increased after narcosis,[1] and it was at first believed that this was due to opening the peritoneal cavity or to the use of corrosive sublimate. It was found that this postnarcotic excess lasts from a few hours to several days after operation,[2] and that if acetonuria is present before the operation, narcosis increases it.[3] J. A. Kelly[4] reported that out of 400 postoperative cases observed

[1] Conti, Vratsch, Dec. 7, 1893; Grevan, Ueber Aceturie nach der Narkose, Bonn, 1895.
[2] E. Becker, Arch. gen. path. Anat. u. Phys., 1895, cxl, 1.
[3] Abram, Jour. Path. and Bact., 1896, iii, 430.
[4] Ann. Surg., 1905, xli, 161.

at the Boston City Hospital 46 showed acetone and symptoms of intoxication, with 6 deaths. J. C. Hubbard [1] concluded, after an examination of 145 postoperative cases at the Boston City Hospital, that the occurrence of acetone after operation was frequent. H. Baldwin [2] found acetone in the urine of 64 out of 78 operative cases the day after operation, and Telford and J. L. Falconer [3] reported 3 fatal cases after chloroform, and symptoms from the presence of acetone in 34 out of 118 postanesthetic cases. A. G. Rice [4] reported that an excess of acetone was found in 90 per cent. of 202 cases after etherization at the Boston City Hospital in which no sugar was present before operation. It appeared most commonly on the second and third day, and after the fourth day it was rare. Of these, 10 per cent. showed symptoms suggestive of acid intoxication. Only 2 cases, however, were severely sick, and of these, 1 died. J. W. Sever [5] found that after 681 etherizations at the Children's Hospital acetone occurred in the urine of 662 and symptoms of acid intoxication in 60. It appeared, as a rule, at once after the operation and lasted on the average three days. Death occurred in 16 cases, in 7 of which the acid intoxication was probably the determining factor.[6]

The condition began to assume clinical importance with the publication of fatal postanesthetic cases apparently depending on a systemic acetone intoxication. Among others, Brewer [7] reported 1 fatal case; Brackett, Stone, and Low [8] reported 7 cases from the Children's Hospital, with 3 fatalities. R. Campbell [9] reported 3 fatal cases after chloroform, and A. N. McArthur[10] reported one fatality after chloroform. Bevan and Favill[11] collected from the literature 29 undoubted cases of this condition, in addition to 1 of their own, of which 28 died. They called attention to the liver as the probable source of the toxemia, and to the similarity which existed between this condition and acute yellow atrophy, phosphorus-poisoning, puerperal eclampsia, and diabetic coma.

[1] Boston Med. and Surg. Jour., 1905, clii, 744.

[2] Jour. of Biol. Chem., 1906, i, 239.

[3] Lancet, 1906, ii, 1341.

[4] Boston Med. and Surg. Jour., 1908, clix, 47.

[5] Am. Jour. of Ortho. Surg., 1909, vi, 408.

[6] Ladd and Osgood (Ann. Surg., 1907, xlvi, 460) found that after 120 cases of etherization by the cone method at the Boston City Hospital 106 showed acetone, 88½ per cent. After the drop method of anesthesia they found acetone in only 26 per cent. of 222 cases.

[7] Ann. Surg., 1902, xxxvi, 481.

[8] Boston Med. and Surg. Jour., 1904, cli, 2.

[9] Medical Press and Circular, 1907, lxxxiii, 198.

[10] Intercolonial Med. Jour., Melbourne, 1907, xii, 434.

[11] Jour. Am. Med. Assoc., 1905, xlv, 691, 757.

It is at present generally assumed that fat is the principal source of the acetone bodies, and that their place of formation is chiefly in the liver.[1] Acidosis is not to be considered, however, as the result of an excessive consumption of fat, but it depends usually upon the absence of carbohydrates.[2] It is caused or accompanied by some marked change in the fat metabolism of the body and, accordingly, L. Guthrie[3] infers that acid intoxication is liable to occur in all cases in which the liver is excessively fatty. Twenty of the 24 cases in the series of Bevan and Favill, which came to autopsy, showed fatty changes in the liver.

The conditions in which the existence of a superfatted liver may be suspected, which should be avoided in general anesthesia, are numerous and include diabetes, deprivation of carbohydrates (starvation), sepsis (acute and chronic), specific infections, as diphtheria and pneumonia, and poisoning with phosphorus and chloroform. The work of the liver is to take up the fat from other parts of the body and bring about certain changes in it, the result of which is to make this material available for the use of the organs in which its potential energy is required. Too active a mobilization of stored fat, or too little activity in dealing with it on the part of the liver, will result in an accumulation of the unfinished product in that organ. A fatty liver is then the result.[4] The condition implies a defective metabolism and oxidation, and the further perversion of metabolism and oxidation by a general anesthetic may give rise to a fatal toxemia, accompanied by a general breakdown of all hepatic functions and fatty acid intoxication, which in extreme cases may go on to an acute atrophy.

The action of chloroform, particularly upon the liver, was noted some years ago without being clearly understood. Recently it has been shown in dogs[5] that central necrosis of the liver occurs after a single chloroform anesthesia of two hours, and intense fatty changes when chloroform is given for a shorter period. Under proper conditions repair begins on the second or third day, and the liver returns to a practically normal condition in ten days.[6] The solvent action of ether

[1] E. H. Goodman, Arch. Int. Med., 1908, i, 397.
[2] Bainbridge, Lancet, 1908, i, 911.
[3] Brit. Med. Jour., 1908, ii, 1158.
[4] Leathes, Lancet, 1909, i, 593.
[5] Howland and Richards, Ann. Surg., 1909, xlix, 419.
[6] Whipple and Hurwitz, Jour. Exp. Med., 1911, xiii, 136. With the necrosis there is a coincident loss of fibrinogen in the circulating blood, so that it may be almost eliminated, and uncontrollable hemorrhage may occur. The fibrinogen reappears in the blood as the liver effects its repair.

and chloroform upon fats is well known, and K. Reicher[1] shows that the important liquids and fats are expelled by the cells under the influence of the anesthetic. H. G. Wells[2] divides the cases of delayed chloroform poisoning into two classes. In one, chiefly children, the symptoms are those of acidemia or acetonuria without jaundice. In these cases the changes of the liver are not very marked, consisting chiefly of fatty degeneration about the periphery of the liver lobules. The other type is observed chiefly in young adults, and clinically is marked by a profound jaundice, hemorrhage, and the usual symptom-complex of a rapidly fatal acute yellow atrophy, the liver being reduced in size, flabby, yellow, and showing microscopically an extreme degree of necrosis, beginning in the center of the lobule, with more or less fatty peripheral degeneration. There are intermediate cases which do not follow distinctly one or the other of the two types. Torek[3] records 2 cases in which death from " acute yellow atrophy " of the liver followed the use of anesthol as an anesthetic.

Youth appears to be an important factor among predisposing causes. All the 7 cases of Brackett, Stone, and Low were in children; of the series of Bevan and Favill, one-half the cases were under ten years and two-thirds under twenty. K. Schrack[4] observed that children were frequently likely to exhibit acetone in their urine, especially in febrile affections and gastro-intestinal derangements. Marpan and Edsall showed the intimate relationship of acetonuria with cyclic vomiting in infants. Hecker[5] asserts that children are especially liable to exhibit acetonuria as a result of disturbed metabolism, and that it is probably due to a defective development of the function of breaking down of fats. Brackett, Stone, and Low believe that the mental state is to be considered of importance in etiology. Homesickness, fright, confinement in the hospital, and change of food in children of a high-strung nervous temperament may coöperate with the anesthetic and the operative shock to induce an acute metabolic upset.[6]

The association of acetone with preganacy has been noticed. Acute yellow atrophy of the liver is said also to occur most frequently in pregnant women and in the latter half of pregancy. L. Knapp[7] reports

[1] Zeitsch. f. klin. Med., 1908, lxv, 235.

[2] Arch. Int. Med., 1908, i, 589.

[3] Ann. Surg., 1910, lii, 489.

[4] Fortschritte der Med., 1889, vii, 746.

[5] Münch. med. Woch., 1908, lv, 1485; 1828.

[6] V. Brun (Clinica Chirurgica, 1908, xvi, 417) states that the use of chloroform in children is severe on the liver. Glycosuria often follows its administration and albuminuria is also very frequent. He has seen several deaths, two with fatty liver.

[7] Centralb. f. Gynak., 1897, xxi, 417.

10 cases of acetonuria in pregnant and parturient women, all of whom gave birth to dead children, and from this he inferred that acetonuria in a pregnant woman is a sure sign of the death of the fetus. H. Thompson[1] reports a case with the symptoms of acute yellow atrophy, in which the woman sank into a stupor, gave birth to a macerated fetus, and died two days later. Couvelaine[2] and Scholten[3] demonstrated a marked increase in the acetone of the urine in the large majority of all cases (94 per cent.) immediately after labor and lasting about three days. It was most abundant after difficult and prolonged labors. J. B. Williams[4] believes that some of the cases of severe vomiting in pregnancy are "cases of toxemic vomiting allied to yellow atrophy."

Authorities seem to agree unanimously in stating that chloroform is far more apt to induce acid intoxication than ether. Of Bevan and Favill's 30 cases, ether was the anesthetic agent in only 4. It is generally assumed also that the danger is greater the more protracted is the anesthetization, although in some cases—probably extremely susceptible—a fatal acetonemia has supervened on a short anesthesia. It is stated as of particular importance, in a patient at all predisposed, that if anesthesia has to be repeated within three or four days, and chloroform was given the first time, ether should be the anesthetic on the second occasion. The nature of the operation seems to be of no importance in determining the subsequent presence of acetone, although it is most commonly reported as occurring after laparotomies. This may be partly owing to the relatively longer time ordinarily consumed in performing laparotomies, as compared with other operations, and partly to the varying degree of starvation to which the patient who comes to the operating-table is usually subjected before an abdominal section is decided upon, and which he necessarily, or by choice, undergoes after the operation.

Other causes which have been considered as predisposing to the occurrence of acetonuria after operation are chronic disease of the liver or kidney; exhaustion from hemorrhage, starvation, and wasting diseases, such as carcinoma; fatty degenerations, as in the limbs after infantile paralysis; and lowered general vitality, as in sepsis; diabetes; and in the presence of a dead fetus.

The *symptoms* of postoperative acidosis are usually mild and transi-

[1] Centralb. f. Gynak., 1898, xxii, 1227.
[2] Annales de Gyn. et d'Obst., 1899, i, 353.
[3] Beiträge zur Geb. u. Gyn., 1900, iii, 439.
[4] Johns Hopkins Hosp. Bull., 1906, xvii, 71.

tory. At any time from the second to the fifth day after operation the patient, who has previously been doing perfectly well, except possibly for a distaste for food, begins to vomit. In serious cases the vomiting soon becomes persistent, and concurrently the sweetish fruity odor of acetone is to be noticed on the breath.[1] The patient rapidly develops a state of collapse and looks desperately sick,—his face shows a gray pallor, his eyes are sunken and staring, and the skin cold and moist; the pulse becomes weak and rapid, and the temperature rises. There may be icterus in varying degree. As the condition progresses the patient becomes restless, even to the point of delirium and convulsions, between the paroxysms of vomiting; then he will quiet down, and become apathetic and stuporous. Thus he will alternate, until the periods of restlessness become gradually less pronounced and the stupor finally deepens into coma. Then he develops an extreme dyspnea, cyanosis and Cheyne-Stokes respiration make their appearance, and death supervenes.

Some cases start suddenly, with mental symptoms, run a short course, and end fatally. On the third or fourth day after operation the patient, having previously been doing well, becomes irrational and restless, starts to scream, and may shortly become maniacal, so as to require forcible restraint. A slight yellowish coloration of the conjunctiva is noticed, and icterus rapidly spreads over the body. Under restraint or sedatives the patient becomes delirious, the temperature and pulse rise, and exhaustion gradually develops. The acetone odor appears on the breath. Convulsions occur, accompanied by incontinence, and finally coma, with Cheyne-Stokes respiration, carries him off, after thirty-six to forty-eight hours from the beginning of symptoms.

The *test* commonly employed for determining the presence of an excess of acetone is that of Legal: To 10 cc. of urine in a test-tube add a small crystal of sodium nitroprussid. Make strongly hyaline by the addition of a saturated solution of sodium hydroxid. Shake. If acetone is present, a deep red color will appear, which will change, on the addition of a few drops of glacial acetic acid, to a purple, which will color the foam if the test-tube be shaken.

A convenient bedside test for diacetic acid is the following: Add a few drops of a 10 or 15 per cent. solution of ferric chlorid to a half test-tube of urine. A Burgundy-red color shows the presence of diacetic acid. The

[1] There has been noted (Cates, Surg., Gyn., and Obstet., 1911, xiii, 517) a bright red appearance of the fingers and mucous membranes. The venous blood appears arterial, and the whole body may be pinkish.

depth of color is to a certain extent a guide as to the intensity of the acidosis. This is best judged by putting one or two fingers behind the test-tube to test the transmission of light. If the fingers cannot be seen through the urine, the acidosis is severe. If diacetic acid is present, acetone is sure to be.

The *treatment* of acetonemia consists, besides stimulation as indicated, in purgation, diaphoresis, and the employment of sodium bicarbonate in large doses, by mouth or by rectum, subcutaneously or even intravenously, in an attempt to neutralize the acids in the blood. There can be no question but that the exhibition of alkalis in sufficient quantity is followed by immediate and gratifying relief of all the symptoms in mild cases. Sodium bicarbonate should be started as soon as the diagnosis is made, and should be continued until it is clear that it is no longer needed. By mouth it may be given in the dose of 20 gr. every hour. In case the vomiting interferes with its absorption by mouth, it should be given continuously by rectum, in a saturated solution, by the drop method, through a tube carried as high as possible. The solution is readily absorbed by rectum, and this route is usually the most pleasant and efficient of all. In case of emergency a solution (6 dr. to the pint) may be given under the breast or into the axilla; there is considerable likelihood of abscess formation, however, as a result.[1]

Some cases are apparently incurable from the start, and upon these alkaline treatment makes little or no apparent impression. After coma has set in, its probable value is slight. There is no argument, however, for the abandonment of the use of sodium bicarbonate early in the attack. Guthrie (*op. cit.*) and others hold that it is extremely doubtful if fatty acid intoxication is ever the sole cause of death. Wilbur[2] has shown experimentally that the acetone bodies in the blood, even after being neutralized by sodium bicarbonate, are toxic, although in a less degree. Bainbridge (*op. cit.*), laying stress upon the importance of carbohydrate deprivation in etiology, declares that a plentiful supply of carbohydrates, not only in a postanesthetic intoxication, but also as a routine preventive measure before opera-

[1] J. B. Nichols (Washington Med. Ann., 1908, vii, 133) recommends the free administration of alkalis. Sodium bicarbonate, 225 gr. a day, plus calcium carbonate, 45 gr., and sodium citrate, 75 gr., by rectum, subcutaneously, or intravenously. But even this, he says, will produce no effect in some cases.

[2] Jour. Am. Med. Assoc., Oct. 22, 1904, 1228.

tion, appears to be rational treatment.[1] We have personally observed, in confirmation of this statement, that diabetics recover after operations with fewer complications and more rapid healing of wounds if they are put upon a moderate carbohydrate diet after operation. Considerable amounts of glucose in normal saline may be given by rectum or under the skin (see Subcutaneous Feeding for technique).

[1] See also W. Hunter (Delayed Chloroform Poisoning, Its Nature and Prevention, Lancet, 1908, i, 993) and A. Sippel (Ein typisches Krankheitsbild von protrahirten Chloroformtod, Archiv. f. Gynak., 1909, lxxxviii, 167).

CHAPTER XX

HICCOUGH: CAUSES; TREATMENT

HICCOUGH, which we ordinarily consider simply as a common and trivial personal discomfort, may in diseased conditions assume a position of considerable importance. In early times it was considered as a disease in itself, and was so classified by Linnaeus. Nowadays it is regarded only as a symptom, although cases of apparently autogenetic singultus have arisen, persisted for days, weeks, or even months, and have gone on to a fatal termination, without anything having been observed during the course of the disease or at autopsy to account directly for the phenomenon. John Hunter first recorded its occurrence after operation, and it may arise as a complication in any disease attended with prostration.

Pathology.—Hiccough is a reflex spasmodic contraction of the diaphragm, excited usually through irritation of the terminal filaments of the pneumogastric nerve, in the pharynx, larynx, thorax, esophagus, stomach, or intestinal tract. It would seem, however, less frequently to be due also to direct irritation of the phrenic nerve or of the diaphragm itself, from conditions in the lung or pleural cavity, or inflammations or growths contiguous to the diaphragm. Normally, the descent of the contracting diaphragm is synchronous with the opening of the glottis; the abnormally sudden contraction of the diaphragm in hiccough often catches the glottis closed or half open, and the incoming column of air rushing through the narrow orifice causes the characteristic "hic," which gives the popular name to the condition. It usually interferes with sleep, which adds to its seriousness; in sleep it may disappear altogether, to reappear, however, with awakening; in well-developed cases it frequently persists in spite of sleep, though with less frequent rhythm. When it once starts, it is apt to continue indefinitely from habit, even after a trivial and momentary exciting cause has disappeared, and this is especially apt to be true in persons exhausted from illness or after operation.

The commonest cause is the ingestion of gastric irritants, such as alcohol, condiments, iced drinks. It may be the expression of an irritation lower down in the alimentary canal, as from worms, enteritis.

In the neurotic it may occur from mental emotion, fright, or, arising from some irritative cause, be continued as a habit. It may occur in the course of a chronic nervous disease, as epilepsy, hysteria, myelitis. It is not uncommon in organic diseases—gout, Bright's disease, congestion of the liver, pleural effusion or adhesions, chronic bronchitis, or unresolved pneumonia, phthisis.

The most important *surgical causes* are pharyngeal abscess; subdiaphragmatic abscess, empyema, or other intrathoracic conditions; visceral inflammation, peritonitis, gastritis, incarcerated or strangulated hernia, meteorism or tympanites; and renal insufficiency after operations on the kidney or genito-urinary tract, especially in elderly men.

Prognosis.—An attack of singultus coming on in a person past middle age, exhausted by a recent abdominal or genito-urinary operation, as on the bowel, kidney, or prostate, is generally considered of unfavorable import. In any patient convalescing from a serious operation, if unchecked, it may become a factor of grave importance.

Treatment.—Since the days when Pliny suggested the sudden exhibition of repulsive reptilians, to the present, the treatment of hiccough has been much discussed, and the list of sovereign remedies is scarcely shorter than the list of men who have written on the subject, but even now cases are reported of patients dying unrelieved, just as cases appear in which the hiccough stops as suddenly as it started, without reference to treatment.

It is reasonable to consider the treatment of hiccough under three headings—physiologic, empiric, and antispasmodic.

It is important, if possible, to find the cause and relieve it. If no direct cause can be found to exist, treatment should be directed toward any contributory cause—renal insufficiency, gout, distention, constipation.

If direct or indirect cause cannot be found, or, if found, is not amenable to treatment, it will become necessary to resort to *empiric measures*. Of these, it is wise to have a considerable number at one's disposal, for often many have to be tried before one succeeds. In mild cases holding the breath, the administration of hot water or ice, tongue traction, or tight pressure, corset fashion, on the costal margins, enough to actually relax the diaphragm, should first be tried. This last procedure is called "throttling the belly" and should be applied with both hands for intervals of three minutes. A tight adhesive swathe may be bound about the lower chest. Local counterirritation may be applied by means of ice, or ether or ethyl chlorid spray over the epigastrium, the application of a mustard plaster to the epigastrium, turpentine stupes to abdomen, ice-bag to spine, or electricity to diaphragm.

Depletion may be tried, if indicated, by means of bleeding, leeches to the anus or epigastrium, or by hot mustard foot-baths. In neurotic cases, mental shock or the revulsive effect of a cold shower-bath may be efficacious. Success has been reported following continued painful pressure of fifteen or twenty minutes on the supra-orbital nerve and after continued pressure on the phrenic nerve in the neck. The sipping of water, whisky, or vinegar for the purpose of bringing on a series of frequent acts of swallowing is said in many cases to be of good service, on the theory that when the vagus nerve is busy with the mechanism of swallowing it will weaken the effect of the reflex to the diaphragm. Swallowing rapidly a considerable quantity of mush, gruel, or sago, swallowing lumps of ice, the rapid eating of ice-cream, have all been stated to have an effect in diminishing the frequency of the spasm or in stopping it altogether. Spraying the pharynx and larynx with an anesthetic solution, such as cocain and menthol in chloroform water, and gargling have been of use, and a severe case has been reported cured by the use of apomorphin to induce vomiting. Stimulation is sometimes of avail in the weak.

Finally, if the case is not one in which a direct cause of the phenomenon can be arrived at or relieved, and if the repeated application of the empiric measures have resulted in no benefit to the patient, it will become necessary to resort to *antispasmodics* and sedatives. Of these, the following have been recommended: aromatic spirits of ammonia, compound spirits of ether (Hoffmann's anodyne), chloral, amyl nitrite, cocain, atropin, morphin, and, as a last resort, to produce sleep in cases which have become exhausted, inhalations of ether or chloroform.

References

C. O'Leary, Hiccough, Trans. Rhode Island Med. Soc., 1894, v, 91.
W. L. Symes, On Hiccough, Dublin Jour. Med. Sciences, 1892, xciv, 488; 1895, xcix, 15.

CHAPTER XXI

THE TONGUE: ITS SIGNIFICANCE

OBSERVATION of the tongue in patients recovering from operation may be of considerable value in aiding the surgeon to determine whether the patient is progressing favorably or otherwise. In the old days much reliance was placed upon this observation, and many fine points of distinction were drawn in the endeavor to work out the significance of the changes which were apparent. Nowadays we have got into the habit of relying chiefly upon the points of pulse, temperature, and respiration. The tongue, however, can assist us in some doubtful conditions. In examining the tongue attention should at the same time be paid to the following points: the age of the patient, time of observation, and temperature. Of the tongue itself the following characteristics are to be observed: first, the color; second, the coat; third, the degree of moisture; fourth, the movements.

Of first importance are the coat and degree of moisture. This coat is due to an alteration in the amount and depositions of the epithelium covering and to the accumulation of epithelium and bacteria. The coat may be slight, in which case the tongue presents a moist, thin, gray coat with a pink background and the sides and tip are clean. If the coat is thicker, the tongue is gray and in places yellow, or even white where the coat is thickest; if the patient has been taking black coffee, the coat may be stained brown; grape juice gives a purple color; if there has been vomiting of bile, the coat may assume a yellow or even an olive-green color. The excess of epithelium, due either to overproduction or retention, may proceed to such a point as to give the tongue the appearance of being roughly plastered over. In this condition the breath is foul, and there may be ulcers or tooth-marks along the margin. Sometimes the filiform papillæ increase much in size and become lengthened so that they stand out conspicuously. This gives us the appearance which is called the furred tongue. This condition is undoubtedly due to disuse and to want of moisture.

The coated tongue is usually moist. In contrast with this we may have a tongue which is clean and without coat, dry, and glazed. This type of tongue is to be regarded with apprehension. In contrast to the coated tongue, which is broad and flat with a rounded tip, this tongue is narrow with a pointed tip. For the most part the surface is smooth and devoid of papillæ. The tongue is liable to crack across its surface. These cracks may intersect so as to give the appearance of crocodile hide; in color it may be pale red or yellowish. It is dry and smooth, as if covered by a thin coat of varnish. The mouth above shows an entire absence of salivary secretion, and the patient is unable to expectorate. A tongue dried by evaporation soon becomes moist if rolled about in the mouth, and its appearance is like the moist, coated tongue already described. Dryness of the tongue is an unfavorable sign when the patient cannot, by an effort, raise sufficient saliva to moisten its surface.

The movements of the tongue when it is projected have some significance. The tongue may be tremulous in any condition accompanied by prostration. The way a patient reacts to the order to stick out his tongue may help in interpreting his condition.

Changes in the condition of the tongue are frequently of local origin. The tongue owes its moisture to the saliva, and any deficiency in saliva will cause dryness of the tongue. Saliva is deficient when fever is present, and hence the tongue is dry. Dryness of the tongue may be due to increase of evaporation, from keeping the mouth open, as well as to diminution of the salivary secretion. In chronic fever the effect of the temperature upon the secretions in general is to cause a diminution, and this includes the salivary secretion. Also the general dehydration of the body causes dryness of the tongue, even without apparent local diminution of secretion. A tongue which otherwise might be dry is sometimes moist by vomit. Prostration has the same effect as chronic fever in causing diminution of the secretion.

The ingestion of food influences the coating and the degree of moisture. The act of eating cleanses the tongue. In such conditions, accordingly, as are accompanied by the decreased ingestion of food, it is natural for the fur upon the surface to become more prominent. This is also true in conditions where the diet is limited to fluids, particularly milk.

Clinical experience has shown that certain conditions in the tongue are associated with certain general conditions which make the appearance somewhat diagnostic. This term must be qualified because the changes are so often local or are modified by conditions independent of the general system. W. H. Dickinson[1] describes twelve classes and

[1] Lancet, 1888, i, 558, 609, 657

three subclasses in his lectures on the appearance of the tongue in disease. The most important of these are:

First, the stippled or dotted tongue. The tongue is moist and dotted with little white points representing an excess of white epithelium on the papillæ. It is usually seen in persons in poor health, usually from some chronic disease which is not grave, and which is not accompanied by a rise in temperature.

Second, the coated tongue. The papillæ are covered with white epithelium, and the intervals between the papillæ are almost filled with epithelium and accidental matters, so as to form a continuous coat. This tongue, whether moist or dry, is seen in acute and febrile diseases with considerable degree of prostration and fever.

Third, the plaster tongue. The tongue is covered with a thick, uniform coat. The papillæ are elongated. The intervals are crowded with accumulations. Saliva is deficient. Fever and prostration are marked.

Fourth, the furred or shaggy tongue. Papillæ are greatly elongated. This tongue represents an advanced stage in the course of a disease. It is the result of disease and want of moisture. The saliva is deficient. It indicates that there has been fever and that probably but little food has been taken.

Fifth, the dry brown tongue. The surface is covered with a dry, thick, felted coat, which is continuous and is largely parasitic in nature. It occurs in fevers with high temperature associated with prostration and absence of saliva. As the patient gets better the incrustation disappears, leaving a bare, red, dry surface.

Sixth, the red, dry tongue. This indicates a more serious condition usually than the dry, brown tongue. It is the tongue of chronic wasting diseases, with or without fever. The tongue is shrunken, red, polished, and smooth. The papillæ have disappeared and the epithelium is stripped off in patches.

Dickinson has not been able to discern any relationship between any state of the tongue and particular gastro-intestinal conditions apart from that which might occur from loss of appetite or restriction in the amount of food. The state of the tongue is dependent not upon the intestinal lesion, but upon the constitutional disturbance. The tongue does not point to particular organs or isolated disorders, but is the gauge of the effects of disease upon the system.

The condition of the tongue is, accordingly, due to—(1) dehydration, (2) exhaustion, (3) pyrexia, (4) local conditions about the mouth. The degree of fever, the state of the nervous system, the maintenance and abeyance of secretion, and the failure of vitality are roughly indicated by the condition of the tongue. The return of the moisture, the removal of fur, and subsidence of tremor at once indicate that the patient is getting better. The persistence and increase of these signs show that the disease is getting the better of the patient. The dry and bare tongue is of serious prognostic omen in all conditions.

So far as is consistent with the surgical conditions present, *treatment* may be directed to any attributable cause, local or general. Intestinal putrefaction should be prevented by the reduction or removal of proteid, especially meat, from the diet, by the use of carbohydrate food, such as bread, cornstarch, cereals, etc., and by the use of laxatives, buttermilk, and, if necessary, internal antiseptics, such as salol or the salicylates. Locally, the tongue should be cleaned daily with a tooth-brush, and the use of an alkaline liquid, such as liquor antisepticus alkalinus, will facilitate the removal of the coating. The teeth should be looked after, if possible, before every abdominal operation.

CHAPTER XXII

BANDAGING

BANDAGING to-day is an art much simpler than as practised a few decades ago. This is in accordance with the general trend of surgical technique, and is due to our more exact knowledge not only of the pathologic conditions present, but also of the means of correcting them.

The almost universal adoption of the gauze bandage has greatly helped this simplification, as, on account of its texture, it can be made to adapt itself easily to the uneven surface presented. Plaster-of-Paris bandage is used for more or less permanent fixation, especially of joints and limbs. Flannel bandages and bandages made of specially woven material, such as the "Ideal" bandage, may be used on account of their elasticity for the support of strained joints and for varicose veins.

The other chief factor in simplification is the almost exclusive use of the "figure-of-8" instead of the "spiral reverse" for the purpose of closely and evenly fitting a part, the diameter of which is increasing. In fact, this figure-of-8 principle, when thoroughly mastered, can be varied to fit any condition, and is the basis of most of the "named" bandages. It can be applied much quicker than a "reverse," it will hold a dressing better, and, when finished, it is much less likely to become disarranged; if, during its construction, several simple circular turns are introduced on the upper loop of the "8," all tendency to slip is overcome, and it is found in good condition after a week's constant wear. Furthermore, on its removal the skin will reveal fewer and less marked ridges than after a "reverse" bandage; the figure-of-8, therefore, is less likely to cause localized pressure—sores or venous stasis—and is of greater value in such conditions as varicose veins, in which an even firm pressure is desired.

Commercial Roller Bandages.—Bandages may now be bought of gauze, flannel, or other material at drug-stores and surgical supply houses. These come in any width, are evenly and tightly rolled, and are usually economical. The ordinarily employed gauze bandages come in 10-yard lengths, and in widths from 1 to 6 in. The commonly used sizes for practical purposes are the 1½ in. about the hand and head, and the 3 in. about the limbs and body. In an emergency, of course, any material available can be torn into strips and rolled into a bandage.

Cleaning.—The parts to be covered in by the bandage should be cleaned with soap and water, followed by alcohol, then thoroughly dried and covered with dusting-powder.

Sheet-wadding for Protection.—Before application of a bandage a layer of sheet-wadding should always be placed over the dressing and the part to be covered by the bandage. This material comes in sheets about a yard square, is very soft and agreeable to the skin, and nonabsorbent. It is most easily applied by roughly tearing into strips, 3 or 4 in. wide, and making into rollers, which are then applied loosely in spiral turns; frequently two or three strips are stitched together so as to form longer rollers.

It should be an invariable rule that, in the application of bandages or any other apparatus, *no two skin surfaces should come together;* this should always be avoided by the interposition of a piece of sheet-wadding or absorbent cotton, well powdered (for example, in recurrent bandage of the hand the fingers should be separated by sheet-wadding).

To Roll a Bandage.—It is frequently necessary to reroll a bandage. To do so fold one end on itself several times into a tight little roll; grasp this at the extremities by the thumb and forefinger of the left hand, which act as the bearings of the revolving axis; the free-hanging bandage is then played between the thumb and index-finger of the right hand, which, by the alternating pronation and supination of the forearm, as in winding a clock, revolves the cylinder and the roller is formed.

To Start a Bandage.—Hold the bandage in the right hand with not more than 3 in. free; take the free end with the thumb and finger of the left hand, lay the unrolled portion against the part to be bandaged; hold the free end firm with left hand; allow roller to run to the right naturally round the part; as it passes to the left on the posterior surface transfer roller to left hand, holding initial extremity firm with thumb of right hand; in front change roller again to right hand and proceed as before, making two complete turns. This turn is called a circular turn, and is used for starting and "fixing." This fixing should always be at a point where there is little or no variation in diameter, so that it shall not slip upward or downward (*i. e.*, at the ankle and not on the cone-shaped calf).

To Remove a Bandage.—Unpin the end and unwind. As the bandage is being unwound the free portion should be gathered into the palm of the hand and transferred bodily to the other hand alternately above or below the limb; it should not be allowed to drag or string out.

Figure-of-8 Bandage.—After fixing, say, on the calf of the leg, allow the bandage to run diagonally upward and backward until it reaches the posterior surface, when it will again naturally become horizontal; as it comes around on the other side, direct its course onto the front of the leg diagonally downward and forward, so as to cross

FIG. 46.—APPLICATION OF BANDAGE.

Preliminary turns have been taken to hold sheet-wadding. Figure-of-8 has been used to cover in foot, and bandage is ascending on leg. (The ends of the gauze roll have been dipped in ink so that the turns may be clearly seen.)

the ascending turn in the middle of the anterior surface. Continuing to descend it passes backward and becomes horizontal on the posterior surface; then it rises again obliquely, passes forward, crosses the downward turn in the middle of the anterior surface, and continues upward and backward as above. Each succeeding turn progresses upward for from $\frac{1}{2}$ in. to one-half the width of the bandage (Figs. 46 and 47).

FIG. 47.—APPLICATION OF BANDAGE COMPLETED.

Foot and leg covered in with figure-of-8 turns, and circular used to end off with.

The crossings on the anterior surface after a little practice naturally arrange themselves in perfect alignment. While applying the bandage, an occasional circular turn helps to fix the bandage firmly and overcomes all tendency to slip; such a turn usually falls naturally, and both edges of the bandage lie flat and with even tension.

The **spiral reverse bandage** was once very generally used to cover any part conical in shape; it is now superseded by the figure-of-8. It is put on as follows: after "fixing" and making one complete upward spiral turn, the hand holding the roller is carried about 6 in. away from the limb, the thumb of the other hand holds the bandage against the limb ½ in. proximal to proposed position of the reverse; the hand holding the roller is carried toward the limb sufficiently to *slacken* the unapplied portion of the bandage, then, by turning the forearm from extreme supination to pronation, the bandage is twisted once on itself, so as to form an angle of about 90 degrees, just beyond the thumb. The reverse is thus completed, and the bandage is allowed gently to fall flat upon the limb; it is then carried around underneath the limb and the desired tension applied. The reverses should be in a line, but not over prominent parts (*i. e.*, anterior border of tibia), as, unlike the figure-of-8, they cause creases in the skin which may easily result in pressure sores.


FIG. 48.—SPICA BANDAGE APPLIED TO THIGH.


FIG. 49.—SPICA BANDAGE APPLIED TO SHOULDER.

The **spica bandage** is really a figure-of-8, one loop of which is made much larger than the other; there are three situations where it is commonly used—the thumb, shoulder, and hip. The *hip spica* (Fig. 48), one of the frequent dressings for hernia, is made as follows: the bandage should be of gauze several folds thick, 12 yds. long, and have a width of 8 to 12 in. Patient is placed with sacrum resting on a basin or spica block, sheet-wadding is applied with a considerable thickness in groin. The bandage is fixed with a circular turn about the pelvis; as it passes from back to front it becomes oblique, runs over the inguinal region into groin, around the leg, up diagonally across the inguinal region to the opposite side, and then around the pelvis; every third turn should be a circular turn around the pelvis and several safety-pins should be introduced during the application.

The *spica of shoulder* (Fig. 49) is similarly applied—a figure-of-8 with the small loop about the upper arm and the large loop about the thorax, and under the opposite axilla.

To Bandage the Heel.—Frequently the heel is left uncovered when bandaging the foot and leg; if it is desired to include it in the bandage, it may be done by one of the following two ways:

FIG. 50.—FRENCH HEEL APPLIED; FIGURE-OF-8 TO LEG.

FIG. 51.—LEG BANDAGE APPLIED. Side view, showing testudo to heel.

FIG. 52.—LEG BANDAGE APPLIED. Front view, showing crosses along median line and circular turn to end off with at top.

(1) After making fast by circular turns around the ankle above the malleoli, the bandage is carried obliquely downward across the foot to near the base of the toes, at which part a circular turn is made. The bandage is then carried up the foot by two or three short figures-of-8; then carried over the point of the heel and around to the dorsum of the

foot; then beneath the instep, around one side of the heel, and up over the instep; from here again beneath the instep around the other side of the heel and up in front of the ankle, from which it may be carried up the leg. This is called the French heel (Fig. 50).

(2) After fixing as above, the bandage is carried obliquely downward across the foot to near the base of the toes, where a circular turn is made; the foot is covered nearly in with short figure-of-8 turns; when running across the top of the instep the bandage passes over outer malleolus, over tip of the heel, and up over inner malleolus; then crosses top of instep, around behind tendon of Achilles, crossing again on front part of instep, it then passes beneath the arch of the foot to the front of the instep. These turns are continued in the form of figures-of-8, with the point of crossing stationary, over the instep, and the loops alternately covering the region of the tendon of Achilles and the arch of the foot, till the heel is covered in, after which the bandage ascends the leg. This is called the testudo (Figs. 51 and 52).

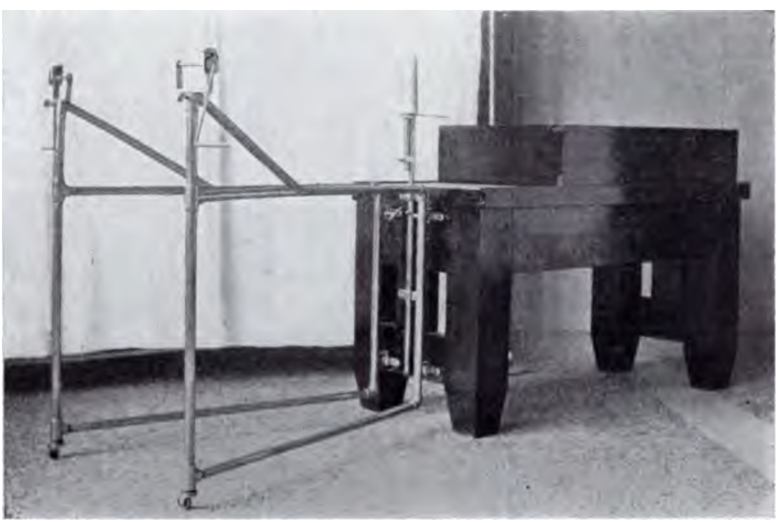

Fig. 53.—Hoffa Table (Boston City Hospital).
For application of plaster-of-Paris spica bandage to hip.

Plaster-of-Paris Bandages.—Plaster of Paris, or gypsum, is used to maintain complete or partial fixation over a more or less extended period. It forms a very convenient splint material and is adaptable to many places and purposes. It is usually applied, in accordance with the principles of technique just described, in the form of a bandage. This is made by thoroughly filling the meshes (16 threads to the inch) of a gauze roller (3 or 4 in. wide) with ordinary dry plaster. Unwashed crinolin probably makes a more satisfactory material. Plaster bandages may be bought at the surgical supply houses put up in sealed tins. Care should be taken that the plaster

FIG. 54.—PLASTER-OF-PARIS BANDAGE.

Sheet-wadding applied. Foot held at right angles, slightly inverted, to overcome tendency to formation of "flat-foot."

FIG. 55.—PLASTER-OF-PARIS BANDAGE.

In removing rollers from water the excess is squeezed out by pressure on the ends, the fingers being closed to prevent the plaster from running out.

FIG. 56.—PLASTER-OF-PARIS BANDAGE IMPROPERLY WRUNG OUT.

The twisting action wrinkles the bandage and removes too much plaster.

does not become air-slaked by exposure to damp air, otherwise the cast will crumble and disintegrate after it is applied. For this reason bandages that have been in stock for some time should be baked in an oven before using.

To apply, cover the leg smoothly and evenly with strips torn from

FIG. 57.—PLASTER-OF-PARIS BANDAGE.
Roller being applied. The foot is being correctly held by an assistant.

a sheet of cotton wadding (Fig. 54), protecting amply all bony prominences. Completely immerse the plaster roller in luke-warm water for

FIG. 58.—PLASTER-OF-PARIS BANDAGE.
The first roller is being finished. This layer will now be rubbed in, and a second and third roller similarly applied.

about two minutes, or until all the air-bubbles are out and the bandage wet through. A pinch of salt dissolved in the water will hasten the setting; if it is not dissolved, it will get into the plaster and make it crumble. If allowed to remain too long in the water, the rollers set and become hard. When taking the roller out of the water, both ends should be grasped and the water gently squeezed out (Fig. 55); a twisting or wringing motion (Fig. 56) will force the plaster to run out through the meshes. Roll around the leg smoothly, following the natural curves with spiral or figure-of-8 turns; never use the reverse; never pull tightly; always keep in mind the danger of localized pressure. After the plaster has been applied about twenty minutes, it is in suitable condition for trimming, splitting, and cutting of windows. Use a small, stout plaster knife (shoemaker's knife) and cut the plaster through until the sheet-wadding is reached. This can be cut later with scissors. It is best to defer removal of the piece which has been cut till the next day to allow the plaster to harden (Fig. 59).

FIG. 59.—PLASTER-OF-PARIS BANDAGE.

Application has been completed, plaster has been allowed to set, and has been split down each side ("bivalved") to allow for swelling and for inspection. Shows the proper method of application of webbing straps to keep the halves together.

Recurrent Bandage—Hand or Amputated Limb.—The bandage is fixed by a few circular turns; then, when the bandage roll is on the front of the limb, turn it at right angles, putting the thumb of left hand on the point of folding to hold it in place, carry the bandage to the end of the extremity, pass over this in the median line, and return upward on the under surface to a point directly opposite the point of starting; then place the fingers of the left hand on the bandage, double it upon itself, and bring the bandage directly back the way it came over the end of the extremity to the point of starting. Each turn should overlap two-thirds of the previous one, first on left and then on right side of median line, until the extremity is covered in; then turn the bandage at right angles so as to secure the folds still held by thumb and finger with circular turns; the bandage may then be continued up the limb by figure-of-8 turns.

Recurrent Bandage of Head.—Fix the bandage by two circular turns around the head, passing just above the eyebrows in front, as close to the tops of the ears as possible on the sides, and just under the occipital protuberance behind; with the roller in front take a right angle turn, so as to pass over top of head to occiput; double back, and run directly forward just a little to one side of the median line to the root of the nose; again double backward to the occiput, this time keeping just a little to the other side of the median line.

FIG. 60.—RECURRENT BANDAGE OF HEAD, SOMETIMES CALLED THE "MELON."

The patient can be made to hold the front angle of turns and the surgeon the posterior. Continue till head is covered in, then complete the bandage by several circular turns about the head to fix the recurrents in place. Pins may be introduced where the recurrent turns were made to make the dressing more secure (Fig. 60).

Modified Barton.—The bandage should be started by two circular turns around the forehead and occiput; then, as the bandage leaves the occiput, it should pass forward in the form of a circular beneath the ear around the front of the chin and back under the opposite ear, where it begins to run obliquely upward, just under the occiput and under and in front of the parietal eminence, across the vertex of the skull, downward over the zygomatic arch, under the chin, then upward over the opposite zygomatic arch and over top of the head, crossing the first turn in the median line and well forward. The bandage is then passed obliquely backward and downward under the occipital protuberance and then out once more over the chin (Fig. 61). These figure-of-8 turns are to be continued until roller is exhausted. The original Barton's bandage omits the turn around the forehead; this, however, adds greatly to its stability.

FIG. 61.—BARTON'S BANDAGE BEING APPLIED.

The Desault Bandage.—Desault,[1] about the beginning of the nineteenth century, devised the following apparatus for treatment of injuries to the clavicle. He placed a wedge-shaped pad in the axilla, which was held in place by circular turns around the body and over the opposite shoulder (first roller); the arm was then securely bandaged against this pad by circular turns, tighter near the elbow than at the shoulder (second roll); forearm supported at right angles in front of the chest by narrow sling at wrist. The third roller was then applied to keep the point of the shoulder elevated; starting in front, going toward the injured side, the first turn passes over the distal end of the clavicle, runs down back of arm under elbow, across front of chest to opposite axilla, obliquely up across the back over shoulder, down front of arm, under elbow, diagonally up and across back to axilla, where it again goes forward and upward to shoulder as before, these turns to be continued until bandage is exhausted.

Velpeau Bandage.—Velpeau,[2] about 1839, finding the Desault apparatus apt to cause serious pressure on the brachial vessels and nerves, adopted the following method of application for injured clavicle: The initial extremity of the bandage is placed in the axilla of the well side; it runs diagonally up over the back and shoulder to the injured clavicle; the hand of the injured arm is placed on the opposite shoulder; the elbow, therefore, is over the tip of the sternum, thus throwing point of shoulder up, back, and outward. The bandage now runs down from

[1] Oeuvres Chirurgicales ou Exposé de la Doctrine et de la Pratique de *Desault* par Xav. Bichat, Troisième édition, Paris, Megnignon, 1813.

[2] Velpeau, Nouveaux Élements de *Médicine Opératoire*, Deuxième édition, Paris, Bailliere, 1839.

the clavicle, first on the anterior then on the outer surface of the arm, finally coming on to its posterior surface under the elbow and out over the forearm and upward to the axilla, whence it started; these turns are repeated twice to fix the bandage. Having completed the second turn, carry the roller transversely around the thorax, passing over the flexed elbow of the affected side to point of origin; from here it runs obliquely across the back to the injured shoulder as before; these alternating turns are applied until arm and forearm are bound firmly to side.

Neither the Desault nor the Velpeau bandage as originally described is frequently used at the present time, but instead the following modi-

FIG. 62.—MODIFIED VELPEAU.

Showing preliminary application of sheet-wadding. The bandage has been fixed and started by two circulars about elbow and thorax; the second turn has been carried obliquely upward across the back, over the tip of the shoulder, under the elbow, up over the shoulder again, obliquely down across the chest.

FIG. 63.—MODIFIED VELPEAU.

In process of application, from behind, showing sheet-wadding placed to protect axilla and shoulder-tip.

fication; this is useful for any injury about the shoulder or whenever it is desired to have the arm immobilized against the thorax.

Modified Velpeau.—First the proper amount of padding is placed in the axilla to fill in the hollows, but this is not of such a material as to cause pressure on the axillary vessels and nerves; sheet-wadding is placed also between the forearm and chest (Fig. 62). The bandage is fixed by two circular turns around the arm and thorax; when the roller reaches the axilla of the well side, it passes diagonally upward across the back, over the shoulder at its outer point down to the front of the arm, under the elbow, up the back of the arm, over the tip of the shoulder, across the chest to the other axilla (Fig. 62). From here it runs backward around the thorax and arm, just at the tip of the elbow, returning to the axilla; then the first turn is repeated over the shoulder, down the front of the arm, under the elbow, up the back of the arm, over the shoulder, across the chest to starting-point, from which a circular turn is made (Fig. 63.) These turns are repeated, leaving one-third of preceding turn uncovered, up the arm and shoulder until all is covered in (Fig. 64).

Fig. 64.—Modified Velpeau, Completed.

Lund Swathe.[1]—The swathe as described by Lund is a most efficient method of immobilizing with comfort the forearm acutely flexed at the elbow. A cotton swathe of the width of the shoulder, and long enough to make a figure-of-8 around the elbow and body, is passed under the flexed elbow, horizontally, its center being at the point of the elbow. The forward end is carried snugly up around the forearm and backward over the shoulder, diagonally downward across the back and under the opposite arm, where it is pinned to the other end, which is brought forward to the front and carried in the form of a circular about the thorax. A simple modification of this which is often used is to continue the part that passes across the front of the chest and under the opposite arm all the way across the back, to be pinned to the part surrounding the flexed arm, thus making a complete circular turn around the body and fixing the arm to the body; the part brought over the shoulder is pinned

Fig. 65.—The Lund Swathe.
Starting the application.

[1] F. B. Lund, Med. and Surg. Reports of the Boston City Hospital, eighth series, 1897, p. 3.

to this circular piece as it crosses the back (Figs. 66 and 67). This swathe can also be applied advantageously after the method of Sayre.

Fig. 66.—Modified Lund Swathe Applied.
Showing sheet-wadding under hand.

Fig. 67.—Modified Lund Swathe Applied.
Rear view, showing safety-pins in place.

Breast Bandage.—The Boston Lying-in Hospital [1] bandage may be easily extemporized by fastening together in the shape of a T two strips of very stout linen cloth, such as towels. The strip, which forms the tail of the T, should be about 4 in. broad, and long enough to a little more than half encircle the patient's chest. The cross-piece should be nearly double that length, and wide enough to extend from a position one inch below the patient's breast to the edge of the areola. This bandage is applied by drawing the tail of the T beneath the patient's back, in such a position that its ends appear at the sides, on a line with the nipples, and with the junction of the tail and cross-bar well external to the edge of the breast on that side. The lower edge of the lower half of the cross-bar should then be drawn tightly across the chest, care being taken to see that it is below the lower border of the glandular tissue. It is fastened by a safety-pin to the free end of the tail-piece, and is prevented from slipping upward by attaching it to the upper edge of the obstetric binder, at two points, which should be opposite the most dependent portions of the breasts. The upper edge of the other half of the cross-bar is then drawn across the chest, entirely above the breasts, and is pinned to the other corner of the free end of the tail-piece. It is prevented from slipping down by shoulder-straps, not less than 2 in. wide, which are attached to it opposite the upper edge

[1] Reynolds and Newell, Practice of Obstetrics, 1902, p. 505.

of the breasts, carried over the shoulder, and pinned to the tail-piece in the middle of the back. The whole surface of the breasts should then be thoroughly dusted with powdered starch or some other powder and a large wad of absorbent cotton placed between them. The breasts are then drawn strongly inward by the hands of the patient, and the bandages pinned together on each side of the axilla, beginning at the outer edge and then working upward toward the nipple, care being taken that the pressure is uniform; the edges of the strips are then brought together between the breasts with safety-pins.

When used to exert pressure upon badly caked breasts, it should be drawn as tightly as possible without seriously embarrassing respiration. Its pressure there almost invariably results in the expression of all the milk, but produces so much discomfort that it has to be loosened after a few hours.

To catch the discharge from the breast a dressing can be placed over the nipples and held in place by lightly pinning an extra piece over the front (Figs. 141, 142, 143, pp. 447, 448).

Many-tailed Bandage.—This consists of a piece of cotton cloth of the desired length and wide enough to considerably more than sur-

FIG. 68.—MANY-TAILED BANDAGE AS APPLIED TO THIGH AND LOWER ABDOMEN.

round the part; into each side tears about 2 in. apart are made. It is extremely adaptable and very convenient for holding in place wet dressings that have to be frequently changed. The lower pair of tails are knotted once and the ends layed upward; the next pair are knotted over the ends of the first; these ends are laid upward and the third pair knotted over them, etc., until the last pair are reached; they are tied in a bow-knot, so as to be readily opened (Fig. 68).

Swathes.—*Swathes* are used for maintaining in place abdominal and thoracic dressings, and are merely pieces of cloth the desired width and length to go around the body and are fastened by pins (see Fig. 153, p. 486).

T-Bandage.—This consists of a narrow belt, to the middle of which one or two pieces are sewed at right angles. It is used to hold perineal dressings and vulvar pads in place. The cross-bar of the T goes about the waist, the vertical limb, starting from the middle of the back, passes between the legs and is carried up onto the front of the abdomen. The three ends meet and are pinned together over the pubes.

Cunningham Hernia Dressing.—This is made of a piece of Canton flannel 6 in. wide and 16 in. long, to each end of which is sewed a strip of adhesive plaster about 16 in. long. The flannel part surrounds the leg; the adhesive pieces cross over the inguinal region and adhere to the flanks. (For illustration, see Fig. 155, p. 488.)

Laced Adhesive Dressing.—This belt, which serves at once to hold the dressing in place, to take tension off the wound, and to do

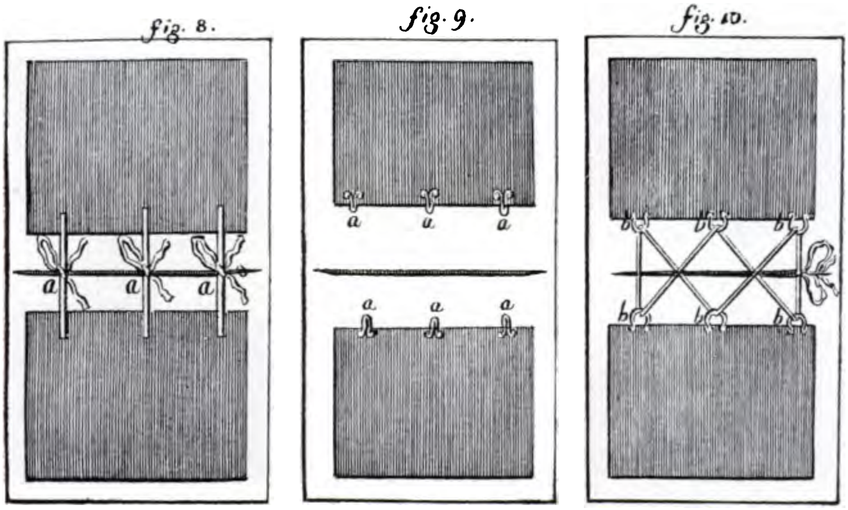

FIG. 69.—FORMS OF LACED DRESSING REPRODUCED FROM HEISTER.

away with the necessity of an encircling band or swathe, was first described in Heister's Surgery,[1] and was first used in its present form by Dr. Ernest W. Cushing, of Boston, in 1894. It consists of two pieces of zinc oxid adhesive plaster (Fig. 70), 5 to 8 inches long and 3 to 6 inches wide. One edge is folded over on itself for about 1 inch with a stick of wood, such as is commonly used for making swabs, within the edge of the fold. This stick gives a firm edge to support

[1] Venice, 1750, Vol. i, p. 109.

the strain of the lacing. Into this turned over margin are now punched a series of metal lacing hooks about 1 inch apart. (A hand tool for

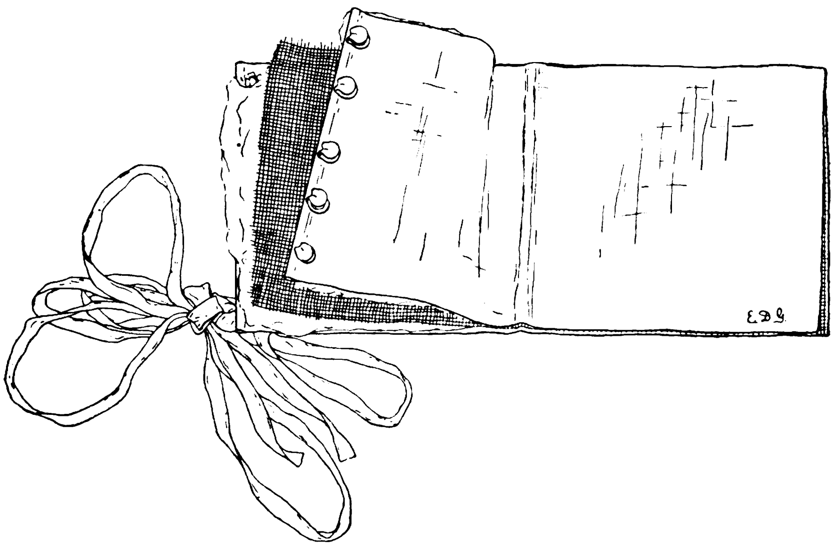

FIG. 70.—LACED ADHESIVE DRESSING AS MADE UP READY FOR USE.
The adhesive surfaces of the two portions of plaster are in apposition with crinoline between, and the lacing tape is tied to one of the hooks.

FIG. 71.—LACED ADHESIVE DRESSING FOR ABDOMINAL WOUNDS.

applying these can be purchased for $1.50.) The sticky side of the plaster, from the hook-edge in, is covered for about 2 inches with sheet wadding, to prevent its adhering to the dressing. The rest of the plaster is applied to the skin on each side of the dressing, so far away that when the edges are thrown back the whole dressing may be removed, and when laced there may be enough tension to give a sense of support. For abdominal wounds it is far more comfortable than, and fully as efficient as, any other retentive appliance. A photograph showing it applied appears on p. 232.

Strapping the Ankle.—Take about six pieces of adhesive plaster, 1 in. wide and 18 in. long. To relieve and fixate the internal ligament start the first piece on the dorsum of the foot, pass outward around outer edge, beneath the arch, up the inner side diagonally,

FIG. 72.—STRAPPING THE ANKLE.
The strip of adhesive plaster is started on the outer border of the foot, carried under the arch, and across to the outer aspect of the leg.

up the ankle to the outer side of the calf. Apply all the strips each overlapping the next about one-half inch. To splint the external ligament reverse the direction (Fig. 72).

Strapping the Ribs.—Have six to eight adhesive-plaster strips, 2 in. wide and long enough to encircle the body; direct the patient to stand with arms elevated and the uninjured side next to the surgeon. Apply the initial end of one strip to the side and order the patient to turn around. The patient then proceeds to wind himself up into the plaster; the amount of tension will be regulated by the resistance which the surgeon, holding the unattached end of the plaster, offers. Each strip overlaps one-third of the preceding strip. This is more effective in controlling the pain accompanying respiration than strapping one-half of the thorax, as often recommended. When many ribs are fractured, care must be taken not to apply too tightly, as there is danger of causing inward buckling of the fragments with increase in pain.

Strapping the Knee.—Take three pieces of adhesive plaster, $1\frac{1}{2}$ in. wide and 9 in. long, apply one strip above and one below the

FIG. 73.—STRAPPING APPLIED TO KNEE.
One strap above patella pulling downward; one below patella pulling upward; one over patella. Each goes only from hamstring to hamstring.

patella, and the third piece directly over the patella, running transversely from one hamstring to the other, overlapping the other two about $\frac{1}{4}$ in. (Fig. 73).

Sling.—A piece of cloth to be used as a sling is usually cut in the form of a right-angled triangle, with the legs about 20 or 22 in. long for

FIG. 74.—SHOWING METHOD OF PINNING CORNERS OF SLING SO THAT THEY LIE FLAT.

FIG. 75.—DOUBLE SLING APPLIED.
Note how the hand is supported.

an adult. It is used to support a part, especially the forearm. The right angle is placed at the elbow, the forearm rests in the trough as the ends of the string are brought up, one in front of and one behind the forearm, and tied or pinned at the neck. A pinned sling is much neater and less irksome than the tied one (Fig. 74). If it is tied, care should be taken that the knot is to one side or the other of the median line. The sling should include the entire hand, and a pin or two may be necessary at the elbow.

Double Sling.—Instead of using a modified Velpeau a so-called double sling may be employed to support the forearm and hold the humerus against the side. The first sling should be applied as already directed. The right angle of the second sling should be placed at the shoulder and the long edge at the elbow. The two ends are pinned together in opposite axilla (Fig. 75).

Suspensory Bandages.—The object of suspensory bandages is to keep the testicles elevated. The objections to the many forms of commercially made suspensories are in the main two:

First, that they are, as a rule, made in three sizes, and, unless the physician instructs the patient as to the size necessary in the given case, the bandage may be too large to keep the testicles elevated or so small as to exert undesired pressure on the organs. Also if the suspensory bandage is used for a swelling of the testicles, the bandage becomes too large as the swelling subsides.

The second objection is that the majority of suspensory bandages exert pressure in the region of the external abdominal ring, as the belt holding the bandage usually presses over this area. It is believed that this sometimes hinders the drainage of inflammatory products through the vas deferens in instances of epididymitis. It also exerts a deleterious influence in varicoceles of large size, hindering the flow of blood from the veins of the cord, and thus inducing and maintaining congestion.

With the end in view of overcoming these objections the following forms of suspensory bandage, which are adjustable in size and exert no pressure over the spermatic cord, have been devised by Dr. John H. Cunningham, of Boston, for the purposes indicated.

Hammock Suspensory.—This suspensory is made of heavy Canton flannel. It consists of an oblong piece of flannel, 16 in. long by 8 in. wide, from the ends of which a V-shaped piece is removed. A buttonhole is cut in each corner. A webbing belt is placed about the waist and buckled. On this webbing belt are sewed two buttons, occupying positions over the anterior superior spines of the ilia. The suspensory is placed well under the scrotum, with the soft side of the Canton flannel against the scrotum, and the upper ends of the suspensory buttoned in position (Fig. 76). The lower ends are now turned up over the scrotum and penis and also buttoned, holding the scrotum in the hammock (Fig. 77). If there is so much pressure in the peri-

FIG. 76.—HAMMOCK SUSPENSORY (CUNNINGHAM). Webbing belt about the waist. Under half of Canton flannel hammock buttoned in place.

FIG. 77.—HAMMOCK SUSPENSORY. Anterior half buttoned up in position.

neum as to be uncomfortable, the waistband may then be adjusted. No perineal straps are necessary. When urination becomes necessary,

FIG. 78.—HAMMOCK SUSPENSORY. Hole cut in anterior half for urination.

the two lower arms may be unbuttoned and the bandage dropped, or a hole may be cut in the suspensory through which the penis is drawn (Fig. 78).

Adhesive Plaster Suspensory.—This method of suspension may be used with advantage in all operations upon the scrotum in which the scrotal incision has been completely closed, in ambulatory cases of epididymitis, and in all other cases of epididymitis in which applications to the skin are not used. In operative cases it prevents the scrotum from hanging down and thus increasing the tendency to infiltration of blood into the lax scrotal tissues. In the ambulatory cases of epididymitis the scrotum is supported continuously, and the bandage can-

FIG. 79.—ADHESIVE PLASTER SUSPENSORY (CUNNINGHAM).

The initial end has been made fast across the perineum. The two sections of the strap are being drawn up onto the abdomen under considerable tension.

FIG. 80.—ADHESIVE PLASTER SUSPENSORY APPLIED.

Note the efficiency with which the scrotum is supported against the pubes.

not be loosened up or removed by the patient, as is sometimes to be feared, especially in the class of patients which are accustomed to frequent the out-patient clinics.

The suspensory consists of a piece of adhesive plaster, 5 in. wide by 12 in. long, and is applied as follows: Patient lies with the legs spread apart. The scrotum is held elevated by an assistant. The adhesive plaster is placed across the perineum on a line with the junction of the scrotum and the perineum. The plaster is then brought upward across the scrotum, and split in the center from the upper end downward to a point corresponding to the junction of the penis and scrotum (Fig. 79). The penis is drawn forward into the apex of this slit and the two ends fastened to the abdomen (Fig. 80). The plaster is then made to fit the sides of the scrotum by sticking the two free edges together. In the upright position the testicles are held elevated.

Fig. 81—Perineal Dressing (Cunningham).

Fig. 82.—Perineal Dressing.
The narrow flaps are crossed and pinned in the perineum; the wide flap is lying upon the table.

If a large scrotal dressing is employed, an additional strap placed across the scrotal bandage and fastened to either side of the scrotum may be of service.

Perineal Dressing Bandage.—This consists of a waistband, 48 in. long and 5 in. wide, in the center of which are sewed 2 flaps, 36 in. long, one of which is split in the center (Fig. 81). It is applied as follows: Patient is in the dorsal position, with the legs spread apart. The

Fig. 83.—Perineal Dressing.
Narrow flaps pinned to belt.

waistband is fastened about the waist by safety-pins. The scrotum is held elevated by an assistant and the perineal dressing applied. The two flaps are crossed over the dressing and a large safety-pin, including

Fig. 84.—Perineal Dressing.
Application finished by pinning up the wide flap.

the dressing, is placed in the center of the perineum (Fig. 82). The edges of these flaps are united by safety-pins around the scrotum, which is held in an elevated position. These flaps are then united to the waistband by safety-pins (Fig. 83). The perineal dressing is thus held firmly in position and the testicles are elevated and held securely away from the perineal wound. The large flap is then turned up and fastened to the waistband, thus covering the under flaps and scrotum, aiding in support and in appearance (Fig. 84). If a catheter is placed in the bladder through the perineal wound, the two flaps are pinned around it and the outer flap perforated.

CHAPTER XXIII

TREATMENT OF THE OPERATIVE WOUND: DRESSING, STITCHES, DRAINAGE, AND STITCH ABSCESS

Time for Dressing.—The natural tendency of wounds is to heal aseptically by first intention, and accordingly it is not advisable, as a rule, to disturb the sterile dressing applied at the time of operation until the time for the removal of the stitches is due. Yet suppuration may take place where it is the least expected—any one of many factors, such as septic suture material, stitches tied too tightly, blood-clot in

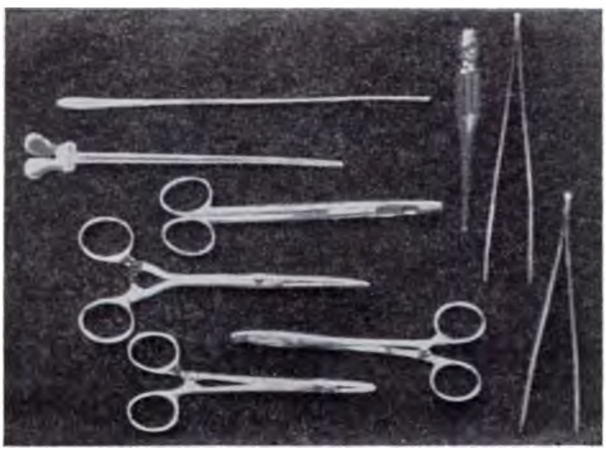

FIG. 85.—LAYOUT FOR ABDOMINAL DRESSING.
Probe, director, blunt scissors, hemostats, irrigating-tip, toothed and smooth forceps.

the wound, etc., may enter in to mar an otherwise perfect healing. Accordingly, it is of considerable importance to detect the presence of suppuration at the earliest date possible, that it may at once be adequately dealt with, and prevented, if may be, from spreading to the whole wound; if this is neglected, when the time comes to remove the stitches the wound will be found separated and more or less broken down and the dressing saturated with pus.

The most valuable guide to the septic or aseptic state of the wound is the temperature chart (see p. 59). Ordinarily, after any perfectly aseptic operation, it is the rule to find the temperature rising to between 99° and 100° F. within forty-eight hours after the operation, as has been detailed before. This is a favorable reaction; in the worst cases it does not occur or it may be replaced by a depression. The temperature reaches normal again by the afternoon of the third day. If the temperature does not drop on the third day, or if, having reached normal, it rises again at any time from the third to the sixth day, sepsis in the wound is to be strongly suspected, and the wound should be examined under aseptic precautions. Pain referred to the site of a wound appearing on the third day or after, under conditions where pain would not be expected, is frequently a sign of inflammation and sepsis.

On examination, however, it may be found that the pain is due to the irritation of the stiff suture ends pricking or scratching the skin, or to the discomfort of the gauze which is next the wound becoming caked from the dried blood or serum. In either case relief may be afforded by applying new sterile gauze next the wound, by means of sterile forceps, removing the caked gauze, and reapplying the old dressing. Sutures causing irritation may be rearranged or snipped off. In this procedure it is not necessary to touch the wound or the gauze except with sterile forceps.

Aseptic Wounds.—Unless there is some good indication,—for instance, the dressing has become loose and misplaced, has been soiled, or soaked with blood or serum,—the dressing should not be disturbed until the time set for the removal of the stitches. The small amount of blood and serum which ordinarily soaks into the dressing from a tightly closed wound becomes coagulated in the air, at the same time serving to seal the wound and to splint and support the skin-edges. If the hemorrhage or serous effusion has been so considerable as to soak the dressing through, so that the outermost layers are moist and damp, the dressing should be changed, because the moist areas serve as an admirable breeding-place for bacteria, along which their growth may rapidly proliferate until they reach the wound. If for any reason it becomes necessary to change an aseptic dressing, all the proprieties of aseptic technique should be observed with the utmost exactness. It is best to leave in place untouched the innermost layers of gauze which are in direct apposition to the wound.

STITCHES

A good rule-of-thumb as regards the removal of sutures is "stitches out on the seventh day." This applies to the vast majority of aseptic cases. If the wounds are small, and if they are on the face or neck, where healing is rapid and the best cosmetic results are desired, and if the stitches are under no tension and simply maintain the skin-edges in approximation, they may be removed as early as the third day. If this is done, it is well to hold the skin-edges together for a few days longer, either by narrow strips of adhesive plaster or by gauze or crêpe lisse and collodion, so that they may not be pulled apart by muscle action or by any sudden strain. If the wound is long and deep, if the sutures hold the parts together under considerable tension, the wound is so situated that muscle pull would tend to separate the edges or stretch the scar, or if a great deal depends upon the sutures, as, for instance, in the case of a laparotomy sewed up rapidly by mass sutures of silkworm gut, the stitches should not be removed until ten days or two weeks have elapsed, and then, if there is any question of the ability of the scar to stand the strain to which it will be subjected, the strain should be relieved by adhesive straps, a swathe, bandage, or some other device.

In a long abdominal wound, or in any case where a great number of skin sutures have been taken, as after amputation of the breast, the stitches may be removed by stages, at intervals of a day or two, partly for the comfort of the patient and partly to test the healing of the incision. As a general rule, the sutures holding the skin-edges should be removed first and the tension sutures last, unless there is reddening of the skin about the tension sutures, when they should be taken out first. Some English surgeons leave their sutures in place after a celiotomy for as long as three weeks. This does fairly well with silkworm gut or horsehair, but a silk suture, whether on account of its irritant action on the tissues or on account of its great capillarity, is apt to show signs of infection after a week or ten days, and it should not be left in any longer than that. If the wound has been sutured with a running stitch of plain catgut, a week or ten days usually suffices to soften up the catgut under the skin sufficiently so that a gentle pull will bring away the remains.

Patients have been taught to look forward with some apprehension to the removal of stitches. It is only in rare cases that the removal causes actual pain, and then it is frequently due to a dull pair of scissors or an unsteady hand. The relief that is felt after the sutures are out, the knowledge that the dread ordeal is over, coupled with the assurance from the surgeon that the wound is healing nicely, more than suffice to pay for whatever petty discomfort may attend the process of removal. As with all dressings,—and this applies particularly in a hospital,—preparations should be made quietly and out of sight of the patient. The only instruments absolutely necessary are scissors and forceps. A pair of slender-bladed "double-blunt" scissors should be selected which will cut at the point. They should be tried, before boiling, on loose absorbent cotton; if the tips do not cut clean, or if there is any pulling of the fiber, they should, if we are particular of our patient, be rejected. There is a special instrument used at the St. Mary's Hospital, Rochester, Minn., called the Littauer-Paynes stitch scissors (Fig. 86). Both of the blades are blunt, making it impossible to injure the tissue while removing the stitches. The stitches are lifted away from the skin by the hook at the end of the lower blade.

FIG. 86.—SCISSORS (LITTAUER-PAYNES) DESIGNED FOR REMOVAL OF STITCHES.

The forceps should be the so-called "anatomic" forceps, with rather weak spring and slender points. These, with the scissors, should be boiled in sodium bicarbonate water in the tray from which they are to be used—not long enough to injure the cutting-edge of the scissors—the water poured off, and the tray placed upon the table or bedside "car." The car should carry, in addition, a basin of corrosive sublimate or weak alcohol for the surgeon's hands or to wipe the skin clean of dried blood, an empty basin to hold the soiled dressing, sterile gauze in can or package for the new dressing, a sterile towel, bandage scissors, absorbent cotton, adhesive plaster, bandage or swathe as needed, and a clean sheet or two to drape the patient. Before the car is wheeled in the one in charge should assure himself that everything which may be necessary is at hand, for nothing suggests to the patient incompetency so much as the necessity for holding up in the midst of a dressing while a nurse is scurrying about for some forgotten collodion, adhesive, or other matter.

The surgeon scrubs his hands clean, using especial care if he has recently come in contact with a septic case, while the nurse wheels in the car, arranges the screens, drapes the patient, and removes the bandage or swathe. Then the nurse removes or turns back the outer layers of the dressing, down to the gauze in contact with the wound, which she takes care not to touch. The surgeon can now remove the dressing without breaking his asepsis. So far as possible everything should be done with instruments—scissors, director, hemostatic or thumb-forceps (Fig. 82). If the dressing has "caked" and stuck to the wound and sutures, the gauze may be moistened with the antiseptic solution to avoid pain in pulling it off.

In cutting the sutures the surgeon should grasp one end with the forceps and pull slightly, on one side, so as to expose a bit of the suture which has been buried. The scissors should now be slipped flat under the suture, and, the points being depressed so that they will divide a part of the suture which has not previously been exposed, the suture is cut and removed by a quick movement of the hand holding the forceps. If these procedures are accomplished rapidly and deftly, with a steady hand, there will be no pain. The suture should be lifted before cutting for two reasons—because the exposed portion of the suture may carry infective material which, being wiped off as it is pulled through the skin and subcutaneous tissue, may give rise to sepsis in the wound, and because the suture material, especially if it is stiff, as silkworm gut, is apt to bend at a sharp angle just at the skin level, and if this kink is pulled through the suture track, it will cause pain. The direction of the pull should always be straight upward or toward the incision, partly because the suture comes out more readily, partly because if the suture sticks, a pull away from the wound is likely to pull the edges apart. If the suture does not come away at the first effort, the tips of the scissors, separated slightly, can be used to make counter-pressure on the skin on either side of the hole from which the suture is being pulled. In persons with fat abdominal walls, if considerable tension is placed upon the sutures, they may be actually buried out of sight. In this case one of the long ends must be grasped and pulled until the knot is brought to view, when it can be divided below the knot.

If the wound edges have been brought together by intracuticular stitch, the same procedure should be adopted. If the wound is a long one, sometimes it is difficult to pull the stitch out; to avoid breaking, it is wise to take a grip with the forceps—the other protruding end being cut short below the skin—and slowly wrap the suture about the forceps, by revolving the forceps between the fingers while pulling. If the suture breaks under the skin, as it sometimes does, the wound edges should be gently separated with the scissors tip at a point about the middle of the fragment left behind, the suture grasped and removed through the wound. The separated edges should be held approximated by collodion or adhesive.

Many fanciful and artistic devices have been suggested for holding wound edges together by means of adhesive plaster, mostly with the intent of providing a narrow bridge of adhesive at the point where it crosses the wound, or of doing away with this bridge altogether. These include the butterfly and dumb-bell plasters and the dumb-bell and window plaster previously described, and plaster strips incorporating hooks and eyes, hooks to be laced over the wound (Fig. 162, p. 506) or to be approximated with rubber bands, and strips incorporating silk ties, to be tied over the wounds. These devices are usually unnecessary. Narrow strips of plaster of good length, if applied while proper approximation is being made, suffice for this purpose.

DRAINAGE

Drainage is provided for one of three reasons—hemorrhage, serous oozing, and sepsis. Depending upon the situation, the size of the wound, and the purpose, a drain ordinarily may consist of one or more strands of catgut, the selvedge of sterile or iodoform gauze, a piece of rubber dam doubled upon itself or coiled in the form of a cornucopia, strips of gauze, or a glass or rubber tube. After operations involving considerable dissection, if muscle is divided and there is oozing of blood, as after a thigh amputation, or if there are any pockets in which serous ooze might collect, as in the axilla after a breast amputation, it is well to put a drain in at the most dependent point; rubber dam is best, because it will not plug up the opening and can be removed readily and without pain. In case of sepsis we are apt to use gauze or rubber tubing, and this condition we will consider later.

In an *aseptic* wound it is not desirable to leave drainage any longer than is necessary to subserve the purpose for which it is placed. It delays the healing of the wound, it may cause an unsightly scar, and it provides a moist, warm, nutrient track along which infection may readily propagate until it reaches the depths of the wound. As all the oozing which is going to occur usually ceases by twenty-four or forty-eight hours after the operation, the drainage in aseptic incised wounds should always be out by this time. At the time of the operation one or two "provisional" sutures of silkworm gut should have been taken at the site of drainage, with long ends tied loosely. These now may be firmly tied, the drainage being out, approximating the separated edges and encouraging primary union. Aseptic drained wounds should be dressed as little as possible, for the possibility for infection from without is great. The best rule is, leave the dressing alone until twenty-four or forty-eight hours have passed, depending on the amount of ooze expected; then dress, removing wick, and tying the provisional sutures. Put on a clean sterile dressing and leave undisturbed until the stitches are due.

In the abdomen the indications for drainage are practically the same—the serous ooze from wounded surfaces and the secretion of the irritated peritoneum; the bloody ooze from raw areas and the bleeding from fine vessels which could not be found or tied but have to be controlled by pressure; and infected or seropurulent fluid.

When the normal peritoneum is handled or irritated, as in the manipulations of any intra-abdominal operation, it secretes a serous fluid, the amount of which varies in proportion to the trauma and the extent of surface which has been injured. For instance, after an easy appendectomy the amount of exudation will be so limited that it will be absorbed by the contiguous healthy peritoneum about as fast as it is formed; if the appendix has been found buried, or if many adhesions have had to be separated, the advisability of leaving in a drain will be decided by the condition of the patient and the experience of the operator; if there has been extensive overhauling of tissues, and considerable areas of raw surfaces have been left behind, as after a double salpingo-hysterectomy, there may be secreted a very considerable quantity of fluid—faster than the peritoneum with which it comes in contact can absorb it. As a result, it tends to gravitate, together with whatever blood may have oozed out through the lines of sutures, into Douglas' pouch, and here it is extremely likely to stagnate and become infected, either by decomposition as a result of the growth of bacteria introduced during the operation, or, as is likely, from contamination through the wall of the intestine. To prevent the occurrence of peritonitis any case in which we apprehend that there will be considerable exudation should be drained, especially if there is any possibility of this fluid becoming infected through the escape of nonsterile fluid or pus into the abdominal cavity, or through the opening of viscera. "*And in any case of doubt,*" says Greig-Smith, "*it is wise to drain.*"

It is not commonly that the abdomen will have to be closed without the assurance that all hemorrhage has ceased. Occasionally, however, this happens, after long and extensive operations in the female pelvis, after operations for abdominal trauma, such as rupture of the spleen, and in operations for postoperative hemorrhage. The customary procedure, in case of actual hemorrhage, is to pack tightly with gauze, so as to stop the bleeding by pressure; if there is slow capillary hemorrhage or oozing, a glass or rubber tube is left in, through which, by capillary attraction or the use of an aspirator, the blood and serum are removed so as to keep the abdomen dry and encourage clotting.

In case of *general peritoneal infection* the object of drainage, whether by tube or gauze, is (1) to allow free escape of septic fluids, the intra-abdominal pressure being higher than the atmospheric; (2) to encourage the escape of these fluids by gravity and by capillary siphonage; and

(3) to a greater or less extent to excite by local irritation an increased peritoneal secretion, both for the purpose of diluting and of antagonizing the infective matter. If the sepsis is local, drainage has, in addition to these functions, the purpose of keeping the intestines away from the infected focus, and of deliberately exciting the growth of adhesions to form a wall surrounding the focus and excluding it from the rest of the abdominal cavity.

The oldest form of abdominal drainage is the **glass tube.** This, in its simplest form, is a cylinder about twice the diameter of a lead-pencil and two-thirds as long, with carefully rounded edges, and near its proximal end a collar to prevent its slipping through the wound into the abdomen, and near its distal end two or three fenestra. Nowadays, in America at least, the use of the glass tube seems to be going out of fashion, although it clearly has some advantages. It excites the formation of no adhesions and its lumen is always patent. The discharge of fluid through it depends upon intra-abdominal pressure and the capillary attraction of the dressing. It is usually wise to reinforce this action by means of gauze inserted through the tube or by means of the "sucker." Either method is practically ideal for aseptic cases. With a gauze wick run through the tube we have all the advantages of continuous capillary drainage exerted just where it is applied, and nowhere else, without exciting adhesions. The drainage action cannot be shut off by a pinching of the gauze wick by the abdominal wound, and if the serum clots in the wick, a new one can readily be inserted.

A "sucker" is a sterilizable glass syringe with firm valve packing having a piece of rubber tubing or a catheter attached, long enough to reach through the drainage-tube to the depths of the wound. The syringe is worked reversed, so as to exhaust the drainage-tube of the blood or fluid it contains. In case of hemorrhage the sucker should be employed often enough to keep the peritoneum dry—every few minutes if necessary. If the end and the fenestra of the tube are blocked by opposing omentum or bowel, the tube should be pulled out a bit and slightly rotated. If the fluids are thick, or if they clot within the tube, the "sucker" will have to be used.

As with all drains, the glass tube should be removed as soon as the case will allow, partly on account of the great risk of infecting the peritoneal cavity from without through the drainage tract, and partly on account of the resulting malapposition of muscle and fascia in the scar, and the consequent liability to postoperative hernia. If the tube has been left in for hemorrhage or oozing, it can, as a rule, be safely removed after twenty-four to forty-eight hours, or as soon as the discharge ceases;

if for suppuration, it should be left in two to four days and then replaced by a rubber tube or gauze wick. The glass tube comes out, as a rule, more easily than any other form of drainage. Before withdrawing it should be loosened, if straight, by twisting or rotating it slightly. In pulling it out one must be careful that no omentum is caught in the fenestra; sometimes small tabs will become incarcerated within the tube and they will have to be tied off. In using the glass tube care must be taken that the tube does not slip in through the wound and be lost. Glass tubes have been known to break while the patient is vomiting or straining. The swathe and dressing should be adjusted carefully, so that the tube is not forced in hard enough that by pressure on the intestinal wall it may cause perforation or partial obstruction.

In applying the *gauze dressing*, as in all abdominal drainage, whether depending upon a tube or upon capillary attraction, the principles governing the siphonage of fluids should not be forgotten. Other things being equal, the greater the mass of gauze outside the wound, the greater will be the capillary attraction, and the lower this gauze is massed below the level of the fluid to be exhausted, the greater will be the force of the siphonage exerted. In other words, the gauze dressing should be bulky, and should be carried well down the patient's side and even part way under his back. If it is moistened with sterile salt solution, its efficiency is increased.

The **rubber tube** was first introduced as a substitute for the glass tube. It is less dangerous mechanically, inasmuch as it cannot break, and there is little danger of its causing perforation of the bowel by pressure. It is used generally for draining particular cavities, such as the pleural, and hollow viscera—the bladder and the gall-bladder. In the abdominal cavity its use is practically limited to diffuse peritonitis, and here it is invaluable, being employed in the abdominal wound, in the flank, and through the vagina. It should be thoroughly sterile and comparatively fresh, otherwise it is liable to decompose and soften if kept in an antiseptic solution, or else become stiff and brittle if kept dry. The lumen may be of any size to suit the individual case; it should be fairly thick-walled, otherwise the lumen is likely to be choked off by the pressure of the abdominal muscles as it passes through the wound, especially in the gridiron or right rectus incision. The ends should be clean cut, and there should be fenestra provided at the end to be inserted, so that if one opening becomes occluded, valve fashion, by a piece of intestine or omentum, others will be provided. If the tube is fenestrated its entire length, it will interfere with the siphonage, and will allow of the spreading of infected fluid from one focus among the intestines and between the layers of the abdominal wall.

Gauze is used as packing to stop hemorrhage, as a drain to draw off serous and seropurulent fluids by capillary action,[1] and as a local irritant to set up a plastic peritonitis and so wall off a localized septic focus from the rest of the abdominal cavity. Its use to drain the general peritoneal cavity is limited to about eighteen hours, on account of its being excluded by adhesions. When used to stop hemorrhagic oozing by pressure, it should be out by forty-eight hours. If during the withdrawal fresh blood appears, part of the packing may be left in, to be removed twenty-four hours later.

Gauze excites a proliferation of every peritoneal surface with which it comes in contact. Granulation tissue grows into its meshes, making it oftentimes extremely difficult and extremely painful to remove on account of the tearing of these granulations, which sometimes bleed considerably. Before forty-eight hours it will be found to come away comparatively easily, because by this time the proliferation has not gone very far. After four to six days from the operation the granulations soften down and retrogress under the influence of the secretion which has backed up behind the wick, and at this stage it will come out easily as at first. If it is left in so long, however, it is likely to be followed by a considerable gush of seropurulent fluid, which has collected, and may be under some pressure, between the wick and the abscess wall it has created, for plain gauze wicking ceases to serve as capillary drainage after about forty-eight hours; serum inspissates within its meshes and clogs its action, so that after forty-eight nours it may act simply as a plug; medicated gauze goes out of action so far as capillary drainage goes earlier than plain. The rule with gauze drainage, then, is to remove it within forty-eight hours, or not until four days.

If the patient is nervous and dreads the pain that the removal of a tight wick will cause, it is best to give gas, ethyl chlorid, or chloroform.

[1] Royster (The Inconsistencies in Gauze Pack, Ann. Surg., 1908, xlviii, 219) states that gauze, instead of facilitating the removal of wound products, acts as a successful stopper to the outlet of the wound and impedes the natural outflow from it. When intended for a drain, gauze should be inserted after the manner of a lamp-wick—that is to say, it should maintain the patency of the wound orifice without either clogging the cavity or obstructing the opening. When used for hemorrhage, it should be packed in like wadding with a ram-rod. The edges of the wound begin to contract around it and become adherent to it in a few hours. Unless the secretion be very thin, no capillarity will be present. There is a field for the use of gauze in packing sinuses, fistulæ, and granulating wounds so that healing may take place slowly from the bottom. Even here, however, the pack should be loosely done, and the gauze preferably saturated with some substance which will prevent sealing of the wound edges.

It is the first pull which is most painful; if the adhesions are separated by a preliminary jerk, the rest is apt to be less uncomfortable. The wick should be seized by forceps or with the right hand, while counter-pressure is being made on either side of the wound with the left, and rotated or twisted on itself, while it is being gently withdrawn, pulling first to one side and then to the other. The hands should be sterile, so that any omentum which is being dragged up into the wound may be replaced. If bright blood appears on the gauze, part of the drain should be left in for twenty four hours longer. If the wick is being removed early, in a supposed sterile case, and pus appears on the drain, another should be left in for three or four days longer, to prevent the infection from spreading and allow the focus to wall off.

When an infected drainage cavity is well established as a single cavity without side-pockets, and the amount of discharge is only that which might be expected from a granulating surface, the wick is left out and the wound poured full of balsam of Peru or sterile glycerin and so left. Such an emollient is dehydrating, stimulating, and slightly antiseptic, and yet prevents the skin from closing over before the depths are healed. If a wound is draining pus, the wick should not be allowed to lie upon the skin, on account of the danger of stitch abscesses—it should be well wrapped in gauze. If the wound or stitch holes tend to become red or macerated from infections or irritating discharge, dry the wound margin and a zone about 2 in. around it in all directions thoroughly, then apply, with cotton or camel's-hair brush, compound tincture of benzoin, letting one layer dry, then applying another.

Provisional sutures should be tied only if the drainage has been removed within the forty-eight hour limit and there is no sign of infection. For gaping of the wound later adhesive straps should be used.

Vaginal drains should come out on the second or third day. With the patient at the edge of the bed, in the Sims posture, and a speculum in place, the wick may usually be removed with little pain. If it shows signs of the presence of pus, it should be replaced by a fresh one; otherwise the vagina is washed out gently and is lightly packed with sterile gauze.

Sometimes a surgeon will combine one or more methods of drainage; he will wrap a glass tube in gauze before inserting it down to the pelvis, he will wrap a gauze strip in rubber dam and call it a "cigarette" wick,[1]

[1] F. Hawkes (Ann. Surg., 1909, xlix, 192) states that the force of gravity is important in draining parts of the abdominal cavity which are not in direct contact with the capillary drain. A complete emptying of these other parts into the drain should occur within the first twelve or eighteen hours after operation, for it is exceedingly doubtful if any drainage occurs

or in a rubber tube split or cut spirally (Fig. 87). A tube wrapped in gauze usually drains freely, both by capillary action and internal pressure.

FIG. 87.—DRAINAGE.
A, Cigarette wick ; B, fenestrated rubber tube ; C, spiral drain ; D, split-rubber drain.

In a septic case the tube should be removed in about forty-eight hours and the gauze left in until the fourth or sixth day. The cigarette wick has the advantage of being removed painlessly and of limiting the irritating effect of the gauze to the area about the tip. The same may be said of the gauze wrapped in a spiral cut rubber tube. Either should be removed as any gauze wick. Sometimes a surgeon will use for an appendix abscess or a localized peritonitis a rubber tube and a half dozen small gauze wicks. The small wicks have the advantage of coming out more easily than the large. The tube is removed on the second day, two of the wicks on the third, two on the fourth, and two on the fifth, and the last ones are replaced by

FIG. 88.—DRAINAGE.
A, Rectal plug, containing core of rubber tubing; B, inverted rubber tube designed for drainage of large cavities.

after this time, whatever form of drain be used, from the portions not in contact with the drain. A loosely rolled cigarette drain, without any projection whatever of gauze from its lower end, is the less irritating, and will drain adjacent regions perfectly for twelve to eighteen hours if adhesions have not formed in them before operation, and if the fluid to be drained is not too thick, but no longer. Capillary action is not so important as intra-abdominal pressure. More surgeons are getting away from prolonged drainings with better results. Remove the drain at the first possible moment and allow the wound to heal.

a single wick, just long enough to keep the wound edges apart. This is practically equivalent to packing an abscess-cavity.

Unless the peritonitis is well walled off at the time of operation, it is unwise to remove any drainage until the gauze has caused a wall to form about it—say, in four or five days—otherwise pus from the wick may be spread broadcast over adjacent coils of intestine. In an early general peritonitis, where there are few or no adhesions to interfere, if the abdomen is left full of salt solution and adequate drainage is provided, currents of flow are set up from all directions to the wicks, which carry off the diluted septic material. In patients with sufficient resistance the infection is overcome everywhere except about the wicks, where the septic fluids mass and concentrate themselves. Here, in due time, the wicks if undisturbed create a wall about themselves, so that in favorable cases we have, after a few days, practically a walled-off abscess to treat at each drainage site. If the gauze drainage in these cases is disturbed too early, the results may be disastrous from a tearing down of adhesions and a distribution of concentrated pus.

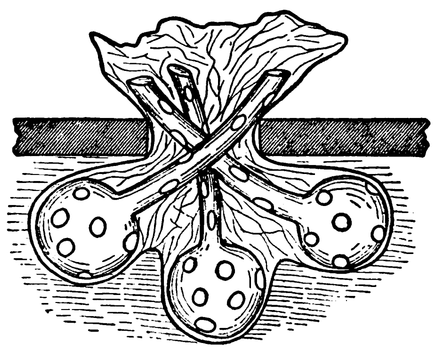

FIG. 89.—MIKULICZ TAMPON FOR PERITONEAL DRAINAGE.

STITCH ABSCESS

Stitch abscesses are most apt to occur after abdominal operations.[1] They may be superficial, that is, running in the suture track of a skin suture, or deep, in case the wound has been sewed up in layers, from infection about a buried suture or ligature. The source of infection in practically all cases of deep abscess is unclean catgut. Surface suture

[1] Dr. W. P. Graves (Boston Med. and Surg. Jour., 1910, clxiii, 610), reviewing 1000 operations personally performed at the Free Hospital for Women, found that 51 cases had some form of wound infection, in all but one case mild, the organism being in all instances a staphylococcus. Twenty-eight of these infected wounds were after celiotomy, and the infection consisted mostly (19 cases) of sepsis about a buried catgut knot, the wound closing immediately after extraction of the knot. Some of the catgut knot infections did not appear until some time after the patient was discharged from the hospital. Nine celiotomy wounds were septic to a greater or less extent throughout the wound. Of these, 7 occurred in extensive abdominal hernia wounds (one of which cases died of secondary endocarditis) and 2 in inguinal hernia wounds. Nine breast wounds were more or less septic, 10 perineum wounds presented stitch abscesses, and there was infection in 4 other operations about the vagina and cervix.

holes may become infected from unclean suture material, from bacteria in or on the skin or on the surgeon's hands, from strangulation of the tissues by tying sutures too tightly, or from tension resulting under the swelling incident on normal repair. Abscess in the incision develops secondarily from the infection of coagulated blood or serum collected between poorly approximated planes of tissue, from an untied vessel, or a vessel pierced unwittingly in sewing up the skin, or as a result of bruising of the edges of the incision by stretching or rough retraction. An abscess may develop either in the incision or in the suture track from contact with the drainage in infected cases. The liability to these occurrences is greater in the presence of a thick, fatty, abdominal wall. If it arises from an infected hematoma, the first discharges have the chocolate color of decomposed blood.

Ordinarily, if the pus forms in the loose subcutaneous tissues, it either finds its way to the skin surface along a suture track, or else it burrows its way to the incision line and discharges through this. If the infection arises below the anterior sheath of the rectus in an abdominal incision closed in layers, either from buried catgut or from a hematoma collected between layers, the pus will be under considerable tension. Unless it finds its way through the suture line in the rectus, or unless a way for discharge is made for it, it will burrow about in the abdominal wall between the fascial planes or else burst into the peritoneal cavity. It is a wise precaution in any patient with a thick fatty layer in the abdominal wall and a long incision to insert a strip of rubber dam obliquely down to the rectus sheath from the lower end of the wound. When this is taken out after forty-eight hours, it will be followed by a copious secretion of golden-yellow serum, representing the accumulation of the exudate from the entire length of the incision. The provisional suture may be tied, especial care being taken that no infection is introduced at this dressing. If the sepsis arises from an unclean catgut ligature, and the catgut does not dissolve or find its way out, a so-called ligature-sinus will result, which may persist for months, or a residual abscess gradually develop, and not give rise to symptoms until months after the operation.

If after a celiotomy closed without drainage the temperature-curve has not reached normal by the fourth day, or if, having dropped to normal once, it rises again on the fourth day or after, and no reasonable cause can be assigned, the wound should be inspected at once. If on the fourth day or after the patient on turning in bed, on coughing or vomiting, feels pain in the region of the wound, the incision should be examined. Usually there will be both pain and fever to some degree;

if the infection is of any virulence, there will also be an increase in the pulse-rate and a leukocytosis. The presence of a high white count will be of considerable aid in making the diagnosis of deep suppuration in the abdominal wound. Sometimes, however, the patient will exhibit no fever and complain of no discomfort, and yet when the sutures are removed, one or more will be followed by a few drops of thin pus, or the dressing may show a narrow line of pus corresponding to the incision and the wound itself be healthy and healing, apparently having spontaneously overcome a low-grade infection. Nevertheless, it is of extreme importance to make the diagnosis and institute treatment early, for with extensive suppuration there is always great delay in healing and the scar is wide, unsightly, and thin, with a pronounced tendency to stretch and give rise to a postoperative hernia. In dressing wounds with stitch abscess, aseptic precautions should be as carefully observed as if the wound were healing aseptically, for otherwise new types of organisms may be introduced, which find a fruitful soil for growth in the discharges and may result in a more serious type of infection.

When, as a result of tension, there is found an area of redness about one or more sutures, painful when pressed with a probe, and there is no pus, simply cutting the suture and leaving it *in situ* will often abort a stitch abscess. Cutting relieves the tension causing the inflammation, and the suture serves as a drain for any exuded serum. If the process has gone so far before it is seen that pus has already collected, or if pus exudes as a result of gentle pressure, remove the stitch on the side of the abscess; if it is only on one side, swab with alcohol and dress with a sterile moist alcohol pad, taking care not to infect other sutures. Another method is to press out the pus and fill the stitch abscess cavity with iodoform powder. If it is necessary to remove neighboring stitches so as to relieve all tension, do so, for if infected serum is subjected to tension, which increases with inflammation, it finds its way along the lines of least resistance, not only into the lymphatics and veins, but between the planes of fascia, so that the wound and all the adjacent structures may be dissected apart. If a stitch abscess or two can be relieved before it has spread to neighboring suture holes or to the incision itself, the temperature will probably fall.

If there is reddening alongside the entire incision, it means that the incision itself is infected. In this case sufficient sutures should be removed, whether infected or not, to allow of a separation of the wound edges. The lips of the wound should be gently drawn apart, and any encapsulated pus or serum released. If none appear, the wound must be gently dissected open with the flat end of the probe, wherever there are signs of inflammation, until pus is found if present. In any case a wick, consisting of a few threads or a selvedge of sterile gauze, should be introduced to the depths to prevent an immediate resealing of the wound.

Sometimes there is little reaction, either general or local, to stitch infection, and when the wound is examined, the process has so far developed that the incision is red and bulging with, if not discharging, pus, and all or most of the stitch holes are surrounded by red and shiny areolæ and are oozing a seropurulent fluid. Under these circumstances radical action must not be delayed. All the stitches are to be removed, and reliance placed upon adhesive straps laid on over the inner dressing to hold the wound edges together. The wound must be separated and all pus and crusts swabbed away. If the condition justifies the procedure, an irrigation, given very gently and under low pressure with sterile normal salt solution or weak corrosive sublimate, is efficient in washing out the free pus in the wound. Preference should be given to the normal saline, as the corrosive forms a filmy coagulum of the albumin in the exudation which covers the entire surface. A female catheter of glass makes a good irrigating tip, which can be inserted to the bottom of the wound. After this, small gauze drains or a fine rubber tube should be inserted, and a sterile pad of gauze, wrung out in hot creolin or carbolic solution, applied over the wound, or a hot sterile solution of salt, sodium citrate, and water (which we will consider later). If the wound is on the arm or leg, the entire limb may be immersed in a basin and soaked. Over the dressing are placed straps which are to hold the wound together, being careful that the strips are long enough so that they will not be loosened by the moisture of the overlying fomentations. These are important, because the moist dressings tend to cause the incision to open up if many sutures are removed. Then comes the hot poultice or fomentation. This should be thick and absorbent and should be renewed hot every two hours. Creolin, chlorinated soda, or corrosive may be employed, and it should be covered with oiled silk or paper to keep in the moisture and sheet-wadding to preserve the warmth. As soon as the sepsis is apparently under control, the bulk and frequency of the dressings may be decreased, the drainage gradually diminished and discarded, and the edges more closely approximated by the adhesive.

CHAPTER XXIV

TREATMENT OF SEPTIC WOUNDS: SOAKS, POULTICES; HYPEREMIA, PASSIVE AND ACTIVE

An aseptic wound should be disturbed as infrequently as the nature of things will allow; septic wounds, on the other hand, must be dressed often. An abscess or a cellulitis is to be considered as a breeding-place for bacteria, which may find their way into the systemic circulation by way of the lymphatics or blood-vessels and give rise to pyemia, and as a center for the elaboration of toxins, which, being absorbed, may cause septicemia. At the same time, a localized septic process may grow by extension, as between planes of fascia, and along lymphatic channels, in the form of lymphangitis, and by implantation of septic material, on the external surface, in glands, etc. Treatment, generally speaking, of septic conditions after operation should be directed toward combating the local septic process, preventing extension, and toward maintaining or increasing the resisting power of the patient.

The fundamental principles of the local treatment of septic processes are rest and drainage. It is essential that any infected wound be laid open sufficiently to insure a free exit for all infected secretions or pus. Whether this can be accomplished without the use of drainage gauze or tubing will depend upon the nature of the case, but, in any event, it is better to err in the direction of oversufficient drainage. The skin wound over any septic inflammatory process should be amply large to allow of access to all parts of the infected area; pockets containing pus or infected serum if found should be broken open, and they should be kept open by means of adequate drainage. If a pocket is deep-lying, there is nothing so good as a piece of thick-walled rubber tubing, with windows cut in it, or even a fenestrated tube of glass. If there are two skin wounds, a tube entering at one wound and making its exit at the other—so-called "through and through" drainage—allows in a most efficient manner for the carrying off of infected matter as well as for washing out the depths by means of a syringe and some antiseptic lotion.

Smaller and well-localized processes, in places especially where the extent and sightliness of the scar will necessarily be considered, may often adequately drain themselves if a strip of dental rubber be inserted in the wound to prevent its edges from adhering. Gauze drainage should be replaced before its capillary action has been destroyed, which usually occurs within forty-eight hours.

The principle of *rest* in the treatment of wounds, which was so clearly formulated by Hilton in his classic work on Rest and Pain, is of as much importance in septic as in aseptic healing. An appreciation of the pathology of septic processes in general will bring one to feel keenly the importance of the maintenance of rest in the affected part. If the entire organism is at ease, mentally and physically, the patient's power of resistance is allowed to work at its best against the infection. Rest of the part involved is important also mechanically in the prevention of extension of the local process and to lessen pain. In some cases it will be important to splint the part; for instance, in a case of infected compound fracture or infection involving tendon-sheaths. A splint can be devised of a framework of wire covered with rubber tubing, or of wood or tin wrapped with oiled silk, which will allow of easy access to the wound and at the same time not interfere with the application of soaks or poultices as may be indicated.

Upon whomsoever devolves the duty of dressing a serious septic wound the importance of avoiding all unnecessary handling and of overcoming the temptation of twisting and turning a limb without good reason should be duly impressed. Poultices and dressings should be applied in such fashion that they may be removed with the least possible stirring up of the affected part. Bandages and wrappings, so long as a patient is in bed, should be studiously avoided. A square of cloth, partly ripped down into strips from the opposite sides to form a many-tailed bandage (Fig. 68, p. 230), can be readily adapted to almost any part or surface, and with its use a poultice can be changed in a minute, practically without disturbing the patient in the least.

The most important therapeutic force which we can enlist in our efforts at combating a local septic process is *hyperemia*, active or passive. Active hyperemia is usually obtained by the employment of heat; passive hyperemia, by the methods with which we have become familiar through the work of Bier—the rubber bandage and the suction cup. Roughly speaking, both depend upon the maintenance of an increased blood-supply in the locality of the lesion, in the first case of arterial, in the second of venous, blood.

Heat.—Heat may be applied dry or moist—dry, by means of the hot chamber; moist, by means of the poultice mass or hot soak. In postoperative technique the hot chamber has little place—the use of moist heat is usually more practicable; in the form of the *hot soak* it provides a means for a thorough cleansing of the wound; in the form of the *poultice* or hot fomentation it provides for the absorption of the wound secretions; and in either form it prevents the blocking of paths of exit by the coagulation of exuded serum. The application of heat is most comforting to the patient.

Basins have been designed for submerging the limbs, and they are provided with covers to prevent the rapid loss of heat by radiation. For a hand or foot an ordinary basin may suffice; on the body, a bath-tub may have to be used. The solution may be of sterile water, salt, and citrate (see p. 262), weak corrosive or carbolic solutions, and creolin. Of these creolin, in the strength of about 1:4000, or the salt and citrate, is to be preferred. The sulphonaphthol or creolin is mildly antiseptic, soothing, and retains the heat; it is not poisonous and does not coagulate albumin. Where a stronger disinfectant action is desired, one can choose the officinal solution of chlorinated soda, diluted about twenty times. To this tincture of myrrh may be advantageously added in small amount, for the odor and the soothing sensation which it imparts as well as for its antiseptic property. Chlorinated soda is penetrating, does not crack or chap the skin as corrosive sublimate solution is apt to do, and seems to be the only efficient means of overcoming the infection with the Bacillus pyocyaneus (bacillus of green pus), which is so apt to contaminate a discharging wound of long standing.

The basin should be large enough to accommodate the lesion comfortably and a considerable margin of normal tissue on each side. It should be half filled with the warm solution and placed where it can be adjusted to the position of the patient. The dressing should be removed, and all gauze wicks and packing be withdrawn before the limb is placed in soak. Then hot water is gradually added until the patient can stand it no hotter, and this temperature is maintained by further additions at intervals. The limb is allowed to soak quietly for twenty minutes to half an hour; it is then removed, any macerated skin or débris wiped or scraped away, the wicks are reintroduced, and a poultice of the same solution as the soak is applied, to remain in place for two to four hours until the next soak.

Wherever, owing to the nature of things, as in a breast abscess, a hot soak is impossible, the same end may be attained in a measure by the use of a hot irrigation. For this purpose a glass or a fountain syringe is employed, the stream being directed so that it may the most advantageously reach the depths of the wound and wash out any retained pus or shreds of slough or coagulum. If the wound is deep, a glass female catheter will make a good irrigating nozzle. Ample provision must be allowed for the exit of the irrigating stream.

Poultices.—The purpose of the poultice or fomentation is similar to that of the hot soak. It is sometimes used to substitute for the soak, and it is practically always used where moist heat is to be applied and the soak is not practicable. The poultice should be absorbent, so as to take up the wound secretions as soon as they are formed. It should be mildly antiseptic, so as to prevent propagation of the infective bacteria within its own mass or about the skin, and it should be so made as to retain its primary heat as long as possible. Many substances have been employed for this purpose, from the old-fashioned bread-and-butter and flaxseed poultice mass down to the modern glycerinated earthy substances, as well as gauze saturated with antiseptic solutions.

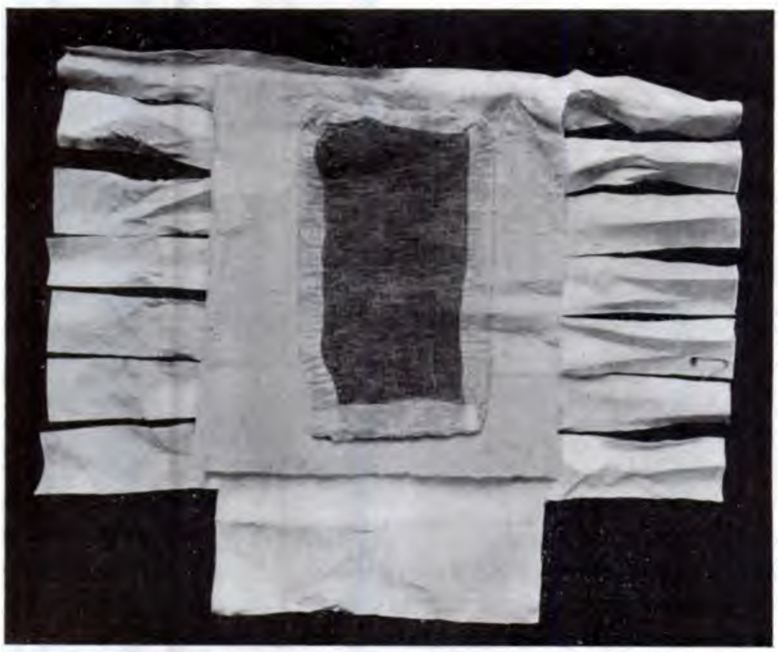

FIG. 90.—FLAXSEED POULTICE READY TO APPLY.

Many-tail bandage, a double thickness of sheet-wadding; flaxseed poultice, backed with oiled paper and cotton-cloth, faced with gauze. Over the wound itself is placed three layers of sterile gauze.

The advantage of the semisolid masses, like flaxseed and cataplasma kaolini, is that they lose heat very slowly by radiation. Of the two, recent experiments have shown that the flaxseed is the better retainer of heat.[1]

The great disadvantage of this form of poultice is the fact of its non-absorbability. Moreover, the material is not antiseptic, even if it has

[1] J. D. Pilcher, The Rate of Cooling of Several Poultice Masses, Jour. Amer. Med. Assoc., 1909, lii, 752.

been in itself rendered aseptic by heating, so that, other things being equal, when moist heat is to be applied to a discharging wound, it is usually preferable to employ fomentations of sterile gauze soaked in

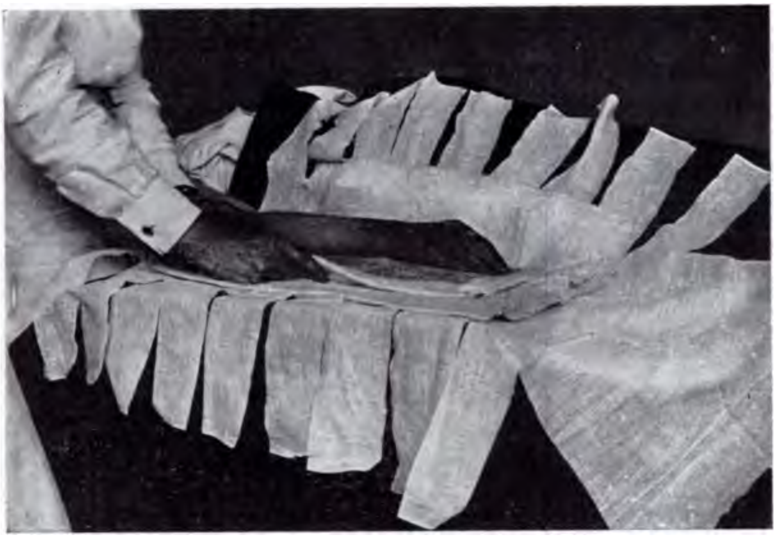

FIG. 91.—FLAXSEED POULTICE READY TO APPLY TO A SEPTIC HAND.

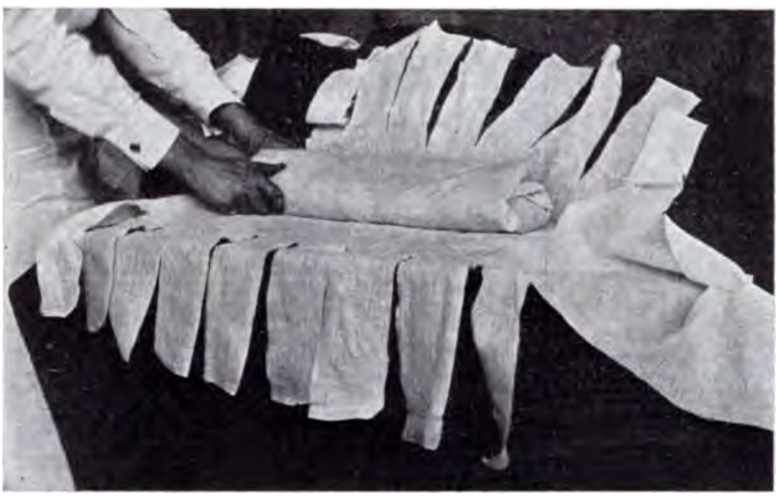

FIG. 92.—FLAXSEED POULTICE AND SHEET-WADDING FOLDED OVER SEPTIC HAND. READY FOR MANY-TAIL BANDAGE.

some antiseptic solution. When desired, however, the flaxseed poultice may be used if a moist sterile dressing is placed between the wound and the poultice. For dressing a moist gangrenous process a poultice, half flaxseed and half pulverized charcoal, made up in the usual way in boiling water, but with a dash of chlorinated soda, will relieve the pain and destroy the odor. In applying poultices or hot fomentations we must take care not to burn the skin. To prevent this it may be well to smear the skin over with sterile oil, vaselin, or boric-acid ointment.

It is sometimes thought that in dressing a septic wound the same precautions that are used in dealing with aseptic wounds are not necessary. This is not so, for a new type of infection may find entrance if proper care is not observed, resulting in a mixed infection which may be more serious than the primary condition.

The poultice exerts a beneficent action upon the tissues only so long as it is hot. This is strictly true of the semisolid masses of which we have spoken. It is true, to a somewhat less extent, in common gauze compresses, which, being absorbent and aseptic, may do some good in relieving the wound of its discharges. Where we desire, however, to get the most beneficent action, we should see that the poultices are changed every two, three, or four hours, and in serious cases this should be kept up through the night without remission. If a poultice is properly covered with oiled or waxed paper or oiled silk, and over this is placed a thick layer of sheet-wadding, the heat will be retained much longer. Each time the fomentation is changed the skin about the wound should be gently wiped clean of pus and coagulated serum, and the wicks and packing should be changed frequently enough to assure of a definite capillary action.

In some cases, where the process is not so diffuse as in a cellulitis, but is walled off like a local abscess and is draining well, it may be considered advisable not to apply heat. Under these circumstances it may be good practice to apply simply a rather thick dressing of dry sterile gauze, relying upon its absorbability to take up the discharges, or an antiseptic powder, such as boric acid or iodoform or some of its odorless substitutes. Frequently the exudate will coagulate about the wound so as to interfere with the efficiency of the drainage. To prevent this, it has lately become a custom to employ sterile gauze which has been soaked in a solution that is known to prevent the coagulation of exudates. Such a solution (*Wright's citrate and saline*) may be made up as follows:

℞. Sodii citratis	5;
Sodii chloridi	20:
Aquæ	500.—M.

or for a recipe for home treatment write—

℞. Sodii citratis	12;
Sodii chloridi	48.—M.

Sig.—Teaspoonful in glass of hot water to wet dressing.

The dressing should not be allowed to become dry. The surrounding unbroken skin should be covered with a protective layer of vaselin, otherwise, on account of the irritative effect of the sodium chlorid, pustulation will be induced. The solution is contraindicated where there is a tendency to persistent oozing of blood from the wound, or where, after abdominal operations, protective adhesions are desirable. It should be employed only during the acute stage of inflammation, thirty-six or seventy-two hours after operation. Used longer it tends to maceration and indolence in healing.[1]

BIER HYPEREMIC TREATMENT

The Bier hyperemic treatment finds its chief field of usefulness before operation. However, it is declared that, when artificial hyperemia is employed and ample outlet for pus is provided, we are able to accomplish with a small incision what otherwise would necessitate extensive incision and too often resulting disfigurements, if not disability. The treatment is applied either in the form of a rubber constricting bandage applied proximally to the wound or else by means of a suction cup applied over the wound. For a constricting bandage, the ordinary Martin's rubber bandage or the Esmarch tourniquet may be employed; for the suction cup, an ordinary cupping-glass or one of the larger special apparatus adapted to the particular part may be used. The rubber bandage should be applied so tight as to cause venous congestion, but not tight enough to give rise to pain or entirely to obliterate the arterial pulse. The bandage should be left in place for a period varying from twenty minutes to two hours and should be reapplied at intervals. The wound should be dressed as already described.

An able and complete exposition of the method is presented in the volume entitled "Bier's Hyperemic Treatment," by Professor Willy Meyer, of New York, and Professor Dr. Victor Schmieden, of Berlin. From this work we quote freely, with Professor Meyer's permission.

"The physician who intends to make use of artificial hyperemia

[1] Crandon (Annals of Surgery, 1910, lii, 541) says: "Two years of experience has amply proved the value of this solution. In office practice an abscess is opened, a small piece of rubber dam is inserted or not, a dressing with the inner layers wet with glycerin applied, and the patient is then given a recipe for one or more ounces of sodium citrate. He is told to go home, to add to a glass (eight ounces) of hot water about two and a half teaspoonfuls of common salt and a large teaspoonful of the sodium citrate. With this solution he is to keep the dressing on his septic wound constantly wet and warm. Inguinal and axillary bubo, abscess of neck, septic fingers, mastoid wounds, otitis media after paracentesis, all drain most efficiently under this method. At the end of thirty-six or seventy-two hours the wound is filled with glycerin or balsam of Peru and is ready to heal."

means to increase the quantity of blood in a given diseased part of the body, hoping thereby to obtain beneficial results. The blood-current accomplishes its task not only under normal conditions, but as soon as the body is invaded by disease requiring an increase or decrease of the blood-current the circulatory conditions become changed. Every one must come to recognize that the body in such instances, in properly regulating the blood-current, does a definite delicate work, thereby often preventing or even curing serious disease.

"He who has followed this train of thought will coincide with Bier that an inflammation—from the physiologic point of view—does not in itself represent a diseased condition, but is a phenomenon indicating the body's intent to resist a deleterious invasion.

"To increase this beneficent inflammatory hyperemia, resulting from the fight of the living body against invasion, is the aim of Bier's hyperemic treatment.

"*By deduction from this simple reasoning we are able to discern the first and most important principle underlying Bier's hyperemic treatment, namely:*

"*The blood must continue to circulate, there must never be a stasis of the blood.* This rule is of paramount importance. Hitherto it was considered the physician's first duty to fight every kind of inflammation, since inflammations were looked upon as detrimental. Bier teaches just the opposite; namely, to artificially increase the redness, swelling, and heat, three of the four cardinal symptoms of an acute inflammation."

"If the physician is mindful of the facts that a *gentle hyperemia only* is required to produce the desired effect, at least in cases of acute infectious inflammation, in other words, that a 'too much' is absolutely injurious, he will soon become convinced that in Bier's treatment we have a most powerful and efficient remedy, altogether unlike any other known to us before.

"It has been pointed out that hyperemic treatment has its greatest triumphs when applied prophylactically. Only by an early and correct definition of the seat and character of the inflammation and prompt resort to artificial hyperemia can the greatest amount of good be accomplished. Nevertheless, in all instances, whatever pus may have formed must be promptly evacuated.

"If the destructive work of the invading bacteria has been allowed to go on unchecked, if thrombosis of the smaller veins within the focus of infection, or even necrosis, has set in, nothing in the world can save such a part. The utmost that even the best of methods can do in that event is to assist in eliminating the infective material and then help in the reconstruction.

"While hyperemic treatment is not a panacea, it is a powerful therapeutic agent on a physical basis, an agent which has its indications and dosage the same as any other remedy. There is much to learn about it yet."

"There are three methods by which hyperemia may be produced: (1) By means of an elastic bandage or band; (2) by means of cupping-glasses; (3) by means of hot air. (1) and (2) produce a passive or venous hyperemia, (3) an active or arterial hyperemia.

"Retarding the return of blood to the heart by compressing the veins at the most convenient place between the focus of inflammation and the heart, with the help of an elastic bandage or band, represents the old and typical method of producing artificial hyperemia. The Germans call this 'Stauungs-hyperämie'—a term prescribing cause as well as effect. This obstructive hyperemia, when produced by means of the elastic bandage, can be employed only in diseases of the head, scrotum, testicles, and the extremities.

"Where hyperemia by means of elastic compression is not feasible, it can be produced by suction. This method is used upon the breast, back, spine, pelvis, and the surface of the whole body whenever a localized acute infection or an open wound (sinus, granulation, etc.) is present. For this purpose, cupping-glasses of various size and shape are employed.

"Hot air is generated in wooden or metal boxes especially to suit the respective case. This represents an arterial hyperemia.

"**The Elastic Bandage.**—Obstructive hyperemia is produced by means of a soft-rubber bandage, same as is used for the production of artificial anemia in the case of bloodless operations on the extremities.

"In slightly obstructing the return of the blood from the extremity to the heart with the aid of such a soft-rubber bandage, the principal point to be observed is that the circulation be never entirely interrupted. What must be our aim is to obstruct the return of blood from the extremity under treatment, in this way increasing the quantity of blood normally contained therein, but in no way to interfere with the influx of the blood through the artery.

"One must at all times be able to feel the pulse below the place surrounded by the elastic bandage. It is not difficult to find the proper measure of compression. *The degree of obstructive hyperemia is a correct one if the patient is not in the least annoyed by the bandage applied.*

"The technique is correct, if there is absolutely no increase of pain and if there is visible hyperemia of the part subjected to the treatment. The portion distal to the bandage must appear bluish or bluish-red—*never white.*

"Bier employs a soft-rubber bandage, 2½ in. wide which he winds around the limb about six or eight times, one layer overlapping the other by about ½ in. In this manner the pressure is evenly distributed over a comparatively wide area. The end may be fastened with a safety-pin or tucked under, or with tapes which are stitched on the bandage. Only in cases which require the bandage to remain in place for longer periods—say twenty to twenty-two hours per day—will it be necessary or desirable to first apply a soft-flannel bandage underneath the rubber

Fig. 93.—Passive Hyperemia.
Rubber bandage in place; note distention of veins and cyanosis.

bandage. With the bandage in place, the distal part of the extremity must feel warm, *not* cold. Every focus of acute inflammation subjected to obstructive hyperemia will quickly show increased warmth. First, we notice a marked redness, then heat and a swelling. On seeing the swelling increase, the practitioner often becomes frightened, but there is no reason for alarm. According to Bier, this phenomenon is to be looked upon as a welcome, salubrious reaction.

"The first effect is the diminution of pain, becoming more and more noticeable with the appearance of the edema.

"The elastic bandage must always be placed on a healthy area proximally to the site of the disease. It should never touch the latter.

"*All dressings ought to be removed while the elastic bandage is in place,* in order to allow the respective part to swell and become hyperemic. Wounds or incisions are covered with sterile gauze, which is kept in place by a towel loosely wound around the same and fastened by means of a few safety-pins.

"If in the case of chronic diseases a distinct hyperemia does not set in, it is advisable to place the part in a bath as hot as the patient can stand it for about ten minutes. This will cause the extremity to turn bright red, after which the bandage is applied.

"*Further, obstructive hyperemia that is continued for several hours produces edema.* During the intermissions following the application of the elastic bandage for short periods, say, from two to four hours each day, the artificial edema always becomes absorbed. In actually infected cases the rapid absorption of this inflammatory edema is often followed by some rise of temperature; this, however, is of short duration only.

"It should be stated, as one of the most important rules, that also, under hyperemic treatment, every abscess has to be opened. The knife takes care of the pus; hyperemic treatment fights the infection. With the help of the hyperemic treatment, the large excisions into the abscess cavity heretofore practised can be dispensed with; often mere punctures will suffice. These punctures can be made without general anesthesia, and naturally heal much more rapidly than large incised wounds. Furthermore, there is no need of the painful tamponade in the course of the after-treatment, and there is no extensive scar formation.

"Experience has shown that acute infectious processes require prolonged application of hyperemic treatment from twenty to twenty-two hours per day. In chronic affections, especially those of tuberculous origin, shorter sittings, say, two to four hours a day, have been found sufficient.

"The physician should at first apply the bandages himself. Later he may train, in chronic cases at least, nurse or relatives, or even the patient himself, to do this, but he must never cease to supervise the treatment, otherwise mistakes or irregularities in the technique may occur which would mar the result."

" For the testicles a rubber drainage-tube is passed around the root of the scrotum and the ends held by a clamp or a tied tape.

" **Suction Cups.**—For other parts of the body suction cups, properly constructed and applied, have proved to be a most efficient means of producing obstructive hyperemia. By applied suction hyperemia it will be seen that the skin, plus underlying tissues, are sucked into the hollow of the glass. This causes a rush of blood into the respective area, but the hyperemia does not involve the surface only; it also reaches into the deeper layers.

"Here again the first rule is *not to overdo. The skin should turn red or bluish-red, but never white*

"To be able to employ the method more generally, it was necessary to have cupping-glasses the shapes which were adapted to the

FIG. 94.—SUCTION CUPS.
Varieties of suction cups designed for various anatomic regions; suction pump; rubber bandage.

varying contours of the body surface (see Figs. 94–98. For illustrations of large vessels suitable for taking an entire extremity, see Meyer and Schmieden.) In the small-sized glasses suction is obtained by a small rubber bulb, which is either directly attached to the glass or communicates with it by means of a rubber tube.

"With gentle pressure on the rubber bulb, the cup is put in place and the hand is removed. The cup will be found to adhere to the skin with just sufficient firmness not to drop off. To facilitate airtight closure of the cup upon the skin it is well to spread a thick layer of vaselin over the border. *Suction must never be too strong and never create pain.*

Fig. 95.—Passive Hyperemia Applied to a Localized Septic Process by Means of a Suction Cup.

Fig. 96.—Passive Hyperemia.
Suction cup used over wounds discharging pus.

Fig. 97.—Passive Hyperemia.
Large cup applied to buttock; suction pump, with stop-cock in tube.

"The vacuum apparatus of larger size is applied with a suction pump, which is inserted in the end of the rubber tube in place of the bulb and regulates the degree of hyperemia. In all of the large-sized suction glasses and some of the smaller ones, a three-way stop-cock is placed in the tube for the purpose of obtaining an air-tight closure of the cup, after the desired degree of obstructive hyperemia has been attained, and also to facilitate their removal.

"In making use of this vacuum apparatus, we not only rely on the artificial hyperemia it produces, but also on its mechanical effect. If we place such a glass over a diseased area which presents a sinus in its middle, the pus, and with it bacteria, are aspirated from the depth slowly and painlessly.

"In thus using the suction glasses in the treatment of suppurated wounds and fistulous tracts, strict asepsis is, of course, *sine qua non.* After using, the glasses must be detached and boiled. The infection from the aspirated pus may further be avoided by anointing with vaselin the border of the glass and also the immediate neighborhood

Fig. 98.—Passive Hyperemia.
Suction cup and pump; lateral enlargement of cup designed to collect exuding pus.

of the wound. This precaution is especially indicated when treating furuncles.

"The suction glasses are applied six times five minutes per day, with intervals of three minutes between the applications, in order to give the edema and hyperemic swelling an opportunity to disappear. Thus the entire time of treatment is three-quarters of an hour each day."

"*Hot Air.*—Any part of the body brought near a source emitting strong heat becomes heated and turns bright red or hyperemic. The hyperemia produced by this is artificial." Dry heat is considered useful only for chronic exudates, infiltrations, adhesions, etc.

"Dry hot air permits the use of a very high degree of heat without injury or pain to the part. It is applied either by hot-air boxes or ovens, or by a hot-air douche.

"Most useful ovens are quadrangular, made of copper or wood, inexpensive in construction. The oven is provided with a lid with openings for the reception of the limb. These openings are lined with cuffs of felt or heavy cloth, which are fastened around the lamp by means of straps and buckles. In one side of the oven is an attachment for the reception of the chimney of the lamp, through which the current of hot air enters. For the purpose of a more even distribution of the hot-air current and the better protection of the lamp a board is placed inside the oven, not far from the internal aspect of the opening. For the same reason, the oven must not be of too small size.

"The patient's own feeling ought to be the best guide for the proper temperature. There must be no pain, or even annoyance, from the heat. If the temperature is gradually increased, a surprisingly high degree of heat can be borne by the patient—often as high as 250° F.

"It must be borne in mind that great heat makes the part less sensitive. If due care is not taken, a burn of the second degree may occur without the patient knowing it until after the sitting. The patient should be in as comfortable a position as possible during the treatment. First, the extremity is comfortably placed in the box and the opening closed. Then the lamp is lighted and placed underneath the funnel. When a comfortable degree of heat has been obtained, it must be the operator's aim to continue the same temperature. After one-half to one hour the light is extinguished, the lid opened, and the part allowed to cool down. Treatment may be given daily or every other day."

H. F. Waterhouse[1] gives a thorough and practical consideration of the theory and application of Bier's hyperemic treatment. The most frequent indications for the employment of the constricting bandage, in his estimation, are as follows:

1. Whitlows: but in the majority, that is, where pus is present, a tiny incision is required prior to the application of the bandage to give vent to pus.

2. Suppurative arthritis of the joints of both upper and lower limbs after incision into the articulation.

3. All varieties of pyogenic infections of the limbs, including cellulitis, osteomyelitis, and lymphangitis.

4. Tenosynovitis of tuberculous, pyogenic, and gonorrheal origin.

5. Gonorrheal arthritis, so frequent in the knee-joint in the male and the wrist in the female.

6. Ununited fractures, or rather delayed union of fractures, in order to expedite the process of repair.

[1] Brit. Med. Jour., 1911, ii, 1577.

7. Crushing injuries of hand or foot, where the hyperemic treatment has a marked influence in preventing suppuration in cases in which this is anticipated.

8. Chilblains, in which the hyperemic treatment often acts as a charm.

Suction, by means of cupping glasses, he has employed with great satisfaction in

1. Furuncles and carbuncles, usually after a punctured incision, but occasionally, as in blind boils, without this preliminary. In such instances the treatment has afforded results that have been uniformly excellent.

2. In acute and chronic abscess after incision.

3. In sinuses persisting after evacuation of a chronic abscess.

4. In mastitis, whether acute or chronic, in the former occasionally, after an incision has been made.

In every case on the above list he claims that the suction treatment has been beneficial. Boils and carbuncles have extruded their sloughs and healed readily; blind boils have aborted; abscesses have run a rapid course toward recovery; sinuses of long duration have closed within days or weeks, and many cases of mastitis, both acute and chronic, have quickly improved. In all the above recovery has occurred considerably sooner than would have been anticipated under any other method of treatment.

The heated air chamber is chiefly of value in chronic arthritic and osteitic affections, in hastening the absorption of adhesions and exudates, and in the alleviation of neuralgic pains; in all of which the elastic bandage will in general prove equally efficient. The hot-air douche he has found to work well in sciatica and occipital neuralgia, and in cases of chronic osteitis, whether of syphilitic or pyogenic origin, involving superficially placed bones, for example, the tibia and mastoid process.

CHAPTER XXV

SINUSES AND FISTULAE: LYMPHATIC FISTULA, FECAL FISTULA, AND ARTIFICIAL ANUS

SINUSES AND FISTULÆ

A SINUS, in surgery, is a long, narrow, hollow tract leading from some center of tissue destruction to the surface, and serving as a means of exit for pus or other pathologic discharges. A sinus may arise from a deep-seated abscess in the superficial tissues, or within the abdomen or pelvis, or from an osteomyelitis; it may take its origin from a foreign body acting as either a source of irritation or infection, such as a loose-lying ligature of silk or catgut, or a piece of necrotic tissue, such as a bony sequestrum, or a sloughed-off appendix; and so long as the offending body or disease remains, the sinus will persist, although it may close up temporarily at intervals. When a tract leads from a viscus, an excretory duct, or a glandular structure, it is called a fistula, and is named for the organ or viscus from which it leads, as renal, biliary, vesical, salivary, gastric, anal, urethral, lachrymal, mammary, etc. If it leads from one viscus to another, it is named for the organs it connects, as vesicovaginal. A fistula ordinarily serves to carry off the normal secretion or excretion of the organ or gland it drains, and it will tend to close of its own accord if all impediment to drainage through the natural exit is removed.

A sinus leading from a superficial abscess is generally not difficult to handle, provided the acute process has subsided and there is no sequestrum, slough ("core"), or foreign body to keep up the suppuration. If the sinus tract is long and tortuous; if as a result of chronic inflammatory changes its walls are thickened and cartilaginous, the process of healing will be long and tedious, even after the primary disease process has been overcome. A sinus must be kept open by drain or tube until the abscess cavity from which it takes origin has filled in or become obliterated; if the cavity is large, and is so situated that it cannot collapse, as, for instance, a bone abscess, or if its walls have become infiltrated and thickened so that they will not come together and so obliterate the cavity, it will have to fill up by granulations and the process of scar tissue formation, which will sometimes be a matter of months. Various injections are recommended for the purpose of encouraging the growth of granulation tissue, and among the best of these are glycerin, tincture of iodin, iodoform emulsion, and balsam of Peru and castor oil in equal parts, or 1:8. The use of a liquefied bismuth-vaselin paste after the method of Beck [1] has been followed by successful results in well-walled-off cavities where there is no danger from pressure or absorption.

So long as a sinus is discharging pus it must be kept wide open, so as not to offer resistance to the discharge and thus cause the pus to "back up" and prevent the cavity from closing in. Crusts must not be allowed to form at the mouth of the sinus and block the exit under the mistaken idea that the tract is closing in, especially if the abscess is intra-abdominal, for the pus will collect within the abscess cavity and after some days or weeks burst out again. If during such a period of quiescence, in the case of a pelvic or abdominal abscess, scar tissue has formed at the mouth of the sinus so as effectually to block the exit, operation may be necessary to reopen the accumulation, or the abscess may burst into the abdominal cavity or into some neighboring viscus, as the bladder or rectum, and so find its way out.

If granulation tissue forms about the mouth of the sinus, it must be kept clipped down with the scissors or burnt down with the silver nitrate stick, so as to cause no impediment to the outflow. The former is the better method. Granulations, as a rule, are insensitive. If, as usually happens in sinuses of long standing, the orifice contracts as a result of the formation of scar tissue, it must be frequently stretched by inserting a pair of scissors closed and pulling them out opened, or enlarged by cutting. If the sinus is so situated that it drains "up hill," that is, if the abscess cavity is lower than the mouth of the sinus, so that pus is likely to collect in the cavity from force of gravity, considerable time may be saved, when practicable, by making a new incision into the cavity at its most dependent point and allowing the old sinus to close up.

Sometimes it will be apparent that a sinus of long standing does not close because the constant and long-continued passage of irritating and infectous discharges has converted it into a stiff and thick-walled tube of scar tissue, which will not collapse, and which serves as a very poor base for the growth of granulation tissue. In such a case, if one is sure that the original infection has lost most of its virulence, it may be wise

[1] Emil G. Beck: Fistulous Tracts, Tuberculous Sinuses, and Abscess Cavities, Jour. Am. Med. Assoc., 1908, l, 868. Ochsner: Beck's Injection Treatment of Fistulæ and Abscesses Following Operation for Empyema, Jour. Am. Med. Assoc., 1909, liii, 319.

to employ a sinus curet and scrape the walls part way through, down to a well-nourished substratum. If this does no good, the sinus may

FIG. 99.—IRRIGATING A SINUS.

FIG. 100.—INSERTING A WICK.
The gauze is held taut between forceps in one hand and fingers of the other hand, and is thus inserted at once to the bottom of the wound.

be packed with gauze and dissected out entire. In other cases where the discharge continues profuse over a considerable period of time, or if for any other reason one is led to infer that the degree of resistance exhibited by the patient toward the specific organism which is responsible for the condition is low, the recently developed science of vaccine therapy may be brought in to assist us. The organism being isolated and identified, a stock vaccine may be bought and injected, or the organism may be cultivated and a vaccine developed (see Chapter LII). If the infection is mixed, involving two or more species of bacteria, the treatment becomes more complicated. The results of this form of treatment are sometimes striking.

The cases in which a sinus is kept open by the persistence of the discharge from a bit of necrotic tissue, a suture, or other foreign body are comparatively common. As already mentioned, the offending body may be a splinter of bone, the distal portion of a sloughed-off appendix, a silk or catgut suture or ligature, or a gauze sponge. Sometimes a stitch, or even a bit of necrotic appendix, may be washed out through the sinus if a nozzle is used which reaches to the bottom of the cavity, and the irrigating fluid is allowed to enter under pressure of 5 or 6 feet. A crochet hook is a useful instrument in exploring stitch sinuses, and with one it is often possible to fish out a ligature which has become a source of trouble. Another maneuver is to bend sharply upon itself a strand of silkworm gut, and introduce the loop into the sinus, twisting it upon itself, in the hope of entangling the recalcitrant knot of silk or catgut. As a final resource, the sinus may be cureted, then gradually dilated with uterine dilators, and with a pair of urethral forceps a minute search instituted over its entire sides and bottom in the endeavor to loosen and grab the ligature.

In the days when silk was the only material used in the abdomen and pelvis operators had much trouble from such stitch sinuses. The material would be contaminated by the surgeon's hands or the tissues which it was made to tie, give rise to an abscess, which was about as likely to discharge into the bladder or rectum as through the abdominal wound. Uterorectal and uterovesical fistulæ were by no means rare, and sometimes the patient had to be operated upon for calculi formed about ligatures which had worked their way into the bladder. Since we have gotten into the habit of using absorbable material for our buried sutures and intra-abdominal ligatures, and have learned better our aseptic technique, these accidents have become far less frequent, although even now a batch of poorly sterilized catgut may give rise to a small epidemic of stitch abscesses.

In the treatment of appendix abscess it sometimes occurs that, for various reasons, after the pus is let out no more than a hasty search can be made for the appendix itself. If the appendix is not found, a reasonable length of time is allowed for it to find its way out in the discharges. If this does not happen, and the sinus does not close, it will become necessary to perform a secondary operation for the purpose of finding and removing the appendix. In cases where the abdominal sinus persists, and there is no evidence as to its source, it is well to bear in mind the possibility of a sponge or other foreign body being left inside the peritoneal cavity, or the existence of tuberculosis.

A sinus which is discharging at all freely should be dressed once or twice a day. It should be gently syringed out with a mild antiseptic and a large absorbent dressing applied. Drainage should be insured by the employment of a gauze wick or a tube. Ordinarily a fenestrated rubber tube of the proper caliber, with fairly stiff walls, is to be preferred; it drains adequately and continuously, from the very bottom of the cavity, and it is easily and painlessly removed and inserted. It can be progressively shortened as the cavity fills in from the bottom with granulations. The part should be kept at rest to insure healing, and it is sometimes of advantage to apply a judicious amount of pressure, by means of adhesive strapping or the bandage, to aid in the coaptation of the walls of the cavity and to facilitate filling in. Dressings should be carried on under aseptic precautions, as mixed infections are ordinarily more difficult to treat.

Some authors[1] note excellent results following the injection of *iodoform emulsion* in chronic sinuses following adenitis, osteomyelitis, mastitis, tuberculous sinuses of any sort, and, particularly, in tuberculous bone disease. The emulsion is made up of 10 parts iodoform to 100 parts glycerin. It is injected under some pressure with a syringe having an olive tip which will fit tightly into the sinus, and in sufficient quantity to distend the cavity. Then the sinus is held tightly closed for five to ten minutes, to allow the iodoform to settle on the walls. Any fluid which escapes after this time will be pure glycerin. The part should be immobilized during the treatment.

The liquefied *bismuth paste of Beck* has been widely used, and, where operative procedures are contraindicated, it will be found to give satisfactory results in a certain proportion of intractable sinuses. The cures recorded by various authors range from 29 per cent. (in tuberculous orthopedic cases) to 76 per cent. (in fistula in ano), with an average of 52 per cent. It acts partly through inducing local leukocytosis and as a weak bactericide, and partly mechanically by distending the cavities and sinuses, and forming a framework upon which new granulation tissue may be built up. It is applicable to all sinuses except intracranial; it should not be used in cases

[1] Vandini, Gaz. degli Osped., 1910, No. 17; Kausch, Ther. der Gegenwart, 1911, No. 4.

of fistula, such as biliary and urinary, in acute abscesses of any sort, in tuberculous bone or joint disease before the formation of sinuses, or in cases complicated with amyloid degeneration of the viscera.

Two formulas are in use: the soft (1 part arsenic-free bismuth subnitrate and 2 parts sterile amber vaselin) is used in the presence of discharge; after the cavity is free of pus *formula 2* is used (3 parts subnitrate of bismuth, 6 parts amber vaselin, and 1 part paraffin). The orifice of the sinus is cleansed, and the paste, being liquefied by heating to between 110° and 120° F. in a water-bath, is drawn into a sterile blunt-nosed syringe. The injection is made slowly with the nozzle pressed tightly into the sinus, until it is estimated that the cavity and its ramifications are filled, or until the patient complains of pressure. A gauze pad is held over the sinus until the paste solidifies. Within the thorax, as for empyema, the cavity should not be distended, 100 grams being the maximum injection, and free drainage of pus should be provided for. In the presence of considerable discharge *formula 1* is used daily, or every second day, until the pus disappears, then *formula 2* is used at first every other day, then less frequently.

Treatment by this method may have to be persevered in for several months; favorable results are not to be expected in the presence of sequestra or foreign bodies (silk ties, gauze) in the sinus. Two dangers have to be guarded against: embolism, from rupture of a vessel by the injection and the introduction of the paste into the general circulation, and poisoning from absorption of bismuth. Eight fatalities from absorption have been recorded in about 8000 cases. The symptoms are stomatitis, with the appearance of a blue line on the gums, and intestinal colic and diarrhea. Serious cases develop paralysis, delirium, and coma. Prompt evacuation of the cavity and flushing out with warm olive oil is indicated to avoid this complication. Mitchell[1] recommends as a simple, efficient, and harmless substitute a paste made of equal parts of petrolatum and chalk.

The treatment of a *fistula* is the treatment of the organ from which it leads. In general, a fistula will continue to excrete so long as there remains any impediment to the normal excretion from the gland or viscus from which it takes origin. In some cases, from the nature of the primary condition, there can be no hope of restoring the natural exit, and thus a patient may carry about a renal fistula or a perineal fistula for the rest of his life. Otherwise, the principle of treatment is to encourage the discharge through the *viæ naturales*, as by tying a catheter into the bladder, and so give the fistula rest and allow it to heal. When this can be accomplished, the fistula will usually be found to heal rapidly, but sometimes plastic operations are necessary for their final closure. Fistulæ may close temporarily and then reopen, and keep

[1] Jour. Am. Med. Assoc., 1911, lvii, 394.

alternating thus between open and closed for some weeks or months before they decide finally to remain closed. Sometimes, on account of the pain from the pressure of the pent-up secretion behind a temporarily closed biliary fistula, it will be necessary to reopen the mouth of the tract with a knife.

LYMPHATIC FISTULA

It occasionally happens that in dissections of the neck the thoracic duct is accidentally opened, severed, or tied off.[1] The integrity of this lymph-channel, conveying the final products of absorption from the digestive organs into the blood-current, must be considered vital to the existence of the organism, and any injury that it may sustain is to be looked upon as serious.

The thoracic duct, which drains the lymphatics of the entire body except those of the right head, neck, and arm, comes up into the neck at the left of the esophagus and behind the left subclavian artery. At the level of the seventh cervical vertebra it arches outward, goes over the subclavian artery, and terminates in the left subclavian vein at its junction with the internal jugular to form the innominate. Its course is inconstant—in nearly one-half of the cases it divides into two or more radicles; in half of these it joins again, in the other half it opens by two or more orifices, sometimes joining with the right lymphatic duct.[2]

Symptoms.—If the thoracic duct is severed and all the chyle diverted, edema appears about the wound, which opens, and large quantities of thick, curdy material are poured out. The digestive organs work to no purpose, and the patient suffers from excruciating hunger and thirst. The discharge of chyle increases as the amount of food ingested is increased, but no matter how much the patient eats, the emaciation and weakness progress. If pressure is exerted in an attempt to limit the outpouring of chyle, the edema increases, the patient complains of pain in the thorax, and as soon as the pressure is relieved there is a profuse discharge of pent-up chyle. The heart's action weakens as the condition progresses, and loss of consciousness and, finally, death ensue.

Prognosis.—Death is by no means the necessary outcome of this accident. Many cases have been reported which have recovered

[1] Lund (Boston Med. and Surg. Jour., 1899, cxl, 354) reports a case of operative injury of the thoracic duct following a radical operation for removal of the breast, and refers to 13 similar cases. The patient recovered.

[2] Parsons and Sargent, On the Termination of the Thoracic Duct, Lancet, London, April 24, 1909.

spontaneously after a profuse discharge, lasting some days or even weeks. When we consider that in nearly half the cases there exist multiple ducts, it is probable that in these reported instances the surgical injury involved damage to one division only, and that a second collateral channel already existed.

Treatment.—If the injury is noted at the time of operation, the treatment should be the same that one would accord in case of a similar injury to an arterial trunk; if the wall is only nicked, it should be sutured; if the duct is cut across, its end should be ligated in the hope that collateral branches exist; if it cannot be reached, a clamp should be applied or compression exerted by means of a pressure dressing. The implantation of the cut end of the duct into a vein has been attempted.

In a considerable proportion of the cases the injury is overlooked at the time of operation and the first sign of its occurrence is the presence of pain and edema about the wound. The edema may spread up onto the left side of the face and down the left arm. In the presence of this edema, sufficient sutures should be released to give free exit to the chylous discharge. A large absorbent dressing should be applied without much pressure. Zinc oxid ointment or Friar's balsam should be applied to save the skin from being excoriated. Everything should be done to maintain the patient's nutrition until such time as the collateral branches are able to take up their vocation.[1] Subcutaneous feeding should be tried.

FECAL FISTULA AND ARTIFICIAL ANUS

A fecal fistula is a fistula communicating with the bowel and discharging fecal matter. When such a fistula is created purposely by sewing the cecum, colon, or small intestine to the abdominal wall, it is called an artificial anus.

Fecal fistula is usually an unavoidable though troublesome complication of the after-treatment of celiotomies; it sometimes arises from causes which might have been avoided. Whether or not the surgeon can be rightly held accountable for the formation of a fecal fistula in a given case, the patient himself will ordinarily be apt to feel that the operator is in some way personally responsible for the unclean and disabling condition from which he suffers.

[1] For further consideration of the subject see Harvey Cushing, Annals of Surg., June, 1898; Allen and Briggs, Am. Med., Sept. 21, 1901; Unterberger, Ueber Operativen-Verletzungen des Ductus Thoracicus, Beitr. zur klin. Chir., xlvii, Heft 3; v. Graff, Zur Therapie der Operativen-Verletzungen des Ductus Thoracicus, Wein. klin. Woch., 1905, Nr. 1; De Forrest, The Surgery of the Thoracic Duct, Ann. Surg., 1907, xlvi, 705.

The most frequent cause of fecal fistula is appendix abscess, either in the form in which the appendix has sloughed off and the base cannot be found and ligated, or such a ligature does not hold, or the wall of the cecum or the neighboring ileum has been rendered necrotic and friable by the septic process and breaks open at the time of the operation or later. The ligature of the stump has been known to "blow off" in clean cases, however, and give rise to a fecal fistula. Fistulæ may appear after operations for the repair of traumatic wounds of the intestines and after intestinal anastomoses, where for some reason the line of sutures has leaked. They may result from slight and apparently insignificant tears of the bowel in separating adhesions and during the removal of tumors to which one or more loops of intestine are closely adherent, even if only the outermost layer or layers of the intestinal wall are stripped off.

If, in the reduction of a strangulated hernia, the replaced gut, contrary to the surgeon's expectations, proves nonviable, a fecal fistula may result. It may result also from the presence of a foreign body, a stitch abscess, or from the perforation of a tuberculous or other intestinal ulcer. It may follow pressure from gauze packing, put in perhaps for hemorrhage at the time of operation, left for too long a time pressing on a coil of gut, or from continued pressure of a glass or stiff rubber drainage-tube. It has been known to follow accidental puncture of the gut by the needle in sewing up the abdominal wound. In any case if the point of leakage is not closed off from the general abdominal cavity by adhesions, or an easy tract of exit appears through the abdominal wound, the case is likely to end in peritonitis.

If an opening in the gut has been left at the time of operation, and a drainage-tube is *in situ*, gas and pus of a fecal odor may appear at the first dressing and fecal matter become evident within twenty-four hours. Sometimes a fistula does not establish itself for weeks after the operation. The color and nature of the discharge vary with location of the perforation—the higher up in the intestinal tract, the more fluid and the lighter in color. The discharge from any fecal fistula is irritating to the skin, but the discharges which come from the higher portions of the intestines are particularly acrid, and those from the duodenum may even digest the skin down to the fascia.

Prophylactic treatment consists in avoiding the possibilities which have already been suggested—particular care should be exercised in handling tissues which may be friable and in separating adhesions; anastomoses should not be dropped until they are demonstrated airtight, and all rents, even if they go only partly through the intestinal wall, should be well sewed up; and drainage of any sort should not be allowed to exert too great a pressure or to stay in place for too long a time.

Once a fistula has established itself, one must first of all see to it that there is no obstruction to free drainage—all gauze should be removed and the sinus dilated occasionally if it shows signs of closing down prematurely, or kept open by a rubber tube. The chief danger at first is from the backing up of feces under pressure. The fistulous tract should be kept as clean as possible by irrigating it once a day with a solution of chlorinated soda, using a female glass catheter as a tip to the douche tube in order to reach its every part. The skin about the wound should be protected by washing once a day with alcohol, drying, and painting an area around about 2 in. in diameter with compound tincture of benzoin.

Healing is encouraged by attempts to divert the fecal contents through its natural channels. The diet should be moderate, easily digestible, and leaving as small a residue as possible. To prevent any back pressure in the intestinal stream the movements of the bowels should be stimulated by repeated low enemas, but not by cathartics. The patient should maintain a position in bed which will dispose the intestinal matter to pass through the regularly ordained channel rather than through the fistula.

Ordinarily, under this regimen, fistulæ from appendix stumps and other small wounds of the intestine will heal, and any constant diminution in the discharge, however slight, should encourage perseverance. If the discharge continues unabated for a considerable period, operative treatment should be considered, bearing in mind that fistulæ sometimes close spontaneously after existing for six or more months.

ARTIFICIAL ANUS

An artificial anus is made deliberately for the purpose of diverting the intestinal stream. Sometimes, as, for instance, in malignant cases, it is intended to serve permanently—usually the formation of an artificial anus is a temporary expedient.

An artificial anus should be dressed frequently and particularly good care should be taken of the skin. Some sort of belt or binder may be devised to hold a pad of gauze against the wound to catch the discharges. As soon as the bowels begin to resume their function, the discharge of feces through the artificial anus lessens, and a man may be about and attend to his affairs if he carries a pad or two of gauze for a change if necessary. (See also Colostomy, p. 468, for details.)

Artificial anus does not tend to heal spontaneously. As soon as it has served its purpose, operation will be necessary for closure. The usual operation consists in dissecting the loop free from its adhesions to the abdominal wound, sewing up the intestinal opening, and dropping it into the abdominal cavity. The earlier this is done after the primary operation the easier it will be to separate the adhesions.

CHAPTER XXVI

SEPTICOPYEMIA

Septicemia is a toxemia arising from a focus of septic infection; *pyemia* is the name applied to the condition in which multiple abscesses occur in various parts of the body from lodgment and multiplication of bacteria deposited by the blood-current. In both these forms of generalized septic infection the bacteria exist in the blood-stream and may be demonstrated by planting the blood, taken under aseptic conditions, on culture-media; in cases of septicemia, however, the organisms are less numerous in the peripheral circulation than in the capillaries of the internal organs, such as the kidneys, liver, and spleen, and it is, therefore, often impossible to detect them antemortem. As the two conditions cannot ordinarily be sharply distinguished clinically, and as they have a common etiology, it will be convenient to consider them both under the heading *septicopyemia.*

Any acute inflammatory or suppurative condition which is due to a microörganism may give rise to a secondary or a systemic infection. The organisms which are usually met with are the Staphylococcus pyogenes aureus (common in circumscribed acute abscesses, carbuncles, etc.), the Streptococcus pyogenes (occurring in spreading superficial inflammations, diffuse phlegmons, lymphangitis, and erysipelas), the Bacillus coli communis (associated with inflammatory and suppurative conditions of the abdominal contents), and, less frequently, the Micrococcus tetragenus (often found alone or associated with other organisms in suppurative conditions about the mouth and neck). Metastatic inflammations and suppurations may follow certain acute diseases, such as gonorrhea, pneumonia, and typhoid, and frequently occur in tuberculosis; in such secondary foci the corresponding organisms may at times be isolated.

Secondary infections may occur—(1) through the lymphatics, (2) along natural channels, such as the urethra, ureters, and bile-ducts, and (3) by way of the blood-vessels: organisms may be carried along directly by the blood-current; a septic phlebitis may cause the formation of a thrombus, which disintegrates as a result of the suppuration and forms septic emboli, or there may be a direct extension along a vein, as in suppurative pylephlebitis. Pyogenic organisms exercise a peptonizing and liquefying action on blood-clot. As a result, infected particles may be taken up by the lymphatic and venous circulation and carried to the various parts of the body. In this case we speak of the condition clinically as *pyemia* or *septicometastasis*. In the lymphatic system they cause lymphangitis and abscesses of the glands of the groin, axilla, and neck. Thrombi reaching the portal system cause the development of mesenteric and hepatic abscesses. In the systemic veins the thrombi are carried to the lungs. If they pass through the pulmonary circulation, those that do not lodge in the heart enter the arterial current and may be distributed over the body to the brain, liver, kidneys, etc.

Symptoms.—*Locally*, skin wounds show marked signs of septic inflammation, often of the lymphangitis, and inflammation of the neighboring lymph-nodes. The skin and subcutaneous tissues become brawny and infiltrated and erysipelas may set in. There may be crepitation from the formation of gas if the bacillus of malignant edema (Bacillus aërogenes capsulatus) is present. If the source of infection is an operative wound, pus may exude from the stitch holes and from between the edges of the wound.

The *objective symptoms* in septicemia are marked—rapid rise in temperature to 101° or over, the process being initiated by a chill; the pulse grows gradually more rapid, the tongue becomes dry and glazed, and the skin hot. As a rule, the temperature-curve is irregular, the fever is apt to be low in the morning and rise a degree or two toward evening. It is at its lowest at about seven or eight in the morning, when it may be even subnormal. The pulse in severe cases reaches 140 or 160 a minute, and as fatal termination approaches it becomes weak and thready. The respiratory rate runs above normal. The patient is frequently delirious as the temperature rises, and at times may be even maniacal, although he is more apt to exhibit the condition of drowsiness or stupor. There may be a complicating septic meningitis. The bowels are usually constipated, although the stools may be watery; the urine is apt, as a rule, to show albumin and casts; it is scanty in amount and high colored.

Diagnosis.—Diagnosis may be made absolute by the isolation of bacteria from the blood.

Prognosis.—Prognosis of septicemia is always grave. If septic metastases develop, the prognosis, as a rule, is bad. If the site of the original infection is superficial, where it may be thoroughly cleaned and drained, the result will be more propitious. The virulence of the infection and the susceptibility and resistance of the patient must always form the premises upon which prognosis is based.

Treatment.—Free drainage of the original site of the infection and of all superficial secondary abscesses. One should not hesitate at amputation of a limb if such a mutilating operation is necessary in the effort to save life. The general treatment should be supportive and stimulating, the diet should be easily digestible, made up chiefly of eggs, milk, broth, cereals, custards, whisky, and the patient should be fed at frequent intervals. Strychnin and whisky are the best stimulants. The bowels should be kept acting freely by the use of calomel or salts. Antipyretics are contraindicated on account of their depressing action. Sponging with cold water and alcohol rubs, with the ice-cap when needed, form the best means of controlling temperature. In the earlier stages normal salt solution should be given by rectum. In critical cases 250 to 500 cc. may be given every four to six hours. In desperate cases the venous infusion of 500 to 1000 cc. may be given. Metastatic abscesses should be incised, evacuated, and drained when accessible. If septicemia becomes chronic, Fowler's solution or elixir of iron and gentian should be exhibited. The use of bacterial vaccines has been followed by good results in some cases. (For discussion of this subject and technique, see Chapter LII.

CHAPTER XXVII

CUTANEOUS RASHES: ETHER RASH, SEPTIC RASH, ERYSIPELAS, SURGICAL SCARLATINA, DRUG POISONING

CUTANEOUS rashes and eruptions are likely to be seen occasionally following operations, especially celiotomies. Usually the operation is only indirectly responsible for their occurrence. They may take the form of an urticaria; the eruption may be papular, it may be macular and resemble measles, or erythematous, like scarlet fever. Often it will be found that nothing more than a digestive disturbance is responsible for their outbreak, but they may be due to drugs taken internally, such as morphin, or used externally, such as iodoform, or to irritant enemas, as of turpentine. Occasionally they are the outward evidence of so serious a condition as septicemia, and it must not be forgotten that measles and scarlet fever may themselves complicate convalescence. While it is true that these postoperative rashes are usually only of passing importance, they are likely to cause considerable anxiety before they are identified, and they should never be allowed to go without a diagnosis.

ETHER RASH

During etherization there not infrequently appears on the face, neck, and chest a bright roseolous rash which marks the height of vascular excitement. The patches are large, sharply outlined, irregularly shaped, and asymmetrically placed. They appear suddenly, just about as the patient reaches full surgical anesthesia, maintain their vividness for two or three minutes, and then slowly fade. It is most common in women, and usually affects the area supplied by the superficial cervical plexus. It is undoubtedly of nervous origin.

No treatment is necessary.

SEPTIC RASH

Associated with symptoms of septicemia there sometimes appears within the course of a few hours a generalized or limited erythematous eruption resembling that of scarlet fever. Frequently, particularly in children, it occurs without any other evidence of general septic infection, although its appearance is sometimes preceded or followed by a breaking down and suppuration of the wound. Whether this is cause or effect cannot be stated.

The eruption occurs ordinarily three or four days after the operation. It is ushered in by restlessness and malaise, and with its appearance the temperature rises to about 102° F. and the pulse-rate goes up proportionately. It is usually uniform in its distribution, with a predilection for the upper half of the body. In mild cases, unaccompanied by septicemia, it usually lasts two to four days and then begins to fade out. If the eruption has been at all severe, it is followed by desquamation.

Just how closely this condition is allied to scarlet fever it would be difficult to say. That it has been, and may be, confused with scarlatina there can be no question. It differs from this condition as it ordinarily presents itself in that it appears rapidly, without premonitory symptoms, such as sore throat and vomiting. The characteristic "strawberry" tongue of scarlatina is absent. The rash does not appear progressively on the neck, chest, and face as the scarlatinal rash typically does. The fever does not run so high, and in some cases at least it is intermittent. It is not complicated by otitis media or cervical adenitis. Finally, it is often allied to wound suppuration or general septicemia.

Treatment.—Symptomatic and supportive; catharsis as indicated, and treatment of any associated septic condition which may be allied causally. Until the diagnosis is clear, isolation is advisable. A powder of zinc oxid and starch may be applied.

ERYSIPELAS

The occurrence of erysipelas after clean operations which have been performed with due respect for the rules of aseptic technique is rare. Erysipelas may, however, show itself after operations for the relief of septic conditions or the repair of wounds accompanied by more or less extensive destruction of tissues. It occurs particularly in those whose resistance is lowered by exposure, alcohol, debility, or old age. The infecting organism is usually the Streptococcus pyogenes, although it has been recently stated that the Staphylococcus aureus may be the organism in some cases. Pathologically, the condition is a lymphangitis, the organism finding its way by some surface lesion into the superficial lymphatic system, multiplying rapidly and spreading throughout the lymph-spaces from the point of inoculation by continuous growth. The organisms may be best demonstrated in the advancing margin of inflammation.

The onset is usually marked by a chill and gastric disturbance.

The temperature rises to 102° F. or over and remains at about this point. The patient is prostrated. In twelve to twenty-four hours he complains of a burning or itching about the wound, and examination reveals a contiguous patch of infiltration, elevated, tender, sharply outlined, and dusky red in color. There is usually an accompanying serous discharge from the wound. The inflammation advances irregularly, preserving its raised sinuous border, the color fading out in the center. This progression is maintained for a variable length of time—from a few days to many weeks—before it gradually clears up. It usually leaves the patient exhausted and relapses occur in about 10 per cent. of the cases. The prognosis should always be guarded, on account of the possibilities of gangrene, cellulitis, and metastatic infection occurring as direct complications, or secondary pneumonia or nephritis. The mortality may be roughly stated at 10 per cent.; it is much higher in infants and in the old or debilitated.

Treatment.—The patient should be kept quiet and apart from other patients. He should be well nourished with a sufficient, though light, diet, and brandy or strychnin should be employed if stimulation is called for. Morphin will often be necessary. The bowels should be kept moving freely with calomel or salines. Locally, all wounds should be kept surgically clean. The inflammatory area should be kept moistened with a refrigerant lotion, such as equal parts of camphor water and ether, applied every half-hour with a camel's-hair brush. If the infection is about the face, the eyes should be protected by compresses of iced boric-acid solution. If for any reason the application of the lotion cannot be kept up through the night regularly, a 10 per cent. ichthyol ointment may be applied at eight o'clock and wiped off the next morning. In case of abscess formation free incision and drainage should be performed, without general anesthetic if possible.

SURGICAL SCARLATINA

At this date there can be hardly any question but that scarlet fever may follow surface lesions, surgical or traumatic. Many cases have been reported following operation, but some have run an atypical course, and probably many of these are of the type which we have already considered under Septic Rash. It must also be borne in mind that a child may be operated upon unknowingly during the incubation stage. Some of the true cases of scarlet fever developing comparatively late in convalescence are undoubtedly due to contagion from the doctor, a nurse, or a neighboring patient.

In a few cases that have been closely observed it is highly probable that a surface lesion was the site of primary inoculation on account of the presence of an areola and lymphangitis about the wound, the shortness of the period of incubation, the typical course with complications, and contagion from the patient resulting in the occurrence of the disease in others

Postoperative scarlatina is most frequent in children. It follows surface lesions, such as burns or lacerated wounds, and operations of one sort or another, but it has been most commonly reported after operations about the nose and throat, as for removal of tonsils and adenoids. The treatment does not differ from that generally employed.[1]

DRUG POISONING

Skin eruptions may follow the use of antiseptics or other local applications, the internal use of drugs, or the use of enemas.

The commoner drugs which are likely to cause eruptions are atropin and belladonna, the bromids, chloral, copaiba, the coal-tar derivatives, such as antipyrin and acetphenetidin, the iodids, mercury, morphin and opium, salicylic acid and the salicylates, sodium benzoate, chlorate of potash, strychnin, and veronal. We have in mind the case of a man who is poisoned by the slightest dose of mercury in any form, such as calomel internally or the bichlorid externally, the administration being followed always by a severe, almost universal, eczema, and we have seen several instances where a copaiba rash was confused with a secondary syphilid. While the appearance of the efflorescence caused by each one of these drugs has certain peculiarities by which they may be sometimes differentiated, they all have points in common which distinguish them from other eruptions in general and aid in diagnosis.

As a rule, a medicinal rash resulting from drugs taken internally may be recognized—(1) By its rapidity of development; (2) its symmetry; (3) the absence of fever; (4) its existence alike on exposed and protected surfaces of the skin; (5) its tendency to generalization; (6) pruritus, and (7) the fact of medication with a drug known to cause skin eruptions. Any generalized rash which makes its appearance suddenly, if we can exclude syphilis and the acute exanthems, is likely to be a drug eruption. They disappear rapidly, as a rule, upon the discontinuance of the responsible drug.

[1] Kredel (Wundscharlach, Arch. f. klin. Chir., 1908, lxxxvii, No. 4) states that in the Hanover Hospital 28 cases of scarlet fever developed among the patients. In 12 the infection followed an extensive operation and in 1 a severe burn. The incubation was only three days in 10 and from five to eight days in the others. He is convinced that the infection occurred in the operating room, and believes that antiseptic rather than aseptic measures might be preferable during prevalence of scarlet fever. Van der Bogart (Arch. of Pediatrics, Feb., 1909) cites a case of scarlet fever following a wound in the foot.

The question of personal idioscyncrasy seems to be an important factor in the occurrence of drug eruptions of all sorts; apart from this, poisoning is more liable to develop in children than in adults and in persons who have unsound kidneys.

Cases of *local poisoning* from the use of antiseptics are uncommon, but by no means rare. Most of the ordinary agents will excite a local reaction if applied too strongly or too freely, especially if their action is concentrated by applying a moisture-proof covering, such as oiled silk or waxed paper, over the dressing. Ordinarily an erythematous rash appears under and about the edges of the dressing, bright red in color, which may itch badly. Sometimes the eruption may spread for some distance about the wound. Unless the condition has progressed so far as gangrene,—as it will after the use of strong carbolic acid,—this local reaction will usually promptly disappear if the irritant is much diluted or changed altogether for something more mild, and the skin protected from its action by boric or zinc oxid ointment.

There are only a few of the antiseptics in common use which by their local application may cause systemic poisoning through absorption. Of these, the most important are iodoform, carbolic acid, and its derivative, picric acid.[1]

Iodoform poisoning may follow the use of iodoform powder in large quantity on raw surfaces, the use of iodoform gauze in packing cavities, and the use of iodoform emulsion or paste in tuberculous glands and sinuses and osteomyelitis. As a rule, there is an areola of inflammation resembling erysipelas surrounding the wound, and there may be the formation of serous vesicles. The first sign that things are going wrong is drowsiness. The temperature rises suddenly to 102° F. or over; there are accompanying nausea and vomiting. Within twenty-four to forty-eight hours a generalized eruption appears, scarlatiniform in type. The pulse-rate rises, and signs of collapse are apparent; the patient is delirious, becomes comatose, and may die; the urine becomes black and shows the presence of iodin.

Treatment.—All iodoform should be removed as rapidly and as thoroughly as possible. Any free iodin left behind may be taken up by scrubbing the surface with moistened starch or irrigating with a solution of starch in warm water. The patient should be supported and stimulated, the bowels and kidneys flushed by the use of salines, diuretics, and water by mouth, under the skin, and by rectum.

[1] Amsden (Jour., Am. Med. Assoc., 1910, liv, 2042) reports a case of generalized maculopapular eruption following the application of aristol as a dusting-powder after a perineorrhaphy.

Carbolic acid or **phenol** has a considerable and lengthening list of fatalities to its credit, although cases of death from its use externally are at present rare. If enough carbolic acid in solution is applied over a raw surface to allow absorption in sufficient amount, the patient within a few hours becomes pallid and drowsy, the respiration is labored and stertorous, and coma gradually develops, followed by collapse; the urine is dark green or black and lacks sulphates.

The treatment of this form of poisoning consists, first, in removing the source of the absorption, and, second, in the administration of Glauber's or Epsom salt and general supportive measures.

Poisoning from **picric acid** is occasionally reported following its imprudent use in the treatment of burns and minor surgical lesions. Although a number of cases of mild poisoning have been reported after topical applications, and even though several suicidal attempts have been made by taking it internally, it is not known that picric acid has ever been the direct cause of death. Absorption is readily recognized by the yellow color which the deposit of this pigment gives to the skin and mucous membrane. The urine may be yellow, brown, or black. There is some nausea and vomiting and headache. It is differentiated from jaundice by the presence of bile in the stools. As soon as the use of the drug is discontinued the symptoms disappear and the yellow color of the surface of the body begins to fade.

Occasionally the *use of enemas* will be followed by a skin eruption. It may be local and patchy, like measles, or generalized, like scarlet fever. It shows up shortly after the administration of a rectal injection, in anywhere from four to eighteen hours, and it usually lasts two to four days. There is no fever. As to its causation, there is some question. It will follow the injection of turpentine and the use of common yellow soap in making suds enemas. No treatment is necessary beyond the use of an antipruritic lotion, such as white wash (carbolic acid, 1 dr., zinc oxid, 1 oz., lime-water, to make 1 pt.).

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CHAPTER XXVIII

RARE COMPLICATIONS: TETANUS, MALIGNANT EDEMA, PAROTITIS, STATUS LYMPHATICUS, HEMOPHILIA

POSTOPERATIVE TETANUS

IN the early days of abdominal surgery it was not rare for patients, a few days after the operation, to develop symptoms of tetanus, and these cases frequently proved fatal. Twenty years ago and more the matter was of sufficient importance to give rise to a considerable literature. Olshausen [1] first described it as occurring after ovariotomy, and he collected 49 cases; Edmund Rose[2] in 1897 collected 58 cases; v. Aćković,[3] 60 cases; Zacharius [4] adds 18 cases, and W. G. Richardson [5] adds 21 more, making a total of 206 cases. Of these, the large majority have been fatal.

The sources to which the infection has usually been ascribed are the use of infected catgut [6] and kangaroo tendon,[7] the use of gelatin which has become contaminated by tetanus bacilli,[8] or contagion from another patient in the hospital through a nurse.[9]

It cannot be questioned but that in the majority of reported instances the infection is referable to catgut.[10]

It was, however, first observed in the cases of Zacharius that the catgut might be sterile on bacteriologic examination. Richardson examined the catgut in 14 of his 21 cases and found it negative in every instance, although in 4 cases a bacillus resembling that of tetanus was

[1] Krankheiten der Ovarien, Deut. Chir., Lief 58, 1886.

[2] Der Starrkrampf beim Menschen, Deut. Chir., Lief 8, 1897.

[3] Central. der Chir., 1897, xxiv, 728.

[4] Münch. med. Woch., 1908, i, 227.

[5] Tetanus Occurring After Surgical Operations, Brit. Med. Jour., 1909, vol. i, 948.

[6] Gunn, Post-operative Tetanus, Dublin Jour. of Med. Sci., 1909, cxxviii, i.

[7] Dorsett, Amer. Jour. Obst., 1902, xlvi, 620.

[8] Haddaeus, Tetanus nach subcutaner Gelatine-Injection, Münch. med. Woch., 1909, 231.

[9] Aspell, Amer. Jour. Obst., 1900, xlii, 867.

[10] R. Kleinertz, Tetanus from Catgut, Berlin. klin. Woch., 1909, xlvi, 1654; and Reuben Peterson, Tetanus Developing Twelve Days After Shortening of the Round Ligaments, Jour. Amer. Med. Assoc., 1910, liv, 108.

found. It was suggested to him that in the locality in which these cases occurred sheep ordinarily harbored tetanus bacilli in their intestinal tract in large numbers. From this suggestion he deduced the theory that the tetanus bacilli were not introduced with the catgut, but that the patient at the time of operation was a host of the bacillus, and the cases were all to be considered as cases of idiopathic tetanus, in which the disturbance of opening the peritoneum was enough to cause the bacillus to become toxic.

This theory of the causation of postoperative tetanus has recently aroused some interest in this country. Matas, at the meeting of the American Surgical Association held in June, 1909, read a paper on the Fecal Origin of Some Forms of Postoperative Tetanus,[1] and reported 2 cases which occurred after the patient had eaten copiously of uncooked vegetables. The result of his careful consideration of this subject may be summed up as follows: Postoperative deaths from tetanus sometimes occur in apparently clean cases. The risk of tetanus infection can be practically eliminated in all operations except in those regions in which postoperative asepsis cannot be secured, for example, the extremities and the anorectal region. Postoperative deaths are not necessarily dependent upon defects of technique or contaminated materials, such as imperfectly sterilized catgut: they may be due to the direct contamination of the alimentary canal and its contents with living tetanus bacilli and their spores swallowed in uncooked vegetables, berries, and other fruits which are cultivated in fertile or manured soil; that is to say, soil that contains the tetanus bacilli. He calls attention to the fact that in both his cases the patients had previously partaken of uncooked vegetables. All cultivated soil in the temperate and tropic zones contains tetanus bacilli. They grow more luxuriantly in the soil of the tropics than in the temperate zone, and, therefore, to a certain extent, tetanus is a disease of warm climates.

Tetanus bacilli and their spores survive the passage through the intestinal canal of domesticated animals, particularly the horse and the cow, and the dejecta of these animals are perfect culture-media for the bacilli. Of normal adult men, 5 per cent. harbor the tetanus bacillus or its spores in an active state in the intestinal canal, and 20 per cent. of hostlers, dairymen, and others intimately associated with domestic animals show tetanus bacilli in their feces.

Matas concludes that whenever a patient is to be operated on in any region where fecal contamination is unavoidable, such as in cases

[1] Monthly Cyclopædia and Medical Bull., 1909, ii, 705.

of hemorrhoids, fistula, stricture, etc., antitetanic preparation should be insisted upon. This consists, first, of purgation for three days before operation, and, second, suppression of all uncooked food, especially green vegetables, berries, and fruit, for the same period. These rules apply particularly to the warm portions of the country and sections where the tetanus bacilli are known to abound. In cases of emergency, when dietetic preparation is impossible, 10 cc. of tetanus antitoxin may be injected subcutaneously at the time of operation.

Gelatin has long been known to harbor tetanus bacilli over long periods, and ordinarily sterilization has been found impotent to destroy their virulency. If gelatin is to be used for subcutaneous injection, the bacilli and their spores must be destroyed beyond a question of doubt. A practical and competent method for accomplishing this purpose is described by Wandel.[1] The gelatin in a neutralized 10 per cent. solution is sterilized in an Erlenmeyer jar, covered with a layer of fluid paraffin to keep out oxygen. A long glass tube reaches to the floor of the jar, the upper end being capped with a tube and stop-cock. A larger short tube in the stopper filled with cotton allows the entrance of air. The whole is sterilized in a linen bag in steam for forty minutes at 100° C.[2] After cooling, it is kept in the incubator at 31° C., then sterilized again for thirty minutes as at first, and this is repeated for fifteen minutes the following day. The gelatin thus sterilized is poured into sterile vials containing 50 cc., and these are then fused. Gelatin thus sterilized and preserved can be kept indefinitely.

The **treatment of postoperative tetanus** is that of traumatic tetanus after the development of symptoms. If the source of toxin supply can be reached, it must be removed or disinfected, if possible, with carbolic acid. Hutchins[3] states on experimental evidence that amputation of an infected limb is of little curative value, because at the time of the appearance of symptoms the body probably contains the maximum of toxin. Use of antitetanic serum in this stage of the disease to neutralize the toxin already circulating in the system is rarely to be depended upon, but in spite of this it may be useful to inject 10 to 20 cc. subcutaneously in the neighborhood of the wound, 10 to 20 cc. intravenously, 10 to 20 cc. into the cauda equina, and, if the patient's life is in imminent danger, 20 to 30 min. directly into the spinal cord. The injection is made between the sixth and

[1] Gelatin in Therapeutics, Therapie der Gegenwart, 1909, I, 265.

[2] Ciuffini states (Policlinico, 1910, xvi, Medical Section, p. 525) that gelatin loses the property of promoting coagulation if it is heated to 130° or 135° C. for half an hour.

[3] Fetschrift für Rindfleisch, 1907.

seventh cervical vertebræ.[1] Exhaustion should be combated by proper feeding, which may have to be carried on through a tube, and by careful stimulation. The patient should be kept quiet in a dark room. Free diuresis and diaphoresis should be instituted. Water should be taken copiously. To lessen the high degree of nervous irritability and the constant muscular contractions, some sedative, such as chloral or the bromids, should be exhibited.

There has been considerable success, so far as diminishing the reflex symptoms goes, following the subdural injection of magnesium sulphate, as suggested by Meltzer. This inhibits the convulsive seizures and produces ascending paralysis, beginning in the lower extremities when injected into the lumbar spine. Care should be exercised in computing the dose or it may be followed by paralysis of the respiratory center and death. The dose for a male adult should be not more than 1 cc. of the 25 per cent. solution for every 20-pound weight. One injection will inhibit the convulsive seizures for twenty-four to thirty-six hours, when the dose will have to be repeated. The advantages of this treatment are: pain is relieved, the patient's strength is conserved, and the use of depressant sedatives is avoided. The patient may be fed by mouth. On account of the anesthesia, other measures, such as local operation and intraneural injection of antitoxin, may be carried on freely. Fox[2] found 50 per cent. of recoveries in 15 acute cases, that is, with an incubation period of less than ten days, treated by this method. In 2 of these cases more than eight injections were necessary.

Dr. Willard H. Hutchins, after experience in 6 cases,[3] recommends the use of chloretone for the control of the muscular manifestations. He asserts that the drug is harmless, easy of administration, and prompt in action. From 30 to 75 gr. may be given, dissolved in 1 ounce of whisky, if the patient can swallow, or through a stomach-tube, or in 1 ounce of hot olive oil by rectum. The dose can be repeated every twenty-four or forty-eight hours, as indications arise.

[1] Rogers, Jour. Am. Med. Assoc., 1905, xlv, 12: As the toxin is centripetal and finds its way to the central nervous system along the motor nerves, it has been suggested that there would be an advantage in cutting down upon the nerve-trunks supplying the part infected and injecting antitoxin into these directly. Success has been reported with this technique. The recent isolation of tetanus bacilli from enlarged glands by C. A. Porter and Oscar Richardson (Two Cases of " Rusty Nail " Tetanus with Tetanus Bacilli in the Inguinal Glands, Boston Med. and Surg. Jour., 1909, clxi, 927) may give an entirely different aspect to our treatment of the disease, bringing it into the classification with the septicemias.

[2] Therapeutic Gazette, 1911, xxxv, 730.

[3] Trans. Am. Surg. Assoc., 1909, xxvii, 279.

He suggests as probable that the therapeutic effect of the antitoxin is due to the carbolic acid or tricresol which it contains as a preservative, and which in itself is strongly recommended by Bacelli.[1]

The carbolic acid treatment of Bacelli is popular in Italy, where it has been used with apparently excellent results. Ascoli[2] reports 33 cases, with one death. It consists in the subcutaneous injection of a 1 per cent. solution of carbolic acid at frequent intervals until 80 gr. (adult) have been given in twenty-four hours. American reports do not show up so favorably. Symmers[3] found 16 deaths in 42 cases where this treatment had been used.

MALIGNANT EDEMA; GAS-BACILLUS INFECTION

The Bacillus aërogenes capsulatus is closely allied morphologically to the tetanus bacillus. It is anaërobic and its habitat is soil and street dirt, which might account for its occasional presence on the skin. Like the tetanus bacillus, it is found in the intestinal tract of man and animals. Infections with the gas bacillus are likely to follow extensive lacerations, crushing wounds of the extremities, and compound fractures, and in our experience it seems to be particularly apt to occur when the wound has been contaminated with grease and dirt from machinery and shafting or wagon-wheels and car-trucks. Welch[4] collected 5 cases in which infection followed hypodermic injections and subcutaneous infusions of salt solution. Cases have been reported following appendectomy, herniotomy, nephrotomy, operations about the urethra and uterus, but, on the whole, its postoperative occurrence is rare. We have known of its following operation about the rectum and curettage for induced abortion, and there has recently been a fatal case following amputation for diabetic gangrene at the Boston City Hospital. The source of infection in these cases may ordinarily be presumed to be the intestinal tract, although cases are on record where the bacilli were deposited by the blood-current in tissues deprived of vitality.

The **symptoms** usually make their appearance within twenty-four to forty-eight hours after infection. The first sign is a livid or bluish swelling about the wound, followed rapidly by the occurrence of gaseous infiltration, which crackles and pits on pressure. A foul,

[1] Sull'azione delle iniezione di acido fenico nelle neoralgie, nel tetano e nella tisi, Lavori di Congressi di medicina interna, Roma, 1888, 1, 342.

[2] Boll. d. Reale Accad. Med. di Roma, xxiv, iv, 495.

[3] Amer. Med., Aug. 15, 1903.

[4] Bull. of Johns Hopkins Hospital, Sept., 1900.

watery, blood-tinged secretion may be expressed, which contains tiny bubbles. Blebs filled with this secretion appear, and the process extends rapidly in the form of a moist gangrene, which may involve the entire limb within twenty-four hours. There is no pain. Profound prostration ensues, with delirium, and the patient usually dies of toxemia. This clinical picture accounts for the name malignant edema, which is sometimes given the condition. Smears from the exuded serum show the presence of the bacilli.

The **treatment** must necessarily be immediate and heroic. Free incision should be made wherever there is infiltration, and moist antiseptic dressings should be continually applied or the continuous bath or irrigation employed. On the theory that the bacillus cannot live in the presence of oxygen, potassium permanganate or hydrogen dioxid may be used freely, or a stream of oxygen may be carried direct into the tissues.[1] If the infection has involved a limb, high amputation offers the best hope for recovery, and should be performed before the patient becomes too depressed to stand anesthesia.[2]

In a recent personal case, following compound fracture of the elbow, where amputation was performed at the shoulder through tissues already edematous, recovery followed wide incision of the tissues, the amputation stump being left open, and the application of salt and citrate, with supportive measures.

PAROTITIS

Inflammation of the parotid glands occurs not infrequently after operations, usually, however, after operative procedures on the abdominal and pelvic viscera. It is on record also as following simple concussion of the abdominal organs.[3] It also occurs during rectal feeding.[4] It is found to occur more frequently in women than in men.[5] It may follow any injury or disease, but is more frequent after in-

[1] Thiriar, Presse Méd., Belge, 1904, lvi, 555.

[2] Abner Post, Pseudomalignant Edema, Boston City Hosp. Med. and Surg. Reports, 1896, seventh series; Paul Thorndike, Clinical Report of Cases of Infection due to the Bacillus Aërogenes Capsulatus, Boston Med. and Surg. Jour., 1900, cxlii, 592; J. H. Pratt and F. T. Fulton, Report of Cases in which the Bacillus Aërogenes Capsulatus was Found, Boston Med. and Surg. Jour., 1900, cxlii, 599; John Bapst Blake and F. H. Lahey, Infections Due to the Bacillus Aërogenes Capsulatus, with a report of 10 cases, Jour. Am. Med. Assoc., 1910, liv, 1671.

[3] Kulka, Secondary Parotitis, Wien. klin. Woch., 1908, xxi, 691.

[4] W. S. Fenwick, The Prevention of Parotitis during Rectal Feeding, Brit. Med. Jour., 1909, i, 1297; and Gaultier, Arch. des Mal. de l'App. Digestif., Jan., 1911.

[5] Paget, Lancet, 1887, i, 314.

juries and operations on the pelvic organs than after diseases in any other part of the body.

In onset and appearance it resembles mumps. The swelling may be one sided or double, and other salivary glands, such as the submaxillary and sublingual, may also become swollen. The inflammation usually appears anywhere from five to ten days after the operation. Its onset is accompanied by a rise in temperature which lasts for two or three days, together with pain in the affected gland. Usually the symptoms are not severe. The swelling may disappear by resolution or the gland may become septic. The temperature, as a rule, does not rise above 101° or 102° F., except in septic cases.[1]

Suppuration occurs in about one-half the cases following operation. An abscess will form in the substance of the gland, and unless treated this is likely to burst into the mouth or burrow a path into the external auditory canal or down the neck in the pharynx.[2] A considerable proportion of the suppurative cases prove fatal.

The origin of the parotitis following trauma or operation is still somewhat doubtful. The association of parotitis with operations upon pelvic organs is suggestive of the oft-noted occurrence of epididymitis and ovaritis following epidemic parotitis, which speaks for some association between this gland and the generative organs. Some authorities consider that toxic agents circulating in the blood are an

[1] A typical case is well described by P. W. T. Moxom (N. Y. Med, Jour., 1911, xciv, 985): A woman of seventy years suffering from acute appendicitis was treated medically, with success. The symptoms had practically disappeared by the seventh day (Jan. 3d), when, late in the afternoon, she awoke from a nap to find her left cheek swollen and painful.

"When seen at 8 P. M. the left parotid was found much swollen and very tender. The swelling extended around under the left ear; there was considerable postauricular edema. Temperature per rectum 98.8° F. The following day the swelling had much increased. The gland was very tender and hard, the skin hot and purplish red. Ice-bag was applied with some relief to the pain, but without much effect on the swelling. The gland continued hard and much swollen until January 8th, when it became somewhat softer and 'boggy,' and although no distinct fluctuation could be made out, an inch-long incision was made into the substance of the gland. Over 2 drams of green, foul-smelling pus were evacuated. On the following day the right parotid became swollen, hard, and painful, the skin overlying it red and shiny, and the right eyelid edematous. The following day the submaxillary and lingual glands were much swollen, but without pain or tenderness. The patient, however, suffered much discomfort from inability to close the mouth, and from the constant flowing of saliva. With the first appearance of trouble in the right gland, an ice-bag was applied and the pain and swelling gradually diminished. Five days later the right parotid was practically normal, and the swelling in the submaxillaries and linguals had subsided. The left gland continued to discharge, at first pus, later a thin watery secretion until January 25th. Six days later the wound was entirely healed."

[2] Bumm, Münch. med. Woch., 1887, xxxiv, 173.

important factor in suppurative parotitis.[1] There is far more evidence, however, supporting the theory that germs enter the gland by way of the mouth.[2]

A patient who is kept upon his back and allowed only a liquid diet or is fed by rectum does not use his jaws in chewing, and, therefore, is not apt to empty his parotid ducts as he would normally. The secretion of saliva is diminished or suppressed, and the germs present in the mouth take on an added virulence. They make their way through the duct into the stagnant gland and inflammation ensues. Parotitis may also be due to the presence of a decayed tooth, or may follow the pressure of the fingers of the anesthetist during an operation in holding forward the jaw.

Reichmann[3] reports 3 cases of parotitis occurring in patients under rectal feeding, with 1 death; Rolleston and Oliver,[4] 21 cases, with 2 deaths; and Gaultier,[5] 3 cases, of which 1 was fatal.

Prophylaxis is important. During periods of withdrawal of food by mouth, and in states of depression, when the patient exists on liquid foods which require no chewing and make no demand on the salivary secretions, particular care must be taken to keep the teeth and mouth clean, and measures must be maintained to keep the salivary glands functioning. Chewing gum[6] or sucking a rubber nipple will usually prove efficacious. Otherwise, the excretory ducts should be massaged several times daily, and their contents expressed.

The **treatment** of this condition consists in keeping the teeth and mouth clean and the bowels active, and the use of morphin for pain when it becomes necessary. Hot fomentations often give relief.

Suppuration should always be suspected if pain is severe and prolonged or if the temperature is maintained at 102° F. or over. When suppuration occurs, incision should be made at once, with care that the

[1] Dyball, Ann. Surg., xl, 886.

[2] Soubeyran and Rives, Arch. Gén. de Chir., 1908, ii, 448.

[3] Archiv. f. Verdauungskrankh., 1905, 133.

[4] Brit. Med. Jour., 1909, 2526.

[5] Archiv. des mal. de l'app. digestif., 1910, 20.

[6] Legrand Kerr (Chewing-gum as a Mouth Cleanser, Am. Med., Oct., 1911) finds the use of chewing-gum very desirable in keeping the buccal cavity clean through the mechanical action of the movement of the tongue, as well as in stimulating the flow of saliva. A fresh piece should be used each time. It is highly effective in its results, and to some people, particularly children, it is more pleasant than other measures of cleaning the mouth, which, however, should not be entirely neglected.

branches of the facial nerve are not wounded.[1] Even if no pus is found, the incision will usually afford relief. After incision, Bier's suction apparatus may be employed with advantage.

So long as the temperature remains normal there need be no uneasiness. Ordinarily, symptoms are slight and of short duration, and the only disadvantages are the depressing effect upon the patient's mental condition and his appetite, and the pain which he may suffer. Death has occurred from secondary cellulitis of the neck and edema of the glottis.

STATUS LYMPHATICUS

It has long been known that children are more subject to sudden death during or immediately following an operation than adults. Sudden death has occurred in children who are apparently in normal physical condition, even following operations of short duration, such as tonsillectomy. The fatality has seemed to be independent of the anesthetic used, and has sometimes occurred when no anesthetic at all was employed. According to some authorities, this condition is the most common cause of sudden death during chloroform anesthesia in cases where the anesthetic is being administered by an expert, although recently (see p. 112) other explanations have been offered.

Autopsy in some of these cases of sudden death has demonstrated the presence of an enlargement of the lymphatic tissues throughout the body. There is hyperplasia of the lymphatic system in general, enlargement of the superficial and deep lymph-nodes, especially those in the neck and the axillæ, and enlargement of the spleen. This in some cases is accompanied by a persistent or enlarged thymus. The association of persistence or hypertrophy of the thymus with sudden death from respiratory interference has been recognized for about three hundred years, and many surgeons of to-day are coming to be of the opinion that this gland is the essential factor in what is usually called status lymphaticus.

The existence of status lymphaticus during life can never be more than suspected. The fact that the child has enlarged adenoids and tonsils is not especially significant. If this enlargement is associated with other evidences of lymphatism, such as general glandular enlargement or enlarged spleen, one should hesitate before administering an anesthetic. The condition is known also to be associated with rickets, and in any suspicious case one should look for enlargement of the area of thymic dulness. Children who are subject to the disorder are apt to be anemic, with the pasty complexion and anxious facies suggestive

[1] D. F. Jones, Boston Med. and Surg. Jour., 1902, cxlvii, 565.

of cretinism, and they are likely to be subject to attacks of syncope and dyspnea, of laryngismus stridulus, or thymic asthma. They may present none of these associated conditions; death after simple operation may come without warning.

Usually death follows so suddenly upon the first appearance of symptoms that treatment is of no avail. Artificial respiration should always be instituted and anal divulsion and cardiac massage resorted to. If opportunity allows, measures should be taken to support and stimulate the patient. Adrenalin, camphor, brandy, and atropin may all be employed, with the hope that they sustain the patient. If there seems to be mechanical pressure upon the trachea to such a degree as to interfere with respiration, tracheotomy should be performed. The introduction of large quantities of fluid by all possible avenues may dilute an overdose of thymic secretion, which may be the condition here present.

The function of the thymus gland has not been definitely determined, though recent experiments by O. Nordman[1] and H. Klose[2] have thrown some light upon the subject. Nordman found that removal of the thymus in young puppies was followed by the death of the animal within one year, with dilatation of the entire heart, especially the right half, but without hypertrophy. He believes the thymus and the adrenals to produce internal secretions antagonistic to each other. Klose, in similar experiments, found that following the removal of the thymus in early life symptoms of acid intoxication set in, presumably from nucleinic acid, and a deficiency of lime salts, with resulting changes in the brain and bones. Partial removal of the gland during the stage of activity or complete removal during the period of involution did not produce permanent injury. Treatment with thymus extract did no good.

If status lymphaticus is due to oversecretion of the thymus gland, and if the theory of Nordman, that the secretions of the thymus and adrenals are antagonistic, is borne out, we would logically be led to put faith in adrenal extracts in treatment.

References.

R. Park, The Status Lymphaticus and the Ductless Glands, Surg., Gyn., and Obst., 1905, i, 140.

R. E. Humphry, Clinical and Postmortem Observations on the Status Lymphaticus, Lancet, 1908, ii, 1870.

W. J. McCardie, Status Lymphaticus in Relation to General Anesthesia, Brit. Med. Jour., 1908, i, 196.

W. H. Roberts, The Status Lymphaticus with Particular Reference to Anesthesia in Tonsil and Adenoid Operations, Jour. Am. Lar., Rhin., and Otol. Soc., 1908, 507.

[1] Archiv. f. klin. Chir., 1910, xcii, 946

[2] Ibid., 1910, xcii, 1125.

HEMOPHILIA

The occurrence of postoperative hemorrhage has already been considered under Chapter VI. Sometimes a patient who is subject to hemophilia is operated upon without knowledge of his condition, and it is not until after the surgeon notices persistent hemorrhage following operation that he is led to make inquiry and so arrive at a diagnosis. Operations of any degree of severity on hemophiliacs are frequently followed by fatal results. Surgical measures, therefore, should not be knowingly attempted except when vital necessity exists.[1] Before operation treatment should be instituted to forestall all expected hemorrhage. Serum or the calcium salts should be administered.

Treatment.—The treatment of the capillary oozing which characterizes hemophilia is frequently tedious and oftentimes barren of results. It should be followed up most assiduously, and it sometimes resolves itself into a duel between death and the doctor. Internally, the patient should be stimulated by a sufficient diet, and iron, ergot, or thyroid extract may be administered. If the wound is accessible, it should be cleaned thoroughly down to the bleeding surface, and a styptic, such as Monsell's solution, tannic acid, or adrenalin in the form of powder or in solution, 5 per cent. gelatin, or 4 per cent. cocain solution on pledgets of cotton, should be applied direct and under pressure to the bleeding capillaries. These applications should be renewed whenever the oozing of blood is sufficient to warrant it. If firm pressure can be brought to bear upon the artery which supplies the part, this may often be efficacious in bringing the hemorrhage to a stop. For nasal hemorrhage, the spraying of undiluted hydrogen dioxid into the nose has been extolled. For hemorrhage after extraction of teeth, freezing the surface with ethyl chlorid spray has been recommended.

Constitutional Treatment.—Calcium chlorid has in some cases been followed with success by increasing the coagulation of the blood; again, it has been of little or no value. The same may be said of gelatin by mouth or subcutaneously. Like gelatin, it sometimes controls the hemorrhage when applied tightly to the wound in a 2 per cent. solution on absorbent cotton. Too much calcium will increase the coagulation time rather than diminish it, and it cannot be given over too long a period, at least without intermissions, without incurring the same result. In some cases it has been useless. The use of calcium lactate (see p. 76) instead of calcium chlorid has recently been followed by good results, and with it more uniformity and certainty of

[1] Dahlgren, Hygeia, 1908, lxx, 481.

action can be expected. It should be given in a dose of about 40 grains. There has been reported success following the use of thyroid extract.[1]

The Use of Animal Serum.—It has long been known that the serum which separates from clotted blood contains an agent which promotes coagulation. Hayem, in 1882, working on transfusion, demonstrated that injected serum possessed the power of increasing coagulability. Weil, while studying hemophilia,[2] first made practical application of this principle. His work forms the basis of our knowledge on the subject.

Weil injected fresh animal sera intravenously or subcutaneously for the purpose of preventing or controlling hemorrhage. He found, by clinical observation in 11 cases, that the blood-serum of horses, rabbits, and, best of all, human beings had the power of controlling hemorrhagic processes by increasing the coagulability of the blood. Beef-serum should not be used on account of the toxic symptoms which are induced. The serum should be fresh, that is, less than two weeks old, and 15 cc. should be given intravenously or 30 cc. subcutaneously in adults—half as much in children. It may be repeated after a day or two without danger; and in hereditary hemophilia he found that repeated injections were usually necessary. The use of the serum locally favors clot-formation. He found that the serum was efficacious in relieving all hemorrhagic conditions, and that definite cures usually resulted in cases of sporadic hemophilia and acute purpura. Given in similar dose before operation it acts as a prophylactic.

Weil's observations were confirmed by his countrymen, Eliçagaray[3] and Carrière.[4] Broca, in Germany, tried the method[5] in 3 cases of hemophilia, using diphtheria antitoxin (horse serum) locally with success. He decided that the method was a very valuable expedient in hemophiliac hemorrhage, and suggested that, although it could not be considered as a cure for hereditary hemophilia, by repeating the injections every three months, using sera from different animals so that the danger from anaphylaxis would be lessened, a hemophiliac could be practically insured against serious hemorrhage.

Lommel[6] reported success with the method in a boy of four years

[1] Rugh, Ann. Surg., 1907, xlv, 666.

[2] L'Hemophilie, Pathogénie et Serotherapie, Presse Med., Oct. 18, 1905; Des Injections de serum sanguin frais dans états hemorrhagipares, Tribune Med., Jan. 12, 1907.

[3] Thèse de Paris, 1907.

[4] Münch, med. Woch., 1907.

[5] Med. Klin., 1907, 1445.

[6] Zeit. für innere Med., 1908, xxix, 677.

afflicted with hemophilia. He used antistreptococcus serum which was a year old, being the only serum that he had at hand, locally and in a dose of 20 cc. subcutaneously. He was obliged to give 10 cc. more. Baum[1] used fresh serum after the Weil method in 3 cases of hemophilia with moderate success. Gangani[2] reported partial success in a boy of four with hemophilia by the use of diphtheria antitoxin. Complete success followed the use of fresh rabbit serum. The injection of 10 or 20 cc. he declared should be repeated and pushed beyond the maximum generally accepted. The fresher the serum the better. The success which Goodman reports[3] with transfusion is undoubtedly due in part to the thrombokinase supplied by the serum of the transfused blood.[4]

Leary[5] used rabbit serum with success in cases of hemophilia, postoperative hemorrhage, hemorrhage of the newborn, uterine hemorrhage, typhoid hemorrhage, purpura, and as a prophylactic against hemorrhage in cases of jaundice before operation. He considers the subcutaneous method as more desirable than the intravenous on account of the danger of hemolysis or thrombosis following its injection into veins.

The rabbit serum can be obtained aseptically by cardiac puncture without seriously inconveniencing the animal. The chest is shaved over the sternum and left side. With an ordinary antitoxin needle a puncture is made to the left of the sternum and about 1 cm. above a line drawn transversely at the junction of the sternum and ensiform. A needle is thrust toward the middle line and slightly upward. The puncture usually penetrates the left ventricle. Blood to the amount

[1] Mitt. aus den Grenz. der Med. und Chir., 1909, xxi.

[2] Gaz. Deg. Osp., 1909, xxx, 753.

[3] Ann. of Surg., 1910, lii, 457.

[4] Clinical success with fresh human or animal serum has been reported also by Beach, Yale Med. Jour., June, 1910; Trembur, Mit. aus den Grenzgeb. der Med. u. Chir., 1910, xxii, No. 1; Sahli, Deutsches Arch. f. klin. Med., 1910, xcix, Nos. 5 and 6, and others. W. Meyer (Surg., Gyn., and Obstet., 1911, xiii, 152), at the suggestion of Welch (Am. Jour. Med. Sci., June, 1910), who commended the use of human blood-serum in hemorrhage of the newborn, and whose technique he employs, used it in cases of uncontrollable hemorrhage following operations on the bile-ducts in the presence of chronic jaundice with success. The blood may be obtained from relatives or strangers, but the Wassermann reaction should be taken as a preliminary measure. Tapping both cephalic veins in two healthy individuals will yield 300 to 400 cc. Thirty to 60 cc. should be administered three times a day, beginning two or three days before operation, and for two or three days after. There is practically no limit to the amount which may be used if necessary. Treatment started after operation may succeed, but less favorable results are ordinarily to be expected.

[5] Comm. of Mass. Med. Soc., 1908, xxi, 123.

of 30 cc. is slowly withdrawn. It is collected in sterile centrifuge tubes. After a short stay in the thermostat the clot is separated by a platinum needle and the material shaken in an electric centrifuge and the serum drawn off.

If diphtheria antitoxin is used for this purpose, it should be less than two weeks old. The serum supplied in Massachusetts by the State laboratory is from six weeks to six months old before it is delivered, because it has to be kept while the animals are being watched for the development of tetanus and other diseases. The same objection probably holds in the use of commercially prepared sera.

Nolf and Herry[1] advise the use of a 5 per cent. solution of peptone (Witte), instead of fresh serum, claiming that it is more energetic, more readily sterilized, and without danger of anaphylaxis. They have used it successfully in 9 cases, injecting 10 cc. of a 5 per cent. solution in 0.50 per cent. sodium chlorid. It is sterilized by heating for one hour at 120° C. For local application they recommend an extract of spleen, lymph-glands, and thymus obtained fresh from a slaughter-house, and made by triturating the organs with a little sand, adding to 1 part of the gland 2 parts of a 0.09 per thousand sodium chlorid and 0.5 per thousand calcium chlorid solution and straining. Kottmann and Lidsky[2] emphasize the value of the local application on tampons of fresh animal blood or serum. To obtain an even more efficient action, they chop and grind fresh rabbit or other animal liver, soak it in water, filter it through an ordinary cloth, and apply the turbid suspension directly to the wound.

[1] Rev. de Méd., 1910, xxx, No. 2.
[2] Münch. med. Woch., 1911, lvii, No. 1.

CHAPTER XXIX

HABITS AND THEIR RELATION TO SURGICAL CONDITIONS: ALCOHOL, MORPHIN, COCAIN, TEA, TOBACCO, SNUFF

Alcohol.—Surgically speaking, there is no habit of worse prognostic significance than the alcoholic; any intemperate person is a poor surgical risk. Confirmed alcoholics present serious chronic metabolic changes—cardiac and peripheral arteriosclerosis, enlarged livers, and impaired kidneys—and unstable nervous systems.

There are two great classes of alcoholics: the constant daily tippler, with his occasional week-end spree, and the periodic victim of overindulgence, who between times is an almost total abstainer. Of the two, the latter is by far the lesser risk. Other things being equal, his alcohol does not so seriously lower his surgical resistance. Unfortunately for him, he frequently meets the surgeon in the midst of one of his sprees, the unconscious victim of an accident. As a rule, his acute alcoholism does not seriously affect the prognosis of the case. It is an excellent plan to wash his stomach out, leaving in a generous dose of Epsom salt and bromids if he is at all unruly. Ordinarily, it is perfectly safe to give him ether and repair whatever slight damage there may be. In severe accidents, aggravated by shock or hemorrhage, the prognosis in his case is made much more serious by reason of his habit.

The other class is perhaps more often met with surgically, particularly in hospital practice. The surgical trouble is often trivial; it is the alcoholic habit that makes the case serious. Often, either because the patient wilfully and to his own undoing conceals his alcoholic history, or from oversight on the part of the attending physician, or from the surgeon's failure to appreciate fully the serious after-effects of chronic alcoholism, the patient is suddenly wholly deprived of his customary stimulant. His nervous system at once wavers. An unnaturally keen attentiveness to surroundings, an abnormally active response to trivial sensations, and a slight tremor of the protruded tongue and extended fingers are the forerunners of the visionary hallucinations and delirium by which the nervous system reacts to its deprivation. Delirium tremens is the price that alcohol demands. To the sudden deprivation of alcohol are added ether anesthesia and enforced rest in bed, either of which in itself is sufficient often to precipitate an attack.

Cheever[1] effectively sums up the situation in the following paragraph: "Patients who do not drink do a great deal better than those who do in every form of accident and injury. The calmness of the body and mind is with the temperate. The resistance to shock is with the temperate. The ability to respond to stimulants promptly is with the temperate, for the intemperate have already used up their powers of vital resistance; they have become accustomed to the overuse of stimulants, and they do not respond readily to them, and you do not get the benefit from stimulants which you expect. An illustration of this is seen in etherization; as we said before, it takes a great quantity of ether and laborious and excitable and protracted etherization to overcome the drunkard and make him go to sleep, whereas the patient who is temperate, as a rule, takes it calmly, succumbs to it easily, and recovers promptly. There can be no doubt, I think, that the continuous use of alcohol has a deleterious effect on the tissues: hardens them, thickens them, prevents absorption as readily, dilates the veins, leads to a slow and labored circulation; in that way delays absorption and, moreover, produces finally some changes in the brain which in the end are structural. All these things count against the patient when he is suddenly brought to meet the strain of a severe accident or a severe operation."

The *treatment* of delirium tremens will be considered later. (See p. 310.) To prevent its development it is always permissible to give alcohol. In many cases beer and ale, if given from the very start, will tide a whisky drinker over the critical period. The patient should be got out of bed into a chair as soon as possible. The exercise of pushing a wheel-chair about serves to occupy the attention and will sometimes ward off an incipient case. Etherization should be postponed when possible until the nervous system has become steadied.

Morphin.—The morphin habitué ordinarily presents a fair surgical risk, provided the physical condition is good. It is essential, as in the case of alcohol, that the drug be continued through convalescence and the dose gradually reduced. Few cases are more pitiable than the suddenly restricted morphin fiend. Moreover, the diarrhea, restlessness, intense misery, and persistent apprehension and wakefulness which follow the sudden withdrawal of morphin constitute a more than imaginary danger. Morphinism must be recognized as a disease.

Cocain.—What has been said of morphin applies equally well to cocain. Before the patient has deteriorated to a marked degree physi-

[1] Boston Med. and Surg. Jour., 1893, cxxviii, 253.

cally from the use of the drug the habit should not be a contraindication to necessary operation. Cocain users are likely to suffer from sleeplessness, tremors, and hallucinations, together with digestive disturbances and emaciation. If they are deprived of the drug, there is apt to follow a profound physical depression. As with morphin, if the opportunity is allowed, two weeks may be given before operation to the gradual withdrawal of the drug.

Sudden deprivation of **tea** or **coffee** in those who are accustomed to use them to excess is sometimes followed by the occurrence of a tremor accompanied by nervous excitation and wakefulness without delirium. This has been noted to occur also in inveterate users of **tobacco,** either smokers, chewers, "dippers," or inhalers of snuff. Both tea and tobacco are likely to induce functional cardiac disturbances, such as palpitation and pseudo-angina pectoris, which may compel a more careful etherization, and, moreover, they may even bring about organic degeneration in the heart and vessels, which may have serious significance. Ordinarily, however, the moderate use of tea and tobacco need cause no anxiety. Deprivation will be followed ordinarily by nothing worse than a temporary nervousness and an intense longing to resume the habit. In so far as it is unwise to attempt to correct habits of this nature during convalescence, and as the return to normal is hastened by agencies which promote comfort and a sense of well-being, it will often be found advisable to gratify to a limited extent the longings of patients in these matters. One cup of tea or one pipe of tobacco a day may justify itself by reconciling the convalescing patient, in part at least, to his enforced confinement.

CHAPTER XXX

POSTOPERATIVE PSYCHOSES: DELIRIUM TREMENS, INSANITY, MENOPAUSE

DELIRIUM TREMENS

THE condition of maniacal delirium from alcohol poisoning is so apt to complicate disastrously surgical convalescence that it forms an important subject for consideration. We meet the condition in one of two forms: in the first it is the result of overindulgence—an acute alcohol poisoning; the other form, which we see more frequently, results from deprivation; it occurs in those habituated to the use of liquor, even though several days or weeks have elapsed since they have partaken of alcohol.

Delirium tremens may be excited by nervous shock from a comparatively slight injury.[1] It may follow elective operations in those who are accustomed to alcohol; it occurs most commonly in surgical practice after operations of necessity, such as compound fractures, etc.

In cases which are operated upon while still under the influence of alcohol a delirium accompanied by tremor and insomnia may occur directly after the patient has recovered from the anesthetic. In the more common form a period of hours or a day or two is likely to elapse before the symptoms become so evident as to be recognized. The patient at first is quiet and subdued, and his condition to a certain degree resembles that of mild shock. Then there gradually develops a delirium in which the chief factor is usually fear. The patient suffers from delusions and hallucinations, which he sometimes succeeds in concealing from the physician and attendants, and he makes efforts to escape from the danger which he imagines pursues him. Unless he is carefully watched, these attempts may result in injury to himself or others or he may even escape from the ward in which he lies.

The course of the disease may be divided into three stages: The *first*, or *prodromal stage*, is characterized by the condition of nervous apprehension. This usually lasts about twelve hours. The patient, as a rule, is submissive and extremely anxious to comply with all the

[1] Forge and Jeanbrau, Death from Post-traumatic Delirium Tremens, Presse Méd., 1909, xvii, 19.

directions which are given him. Whatever he is asked to do he does with precipitance and sometimes violence. He frequently labors under the apprehension that he is going to die. His mind is changeable, and no impression lasts longer than a few seconds. In his fear of death or danger he forgets pain, and he may get out of bed, tear off his dressings, or walk about on a fractured leg in spite of the admonitions which have been given him. His hands and tongue are markedly tremulous. This stage shows itself usually on the second day after operation.

The second stage is that of *active delirium.* The state of apprehension occasionally gives way to lapses of intelligence, during which illusions of sight and hearing and hallucinations of persecution become evident. The patient becomes anxious and refuses to take food. He is listless and may lie restlessly quiet for hours at a time, muttering unintelligibly to himself, and picking at the bed-clothes and at imaginary objects in the air. He sees insects and reptiles or other animals in the corners and on the ceiling. He keeps up active purposeless movements without intermission until he perspires from weakness and sleep is an impossibility.

From this stage of active delirium the patient is likely to descend into a condition of *low muttering delirium,* and finally stupor develops. The prostration becomes excessive, pulse soft and weak, and he gradually sinks into a coma from which he cannot be aroused and death ensues.

Treatment.—If the patient has been operated upon while still under the influence of an alcoholic debauch, means should at once be taken after he recovers from the anesthetic to eliminate whatever of the alcohol may still remain. A stomach-tube should be passed and the stomach washed out, and two ounces of a saturated solution of Epsom salt poured into the stomach through the tube. He should be given water in considerable quantity to drink and potassium acetate in doses of 15 gr. to further aid elimination through the kidneys. At the same time he should be sweated by means of a hot-air bath or hot pack. In order to lessen the desire for liquor, and to forestall an acute gastritis, he should be given capsicum, 10 minims of the tincture in a glass of hot milk, every two hours. Alcohol, best in the form of beer or ale, may reasonably be given in cases of this sort in small quantities. After twenty-four hours he should be gradually worked up to a normal diet. If his sleep is interfered with, sedatives should be administered.

If the delirium arises from delayed alcohol poisoning, its treatment is more complicated and less certain. If the patient can be made to eat and to sleep, cure is practically sure. To obtain sleep in delirium tremens the sedatives and hypnotics of the pharmacopeia have been exhausted. Opium in ordinary doses is ineffectual and in large doses it may precipitate coma. Chloral and paraldehyd in such doses as are usually necessary are too depressant, and the same may be said of sulphonal, though sulphonal, 30 gr. every four hours, to 6 doses, is often used. Ether by inhalation will give the patient temporary respite, but the delirium recurs on awakening. Hoffmann's anodyne is a mild sedative and at the same time a stimulant. The sedative which is ordinarily employed is the bromids. These are the least depressant of the active sedatives. Usually they are given in the form of equal parts of the bromids of sodium, potassium, and ammonium, on account of the depressant action of the sodium. This mixture may be given in doses up to 90 gr. Chloralamid may be given in doses of 20 gr. every four to six hours. Digitalis was at one time held in high repute, because it slowed the pulse and quieted the circulation and in this way aided the system to gain repose. It was formerly given in doses as large as a dram of the tincture at a time. It was found, however, in some cases to prove fatal. It is now frequently given in ordinary dosage to overcome the depressant action of the large doses of sedative which are ordinarily necessary. Fluidextract of ergot, 1 dr. repeated every four hours, has been recommended. Capsicum is valuable when given for the purpose of stimulating the gastric mucous membrane. Alcohol in the form of beer or ale is useful as a stimulant, and when given in limited quantity is justifiable.

When the delirium becomes active, restraint becomes a necessity. The use of a strait-jacket, or even a sheet tied over the body, is directly injurious, and should not be allowed unless it is absolutely necessary. Under the best form of treatment physical restraint of any sort is usually not considered. A good nurse should talk with the patient, try to amuse him and to win his confidence. In this way the patient can be made to forget most of his fear and he does not exhaust himself by his endeavors to ward off danger. If he starts to rise, a restraining hand can be put upon his shoulder and he is readily persuaded to lie quiet in bed. To be left alone terrifies him. He likes to be in the presence of people, he likes cheerful conversation, and he is particularly afraid of the dark. Sleep is to be sought for above all things, and when it comes and lasts, recovery is almost sure. If it is interrupted, the patient has a succession of ineffectual short naps and no good results.

Next in importance to sleep is nourishment. If the stomach will tolerate food, the prognosis is good. Usually there is no appetite and food has to be forced, or the stomach is irritable and will not retain the food. In the latter condition effervescent waters and small doses of calomel are of benefit. Ice may be given freely; milk and lime-water, malted milk, etc., should be tried. If the stomach retains food, the patient should be given liquids at frequent intervals and in considerable quantity.[1]

POSTOPERATIVE INSANITY

The existence of mental disturbances following operation was noted many years ago. In the sixteenth century Paré remarked that before an operation the patient must be in a condition of spiritual calm, in order to avoid delirium and other harmful after-effects. Dupuytren (1819) was the first to describe a condition of mental excitation, which he called delirium nervosum—coming on immediately following operation. Herzog (1842) described a case of mania following an operation for strabismus, and Sichel (1863) reported 8 cases after cataract extraction. These reports were followed by many others, all succeeding operations on the eye. Von Courty, in 1865, described the first case following ovariotomy, and in 1880 Lossen and Furstner reported a case after hysterectomy. Since that date there has developed a very considerable literature on the subject.

Occurrence.—Various forms of mental disturbance may follow operation; genuine insanity may occur, but it is relatively rare. Just how often psychoses traceable to anesthesia or surgical procedures occur it will always be difficult to say, many of them not making their appearance until weeks or months after surgical recovery. Dewey, in 5000 insane, found only 3 cases of insanity following operation in persons previously of sound mind. J. K. Mitchell examined 344 patients, and, excluding all cases where concomitant causes existed, found 31 instances of neurasthenic or mental disorders following operation or anesthesia. Of these, 94 per cent. were women and 6 per cent. were men. It is uncommon also in proportion to the total number of operations, various writers reporting from 0.25 to 0.50 per cent. As to the nature of the operations which seem to induce insanity, operations on the genital organs in women or men take the lead, and eye operations come next, though almost every possible operation has found a place on the list. Rohé, of Baltimore, in studying 196 cases of postoperative insanity etiologically, found that the condition followed genital operations in 65 cases, cataract operations in 35 cases, and various operations in 96 cases. The preponderance, as regards sex, is generally placed at about 4 to 1 in favor of women. This is clearly due to the large proportion of gynecologic operations in women as compared with operations on the genital organs in men, for Sears,

[1] Cheever, Lectures on Surgery, Boston, 1894, 39.

of Boston, has shown that in operations common to both sexes the proportion is about equal.

Causes.—A patient suffering mildly from delusions may be operated upon without her mental condition being appreciated by the surgeon. It is not uncommon, for instance, for a woman affected with cyclic insanity to complain of vague abdominal pains, or to suffer from a variety of symptoms referable to the genital tract. Such a one may become insane at the application of the anesthetic. Generally speaking, however, operations may be performed on those frankly insane without detriment, and sometimes even with benefit to their mental trouble.

It may be considered, in general, that the essential prerequisite for the development of postoperative insanity in those previously of sound mind must be a neurotic organization, temperamentally predisposed, either from hereditary taint or from acquired nervous instability, to become unbalanced in consequence of an active disturbing factor. As Weir Mitchell has expressed it, "We must consider the patient as a loaded gun, and that the surgeon merely pulls the trigger." This determining factor may be psychic—strange surroundings, worry, vacillation between hope and fear, pain, anticipation of blindness, sterility, or climacteric. It may be toxic, as the withdrawal of alcohol, cocain, or morphin in those accustomed to their use. It may be traumatic, as head injuries or operations. Old age and arteriosclerosis, inanition, and feeble circulation are other predisposing factors. The nature of the operation, its duration, and severity even, must be considered of secondary importance.

Besides these preoperative causes, we must consider as important the toxic effect of the anesthetic, especially if long continued, and shock, hemorrhage, and collapse. In the postoperative stage we have to consider pain, enforced isolation, deprivation of light (in eye cases), deprivation of water, septicemia, acetonemia, and uremia. Finally, there are various drugs which may induce delirium—iodoform, atropin, sodium salicylate.

Forms.—There is no special form of mental disturbance to which the name postoperative insanity can be applied. Clinically, the term encompasses a variety of psychoses which are related to each other only in so far as they follow after a surgical operation. The condition ranges from the transient delirium or mental confusion, which may follow immediately on the use of any anesthetic—through the drug psychoses attending the local use of iodoform, the employment of collyria of atropin, or the internal administration of sodium salicylate, all of which usually subside with the withdrawal of the agent—and acute confusional insanity, frequently due to sepsis or toxic conditions, which often lasts weeks or months, and includes premature climacteric insanity in the form of melancholia following the removal of the ovaries, and premature senile dementia, not infrequently occurring after genito-urinary operations in the male. The manifestations may be maniacal, depressive, or paretic. The commonest type is acute confusional insanity—outbreaks of excitation with confusion and hallucinations, alternating with periods of stupor, coming on after a prodromal period of nervous irritability and mental anxiety. Sudden outbreaks of violence, as in puerperal and alcoholic insanity, occur uncommonly.

Prognosis.—If the mania has developed slowly in a young person otherwise of sound constitution, a perfect recovery may be usually expected, though some patients die of exhaustion. In older persons and patients suffering from grave organic disease, or weakened by alcoholism or syphilis, the development of a chronic dementia is to be feared. Recovery, when it takes place, is rapid, and leaves behind only a dim recollection of the events between the operation and the return to normal.

Treatment.—In the way of prophylaxis everything should be done before operation to induce a state of confidence and tranquillity of mind in the patient, and to lessen the nervous shock of any procedure which involves the genital or genito-urinary tract. The unpleasantness of the operation should be minimized. The surgeon should maintain a constant attitude of optimism and encouragement, and he should inspire the patient with sufficient confidence so that she will acquire from him moral support. Especial attention should be paid if the patient is known to be "high strung," has had attacks of mental instability, or has a suspicious heredity. In deciding for or against an operation of choice, the mental condition should be an important factor. Operations upon neurasthenics should be avoided when any other treatment will avail; operative procedures may relieve the symptoms, but the neurasthenia remains just as bad, and it may become much worse.

Treatment should be directed toward relieving any possible causal condition, septicemia and uremia should be combatted, toxic agents should be withdrawn. The patient should be kept in bed in cheerful, airy surroundings; isolation is not desirable. He should be kept clean, and particular attention paid to forestalling bed-sores. His nutrition should be well looked to; he should be encouraged to eat, and stomachics and stimulants employed if necessary. The bowels should be kept free with mild salines. Warm baths will usually suffice to control restlessness and sleeplessness; when hygienic measures fail, opium or hyoscin becomes necessary. Bromids should be avoided, as being too depressing.

Regis[1] has reported success with the use of ovarian extract in a woman who had had her ovaries removed, and A. T. Cabot[2] reported a case of confusional psychosis in which prompt improvement followed the exhibition of testiculin.

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MENOPAUSE

Mild psychoses analogous to those which sometimes occur at the climacteric may develop after destructive operations upon the pelvic organs in women. These manifestations are rarely of sufficient importance to necessitate treatment. They depend chiefly upon the apprehension with which most women regard this natural cessation of function. Many women look forward to the climacteric with dread, because they have seen or heard of cases of malignant disease or of nervous prostration occurring in others at a similar period. Others are apprehensive of a decrease in attractiveness and an early senile decline.

The symptoms which accompany this artificial menopause are usually emotional or melancholic, but they sometimes take the form of nervous instability, accompanied by hot flushes, vertigo, and palpitation. Rarely the condition goes so far as to cause a nervous breakdown which requires isolation and treatment. Ordinarily, whatever nervous manifestations arise are of a temporary nature, and disappear as the patient gets out of bed and about. Sometimes after removal of both ovaries the patient, if she has previously been thin, will become fleshy. Usually sexual desire is preserved unimpaired, although this seems to vary with the patient.[3]

[1] Am. Jour. Insan., 1893, l, 345. [2] Com. Mass. Med. Soc., 1893, xvi, 657.

[3] Walthard, Psychoneurotic Climacteric Phenomena, Zeit. f. Gyn., 1908, xxxii, 564; D. H. Craig, The Menopause, Jour. Am. Med. Assoc., 1908, li, 1507.

CHAPTER XXXI

GENERAL TREATMENT IN CONVALESCENCE

SOME surgeons make it a practice to administer tonic and stimulant drugs during recovery from operation to hasten convalescence. As a routine, the habit should be disapproved. Patients come to the surgeon in a state of more or less profound constitutional depression caused by their surgical condition, or else they are normal as regards general health, and present a condition which has caused no constitutional disturbance whatever. In the first case the removal of the depressing influence should be at once followed by the exhibition of a tendency toward a recovery of the normal tone and physical well-being; in the latter case, operation is a mere incident, and, except for the effects of anesthesia, the balance of metabolism should not be seriously disturbed. Ordinarily, a person who expects to be restored to complete health after an operation, who has not been sick long enough to have lost his impulse toward recovery, will need no artificial aids except cheerful, comfortable surroundings and companionship, a sufficient and proper diet, and plenty of sunlight and fresh air, if these may be called artificial.

The treatment of patients in whom ultimate recovery is not expected, and those whose spirit has been broken by prolonged illness or repeated disappointment, will depend on the nature of the case and the personality of the surgeon. Tonics and stimulants are indicated when they will impress the patient or sustain or improve his physical or mental tone. Added to, and better than, these is the moral influence of an energetic, strong-willed, and trusted physician. Ordinarily, surgical convalescence is comparatively brief, and the surgeon is not so likely to have cast in his way that bug-a-boo of the internist—the "chronic." Whenever, however, a surgeon becomes convinced that he is losing or has lost the confidence of a patient who is progressing slowly, and whose convalescence is likely to be prolonged, he will be wise if he calls a consultant or brings to his aid some other fresh and outside agency, be it psychotherapy, electrotherapy, hydrotherapy, light or mechanotherapy, the *x*-ray, or massage. Such a move will usually react to the advantage both of the patient and the doctor, and it should not be too long postponed.

The use of morphin in suffering incurables, and the use of proper medicines in those who have coincident disorders which require medical treatment, such as malaria or syphilis, is to be taken as a matter of course. If any other indications develop which require medication, they should be met. For instance, constipation, nervousness or insomnia, loss of appetite, impoverished blood, remembering what we have already stated, that a proper regulation of surroundings and habit and sufficient food and sunlight will often render drugs unnecessary.

Among the tonics and stimulants we will consider iron, strychnin, arsenic, and alcohol.

Iron is frequently indicated to overcome the effects of hemorrhage. It is best absorbed, in surgical convalescence at least, apparently not from the liquid preparations, but in the form of ferrous carbonate—Blaud's mass. Direct measurements of the number of red corpuscles and of the hemoglobin in an investigation which one of us carried out in two series of cases showed a distinctly more rapid increase in both respects on Blaud's mass than on reduced iron or several highly extolled liquid and proprietary preparations. The Blaud's mass should be given either in soft pills, not too old, or, better, as a powder in gelatin capsules.

Strychnin, either in the form of the sulphate, $\frac{1}{60}$ to $\frac{1}{40}$ gr., two or three times a day, or in the form of tincture of nux vomica, is a standard stomachic and nerve stimulant, and should be given in appropriate cases, withheld at night, or the dose diminished if it leads to sleeplessness.

Arsenic may be given as the trioxid in doses of $\frac{1}{100}$ gr. after each meal, or in the form of Fowler's solution, liquor potassii arsenitis, 3 to 6 minims, to be stopped at the occurrence of diarrhea or any other symptom of poisoning.

Alcohol in the form of bitters before meals, or ale or beer, undoubtedly has some place in convalescence, but in case of the slightest doubt as to its appropriateness it should be withheld.[1]

Out-of-doors and Sunlight.—Nearly all that has been said as to the value of out-door life and sunshine in surgical tuberculosis, applies, in our opinion, to the healing of all wounds and to surgical convalescence in general. The much-vaunted air of the Engadine is, after all, only

[1] In most of the English hospitals, porter, ale, and stout have been provided *ad lib.* to the inmates, the total expenditure for these potables, with wine and spirits, frequently exceeding the cost of milk supplied to the hospital. The curious arrangement still persists in some even of the larger hospitals of London of supplying ale, champagne, and alcoholic liquors to the patients, but classifying such articles as sugar, butter, and tea as luxuries, to be provided only at the expense of the individual.

pure air, and we need not cross the ocean to find that. It is obvious that in the presence of disease of the kidneys, and in possibly certain other special conditions, care must be taken not to expose the patient too early to a possible chilling of the skin in the out-door atmosphere, but in general the respiration and all other vital functions are stimulated by a convalescence spent, so far as possible, out-of-doors. There is an open-air sanatorium at every door, from which any surgeon with sufficient energy and originality can benefit.

A surgical operation should not be looked upon as an experience in disease, but rather only as an affection of a part—an aggravated sore finger, as it were, After an operation the patient should, as soon as possible, be surrounded by an atmosphere of normality, with rather the spirit of the theoretic soldier who binds up his wounds and proceeds. The mental attitude to encourage is—the patient has not been sick, he has been wounded.

It is not a contradiction of this sentiment of returning to normal life as soon as possible to say that, in the matter of visitors during a smooth surgical convalescence, the choice and number of visitors should be decided entirely by the patient, and the duration of their stay by the attending nurse, if she is a wise woman. Ordinarily, friends need only be told that it is to the patient's advantage for them to stay away, and they do so.

CHAPTER XXXII

BED-SORES: CAUSES; PREVENTION; TREATMENT

DECUBITUS, or bed-sore, is an area of moist gangrene caused by pressure. It is most apt to occur on the backs of patients who are confined in bed for an extended period, but it may occur wherever pressure is likely to exist unrelieved for any length of time. On the back, it occurs ordinarily over the bony prominences about the sacrum and on the buttocks. It may occur also on the heel, over the great trochanter, or at the edge of a splint, and the pressure of bed-clothes upon the toes may even be sufficient to cause it. Liability to the occurrence of bed-sores is always increased in conditions which allow of little or no voluntary movement on the part of the patient, especially in paralysis. It is increased by the lack of proper cleanliness or the presence of irritating secretions, and particularly the state of incontinence of urine or feces. Crumbs of bread, creases or folds in the sheet or bedgown, bits of string, pins, or other extraneous objects in the bed will furnish ample cause for the formation of a bed-sore. The absence of bed-sores in bed-ridden patients is usually held to be a criterion of good nursing.

The underlying cause of bed-sores is a lessening of the vitality of the skin by persistent localized pressure. If the nutrition is withheld from the cells, they slowly die and are cast off in the form of slough. The first clinical manifestation of a bed-sore is a reddening of the skin. This increases to a local congestion, which gradually becomes pale and then bluish. Finally, a line of demarcation forms and the area sloughs away. This leaves an ulcer with a foul, ragged bottom, which excretes a thin, acrid fluid. Unless relief is furnished, the ulcer increases rapidly in size and works its way deeper into the tissues. Sometimes an untreated bed-sore will extend so as to involve areas of considerable size and lay bare, for instance, the entire sacrum. Such ulcers are a severe drain upon the vitality of the patient and seriously complicate convalescence.

Any case in which the possibility of bed-sores may arise should be carefully watched, so that their occurrence may be forestalled. Prophylaxis consists in preventing unrelieved localized pressure. The bed-clothes should be kept clean, dry, and smooth, and no crumbs or extraneous substances should be allowed to find their way under the patient. The patient's own discharges should be looked out for carefully, and if there is any moisture about the genitalia, it should be dried and the parts powdered. Bandages and splints should be adjusted from time to time. The patient who is unable to turn in bed should have his position changed frequently by an attendant. All bony prominences on the back and points liable to suffer from pressure should be massaged and kept absolutely dry and powdered.

In case redness appears over the bony prominences action should be at once taken to distribute the pressure over a larger area and thus afford relief. On the back, this can be accomplished by making a so-called doughnut pad of oakum or tow, wrapped in gauze bandage, and placing it so that the opening will come opposite the point suffering from pressure. The same object can be accomplished by means of the rubber ring which is inflated with air. If there is pressure on the heel, as in a case of fracture or paralysis, the pressure can be removed in the same way. Other points which are liable to become pressed upon, such as the malleoli, tibia, and head of fibula, in case of splint or plaster-of-Paris bandage being worn, should be protected by careful padding. In order to keep the weight of the bed-clothes off the tips of the toes when they cannot be moved by the patient, a cradle of wire or wickerwork should be employed, or a 10-inch board on edge between the sheets along the foot of the bed may be used.

In all cases where patients are badly emaciated, or where the necessity for lying in one position will continue for a long time, they may be put upon a pneumatic bed, or a water-bed, which distribute the pressure from the weight of the patient over a wide area. Patients who are under treatment for fracture of the hip or thigh can be handled conveniently only when lying upon a Bradford (gas-pipe) frame or some similar device. These patients should be turned over twice a day, and any region found subjected to pressure should be washed and then thoroughly dried. It should then be rubbed gently with a soft towel, so as to improve the nutrition, and, finally, the skin should be powdered with some emollient powder, such as zinc oxid and starch or stearate of zinc. A piece of chamois skin placed between the skin and the sheet will cushion an irritated area and act to prevent friction. The use of alcohol or spirits of camphor will render the skin more resistant and less liable to ulceration, and the same is true of the compound tincture of benzoin. Sometimes a generous dressing of absorbent cotton, held in place by collodion, will serve to protect a small area of pressure hyperemia, or the skin may be painted directly with collodion or covered with adhesive plaster.

When the bed-sore has formed, the part should immediately be relieved of all pressure by turning the patient into another position permanently, or by the use of the ring cushion or water-bed. Dry dressings are to be preferred unless slough occurs, in which case the patient should be turned upon his face and moist applications frequently applied. For these dressings, nothing is so good as chlorinated soda and myrrh. The separation of the slough in deep-lying ulcers is usually tedious, and it may often be hastened by the use of a digestant, such as enzymol, or by clipping it away with scissors. Hydrogen dioxid is also of account in case sloughing occurs. After the slough has separated and the ulcer presents a granulating surface, skin-grafting, after the Reverdin method, may be resorted to with advantage. Otherwise some ointment, such as ichthyol (10 per cent.), ichthyol and zinc oxid ointments in equal parts, or a mixture of equal parts balsam of Peru and castor oil, may be relied upon. Stimulation, nourishment, and sleep are all valuable adjuvants in treatment.

CHAPTER XXXIII

FOREIGN BODIES LEFT IN THE ABDOMINAL CAVITY

ALTHOUGH this accident is not a title to greatness, it is said that every great surgeon has had it happen. It is certain that foreign bodies have been left in the abdominal cavity much more often than has been reported—first, because of cases ending fatally without autopsy, and, second, because surgeons are not likely to publish such experiences. The most complete recent papers on the subject are by Schachner in 1901 [1] and F. Neugebauer.[2]

Schachner has collected 155 cases of foreign bodies left in the abdomen, including in this number the cases collected by Wilson and Neugebauer. In Neugebauer's collection of cases there are 31 instances of sponges left in and 19 cases where artery forceps were overlooked and left behind. Probably every active surgeon, at one time or another, comes across cases which represent careless technique on the part of some one else. For instance, we have recently seen a case in which, four months after a patient left the hospital for a nephrectomy, a gauze strip a yard long was removed through a small sinus which had persisted in the scar since the operation. One of us has also removed fragments of glass, remnants of a broken irrigation tip, from a prostate, and an entire fenestrated rubber drainage-tube from a sinus which led into a deep-seated ischiorectal abscess. A case is on record[3] where a surgeon after a celiotomy noticed that he had lost a seal ring. The patient some time later was operated upon through the vagina by a second surgeon, who extracted the ring. Imagine the state of mind of the first surgeon when his former patient paid him a call for the purpose of restoring his property.

Symptoms.—The symptoms that follow the retention of a foreign body in the abdomen will depend upon the nature of the body, the region in which it is situated, and whether or not sepsis is present. If an instrument has been left behind after a clean celiotomy, it has been shown by several instances that the patient may suffer very little in-

[1] Ann. Surg., 1901, xxxiv, 499.
[2] Monats. f. Gynak., 1900, xi, 821.
[3] W. J. S. McKay, Care of Section Cases, p. 561.

convenience for weeks or months; indeed, it has happened that the occurrence has not come to light until after an autopsy for some intercurrent affection. Usually, however, sooner or later, the foreign body sets up an irritation, and becomes the source of an abscess which causes a fistulous opening, through which it is finally discharged by way of the vagina or bowel, into the bladder, or even through the abdominal wall. Accompanying this process there is apt to be obscure abdominal pain, sometimes with symptoms of incomplete obstruction and slight fever. Rest and a limited diet will bring temporary relief, but the symptoms are likely to recur soon after the patient gets up and about. There may occur a sudden exhibition of symptoms which will lead to an immediate exploratory operation, when the true cause will be disclosed, or else the symptoms will continue indefinitely with remissions until, after a flareup, they subside for good and the foreign body will be passed. If the case is septic at the start, there are immediately evident the symptoms of general or localized peritonitis or abscess.

Neugebauer, in his summary of the fate of the cases in which *forceps* were left behind, shows that 6 died almost immediately after the operation of sepsis and 1 after a second operation, performed some months later for the removal of the foreign body. In three cases the forceps were expelled spontaneously per anum—1 four years, 1 nine months, and 1 ten months after operation. In 1 case the forceps worked through into the bladder. In 2 cases they were discharged through abscesses in the abdominal wall. In 1 case the artery forceps were found in Douglas' culdesac before closure of the abdominal wound. In 2 cases the loss of the forceps was noted immediately after the closure of the wound, and they were recovered before the patient was removed from the operating table. In 4 cases a subsequent abdominal section was required for their recovery from three months to two years after operation.

When a *sponge* or a piece of gauze has been left behind, recovery is retarded seriously, especially if the case is septic. If the patient does not die, the presence of gauze will sooner or later give rise to an abscess or a sinus. In rare instances a piece of gauze has been known to have been retained without giving rise to symptoms. In some cases the gauze ulcerates into the bowel and is discharged by rectum.

In 31 cases where gauze sponges were left behind, death occurred in 7. The gauze was discharged by the rectum in 10 cases, the time varying from two days to twelve years after the operation. A second abdominal section was done in 4 cases, and in the others the gauze was discharged through intestinal fistulæ. In 2 cases the sponges were missed before the wound was closed. In 3 cases the wound was reopened before the patient left the table; in 3 cases the wound was reopened in twenty four hours; in 1 a sponge was discharged five months after operation through an abscess in the abdominal wall. In 19 cases sponges were discovered at autopsy.

Prognosis.—Neugebauer's collection of cases shows that 58 per cent. of the patients recovered and 42 per cent. died. Some of the deaths must be referred, not to the foreign body, but to sepsis. If the case is a clean one, the retention of a pair of forceps or a piece of gauze in the abdominal cavity, while a serious accident because of the fistulæ and abscesses likely to be formed sooner or later, it is not to be regarded as an accident that is likely to lead to an immediate fatal result.

If the foreign body is practically aseptic in its nature, the tendency is for it to become enveloped in a capsule of fibrous exudate, and the isolation is still further carried on by adhesions between the surrounding organs. Thus encapsulated, it may remain quiescent for months or years, or its presence may lead to suppuration and the foreign body may be discharged through the fistulous tract, which may communicate with the surface, the bladder, the bowel, or the vagina. When it enters the bowel, complete obstruction of the bowel may occur or a fecal fistula may form. It has happened that a pair of forceps, free in the abdominal cavity, has, by a sudden movement, been violently driven into a large blood-vessel and caused the immediate death of the patient, active and without symptoms, several months after the operation.

Prophylaxis.—*No sponges should be at hand during a celiotomy.* For abdominal work gauze should be folded in the form of *strips* sufficiently long so that an end of 3 to 6 in. may be allowed to hang out through the wound. To this end a hemostat should be applied by the first assistant *as soon as the strip has been introduced.* Some surgeons use strips to the ends of which a piece of tape 6 in. long is sewn, and to this tape the hemostat is fastened. This allows many strips to be introduced into the abdomen without crowding the wound. As soon as the strip is soiled it should be thrown on the floor, and the operating field should be kept free of strips that are not at that moment in use. No strips should ever be allowed to be cut in two. This interferes with the sponge count, if the surgeon desires a sponge count, and a cut strip is always more readily left behind than a strip which is kept entire. The strict observance of care in these details will render sponge counts unnecessary.

The importance of exercising proper care in preventing this unfortunate accident can be emphasized in no better way than by citing a characteristic case.[1] A surgeon of many years' experience operated upon plaintiff for ovaritis. The patient did not respond by the expected recovery, but she grew worse, and thirty days later it was discovered through a part of the original opening made in the abdomen that some foreign substance was lying near the surface, which upon being removed was discovered to be one of the surgical sponges used at the operation. It was incrustated and saturated with foul-smelling pus. After its removal the patient improved in health, but there was left a sinus which it was claimed had developed into a fecal fistula.

"Many of the physicians testifying on behalf of the defendent said that the best of surgeons left a sponge or some foreign substance in the bodies of their patients in performing similar operations. It was argued from this that, as the highest degree of skill and care was not exempt from the commission of such accidents, a similar lapse by the defendant was not at least other than ordinary care, but that did not follow; because all men are sometimes careless does not relieve any man from the legal consequences of his careless act; but, even then, it was for the jury to say whether the defendant exercised the degree of care in the case which ordinarily prudent and skilled surgeons who practise in similar localities usually exercised in such matters." The verdict—a judgment for $3500 for the plaintiff—was accordingly confirmed by the Court of Appeals.

Operation.—If we discover immediately that a sponge or a pair of forceps has been left behind, we should at once proceed to open the abdomen, unless the patient is suffering from great shock, when we may postpone the operation for some hours until the patient has rallied. If the case has been a clean one and the patient is very weak, we need not interfere for two or three days. If the case is septic, we should act as soon as possible. If a vaginal examination shows a foreign body in Douglas's pouch, an incision in the posterior fornix is preferable to opening the abdominal wall.

In infected wounds a retained foreign body of whose presence we are ignorant must lead to prolonged suppuration without very obvious cause. Perinephric abscesses and pelvic abscesses, and occasionally appendix abscess, may give rise to a copious discharge of pus. After a period prolonged to weeks, if this suppuration goes on without definite diminution in quantity, or if the excursions of temperature continue, the existence of a foreign body should be considered. One should, from day to day, explore the depths of the sinus with a metal crochet

[1] Jour. Amer. Med. Assoc., 1909, liii, 1229. Court of Appeals of Kentucky, 118, S. W. R., 339.

hook, and hope therewith to catch into the meshes of gauze or the loop of silk or other non-absorbable suture if such has been used. If, however, a definite abscess collect in the depths of a wound, a second operation, which may frequently be done in the bed under primary anesthesia, should open it freely and give opportunity for exploration and removal of the cause if it be a foreign body.

CHAPTER XXXIV

POSTOPERATIVE HERNIA; ADHESIONS

POSTOPERATIVE HERNIA

AFTER any celiotomy there exists a possibility of the occurrence of postoperative ventral hernia. It occurs most frequently after median line incisions, particularly at the lower end of the wound, below the umbilicus, and just over the pubes, where the pressure of the abdominal contents is greatest and strain most likely to be felt. It is not infrequent after operations on the appendix, particularly operations on appendix abscess, and in cases where the muscle-splitting or McBurney incision is not used. With the commonly used right rectus incision hernia may be expected to occur, according to statistics, in about 3 per cent. of undrained cases, 12 per cent. where a drainage-tube is left in, and 20 per cent. where the wound is left wide open. Hernia is apt to occur also in lateral incisions for extensive drainage, as in peritonitis, and it recurs after operations for hernia, either on account of sepsis in the wound, poor technique, division of nerves, insufficient musculature, scar tissue, or imprudent postoperative care. It may be immediate, resulting from a rupture of the abdominal wound during coughing, straining, or careless transportation, or it may take months or even years to develop. It may, however, be fairly estimated that one-half make their appearance within the first year.

The **occurrence** of postoperative hernia depends, first, on *sepsis*, either within the abdomen or in the wound. Sometimes the surgeon must assume the responsibility for infection; at other times suppuration is unavoidable. Other things being equal, the longer the suppuration continues, the greater the tendency to hernia. Particularly is to be condemned the too persistent use of the drainage-tube.

Second to be considered is the *abdominal wound*. The longer the incision, the greater the likelihood of postoperative hernia. Median line incisions are more prone to develop herniæ than are right rectus or flank incisions. Division of nerves causes atrophy of the muscles which they innervate. An incision in which the various structures are separated along their own line of cleavage, so that they will come together more naturally, and so that one layer will buttress the opening in the next, is ideal from this point of view. Naturally, the median line incision, which traverses only one layer of fascia and no muscle, and in which reliance must be placed entirely upon the edge-to-edge union of this poorly healing tissue, and where there is no reinforcing action of aponeurosis or muscle to take off the strain or keep the wound closed, is just the opposite. The incision recently introduced by Pfannensteil has demonstrated its practicability where the median incision is ordinarily indicated, and, theoretically, it should overcome the objections of the older methods. It consists of a transverse incision, slightly concave upward, just over the pubes, through skin and superficial fascia. The aponeuroses are divided transversely, and the rectus muscle, to one side of the median line, separated vertically. The contraction of the muscle brings together the cut edges of the aponeurosis. The technique is frequently modified to mean a transverse skin incision, and then the ordinary right or left rectus incision, just to one side of the median line. This gives good pelvic exposure, usually heals rapidly in undrained cases, and with lessened liability to hernia.

Third, is the matter of *wound closure.* The peritoneum, even, cannot afford to be neglected, since,[1] after operation, where for any reason the peritoneum has failed to unite, there may be protrusion of gut immediately beneath the skin without sac formation. It has become generally accepted that, in sewing up an abdominal wound, homologous structures should be brought together. This is the basis of our modern technique, the so-called tier or layer suture. Muscle is united to muscle and fascia to fascia, and no foreign structure is allowed to interpose. It is of undoubted advantage, also, if in suturing aponeurosis or fascia the structures be overlapped ⅓ in. or so, instead of being brought edge to edge. This gives a broader surface for the exercise of plastic repair and a consequently much firmer union. This technique brings together structures of a like nature firmly but without tension. It has the minor disadvantage of creating potential dead-spaces between layers. The great disadvantage of the through-and-through suture is the necessity of drawing the sutures tightly in order to maintain adequate apposition, particularly in thick abdominal walls, and the subsequent liability to suppuration. Noble[2] states that hernia occurs with the through-and-through suture in about 5 per cent. of the cases, whereas after the tier suture, in America, hernia occurs in not more than 1 per cent. If suppuration occurs in a wound, hernia may follow, no matter which method

[1] De Garmo, Abdominal Hernia, Its Diagnosis and Treatment, Phila., 1907.

[2] The Abdominal Wound, its Immediate and After-care, Amer. Jour. Obst., 1907, lvi, 328.

we employ; however, the smaller the opening and the shorter the duration of drainage, the less the likelihood of hernia.

Finally, it is important to consider the etiologic influence of *after-care.* It must, first of all, be accepted candidly that scar tissue, even of aseptic healing, rarely has the strength of the tissue which it is designed to replace. It is extremely likely to stretch, unless it is bolstered by adequate muscles, under any form of strain, particularly in the case of patients of sedentary habits who gain weight rapidly after operation. It must be remembered, also, that the plastic processes concerned in the repair of an abdominal incision take place under conditions of unrest and irregular strain, from respiration, vomiting, etc., not present in many other parts of the body. In those with ill-developed muscles the scar tissue yields to the strain of crying, coughing, and defecation, and hernia results. Whereas, this is less likely to occur in early life, it is quite prone to take place later on, when fat has accumulated and the general muscular tone of the body is falling off.[1] The modern tendency of getting patients out of bed early is likely to increase the tendency to hernia. The use of swathes will be considered in the next chapter.

The commonest *type* of postoperative hernia is a direct hernia of the abdominal wall, the ventral hernia, or so-called "hernia in the scar." Very rarely one sees a right inguinal hernia following an appendix operation, probably the result of muscle atrophy from loss of nerve supply. Femoral hernia may follow operation for the cure of inguinal hernia, or *vice versa:* one canal is dilated by the pull on structures involved in closing the other. Postoperative hernia is properly to be distinguished from recurrent hernia, which signifies simply the recurrence of a previously operated hernia.[2]

Symptoms.—The symptoms of postoperative hernia are usually

[1] See Barker, Causes and Operative Treatment of Umbilical and Ventral Hernia, The Practitioner, 1908, i, 149.

[2] Dr. E. Wyllys Andrews has recently reported (Surg., Gyn., and Obstet., 1911, xii, 190) 2 cases of desmoid tumors following operation for hernia. These tumors are found in the fascia and aponeurosis of the abdominal wall, particularly in the posterior sheath of the rectus; they are apt to grow inward into the abdomen, so that ultimately they have only the peritoneum for a covering. Histologically they are hard white fibromata, the result of hyperplasia of fibrous connective tissue from long-continued irritation or trauma. Most of the reported cases have occurred in women after repeated pregnancies. Desmoid tumors should be removed by operation on account of their tendency to increase in size, and on account of the possibility of malignant changes developing; some of them are undoubtedly sarcomatous in nature. E. Benelli (Beiträge zur klin. Chir., 1910, lxxv, No. 3) reports 12 cases of bone formation in the cicatrix after celiotomy. Most of the cases were in men over forty.

never marked, and depend on the site and nature of the hernia and its manner of occurrence. If the hernia is of gradual development, it at no time, practically, presents noticeable symptoms, such as pain, although there is likely to be a more or less constant feeling of strain or soreness. If the hernia is in the nature of a general bulge, this soreness may be marked during activity, particularly if the patient wears no support. If the bowel or omentum comes out through a small opening, such as that left by a drainage-tube, the condition will simulate that of an inguinal hernia, and there may be occasional attacks of sharp, colicky pain, as knuckles of bowel or omentum get temporarily caught.

Frequently the patient is altogether unconscious of the fact that he has a hernia. Habitual constipation generally accompanies large ventral herniæ.

The means of *prophylaxis* have already been dwelt upon. Summed up, it consists in making an incision which will allow of as complete a return to the original integrity of the abdominal wall as possible, and sewing it up so that this return to normal conditions is encouraged and facilitated; in shunning possibilities of sepsis, and in guarding the convalescence so that no strain is put upon the scar until it is ready to bear it. The advantages of reinforcing the wound by adhesive strapping have already been referred to.

Treatment.—A hernia occurring early in the convalescence should be treated by strapping the edges of the wound closely together by means of adhesive plaster straps. Straps properly adjusted should relieve the healing scar of all possibility of further strain, and thus prevent stretching and consequent thinning out of the scar tissue. As soon as the patient is up and about, a swathe should be fitted and worn until an operation is decided upon, or permanently, if operation is contraindicated. No truss or other apparatus should be worn which provides a pad to exert pressure on the region of the scar, for this will lead to atrophy and certain increase in the extent of the hernia.

Operation is usually postponed until healing is complete and the scar has reached its maximum degree of contraction. After this it should not be put off too long, on account of the tendency for the formation of adhesions of viscera to the scar, and on account of the increase in size of the hernia and the resulting increased liability to recurrence. Mere end-to-end approximation of the freshened edges of the aponeurosis which form the ring does not suffice—the fascia must be cleared back and the edges made to overlap. The flap may be transverse or longitudinal, as best suits the mechanical requirements of the situation. If there is a redundancy of skin-flap, the excess may be removed by including it in an elliptic incision. In order to better the chances for healing of the new wound without hernia formation by relieving the intra-abdominal tension, it is wise to reduce the bulk of the viscera by removing such omentum as is adherent to the sac *en bloc*. This is desirable also if the omentum has to be handled, or is oozing as a result of the manipulations necessary for separation of adhesions. The operation, in wide median line herniæ, is usually so planned that the elliptic area of skin, the underlying fat, the sac, and the tied-off omentum which is adherent are removed in one mass. Catgut only should be used, as primary healing is indispensable; necessary drainage and stitch abscesses account for most of the cases of recurrent hernia.

ADHESIONS

The peritoneum has the property of sticking together and forming adhesions when infected, irritated, or injured. This is the property by which it responds to protect itself against perforation, to limit septic processes, and to protect the organism against general infection. The peritoneum serves the purpose most intelligently; for instance, when it has tried in vain to prevent perforation of a gastric or intestinal ulcer, by reinforcing the viscus at this site, it limits the abscess which results by forming a circumscribed pocket for it to pour into, and after a time provides for its outlet by directing a second perforation into the intestine or externally. Accordingly, we frequently rely upon this function of the peritoneum for aid in overcoming disease processes.

This useful property has, however, another aspect. Adhesions may arise after clean operative procedures in cases where, to the surgeon's understanding, they can serve no useful purpose. In other cases, where they have been of valuable assistance, they may persist after their usefulness is ended and interfere with the normal function of the viscera to such an extent that the patient, freed from his primary trouble, may have to be operated upon for relief from his adhesions. Moreover, adhesions may stretch into bands under the influence of the intestinal activity, and they are always a potential cause of acute obstruction.

The chief source of postoperative adhesions is infection; this may vary from a mild inflammation to a virulent sepsis, but, generally speaking, the greater the degree of suppuration, the more extensive will be the adhesions. Imperfect hemostasis may cause adhesions; the blood which oozes out clots and organizes. Another important source is the leaving behind of raw surfaces, without peritoneal covering, either from accidental tears or necessary stripping of the peritoneum. Operative irritation acts similarly, by causing a necrosis of the delicate endothelial layer which constitutes the peritoneum. This irritation may be chemical, as by the use of antiseptic solutions in washing out, or mechanical, from injudicious use of retractors, rough or excessive manipulation of viscera, unnecessary sponging, the use of dry gauze, the undue exposure of the viscera to dry or cold air, and the use of unprotected gauze drainage. Gauze, indeed, is frequently used when we are desirous of encouraging and training adhesion formation to serve our purposes in septic cases.[1]

Wherever the peritoneum is irritated, cut, inflamed, or denuded from whatever structure it invests, there is an immediate outpouring of more or less bloody lymph. This coagulates and becomes organized into granulation tissue, which finally becomes fibrous. Any organ or structure which comes into contact with the area so covered with exudate or granulation tissue is extremely likely to become adherent to it within a few hours, particularly if it has itself undergone similar inflammation or injury. Thus, the omentum practically always becomes adherent to an abdominal incision during the process of healing. This is salutory, in so far as it prevents the formation of adhesions directly between intestine and scar, and it is usually intentionally promoted by bringing down the omentum to cover the intestine before closing an abdominal incision.

Adhesion formations of this type tend to elongate and stretch under the influence of the normal motility of the organs which they connect. Sometimes the bands which result are firm enough to be the source of danger from intestinal obstruction. Operations in the lower peritoneal cavity and pelvis are more likely to be followed by acute obstruction than operations on the stomach and gall-bladder, for it is into the lower portion of the peritoneal cavity that the intestine naturally gravitates. The omentum, moreover, may become adherent at several points, leaving loops through which knuckles of intestine may be wedged and caught. Bands usually tend to attenuate and gradually disappear, apparently under the influence of peristalsis, which should be started early after operation. Sometimes there is a massive outpouring of exudate instead from some generalized cause, and deposits of fibrin cover intestine and parietes in thick layers, which, organizing, unite each to each, and bind together the viscera in a mass of adhesions. This matting together of intestines is less likely to be

[1] Dry gauze is stated (E. H. Richardson, Bull. Johns Hopkins Hosp., 1911, xxii, 283) to adhere to peritoneum in twenty minutes so intimately that when it is pulled away it brings the endothelial layer with it.

followed by obstruction than is the band formation, largely because the normal bowel relations are in a measure preserved, and it likewise tends to attenuate and may in time disappear entirely.

The formation of adhesions, and their elimination when once formed, seems to depend in a certain measure upon the individual peculiarity of the patient. In some peritoneal cavities we find that very slight provocation has been followed by the formation of extensive or even universal adhesions, and sometimes, on the other hand, we find very slight adhesion formation after serious bacterial inflammation. In the same way in some persons extensive adhesions will apparently take care of themselves and give no trouble after operation, and in others mild adhesion formation after a clean celiotomy may cause symptoms of so aggravated a type as to make necessary surgical interference.

The operation which most frequently gives rise to trouble from adhesions is appendectomy. It is practically impossible to perform an operation upon the appendix or gall-bladder, for instance, with the assurance of complete bacteriologic sterility. In interval cases the adhesion formation is slight; in acute or septic cases the intestines may be matted together, and the lower end of the ileum may be tied to the inner side of the cecum and so angulated or compressed as to interfere seriously with its functioning. Similar results may occur after operations in the female pelvis, if care is not taken to float the intestines out of the pelvis before sewing up. Another frequent source of origin of postoperative adhesions is operation upon the gall-bladder or bile-passages. Bands are likely to constrict the ducts so as to interfere with normal drainage or to limit the functions of the gall-bladder. Adhesions after gastro-enterostomy may be the cause of protracted bilious vomiting.

The **symptoms** arising from postoperative adhesions may be either insidious or fulminating. While it is true that intestinal adhesions may exist and the patient suffer no impairment of health, nevertheless they are the frequent cause of digestive disturbances, ill-defined or sharply localized abdominal pain and soreness, and sometimes acute intestinal obstruction.

In the insiduous form the symptoms at first are slight and they may appear only at intervals. The patient complains of soreness in the intestines or about the region of the scar. She is usually constipated, and finds that ordinary cathartics do not relieve, and sometimes, after a dietary indiscretion, the bowels will be completely inactive for a week or so and then move again with fair regularity. She is apt to experience an unusual amount of pain or distress with the menstrual flow, of a griping or colicky nature, even if the operation has not involved the pelvic organs. In many cases the patient gets more or less accustomed to her new state, and gradually, in the course of time, the symptoms wear away as the adhesions attenuate and disappear. Not infrequently, however, a condition of neurasthenia develops, and the morbid interest of the patient in her own symptoms magnifies them until she becomes a neurotic, ill-nourished invalid.

In contradistinction to these effects of partial obstruction or impairment of function, as the intestines or viscera are distorted or constricted by the pull of adhesions, is the strangulation which sometimes occurs from the constriction of a loop of intestine under or about an adhesion band. Acute obstruction may occur at any time from a few weeks to many months after the operation. It is usually preceded by some of the indefinite symptoms just noted, but it may appear out of a clear sky—as, for instance, in a patient upon whom we recently operated for strangulation of the gut in a loop of omentum twelve years after the uneventful recovery from an abdominal operation.

The symptoms are those of acute intestinal obstruction from any cause. They depend to some extent upon obstruction of the current of gas and feces, but probably to a greater degree to obstruction of the circulation. Thus, a patient with obstruction may nevertheless continue to pass small quantities of semifluid feces and gas. The characteristic symptoms are acute pain with colicky exacerbations, and more or less generalized, but often referred to the epigastrium, and tenderness, at first directly over the seat of the trouble, but later rather difficult to localize on account of spasm of the abdominal muscles; there are nausea, vomiting, distention, at first to be noted just above the seat of the constriction, spasm, which is ordinarily less marked than in peritonitis, and general pallor and sweating. The first enema or two may bring away feces if the bowel below the point of obstruction was fairly full before the strangulation began, or if the lumen of the intestine is not entirely closed off at the point of constriction. The temperature is not elevated at first and may be subnormal. The pulse is normal or somewhat increased.

Prophylaxis.—The matter of prophylaxis is an important part of abdominal technique, and the lines which are to be followed at the time of operation have already been suggested. The English sum these up under the expressive phrase, "toilet of the peritoneum." They may be restated categorically, thus:

Employ aseptic rather than antiseptic technique, avoid the use of chemicals for any purpose, and use only warm normal saline for flushing out.

Operate under conditions of warmth and moisture which will as closely simulate those of the peritoneal cavity as possible; keep all exposed or delivered viscera protected from the air by gauze pads kept warm and moist by hot saline solution.

Protect such parts as are not involved in the operation by walling off with pads of moist gauze.

Allow no rough retraction, no inconsiderate handling or sponging of the intestine, or needless or ungentle manipulation.

Use moist or hot dry strips and sponges within the abdomen.

Suture the peritoneum carefully and avoid the use of the cautery.

Cover the ends of pedicles, appendix, and hysterectomy stumps so far as practicable by sewing the peritoneum together over them in such a manner as to leave a smooth peritoneal surface behind.

Leave no large surfaces denuded of peritoneum; if no other means of relief offers, cover in by means of an omental flap or graft.

Remove all blood-clot; if oozing is anticipated after sewing up, provide for its stasis or outlet.

Drain only when necessary, use only a sufficient amount of gauze to serve the purpose, and, except where contact with peritoneum is intended, protect it by rubber tissue.

After the Trendelenburg posture, rearrange the coils of intestine in their natural positions.

Before sewing up draw down the omentum under the abdominal wall.

Various methods have been commended, largely on an experimental basis, as means of preventing the formation of postoperative adhesions within the abdomen, between brain and dura, and about tendons. While some have been shown to be of doubtful value, and no single agent has demonstrated its assured fitness for this purpose, the observations are worthy of record.

On the theory that active peristalsis prevents or limits the formation of intestinal adhesions, D. C. Craig[1] has recommended the subcutaneous injection of salts of physostigmin (p. 177). Heile,[2] with the same end in view, advises the injection of 50 to 100 cc. of warm castor oil, preferably emulsified with a little soda and water, directly into a high loop of the small intestine, before closing the abdomen, in cases of diffuse peritonitis.

[1] Am. Jour. Obstet., 1904, xlix, 440.
[2] Central. f. Chir., 1909, xxxvi, 1073.

The use of antifibrin, phosphorus, and peptone to prevent coagulation of exuded serum and the consequent agglutination of apposed raw surfaces, of thiosinamin or fibrolysin to soften or dissolve adhesions, and of the iodids to promote absorption of the newly formed connective tissue, have all had their advocates.

Müller originated the plan of leaving the abdomen full of salt solution, with the purpose of floating the coils of intestine and so preventing the apposition of raw surfaces. The solution, however, merely floats the loops, but does not separate them, and it absorbs too rapidly to permit of much growth of endothelium before they come again in contact with the parietes. Vogel[1] declares it ineffectual. E. Marvel[2] regards a solution of adrenalin in normal saline as of value in preventing plastic exudate.

Distention of the abdomen with gases has recently been advocated. T. Weiss and L. Sencert[3] state that oxygen injected in continuous stream into the abdominal cavity through a small buttonhole in the anterior wall stimulates the cardiovascular and respiratory systems, arrests absorption of septic fluids, promotes healing, and prevents the formation of adhesions. The gas comes out, bringing with it pus and fluids, through various drainage holes. The use of carbon dioxid gas has already been mentioned in connection with the Henderson theory of the causation of shock.

Lubricants have been employed for various years by many men with the expectation that raw surfaces would be protected thereby until sufficient time had elapsed for the regeneration of their normal endothelial covering. The use of sterile olive oil was first made by August Martin.[4] J. B. Blake, of Boston, concludes,[5] as a result of an experience with its use in 14 operations on animals and 7 on human beings, that "oil, absolutely sterile, may be used in the peritoneal cavity of patients in moderate quantities, 1 to 4 drams, without danger, general or local; that it remains in the peritoneal cavity for periods of from five to fifteen days and possibly longer; that its presence tends to prevent early and direct adhesions of denuded or inflamed peritoneal surfaces, and, therefore, that its use, under the above precautions, is indicated and is moderately effective in sometimes preventing and usually diminishing the formation of postoperative peritoneal adhesions." Vogel[6] has reported good results with a mucilaginous solution of gum arabic (gum arabic 1 part, normal saline, 2 parts; filter and sterilize) injected through a tube just before the abdominal wound is closed, and others have confirmed his report. Sterile vaselin has been commonly used, and is well spoken of.[7]

[1] Deut. Zeit. f. Chir., 1902, lxiii, 296.
[2] Jour. Am. Med. Assoc., 1907, xlix, 986.
[3] Revue de Chir., 1910, xli, 563.
[4] Ellis, Proceed. Path. Soc. of Phila., 1906, ix, 178.
[5] Surg., Gyn., and Obstet., 1908, vi, 667.
[6] *Op. cit.*
[7] E. H. Richardson, Bull. Johns Hopkins Hosp., 1911, xxii, 283.

Other substances which have been recommended are agar, gelatin, lanolin,[1] prepared animal fat,[2] and Glimm's method of injecting 30 cc. of sterile 10 per cent. camphorated oil into the abdominal cavity.[3]

In contradiction to these reports, however, stand the researches of M. Busch and E. Bibergeil.[4] They have experimented with clean olive oil, solid paraffin, anhydrous lanolin, liquid paraffin, gum arabic, agar, and gelatin, and they conclude that it is impossible to prevent contact between abraded and injured surfaces of peritoneum and the consequent production of adhesions by means of mucilaginous or similar substances left in the abdominal cavity. Some of the materials, such as lanolin, paraffin, oil, and agar they assert cause irritation of the peritoneum, while non-irritating solutions, such as gum arabic and gelatin, are too rapidly absorbed to be of any mechanical advantage. They had no better results with the prophylactic use of physostigmin and fibrolysin.

Non-absorbable protective membranes of various sorts have been used. The painting of collodion over raw surfaces was suggested by Stern,[5] but it has been discarded. Similarly, xylol and a solution of gutta-percha in chloroform have been used. A thin silk protective has been advocated by C. Lauenstein,[6] as well as thin sheets of rubber fabric. The filmy coagulum produced by aristol acting on lymph has been employed, as well as a gelatin-formalin coagulum, but with poor success. M. C. Harris,[7] however, has had good results from the use of silver-foil after operations on the brain, and Ellis[8] has demonstrated the value of films of celloidin wrapped about tendons to prevent adhesion to their sheath.

Non-viable animal membranes have had more or less enthusiastic advocates. Thin goldbeaters' skin (the peritoneal coat of the cecum of the ox) was recommended by Duschinsky.[9] From this developed the use of shark's peritoneum, the peritoneum of oxen (Cargile membrane), and a finely woven cloth of catgut. The experiments of A. B. Craig[10] and Ellis show that little reliance can be based on this method; theoretically, such substances are foreign bodies, and might be expected to provoke rather than prevent adhesions.

The method which promises the most, in the limited field where it can be employed, is the use of living animal membrane, either in the way of an autogenous graft of omentum or by plastic operations on the peritoneum, or

[1] Gellhorn, Surg., Gyn., and Obstet., 1909, viii, 509.
[2] Crump, Surg., Gyn., and Obstet., 1910, xi, 491.
[3] Hoehne, Münch. med. Woch., 1909, lvi, 2508.
[4] Archiv. f. klin. Chir., 1908, lxxxvii, 99.
[5] Beiträge z. klin. Chir., 1889, iv, 653.
[6] Archiv. f. klin. Chir., 1890, xlv, 224.
[7] Jour. Am. Med. Assoc., 1904, xlii, 763.
[8] *Op. cit.*
[9] Inaug. Dissert., Munchen, 1898.
[10] Ann. Surg., 1905, xli, 801.

the use of material from a freshly killed animal. Omental grafts adhere and establish a good blood-supply within twenty-four hours. If transplanted onto fixed surfaces or viscera which have weak peristalsis, as stomach or bladder, they are likely to adhere to neighboring loops; accordingly, they are used to best advantage on the small intestine, to cover weak points, raw areas, and suture lines. For the same purpose Richardson[1] recommends taking one leaf of the adjacent mesentery, freed up through an incision parallel to the bowel, and sewing the freed edge to the margin of the area to be covered. This rotates the bowel somewhat in its longitudinal axis, but it causes no kinking or occlusion. If the leaves cannot be separated, the whole thickness of the mesentery can be similarly used. In case of great loss of peritoneal substance in the pelvis from pelvic abscess, tumors with adhesions, etc., Summers[2] transports the sigmoid flexure across the pelvis and sutures it to the lateral walls of the excavation, across the fundus of the uterus, or, if the uterus is gone, to the bladder, in such a way as to cover over all the raw surfaces. Drainage is had in cases of total hysterectomy through the vagina, otherwise from under sigmoid and out of lower angle of wound. He claims that this technique prevents the spread of infection and postoperative intestinal obstruction.

Treatment.—The *non-operative treatment* of adhesions consists in the early and consistent use of gentle laxatives and a carefully selected diet. This should be digestible to the point of leaving little residue, which might clog the narrowed and imperfectly acting gut. It should be finely divided and well masticated. Byford[1] has obtained relief from symptoms through active exercise, probably through the stretching and attenuation of the adhesions which result. He cites one case which was permanently cured by horseback riding on a roughly gaited horse. In cases where this is not practicable or advisable, massage and electricity may be applied to the abdomen with advantage. (See Chaps. XXXVII and XXXVIII.)

Operative treatment becomes imperative in cases where non-operative methods give no relief, when pain and spasm become severe, or when symptoms of acute obstruction appear. In the ordinary case the surgeon should not wait for the obstruction to become absolute, for by this time beginning necrosis of the bowel is already frequently in evidence and resection may be necessary.

The incision should be made nearly over the obstruction, if this can be localized, otherwise in the median line, below the umbilicus. Care should be taken in incising the peritoneum lest adherent intestine be

[1] *Op. cit.*
[2] Surg., Gyn., and Obstet., 1911, xiii, 125.
[3] Ibid., 1909, viii, 576.

punctured. Recent delicate adhesions may be separated by sponging; if they are broad enough to contain vessels of size, they should be tied off. Adhesions a year or more old usually are poorly supplied with vessels, and, if not too large, may simply be divided at their points of origin and the intermediate portions removed, lest a long end left free in the abdomen contract fresh adhesion. Broad adhesions leave behind large raw areas which should be protected in any suitable fashion. If the intestine is kinked by a band, it usually straightens out as soon as the band is divided. If it is obstructed by close adhesion to the parietal peritoneum, it is best to cut out the peritoneum and leave it attached to the bowel, covering over the raw surface left behind by bringing the peritoneal edges together. This plan must also be employed as far as possible in case the intestine is matted together. Raw surfaces which cannot be protected in other ways should be covered with portions of omentum.[1]

[1] F. B. Lund, Remarks on Intestinal Obstruction by Bands Following Operations on the Peritoneal Cavity, Boston Med. and Surg. Jour., 1902, cxlvi, 565; J. C. Webster, The Prevention of Adhesions in Abdominal Surgery, Surg. Gyn. and Obst., 1909, viii, 574.

CHAPTER XXXV

ABDOMINAL SWATHES: THEIR USE AND ABUSE

It has until recently been considered the proper thing to recommend that a fitted abdominal swathe be worn one to twelve months after all abdominal sections,[1] and that trusses or specially adapted swathes, containing pressure plates, be applied after all operations for hernia. The practice is rapidly becoming more and more restricted.

If an abdominal incision is made with proper regard for anatomic mechanics, and is closed with efficient deliberation, and the approximation of the wound-edges is then supported by strips of adhesive plaster carefully applied and maintained during the plastic period of healing —namely, twenty-one to thirty days—a solid and resistant scar is to be expected. With median line incisions, in fat, flabby-muscled individuals, and in the presence of sepsis, further support may be necessary. Otherwise, it may be contended that an abdominal swathe has a positively deleterious effect in so far as it encourages atrophy of abdominal muscles through disuse. Abel[2] shows by statistics that the abdominal swathe has nothing to do with preventing the formation of hernia.

The arguments advanced by those who favor the routine application of the swathe without special indication are varied. They hold that the presence of a swathe serves to remind the patient of the fact that he has a weak spot in his abdominal wall, and that he will accordingly refrain from straining himself by lifting and muscular overexertion. The swathe is said to guard the scar against the extra tension resulting under conditions such as constipation and respiratory affections, and during physical effort. Finally, it is stated that the public has become so accustomed to the idea of wearing a swathe after abdominal operation that any surgeon who neglects its use will lay himself open to the serious criticism of his patients in case postoperative hernia does develop.

Wounds heal by the process of scar-tissue formation. After about ten days the line of incision shows under the microscope as young vascular connective tissue. In the course of weeks and months this red scar tissue gradually contracts and loses its vascularity, becomes more

[1] Kummer (Corres. f. Schweizer Aerzte, 1901, xxxix, 361) insists that an abdominal bandage be worn for three months after a celiotomy.

[2] Archiv f. Gyn. u. Chir., lvi, 656.

fibrous in character, and changes permanently into white scar tissue. Skin and peritoneum proliferate quickly and heal rapidly by the formation of new similar structures; connective tissue, fat, and muscle repair more slowly by the formation of connective tissue; fascia and tendons repair very slowly by means of connective-tissue formation. Whenever circumstances allow, it is theoretically advisable carefully to approximate homologous structures, so that scar contraction will unite firmly muscle to muscle and fascia to fascia, restoring in this way to a greater extent the integrity of the abdominal wall. Septic wounds require a longer time for healing than do aseptic, and repair by the formation of much larger amounts of connective tissue, resulting in larger scars.

Postoperative swathes were devised to support the abdominal wall until the firm white scar was fully formed, in an endeavor to prevent hernia during the process of healing, and to overcome the tendency to the formation of a thin, wide scar. It must be borne in mind that a swathe is to all intents and purposes a splint, and a splint causes atrophy of the muscles it supports and whose activity it limits. It is not to be denied that there are cases which are benefited by swathes and are protected from the occurrence of hernia, but the indications are gradually becoming more limited, and the ill effects are safeguarded by suitable exercises for the abdominal muscles to preserve their tone and to increase their development. The majority of cases, depending on the character of the wound and on the muscular development of the individual, do perfectly well without a swathe and almost never show postoperative herniæ.

In the McBurney or muscle-splitting incision the only cutting done is in going through the skin and peritoneum; the muscles and fasciæ are torn apart in the direction of their fibers. The result is that the structures fall together naturally, requiring but few sutures. Such a wound needs no support; as soon as retraction ceases, each layer assumes almost its former integrity, and so buttresses every other layer against strain that the patient may be allowed up in three days, or even earlier in a small wound, without support or risk, provided that adhesive plaster strips are used.

The right rectus incision, while not perfect mechanically, is well designed in that it brings the center of the injured rectus muscle over the wound in the deeper layers and supports it against strain. A patient with such an incision does perfectly well without a swathe. Occasionally herniæ are reported after these two incisions, but investigation practically always reveals the fact that the blame can be placed on sepsis, too long an incision, or unpractised technique. Incisions above the level of the umbilicus are subject to no great amount of intra-abdominal pressure, and, if properly closed, practically never require support.

Incisions in the median line, where there are no muscle-fibers, heal slowly and entirely by connective tissue. It is safer to insist that such cases, particularly if drained, wear a swathe and take supplementary exercises for about six months. By that time the scar is as firm as it will ever be, and the further support of a swathe is useless and even detrimental. A case has recently come to our notice of a young woman who is wearing a swathe six years after operation simply because she has never been told she could go without it.

Abdominal wounds which have been drained, or allowed for sepsis or some other reason to heal by granulation, should be supported by swathes for six months. Advocates of the McBurney technique declare that this is usually unnecessary in their muscle-splitting incision. However, it must be borne in mind that in a McBurney incision which has been drained for any length of time, say, forty-eight hours or over, the different layers fail to fall together into close approximation, and the intervening space has to fill in with granulation tissue. In the case of abdominal wounds which, by reason of emergency, have had to be sewed up by through-and-through sutures, or left widely open for a time, fitted swathes should be worn until the surgeon is satisfied that the scar will not give way. For this class of cases it is far better to wear the swathe a lifetime if the patient is one who, should hernia appear, would not be willing or in condition to have it treated surgically.

In addition to the character of the wound, we must give consideration also to the physical development of the individual. Just because a patient is fat is not a sufficient reason for applying a swathe. Under the fat there may be good firm muscles capable in themselves of preventing hernia. Fat patients generally, however, are inclined to have flabby muscles, strained by the large accumulation of intraperitoneal fat. Such cases demand, first of all, exercises for those muscles, and the exercises will also tend to diminish the fat; a swathe may often be worn with advantage during this process. Moreover, in a fat person a swathe imparts a sense of security and satisfaction that will give confidence to undertake and continue exercise. In a man whose abdomen is approximately the size of his chest at expiration, or smaller, a swathe is hardly ever to be considered necessary.

Women ordinarily stand more in need of abdominal support than men during wound healing, on account of their naturally less muscular development, decreased still further, frequently, by the wearing of corsets and by repeated pregnancies. In a well-developed woman with small abdomen who has not worn corsets no swathe is necessary under ordinary circumstances. In a woman used to wearing corsets no swathe can serve so well as the present-day straight-front corset, laced from below upward. The corset should be advised, if support is necessary, as soon as the tenderness of the scar will permit its being worn. In a woman with pendulous, flabby abdomen, a fitted swathe, with perineal straps, or a specially made corset, may be prepared for the purpose of relieving the scar of strain and the weight of the abdominal contents. Cases operated on for malignant disease which show any signs of cachexia should wear swathes in order to support their weakened muscles. Cases undergoing an operation which materially reduces the intraperitoneal contents, either by the removal of the fluid, cysts, or masses of omentum, should wear swathes until the abdominal walls have readjusted themselves. Any case subject to chronic cough of any nature, and the old or feeble, should wear a swathe.

The question of *swathes following hernia operations* is worthy of special consideration. Many varieties of swathes have been devised for use after operations for inguinal and femoral hernia. In order to relieve tension on such wounds the thigh must be kept flexed on the body, slightly adducted and inverted. No swathe yet devised will do this with any degree of comfort to the patient. The patient should be kept in bed until satisfied that the scar is firm, usually about three weeks, and then he should be allowed to get up, with instructions not to bend backward or to the well side and not to straddle. In this way he will avoid nearly all undesirable strains. As epigastric and umbilical herniæ nearly always occur in fat people, and the operative scar is necessarily in the median line, such cases should wear swathes. Operations for ventral and postoperative herniæ should be followed by the use of swathes.

The matter of the *kind of swathe* to employ, when one is decided upon, is not to be settled off-hand. Like most apparatus designed as a substitute for or to reinforce normal physical function, the swathe is a makeshift. Many forms have been designed sufficiently complicated to suit the most ingenious mind, and depending in principle on minor details usually of no great importance. These are marketed under various names. It must, however, be understood, first of all, that no one type of swathe, whether or not it represents the copyright hobbies of some enthusiast, will do for every case. The surgeon should have clearly in mind what purpose he expects the swathe to serve. Most hospitals have relations with a clever woman who is adept in designing and fitting swathes in accordance with the instructions of the surgeons. In special cases, at least, swathes should be specially fitted.

Ordinarily, simple and inexpensive swathes of the types pictured (Figs. 101, 102, 103) may be purchased which will serve every purpose.

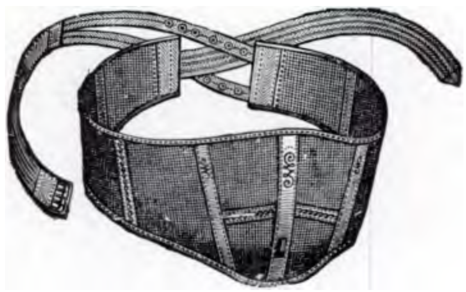

FIG. 101.—SWATHE.
Showing elastic webbing straps, buckling low down in front, and designed to exert an upward pull on lower abdomen (Kny-Scheerer).

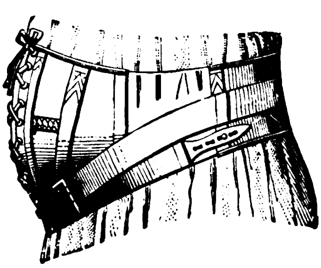

FIG. 102.—SIDE VIEW OF SWATHE.
Similar to that in Fig. 101, with front lacing (Kny-Scheerer).

FIG. 103.—SWATHE OF LINEN MESH, POROUS, AND CONTAINING NO ELASTIC (J. ELLWOOD LEE).

The less the complications and the fewer the straps and buckles, other things being equal, the better. A swathe should be washable, and if it contains no or little elastic webbing, so much the better. It should support and not constrain the abdomen, by exerting a constant lift on the suprapubic bulge. If the swathe is likely to slip up, it should be held down by perineal straps or leg-binders.

When the swathe is applied, the patient should be clearly informed as to how long it is expected that its use will be necessary. He should understand also the dangers of swathe wearing, for nothing encourages inguinal hernia more than body movements with a swathe improperly applied, for instance, tight about the waist and loose below. A swathe which constricts the abdomen but does not support it will do far more harm than good. The use of exercises has already been dwelt upon. The surgeon should see the patient at intervals to satisfy himself that the swathe is properly worn and the directions carried out.

CHAPTER XXXVI

ARTIFICIAL LIMBS; POSTOPERATIVE FLAT-FOOT

ARTIFICIAL LIMBS

IN the operative treatment of wounds the surgeon is ordinarily actuated by the principle that all viable tissue should be saved. The only exception to this principle should be in cases involving amputation of limbs. Due consideration must here be given to the important matter of efficient prosthesis. It is true oftentimes, for example, that saving too long a tibial stump means inconvenience and discomfort when the patient is ready later to wear an artificial leg. It is important, therefore, in performing amputations to be governed by the experience of those who have to do with the making and fitting of artificial limbs.

Amputations through the *tarsus*, such as the Chopart and Faraboeuf, are usually not highly satisfactory. The tarsal bones which remain are liable to be pulled out of place, and oftentimes the heel is so retracted by contraction of the tendo Achillis that the scarred surface is drawn under the leg in such fashion that it becomes the bearing point of weight. On account of its unevenness it is usually intolerant of pressure. This retraction also so lengthens the leg that a compensatory elevation of the sole of the shoe on the other foot must be employed. The only efficient artificial limb for this sort of amputation is one having a leg, the front half of which is made of aluminum, and the rear half, which encloses the calf and the aluminum shell, of leather. As an ankle articulation would be cumbersome, it is better to have instead a stiff ankle and a sole made of rubber. This appliance should be so fitted that the weight of the body is borne by the calf of the leg, not by the end of the stump.

Amputations about the *ankle-joint*, the Syme's and the Pirogoff, which have flaps formed of the resistant tissues of the heel, usually provide stumps which, though clumsy, are capable of weight-bearing. If, however, the cicatrix extends over the bearing point, or if the stumps are tender, they do not allow of end-bearing, and legs must be planned which allow of no pressure on the extremity but distribute the weight over the lower leg. The leg ordinarily applied is one similar to that already described. If fitted with a mechanical ankle-joint, it is usually cumbersome and uncomfortable.

The amputation at the *point of election* between the ankle and the knee is the amputation of both bones, which gives a stump from 6 to 8 in. long. Generally speaking, in operations above the ankle the longer the tibial stump the better, but stumps which reach close to the ankle are usually, in the majority of cases, not capable of bearing pressure, because the flaps are poorly nourished, and are, therefore, slow in healing, and are extremely liable to ulceration if subjected to pressure. This is due partly to poor collateral circulation in the lower third of the leg and partly to the absence of muscle in the flap. Ulceration frequently necessitates re-amputation. Moreover, these stumps are usually hypersensitive. Long tibial stumps are likely to be enlarged or bulbous at the tip, which interferes with the use of a socket.

Tibial amputations short of 4 inches are of practically no use in throwing the lower leg forward in walking. In addition, they are likely to become atrophied or contracted. The fibula, which is practically subcutaneous as a result of friction, may be excited to periostitis, and sometimes re-amputation above the knee is the only relief from the soreness or infection. Amputations, therefore, in the middle third of the leg are the most likely to give good results, both from the point of view of the surgeon and the maker of limbs. The fibula should be sawn off slightly shorter than the tibia, and the front of the tibia should be beveled off.

The legs which are suitable for such an amputation consist of a lower leg or socket made of willow covered with parchment, a foot made of willow, felt, or rubber, with or without an ankle-joint, and a thigh socket made of leather, to lace about the thigh and connect with the lower leg by means of side irons hinged at the knee. Various modifications are provided and lauded by the several manufacturers, but none are essential, and a simple well-made leg, without pretended "improvements," can usually be relied upon.

The following personal letter is from a patient whose leg was amputated at the point of election. It is given entire, because it presents the subjective attitude of one artificial-leg wearer. The writer is a man of keen intelligence and good mechanical ability:

"Dear Dr. Crandon:

"In regard to the artificial leg business, it has been my experience that the different manufacturers all have a story to tell trying to convince one that theirs is the only real thing. All these patent ankles and different appliances simply give them something to talk about.

"The first limb I had was what they call a slip-socket, which was made of leather. It is a very heavy, cumbersome leg, and the slip-socket I do not consider of any benefit. The only thing for me to do is to select a good, honest, painstaking leg manufacturer and one who has patience to see that you are suited. I consider a wooden leg the most satisfactory, inasmuch as it is lighter and not so cumbersome, being smaller in cumference, and will hold its shape much better than any leather preparation, which, as you will readily see, will change if it is subjected to moisture and then heat, which they all are.

" I suppose any artificial limb would be a disappointment to a person at first, but after one gets accustomed to wearing it, they soon find out that it is not altogether in the limb, but rather the unnatural feeling which a person has, and, of course, the stump being tender, there is nothing made that a person can put on and wear without more or less inconvenience at first.

" I am getting along first-rate, and as I look back I think I have done as well, if not better, than can be expected. I have been able to drive my own car all summer without any inconvenience—in fact, have just returned from a trip through the White Mountains.

" In regard to circulars or catalogues, I should read them all critically and be slow to decide."

Not infrequently in cases of tibial amputations the knee-joint becomes contracted, either as a result of the primary injury or from neglect in exercising the leg during the period after the stump has healed and before the leg is finally applied. If a stump becomes contracted at right angles so that it cannot be fully extended, or in case a stump is so short that it is of no value in flexing the knee-joint of an artificial leg, it is allowed to remain contracted, and the stump then becomes a knee-bearing stump, and a leg is constructed so as to receive the knee in the flexed position. This appliance is unsightly and complicated. Ordinarily, a stump of proper length can be brought to full extension either by manipulation or by the use of an artificial leg which has been properly adapted. This may be accomplished by applying a leg which is fitted with a lacing attachment that passes over the rear of the stump in such a way as to exert constant pressure. This appliance tends to stretch the contracted hamstrings progressively, until at last it can be removed and the ordinary socket worn.

Amputation through the *knee-joint* may give a useful stump if properly performed. In order to bear weight the flap should be thick and the scar high up and out of the way. The condyles should not be scraped or otherwise disturbed, and the patella should be either removed or else firmly fixed in the depression between the condyles. Such a stump will have a nodular end and may be clumsy in appearance, but it will usually be capable of end-bearing without sensitiveness or pain.

In amputations of the *thigh* the same principles should govern the operator as in the case of tibial amputation. Thigh stumps, like those of the tibia, are not capable of bearing weight upon their extremities, as a rule, and, therefore, reliance must be placed upon the socket. Amputations which are too close to the knee do not allow sufficient room for the mechanical knee-joint with which these legs are supplied. For this reason it is found that the most suitable point for amputation is at the junction of the middle and lower thirds. Thigh amputations which leave a bony stump short of 5 in. in length usually are inadequate from a functional point of view, on account of insufficient leverage. For this reason, in cases of amputation above the point of election the perfection of the flap should be sacrificed to the length of the bone.

Thigh stumps, like those below the knee, are subject to contraction, provided the use of an artificial leg is too long postponed. This contraction is, however, usually overcome with slight difficulty after the leg is applied. The legs are made like those already described for tibial stumps, except that the socket is fitted to the thigh and the knee is supplied with a spring which allows of flexion in walking so as to simulate the natural gait. An appliance is fitted to the knee, which holds it in the flexed position when the wearer is sitting. The socket is held on by a band of webbing which goes over the opposite shoulder.

After amputation through the *hip*, legs are supplied similar to those just described, with a few modifications. The socket is wide and shallow, and has a broad, rounded edge, so that the wearer is practically sitting upon it. It is held in place by a broad belt and suspender.

In all *amputations in general* there are details which should never be overlooked. Of these, the most important is the position of the scar. If the stump is to be end-bearing, that is to say, if the extremity, as in the case of the amputation at the ankle- or knee-joint, is to take the weight of the leg, the scar should be out of the way in front or behind. If the stump is to be a conical one, as in the case of amputations of the tibia and thigh, the scar should be so placed near the extremity that it will not be subjected to pressure or irritation from the socket. The presence of sharp edges or spicules of bone or corners which are not rounded off will make themselves disagreeably felt after the stump has atrophied with use. The slightest pressure will cause irritation of the skin over such points and usually leads to ulceration, which does not heal up permanently until the bone is properly trimmed. Nerves should always be drawn down and cut off short, so that they will retract into the tissues. If they are caught in the scar, they will give rise to amputation neuralgia or other serious symptoms. Sometimes the cut ends will proliferate and form neuromata, which are accompanied by hallucinations of sensation in the absent limb, and usually necessitate re-amputation.

The flap should be so well planned that it will be well nourished. It should contain tissue enough to amply protect the bony stump, but the tissue need not be thick, because it must shrink to its maximum before the socket can be worn to the best advantage. It is best to have this shrinkage accomplished and the desired conical shape attained before the leg is fitted, as this will save the trouble and expense of successive refittings of the leg-socket as the stump shrinks in use.

This shrinkage may be accomplished by keeping the stump tightly bandaged from the time the skin is healed. The bandage may advantageously be made of cotton flannel, and it should be applied in case of a tibial stump from the tip to the knee, and in case of a thigh amputation from this extremity to the body. Unless this is carried out, the stump will be soft and flabby. If it is properly attended to, the stump will become tough, solid, and resistant, and will gradually diminish in size.

Instead of the bandage, we can make use of a leather appliance called a stump-corset. This is molded to fit the stump, and is made to lace up so that graduated pressure can be applied and the desired end attained. Ordinarily, under this treatment the patient is ready to be measured for his leg within a fortnight after the wound has healed, so that he can be up and about on crutches. To prevent contractions the stump should be exercised and given proper massage and manipulation until the limb is ready. If the stump undergoes further shrinkage in the socket, a new socket may be supplied, or, if the shrinkage is slight, it can be compensated by wearing thicker socks.

Artificial hands may be fitted to a forearm which is amputated at or above the wrist, or, if part of the hand remains, artificial fingers can be supplied. For amputation at the middle of the forearm an appliance may be fitted which will allow of motion at the elbow. It is held in place by a broad strap, encircling the arm above the elbow. The thumb of the artificial hand may be made to grasp by means of a cord which goes over to the opposite shoulder.

In amputations above the elbow the socket is made so as to go over the shoulder, and it is held in place by a strap about the body. Cords may be fitted to control motion at the elbow and thumb. Stumps on the upper extremity are not required to bear weight, but insomuch as friction from the socket comes upon the sides of the stump, it is advisable to have the scar at the extremity.

POSTOPERATIVE FLAT-FOOT

After a severe operation or in a patient for any reason much debilitated, on putting the feet first down to the floor and attempting to walk, the feet, ankles, and legs are liable to swell. Cold spraying, massage, and flannel bandages will help to make this stage pass quickly.

Many patients after a severe surgical experience, especially if the stay in bed has been long, will rise at first with their muscles and ligaments so atrophied that symptoms of a weak or "flat" foot will immediately appear. This is especially seen after fractures, particularly if the foot has not been held at right angles to the leg and well adducted.

This condition of muscle atrophy, through disuse or improper use, is indeed the common etiology of so-called flat feet, and for it the following exercises are recommended:

I. Stand stiff-kneed, the feet 3 or 4 inches apart, parallel or slightly toeing in, the toes making a grasping effort. This is the correct standing posture (Fig. 104).

FIG. 104.

II. Standing with knees "broken" or slightly bent forward, the knee-caps turned outward to simulate bow-legs, the feet as before, parallel or slightly toeing in, the toes grasping. This is a position such as the gorilla or the ourang takes. It is a perfectly stable, strong posture. The weight of the body as the next step is taken in this position is not thrown suddenly and wholly on the arches of the feet, but the load is taken up and distributed in the spring action of knees, ankles, and feet (Fig. 105).

Fig. 105.

III. The legs are crossed, the feet placed parallel, 2 inches apart, the weight equally divided between the feet. This posture, maintained one

Fig. 106.

minute and then reversed, brings into play all the muscles of balance (Fig. 106).

IV. Stand on one foot placed straight forward, the other foot curled around behind the standing angle. Balance in this position without other support for a minute, first on one foot, then on the other (Fig. 107).

FIG. 107.

These exercises barefooted, or in correct shoes, should be taken for two or three minutes, five to twenty times a day; in other words, whenever the

FIG. 108.—WEAK, OUT-TOEING POSTURE, CALLED "LADY-LIKE."

opportunity presents for a moment, until the springy, balancing posture and gait of childhood are recovered.

The shoe, to allow for this correct standing and walking, must have the following characteristics (Fig. 109):

It should be light in weight, soft and flexible in shank and all other parts, and the low, flat heel should be rendered balancing and unstable, best by the use of soft rubber, either for the whole heel or for the outer front corner. The construction should be such that in size and shape the shoe shall not pinch the extended foot, bearing all the weight of the body, and the inner sole so made that the foot shall not, after a short time, sink down in the middle of

FIG. 109.—GOOD SHOEING.
Oxford, thin leather, unstable heel, flexible shank, "foot-shaped" last.

the plantar region as into a trough. The upper should be high enough in front to allow the freest toe-flexion, and over the middle of the foot, to let the dorsum of the foot raise itself as the toes grasp the sole. The counter should be low, to allow free motion at ankle. There should be no "fit" in the usual sense of the word, but yet enough fitness for the particular foot for a loose lacing to prevent slipping at the heel.

The shoe should always be an Oxford, allowing for freest play of the ankle-joint. It is no more reasonable to bind a high shoe round the ankle than to put a leather support on the knee.

CHAPTER XXXVII

MASSAGE: FRICTION, PERCUSSION, KNEADING, AND REMEDIAL MOVEMENTS

MASSAGE, in a broad sense, is the systematic manipulation of parts of the body whereby the nervous, circulatory, lymphatic, and muscular systems may be stimulated, exudates absorbed, waste matter taken up and eliminated through the proper channels, recent adhesions broken up, and the tone of the body as a whole improved.

Nervous System.—In cases where there is a partial or entire loss of nerve force or where the nerves are sluggish, as in the paraplegias, neuralgias, and neuritis, unless there is great hypersensitiveness, massage acts as a stimulant.

Circulatory System.—Massage acts first as a vasoconstrictor, later, as a vasodilator. It mechanically pushes the venous blood along, which, in conjunction with the dilatation of the arterial and capillary systems, lessens the resistance to the blood-stream, and thereby decreases the effort necessary on the part of the heart muscle; at the same time more blood is sent into the parts under treatment, the superficial circulation improves, and the skin is made to functionate more freely.

Muscular System.—It is known that a muscle will begin to develop signs of atrophy rapidly when not in use, where it is immobilized, where the nerve force is lessened, or where the circulation is obstructed. When properly stimulated, however, by muscular exercise, or, where this is not possible, by the use of massage, atrophy of the musculature is prevented, or if it has already occurred, it improves rapidly. The individual fibers become firmer and larger and new fibers are also formed.

An analysis of the manipulations employed in massage demonstrates that there are fundamentally four procedures: friction, percussion, kneading, and remedial movements. These may be applied separately or in combination or sequence, and with more or less force, as indicated.

I. FRICTION

Friction, or *effleurage*, is a light introductory movement used in the beginning of all manipulations, slow stroking with palmar surface of the fingers, the flat hand, heel of the hand, or thumb, governed by the location and condition for which treatment is given. The effect is to aid the forward movement of the lymphatic and venous circulations. It is soothing and slightly stimulating, and it may be useful in the removal of serous exudates, as edema following fractures, cellulitis, and such conditions.

The strokes may be circular or in straight lines, corresponding to the long axis of the limb. In either case the pressure during the upward strokes should be slightly the stronger, and the return should be hardly more than a grazing of the surface. The strokes may be applied at the rate of 90 to 180 per minute, depending on the length; and they should not be strong enough to bring more than a blush to the skin.

II. PERCUSSION

Percussion, or *tapotement*, may be defined as the administration of a series of sharp blows with the hands, delivered in rapid succession, all the joints of the hand, wrist, and elbow being held flaccid. It is used over muscular masses, and may be applied in several ways: (1) With the ulnar edge of the extended hand, "hacking"; (2) with the ulnar border of the hand half-closed, "beating"; (3) with the ulnar border of the hand, with the fingers so separated that they will strike together with each blow; (4) with the tips of the fingers held closely together, the hand being half-closed; (5) with the backs of the ends of the fingers held loosely; (6) with the flat palm of the hand, "slapping"; and (7) with the palms lightly flexed, so as to form a cup-shaped depression which compresses the air.

Generally speaking, a muscle should be percussed transversely to the direction of its fibers. The blows should be delivered alternately with the right and left hands, and the percussion should be rapid, from 200 to 600 blows per minute. The delivery should be active and springy, with a quick recovery, not solid or sluggish.

Percussion is very stimulating. The superficial arteries are contracted by gentle percussion, while they are dilated by strong percussion. When applied over tendons and muscles in certain regions it causes sharp reflex muscular contractions. Overstimulation and nerve exhaustion may be caused by too prolonged or too strong percussion, and unless carefully used it will leave the muscles lame and sore. It increases the functional activity of the skin, improves the circulation, and promotes the nutrition and development of wasted muscles, as in the paraplegias and certain of the arthritides. It should never be

FIG. 110.—TREATING A RECENT COLLES' FRACTURE: FIRST STEP.

The hand is strapped to the anterior splint, the forearm resting on a pillow held on the lap of the operator, who holds the patient's hand with his left hand, and applies gentle petrissage or kneading.

FIG. 111.—TREATING A RECENT COLLES' FRACTURE: SECOND STEP.

The splint has been removed and the fracture is being held in place by resting on left palm of the operator. Lateral pressure is being applied to the sides of the wrist and lower part of forearm while performing gentle friction or finger-tip petrissage. As in the preceding illustration, the forearm rests on a pillow.

used where there exists a tonic contraction of any muscles or group of muscles.

Vibration.—Vibration is sometimes included under tapotement.

FIG. 112.—TREATING A RECENT COLLES' FRACTURE: SECOND STEP CONTINUED.
The hand is being held as in the previous view, while petrissage or kneading is applied to the forearm muscles.

FIG. 113.—TREATING FRACTURE OF EXTERNAL CONDYLE OF LEFT HUMERUS.
The elbow is held with the right hand of the operator, who is exerting firm lateral pressure, the left hand being used to effect passive motion. A sympathetic polyarthritis is developing in the hand and wrist.

It is performed with the hand held cup shaped, with the finger-tips touching the subject held tightly, but not rigidly, and with a series of very rapid and vibratory motions imparted to the fingers by the contraction of the forearm muscles. Vibration is usually done by machine, unless by skilled operators, who can govern the force with more accuracy than can be done by any machine.

Vibration stimulates the nervous, circulatory, and lymphatic systems, as well as deep-lying muscles, and is especially useful in any

FIG. 114.—TREATING A FRACTURE OF THE SURGICAL NECK OF THE LEFT HUMERUS: FIRST STEP. The elbow is resting easily on pillows in the operator's lap, held tightly to prevent slipping, while with the right hand gentle petrissage is being done.

condition where the nerve power is diminished, as in paraplegia and neuralgia. It should not be used over inflammatory surfaces.

III. KNEADING

Kneading, or *petrissage*, is one of the most important elements of massage. It consists in picking up the tissues under treatment with the base of the fingers and thumb and kneading the parts, a small portion at a time. It may be either superficial or deep. As the term

FIG. 115.—TREATING A FRACTURE OF THE SURGICAL NECK OF THE LEFT HUMERUS: SECOND STEP.
The patient is lying with shoulder on a pillow; while the elbow and forearm are held, gentle passive movements are being done. The same method is used in assistive and, later, in active and resistive motions.

FIG. 116.—TREATING A RECENT RIGHT POTT'S FRACTURE.

Patient is lying down with heel resting on pillow and operator's left hand under ankle-joint exerting firm pressure to prevent slipping of lower end of fibula, while the right hand is passively dorsiflexing the foot. The other muscular movements are performed by the same method.

implies, *superficial kneading* is applicable to the skin, which is picked up and kneaded by alternately tightening and relaxing the grasp, care being necessary not to grasp the parts with the tips of the fingers to avoid pinching. *Deep kneading* consists in picking up a muscle or a group of muscles, or rolling or kneading between the hands, or pressing on the underlying bone. *Fist kneading*, in which the fist is used to compress the tissues, is especially useful in the abdominal region. *Wringing*, where the hands grasp the tissues and wring them in opposite directions, is useful only on the extremities.

Superficial kneading stimulates the nerves of the skin and increases its functional activity. It is indicated particularly in local edema following injury, fracture, local sepsis, etc. Deep kneading stimulates the deeper nerves, aids the venous and lymphatic circulation, and promotes the absorption of inflammatory exudates. It breaks up adhesions and relieves venous congestion, thus producing an active hyperemia, stimulating and stretching the muscles, preventing contraction, giving tone, and strengthening them. The heart is relieved of some of its work by the pushing on of the venous and lymphatic streams.

IV. REMEDIAL MOVEMENTS

Remedial movements are divided, according to the amount of work required of the patient, into: (1) Passive movements; (2) assistive movements; (3) active movements; (4) resistive movements.

Passive movements consist of motions produced wholly by the operator, where the subject makes no effort at active muscular movement whatsoever. One hand of the operator supports a part, while the other hand produces motion. This is useful in very recent fractures, dislocations, or sprains.

Assistive movements, as the name implies, consist in helping the patient make the motions, allowing him only to do a small part at first, gradually increasing the amount of work, until such time as he may have arrived at the point where he can safely perform the active movements.

Active movements are those in which the patient slowly moves the member through a part of the arc of motion at first, gradually increasing until the whole arc is completed.

Resistive Movements.—In these the operator resists the patient's action of a muscle, at first slightly, increasing gradually, in this way strengthening the motor power. Resistive treatment may be carried out by Zander machines (Fig. 119) if one is near a city where they are

FIG. 117.—GIVING MUSCULAR TREATMENT TO A KNEE FOLLOWING FRACTURE OF THE FEMUR.

The patient is lying prone, with knee resting on the right palm of the operator, while passive motion is being given with the left hand.

FIG. 118.—DIFFERENT TYPES OF BAKERS IN ONE OF THE DEPARTMENTS OF THE MASSACHUSETTS GENERAL HOSPITAL.

The one on the left being a shoulder baker, which may be raised or lowered to accommodate the height of the patient. Heat here is by means of electric lights arranged in a series. The baker on extreme right is used for arms, and the heat arrangement is similar to the one described. The central machine is a leg baker, the heat being furnished by a Bunsen flame.

installed. They may be carried on at home if one has the time and patience, all movements of this sort being simulated by the hands with fully as good results.

Some operators require the use of a lubricant, as cold cream, for work on the deeper structures. Cold creams have as a base petroleum oil, which stimulates the growth of hair, and as this is objectionable to most patients, it should not be used. If anything is required, talcum powder is cleaner and more desirable. If cold cream is used, it should be thoroughly removed with dilute alcohol after each treat-

FIG. 119.—A PARTIAL VIEW OF THE ZANDER ROOM OF THE MASSACHUSETTS GENERAL HOSPITAL.

Showing some of the machines in use in giving active, passive, and assistive movements, as well as vibration and kneading. These machines are so designed that any group of muscles may be exercised, the amount of work given being regulated by the operator to fit the individual needs of each case, and changed at his discretion from time to time, as the case assumes a different aspect.

ment, and wiped dry with a soft towel. Where superficial treatment is required, no lubricant at all should be used.

There are certain general rules which should be followed in carrying out these procedures. The patient should be disposed comfortably and without restraint in a cool, well-ventilated room. The operator should be near enough to get the most definite and energetic action, and yet not so near that his movements will be in the least cramped. He should begin his manipulations slowly and gently, increase them gradually to the fullest speed and force desirable, and then gradually lessen them. He should cover the greatest extent of surface with his hands and fingers which the conformation of the part and the nature of the manipulation allow, so as to get the widest effect with the least effort, and to save time. The direction of all the procedures employed in massage should be centripetal: from extremities to trunk, in the direction of the return circulation, and, generally speaking, from insertion to origin of muscles. Gentleness should be cultivated above all else; crude operators are prone to be-

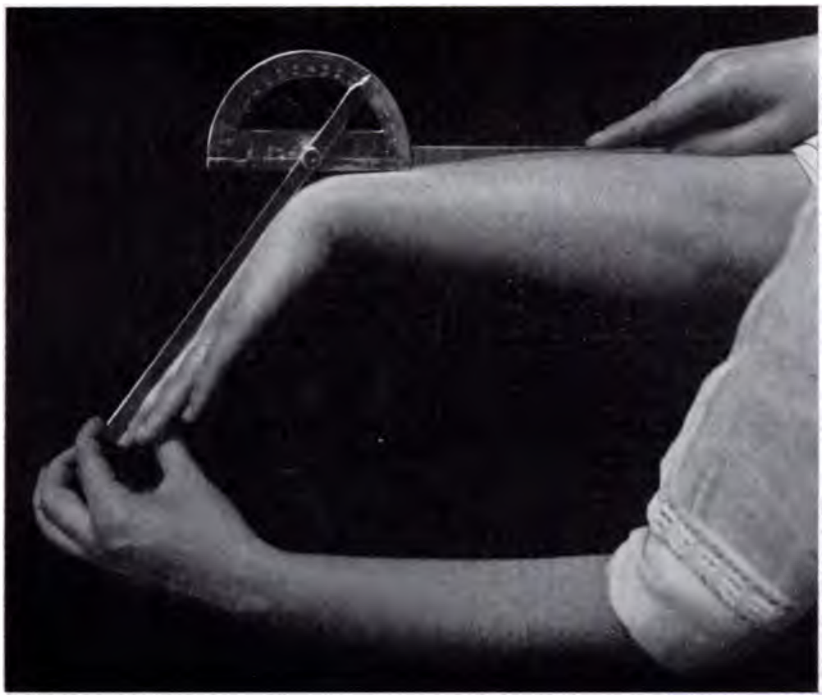

FIG. 120.—MEASURING THE FLEXION AFTER MASSAGE OF THE WRIST.

Showing measuring device and method of use by means of an instrument modified by Dr. L. P. Felch for ascertaining the degree of motion in a joint for purposes of record; applicable to positions where it is possible to measure the outside angle.

lieve that the efficacy of massage depends upon the force which they expend in accomplishing it.

The question of the dosage involves the form or forms of procedure to be employed and the frequency with which they are applied, the length of time to be given to the manipulation, and the intervals proper between treatments. All this has to be measured by the indications, and by the skill and experience of the operator. A well-trained and experienced masseur can accomplish more in less time and with less effort than the amateur, and to better advantage.

Nevertheless, the comparatively crude manipulations of the nurse or attendant may become, if properly supervised, of considerable aid during surgical convalescence, and should by no means be despised. In cases involving any important question of dosage, an expert should be called in.

CHAPTER XXXVIII

ELECTROTHERAPY; *X*-RAY THERAPY; RADIUM

Historic.—The first application of electricity to medicine was made during the early part of the eighteenth century. Static electricity was the only form then known. Its use was entirely empirical, and appears to have been suggested by observations of its effect upon persons who took electric shocks to gratify curiosity. De Haen, of Vienna, was the first to make extensive employment of electricity as a therapeutic agent,[1] publishing his observations in 1756, although others had previously reported isolated cases. In 1758 Benjamin Franklin introduced electrotherapy into America,[2] treating a number of paralytics without much success. Another well-known layman who was interested in this subject about the same time was John Wesley, who, in 1759, wrote a treatise on it.[3]

The use of electricity extended and soon became wide-spread. The number of patients who were treated by it was prodigious, and the reported cures were indeed miraculous. After the first misguided and exaggerated enthusiasm had subsided, investigations by leading physicians threw discredit upon the therapeutic value of electricity, and its use was for a time relegated to quacks and imposters. A more rational view soon prevailed, however. Writing in 1780, Cavallo[4] says: "But at prefent a much better acquaintance with the ſcience of electricity than philoſophers had about thirty or forty years ago, has pointed out the real effects of that power upon the human body in various circumſtances, and has ſhewn how far we may confide in it; eſtabliſhing, upon indiſputable facts, that the power of electricity is neither that admirable panacea, as it was conſidered by ſome fanatical and intereſted perſons, nor ſo uſeleſs on application as others have aſſerted; but that when properly managed, it is an harmleſs remedy, which ſometimes inſtantaneouſly removes divers complaints, generally relieves, and often perfectly cures various diſorders."

[1] Beard and Rockwell, Medical and Surgical Electricity, New York, 1891, eighth edition, 200.

[2] Kassabian, Electro-therapeutics and Röntgen Rays, Phila. and London, 1907, 31.

[3] John Wesley, The Desideration: or Electricity made Plain and Useful by a Lover of Mankind and of Common Sense, 1759.

[4] Cavallo, An Essay on the Theory and Practice of Medical Electricity, London, 1780.

At first very strong shocks were given, but it was soon discovered that these were no more effective than weaker ones and were even productive of harm. Electricity was tried in almost every conceivable medical or surgical condition, but its field of application soon became fairly clearly defined, at least among the more enlightened members of the profession, and, except that we now no longer use static electricity upon abscesses or in tonsillitis, it has not changed greatly up to the present.

With the discovery of animal electricity by Galvani, in 1790, and the invention of the Voltaic pile, ten years later, the continuous current began to be used in therapeutics, and, after the work of Faraday in 1831-1832, the induced current also received wide employment in medicine. These were, however, used empirically and indiscriminately until Duchenne, in 1850, laid down the principles for the scientific use of local faradism, and it was not until even later that Remak, of Berlin, applied the same principles to the use of the galvanic current.

Steady progress from this time on was made in the rational application of electricity, but with no great impetus until the discovery of the Röntgen rays in 1895, and of light therapy by Finsen two years previously, ushered in an era of rapid development, to which the recent discovery of the therapeutic possibilities of radium has added an important factor.

In the after-treatment of surgical conditions electricity in its various forms has as definite and useful a place as in general medicine. It is not a panacea, but when intelligently used to meet definite indications, it is invaluable. These indications, the form of electricity to be used, and the technique of its applications, will be briefly set forth in the following pages:

INDICATIONS

Relief of Pain.—Pain may be divided technically into—(*a*) Habit pain; (*b*) pain due to congestion or stasis; and (*c*) pain due to cicatricial pressure.

(*a*) *Habit Pain.*—It is a well-known fact that frequently pain that has existed for some time prior to an operation will persist to almost the same degree postoperatively. Where we find no cause for such pain we are forced to call it a habit pain, though with refinements in methods of diagnosis the number of so-called habit pains is constantly growing less. In a true habit pain some mechanic or electric method of treatment offers the quickest possibility of relief. Where we can determine the nerve supply involved, vibration, applied to the appropriate nerve-center in the spine until inhibition is produced, is the first choice. This treatment should be given for ten to twenty minutes, and should be repeated often enough to "bridge the pain"; that is, so as to render the patient free from pain, which may mean daily treatments, or treatments every second, third, or fourth days. (See Vibration.)

Other cases may be relieved by the incandescent or the arc light; the superficial hyperemia which is produced will cause analgesia of the part, plus the effects of increased nutrition. If the blue light be used, there is produced a local anesthesia of the nerve-endings as well as local ischemia, due to stimulation of the vasoconstrictors. (For technique, see Light Therapy.)

At times the positively connected sponge of the direct (galvanic) current, saturated with a 20 per cent. solution of cocain hydrochlorid, placed directly over the painful areas, the negative pole being placed indifferently, using large, well-moistened pads with a current strength of from 5 to 50 ma., will be found of advantage. The main object of treatment is to keep the pain under control, so that the chain of habit may be broken.

(*b*) *Pain Due to Congestion or Stasis.*—Frequently, for example after a resection of an ovary, there remain behind large and varicosed blood-vessels, which, distributing the same supply of blood to the part as before operation, will cause the same pain and feeling of weight to persist. Here the static wave current, by producing deep-seated muscular contractions, by its apparent power of restoring muscular tone, and by its analgesic effect on nerve-endings, is the treatment par excellence. A metal plate of block tin, large enough to cover the sacral and lumbar portion of the back, should be connected by a wire to the positive pole of a static machine; similarly, another strip of metal sufficiently large should be placed over the abdomen and this plate also connected to the positive pole. The further technique is given under the head of the static wave current. Treatments should be from fifteen to thirty minutes every other day.

At times, though painful, the indirect static spark, by producing deep-seated muscular contractions, will give the same effect. The sparking should be applied over the area of pain, single not multiple sparks being employed, and continued until all pain is gone. At first daily treatments should be used.

(*c*) *Pain Due to Cicatricial Pressure.*—Those who have seen even a keloid disappear under the Röntgen rays know what great power of absorbing scar tissue the rays have. A tube which shows the bone of the hand black is the best one to use, and it should be employed for eight minutes at a distance of 10 to 12 in. from the skin, measuring from the central anode of the tube. For the first four treatments every third day will be enough, and then every five to eight days, until the pain has ceased or a slight dermatitis has developed.

A hard, constricting cicatrix may be replaced by a soft, pliable scar by means of metallic electrolysis. The technique is—connect with the negative binding post of the galvanic plate a needle, or needles, inserted $\frac{1}{8}$ in. into the periphery of the scar. A sponge electrode the size of the hand is bound anywhere on the patient, and a current of 2 to 15 ma. is allowed to flow until the tissue around the needles is completely bleached. This requires from one to two minutes, and is to be repeated until the scar is completely surrounded by a ring of these bleached marks. Cocain cataphoresis will render the operation nearly painless. No antiseptic or cerate dressing should be used afterward. Repeat in a week if necessary.

Atrophy of the Musculature Due to Disuse.—This is one of the most important indications for postoperative electrotherapy. Here the induced current (faradic) should be employed, using the rapid interruption, and current strength enough to produce gentle but decided contractions of the muscle or muscles involved. One pad should be placed over the spine while the other should be gently stroked over the muscles for ten to fifteen minutes every other day. This may be followed by massage or vibratory stimulation, using the large round rubber vibratrode for five to ten minutes; or the sinusoidal current, employing the same technique as in the induced current, may be advantageously used. The advantage of the sinusoidal current is, first, that it is much more agreeable to the patient, as it is symmetric and regular in its intermittency; and, second, by means of a low-priced suitable controller it can be taken from the alternating commercial light service.

Nerve injuries may be divided into three classes: (*a*) Pressure neuritis; (*b*) operative injury to nerve; and (*c*) severed nerve.

(*a*) *Pressure neuritis* is due to pressure sustained by a nerve during a prolonged operation. If no reaction of degeneration be present, the resulting paralysis may be treated similarly to atrophy of the musculature due to disuse. If there be a diminished reaction to the induced current (faradic) and no pain is present, high-tension faradism may be used for five minutes, followed by interrupted galvanism (60 to 100 interruptions a minute), the negative sponge being stroked over the affected muscles while the positive is firmly affixed over the spine. If pain is present, the positive sponge of the direct current (galvanic) should be gently rubbed over the nerve-trunk, care being taken not to use the interrupter nor to cause muscular contraction by breaking the contact of the sponge with the skin. If the pain is excessive, the positive sponge may be saturated with a 20 per cent. solution of cocain or the indirect static spark employed for five minutes.

If a complete reaction of degeneration be present, the positive sponge should be used as above, without interruption if pain is present and with interruption if there is no pain. A current of 2 to 20 ma. for ten to thirty minutes, repeated every other day, is sufficient. If the pain is severe, the positive sponge may be bound on the part, as the mere act of stroking may cause increased pain, and, for this reason, massage or vibratory stimulation, if used at all, should be tried guardedly. The high-frequency monopolar vacuum tube (exhausted to a blue vacuum) and light, incandescent or arc, are at times also useful in palliation of pain.

(*b*) *Operative injury to nerves* should be treated as above, the treatment varying with the amount of the reaction of degeneration and the pain present.

(*c*) *Severed Nerves.*—If the cut ends are nearly approximate, union may take place, and they should be treated as a complete reaction of degeneration with pain. If the approximation is not present, no result will be obtained.

Adhesions and Ankylosis.—This subject may be considered under the headings: (*a*) Joints; (*b*) contractures of fingers or toes; and (*c*) adhesions elsewhere in the body.

(*a*) *Joints.*—After operative work on the joints pain and limitation of motion, due to adhesions or ankylosis, may be a prominent feature. This may ordinarily be speedily relieved by the following method:

First, baking the joint with superheated dry air, which, inducing an active hyperemia, relieves the pain and causes increased absorption of exudates (for Technique, see Superheated Dry Air), followed by stretching of the joint by massage and manual manipulation, or vibratory stimulation while the joint is on the stretch, using the ball vibratrode and as great an excursion of stroke as the patient can tolerate. If there is increased pain after this procedure, the indirect static spark, the static wave current (wrapping a sheet of foil around the joint), or the monopolar high-frequency vacuum tube may be used from ten to fifteen minutes. Treatment should be repeated every third to fifth day until relatively free and painless motion is obtained.

(*b*) *Contractures of Fingers or Toes.*—A saturated solution of sodium chlorid on the negative sponge of the direct current (galvanic) should be placed over the contractures, with the opposite side resting on the positive sponge and a current of 10 to 30 ma. driven through the part for fifteen to twenty-five minutes, the object being to soften the tissues through the resolvent effect of the chlorin atoms or ions liberated by the negative pole saturated with sodium chlorid. Massage and stretching by means of the vibrator should follow. Repeat every other day unless the skin becomes too tender.

(c) For *adhesions in the abdomen* there is a slight chance, by the use of the x-ray (remembering the possibility of producing sterility), by the sodium chlorid cataphoresis described above, or the gentle vibration, to relieve the condition, though ordinarily adhesions sufficient to cause much in the way of symptoms call for operative interference.

Low Vital States.—In addition to proper hygiene and diet, and tonic treatment where indicated, static insulation, the static wave current, or the arc light may be used every other day for fifteen to thirty minutes to increase the hemoglobin and number of red corpuscles. For exhaustion the high-frequency monopolar vacuum tube, or the static wave current with the metal electrode down the spine, is useful. (See Postoperative Neurasthenia.)

Postoperative Neurasthenia.—In this condition the treatment is general and symptomatic. If there is any toxic basis for nervous exhaustion autocondensation, by its apparent stimulation of the sympathetic nerve system, will cause increased elimination (as may be proved by urinary examination), and will engender a feeling of well being. Exhaustion on the slightest muscular exertion will call for general faradization (which see) and general vibratory stimulation. For headache and sense of pressure in the head the static wave current with a metal strip along the spine for twenty minutes, followed by a positive static breeze for ten minutes, will afford much relief. For a tender, irritable spine, the arc light, the static wave current, the high-frequency monopolar vacuum tube, or a long sponge connected with the positive side of the galvanic plate, the negative over the abdomen, 10 to 30 ma. for twenty minutes, may be employed.

For the various paresthesias the faradic wire-brush or the high-frequency monopolar vacuum will be indicated. For insomnia use the static wave current, the positive head breeze, or the incandescent or arc light over the spine. For mental exhaustion employ the high-frequency monopolar vacuum tube along the spine and over the head for fifteen minutes with a current strength as great as the patient can tolerate, followed by the positive static head breeze for ten minutes. For fermentation use the static wave current with a large metal plate over the abdomen, repeated every second or third day for twenty to thirty minutes.

High Blood-pressure and Sclerotic Changes in the Arteries.—Where there is a high blood-pressure and there is no chronic interstitial nephritis, the blood-pressure may be steadily and apparently fairly permanently reduced by autocondensation with 200 to 400 ma., flowing for twenty to thirty minutes. The treatments should be repeated every third day until a normal pressure has been reached. Cases so treated have remained normal for over two years. The more moderately increased pressures may be reduced by applying the high-frequency monopolar vacuum tube over the spine and the solar plexus for ten to fifteen minutes.

This reduction in pressure is apparently due to the stimulation of the sympathetic nervous system. The immediate drop is due to stimulation of the vasomotors, and the permanency to the increased elimination due to the sympathetic stimulation.

After Operations for Malignant Disease.—Whatever one's opinions may be regarding the use of the Röntgen ray before resorting to operation in malignant disease, there can be little doubt that it forms an often valuable and effective means of dealing with recurrent growths and of preventing recurrences. At the symposium upon the therapeutic value of the Röntgen ray in surgery, held at the meeting of the American Surgical Association in 1902,[1] its postoperative use was advocated by Williams, Bevan, Coley, Rodman, Pfahler, and Johnson for both these indications.

Holding[2] has analyzed 148 cases from the literature of inoperable or recurrent malignant disease treated by the Röntgen rays and found that 32 per cent. were "apparently cured" (meaning complete disappearance of the growth, but without five years having elapsed), 58 per cent. were improved, and only 10 per cent. not benefited. Of the entire number, 16 were recurrent carcinomata, and of these, in 13 the growth disappeared entirely, and in the remaining 3 marked improvement was noted.

Although the widest employment of the rays has been in carcinomata, they have also been well tried out in sarcomata. Coley,[3] whose experience with the treatment of sarcomata, both by the mixed toxins of the streptococcus and bacillus prodigiosus and the Röntgen rays, has been extensive, states that the rays have caused disappearance of

[1] Trans. Amer. Surg. Assoc., 1903, xxi, 208.
[2] Albany Med. Ann., 1903, xxiv, 94. [3] Ibid., 215.

the disease in some cases where the toxins alone have failed, but that in each of these, however, the growth soon returned, whereas a considerable number cured by the toxins remained well after a period of years. He states that the poorest results of the Röntgen rays have been in the spindle-cell sarcoma, in which variety the best results are obtained by the toxins. Therefore, he advocates the combined use of these two agents in the hope that the rays may accomplish what is left undone by the toxins.

In tuberculous lymph-nodes the Röntgen ray has been apparently of decided therapeutic value in some cases when used in conjunction with the general measures for the treatment of tuberculosis. Sinuses have been reported to heal rapidly under its use.

Keloids frequently disappear with rapidity under Röntgen-ray treatments, leaving a fine white line, soft and pliable, which in the course of time closely resembles the surrounding skin.

ELECTROTHERAPEUTIC TECHNIQUE

Static electricity is exhibited in three forms: (*a*) Wave current. (*b*) Spark. (*c*) Head crown breeze.

(*a*) *Wave Current.*—Patient on insulated platform; spark balls of machine together; negative pole grounded; positive pole connected by a wire to tin-foil firmly placed against the bare skin of the part to be treated (if around a joint, bind with bandage); machine started at not more than 200 revolutions a minute, and spark balls gradually pulled out to the point, just short of causing pain to the patient. Treatments every second or third day; duration, fifteen to thirty minutes. Any prickling sensation means that the foil is not in close approximation to the skin and may be overcome by having the patient press that point against the skin.

(*b*) *Spark.*—Patient on insulated platform; spark balls of the machine wide apart; negative pole grounded; positive pole connected by metal rod to platform; the other ground wire (connected to gas-pipe or water-pipe) connected to ball electrode, which is brought near enough to patient to cause a spark to leap forth. Single sparks (as multiple sparks are poorly tolerated) should be given over as wide an area as possible until pain is relieved. Treatments repeated on any return of pain.

(*c*) *Head Crown Breeze.*—Patient seated in a comfortable chair on an insulated platform; negative pole grounded; positive pole connected with metal rod to platform or held by patient, the other ground connected by wire to metal head crown, which should be suspended at such a distance above the patient's head that he feels a strong breeze with just a suggestion of tingle. Treatments repeated as often as needed to relieve condition. Time of treatment, ten to thirty minutes.

High Frequency.—(*a*) Autocondensation. (*b*) Low vaccum tubes.

(*a*) *Autocondensation.*—To one pole of the d'Arsonval current of the American type of high-frequency machine a long metal rod is connected, which is held in the hands of the patient. The other pole is connected with a metal plate, which is insulated from the patient by two sheets of rubber and a felt cushion or mattress at least 3 in. in thickness. The best result is obtained by having the patient reclining on a rattan couch free from metal nails or screws. With a hot-wire meter in the circuit, from 200 to 400 ma. of current is turned on for ten to twenty minutes. Repeated every third day.

(*b*) *Low Vacuum Tubes.*—Tubes exhausted to a blue vacuum are best for relief of pain. Ordinarily they are connected by the monopolar method and are applied over the bare skin, as thereby a greater degree of current can be tolerated by the patient. If a strong counterirritant effect is desired, they can be applied through the clothing. As strong a current should be used as the patient will stand, unless the erythema of the skin becomes too marked. The local action is decreased nerve irritability, followed by local anesthesia, increased action of the sweat-glands, hyperemia of the skin, increased temperature, and liberation of free ozone in the tissues. Duration of treatment, five to fifteen minutes; frequency, every second, third, or fifth day. If the vacuum tube sticks to the skin, a little talcum powder will allow it to be moved freely over the surface. If the patient complains of pricking or tingling afterward, this may be relieved by the application of cold cream.

Direct Current (**Galvanic**).—With the direct current polarity is all important. As large pads as possible should be used, well moistened, as thereby a greater amount of current can be employed with less discomfort to the patient. The treatment in general is, wherever there is pain or complete reaction of degeneration, use the positive pole, while if there are no pain and no polar inversion, the negative pole is indicated. For the introduction of medicinal solutions into the tissues we find that the acids and acid radicles, being electronegative, should be placed on the negative pole, while the bases and alkaloids, being electropositive, should be placed on the positive pole; thus, for example, if we wish to introduce cocain hydrochlorid, the cocain would be placed on the positive pole; if we wish to introduce the chlorin atoms of sodium chlorid, or the iodin atoms of potassium iodid, the negative pole should be employed. If there are no pain and no reaction of degeneration in the paralyzed muscle, the faradic current may be used, while if there are a partial reaction of degeneration and no pain, and interrupted galvanic, 60 to 100 interruptions a minute, is best.

The direct current has a decidedly nutritional effect on the nerve tissues, and hence should be employed where we desire increased nerve nutrition or stimulation.

Light Therapy.—For therapeutic purposes two forms are ordinarily used: (*a*) Incandescent light and (*b*) arc light.

(*a*) *Incandescent Light.*—This may consist of a cluster of lights under a polished metal reflector or a single light of 200 to 500 candle power. The main effect from either is the heat-production and stimulation of the tissues by the radiant light-rays. The heat and the resulting active hyperemia are the main factors to be considered. The technique is as follows: The exposure should always be made over the bare skin. The patient is best treated in a recumbent position, the light being suspended overhead. The light should be gradually brought down nearer the surface until tolerance of a considerable degree of heat has been established. Swinging the light from side to side will prevent any burning from focusing the light-rays on one point for too long a time. Stroking the flesh with the hand will achieve the same result. Treatment should be continued until the pain has ceased or until the patient's temperature has reached over 100° F., or until the pulse-rate has increased to 120. The treatment should be repeated as frequently as necessary to relieve the symptoms, whether it be every day or once a week.

(*b*) *Arc Light.*—The arc light has a spectrum analogous to that of the sun, and is especially rich in ultra-violet rays. Except for the cost of operation and the closer personal attention required, it is far superior in every way to the incandescent light. The technique is as follows:

(1) *The Whole Arc Light.*—Exposure made on the bare skin; light at a distance of 18 to 36 in., depending on the tolerance of the patient to the heat; time of treatment, five to fifteen minutes on each part exposed; maximum of treatment, twenty-five minutes. Applications from every day to over a week, dependent on pain.

(2) *Blue Screen.*—Here a screen of blue glass is interposed between the light and patient and the technique is similar, only we do not need any great amount of heat, as the effect we wish to produce is a local ischemia and anesthesia. The blue screen has a strong sedative effect, and will produce a local anesthesia sufficiently strong to allow one to open small furuncles painlessly. The vasoconstrictors are stimulated, and consequently a more vigorous circulation is established through any

region where stasis has been present. A striking example of its anesthetic properties is in orchitis, when, after fifteen minutes' exposure, examination may be made without pain. Granulating surfaces which are indolent and painful heal rapidly and with a great decrease in pain.

(3) *Red Screen.*—Technique similar to that of blue screen. The red screen has strong stimulating powers and acts as a direct nerve-irritant and stimulant.

Superheated Dry Air.—The source of heat may be alcohol, gas, or gasoline, and a special baker is provided for the different joints. The main object is to raise the temperature to from 350° to 450°, with its consequent very active hyperemia and dilatation of the superficial blood-vessels. This intense heat and increased circulatory activity is accredited with certain bactericidal powers also.

The technique is as follows: The joint should be entirely bare and then wrapped with several thicknesses of Turkish toweling, and in this condition placed inside the baker. Any point which may become ischemic from pressure should have an extra fold of Turkish toweling, so as not to become burned. The ends of the baker are well covered and the heat gradually increased until 400° or 450° is obtained, or to the point of tolerance of the patient. This should be continued from fifteen to thirty minutes. As in the incandescent light, the pulse, temperature, and general feelings of the patient are the guide as to the length of treatment, and arteriosclerotics should be watched carefully. This may be repeated every third or fifth day, and, after every treatment, if there is any ankylosed condition in the joint, it should be stretched by means of the vibrator or by massage with manipulations.

Vibration.—For successful vibratory treatments a vibrator having either the lateral or gyratory stroke is essential. The percussive stroke is of very limited value. We can hope to accomplish one of two main objects with vibration—either stimulation or inhibition. The latter is the result of excessive stimulation. In all vibratory treatments it is desirable to apply the vibratrode directly to the bare skin and to have the patient recumbent, as thereby much better relaxation is secured. For general vibratory stimulation the patient should remove all tightly fitted clothing, and the remaining clothing should be so arranged that it will be easy to get at the various parts of the body. It is better to have a loose gown which ties up the back than to use a sheet. For general stimulation the patient should lie on the table, back up, arms hanging down at the sides, head turned to one side. Now bare the back, and apply vibration with a medium stroke and as much pressure as the patient can stand, between the transverse processes of the vertebræ, for fifteen to thirty seconds at each point, using the ball vibratrode. Then, with the flat brush vibratrode, go over the arms and legs, back muscles, chest, and the abdomen. If constipation is a feature, continue the vibration over the course of the colon and over the epigastrium to stimulate the solar plexus, and longitudinally across the abdomen to stimulate the small intestine. For inhibition the vibration should be applied for a longer period—one to three minutes—over the appropriate nerve centers in the spine. Treatments should be repeated daily if necessary. Similarly, stimulation or inhibition may be applied locally in the treatment of strains, sprains, or contusions, and, as already described under Adhesions, for postoperative joint conditions.

Induced Current (Faradic).—This is useful for muscle stimulation, and, as we saw when discussing the direct current, it may be used to prevent further atrophy, provided there is no reaction of degeneration. It has been considered that its polarity was theoretic only, but some experiments recently made seem to show that there is considerable polar action. It should be used by placing one sponge indifferently and stroking the affected muscles with the other. One form of treatment of great value, but unfortunately little used, is the so-called general faradization. Its technique is to have the patient thoroughly undressed, with both bare feet resting on a copper plate which has been wet with a little warm water, and with a sponge connected with the other pole of the faradic coil to apply the current over all parts of the body, paying special attention to the top of the head, the ciliospinal center (seventh cervical), and the solar plexus. The object is to put all parts of the body under the effect of the current. The spine should be treated for five minutes, the muscles of the back for three, each extremity for two, the abdomen for four, and the chest muscles for two. Treatments should be repeated every third day and sufficient current strength used to cause agreeable muscular contractions.

Sinusoidal Current.—This is an alternating current absolutely symmetric in character, and consequently more agreeable from a patient's standpoint. It may be employed by taking it directly from the alternating street current, interposing a resistance, so that the patient can receive a graduated quantity. Because of its pleasant character it is used in England in preference to the Faradic or induced current. The technique is the same as for the induced current.

The Röntgen Ray.—Since any surgeon about to purchase an x-ray outfit would naturally consult one of the several text-books devoted to this subject, it does not fall within the scope of this work to discuss such apparatus. The general principles of the use of the x-rays in surgical after-treatment we shall, however, describe briefly. The method of procedure inaugurated by Dr. Williams, at the Boston City Hospital, is as follows: After operation for malignant disease the treatment by the Röntgen rays is commenced as soon as the patient can be transported to the x-ray department (*i. e.*, in from two to seven days). The scar and the region of the neighboring glands are exposed to the rays for from five minutes to one-half hour, depending upon the size of the area to be exposed—the larger the surface, the longer the exposure. The rays are transmitted through an aluminum screen. The distance of the patient from the tube is determined by means of Dr. Williams' fluorometer, by which the point at which the rays are of greatest strength is found, and the surface to be exposed is placed at this distance, usually about 18 in. from the tube. Treatment three times a week is kept up for at least two months. If at the end of this time there is no sign of recurrence, it is discontinued, but the patient reports once a month for one year and then every three months up to five years for observation. At the slightest sign of return of the disease treatment is reinstituted.

When a recurrence has already taken place, treatment should be commenced at once. The area involved is exposed for a short time (five minutes or longer) and the reaction is noted. This reaction consists in swelling, exudation, crust formation, and some softening of the pathologic tissue. In some instances there is only a slight redness of the surface. If there is more than a slight reaction, it is allowed to subside before the second exposure is made, and the duration of the treatment is shortened. On the other hand, if there is no reaction, or only slight reaction, the next exposure is made in two or three days, and its duration increased. In this way the frequency and length of the treatments are determined in each individual case. Growths will usually begin to show improvement within two weeks. Treatment is continued until all evidence of the disease has disappeared and then stopped, but the patient is kept under close observation and treatment reinstituted if there is the slightest sign suspicious of recurrence.

Radium.—The use of the radiations from radium salts as a substitute for the x-rays was first suggested by Dr. William Rollins, of Boston.[1] In the development of the therapeutic use of radium Dr. Francis H. Williams holds the leading place. The action is exactly similar but much superior to that of the x-rays, which, where available, it has entirely supplanted in the treatment of small, easily accessible growths. In growths occupying a large area the x-rays alone, or in combination

[1] Williams, Communications of the Mass. Med. Soc., 1908, xxi, 263.

with radium, are indicated, and the x-rays alone in the case of malignant disease of the internal organs. The general principles for the employment of the x-rays as regards indications for, reaction from, and frequency of exposure, apply also to radium.

The high cost and the inability to secure radium of sufficiently high radio-activity has prevented its general use. In brief, the results may be said to be brilliant on epithelial tumors of the skin and in nevi, in warts and moles, and in a certain number of myeloid sarcomas,[1] while in epidermoid cancer of the lip, tongue, tonsil, inside of the cheek, esophagus, stomach, rectum, and uterus the results have been nil.

From a tube of radium three kinds of rays are given out—the *alpha*, *beta*, and *gamma*—of which the *alpha* is very feeble in availability and power, though it may burn the skin.

The greater part of the available rays of radium are the *beta*, which carry a negative charge of electricity, are capable of being deflected by a magnet, and are able to penetrate deeply into the lung tissue.

The *gamma* rays carry no electric charge and are able to penetrate deeply into tissue, even through considerable thicknesses of metal. The *beta* and *gamma* rays are the ones used in treatment. The safer *beta* rays irritate the skin and have little penetration, hence they are filtered out by the interposition of thin sheets of lead.

As with x-ray, radium seems to have an inhibitory effect on cell-life. Seed exposed to radium for a sufficient time will not germinate. Bacteria on the surface of Petri plates exposed to radium will be killed. The technique is simple and is governed by the highness of the radio-activity of the radium employed. The higher the radio-activity the less the exposure needed.

The method of application of radium is the following: 50 mg. (a little less than 1 gr.) of pure radium bromid contained in a capsule, covered with a sterilized rubber cot for sake of cleanliness, at the end of a handle at least 1 ft. long, is moved about close to the surface to be treated for from two to fifteen minutes, according to the size, beginning at the least affected portion, but applied longest to the most active spot of disease. The radium must be kept constantly moving and not held still over any one spot. Several such applications are made, and then a visit in two or more weeks is in order to determine the amount of reaction produced. Where the growth is very extensive, radium may be used on the worst part and then the entire surface exposed to the x-rays.

[1] R. Abbe, Radium's Contribution to Surgery, Jour. Am. Med. Assoc., 1910, lv, 97.

The disadvantages of radium are the small surface from which the rays proceed and its enormous cost.

Carbon-dioxid Snow.—This has acquired great and deserved popularity because of the ease with which carbonic acid gas can be obtained, because of its cheapness and the simple technique required, the ability to control the reaction, and the superior cosmetic effect produced.

The technique is simple: The gas is released from the carbonic acid tank into a specially modeled perforated mold, here it is collected in the form of a snow, which is compressed by a metal plunger into a crayon of ice and snow with a temperature of 72° C.

This ice crayon is held by means of chamois skin in the fingers, and the end of the crayon is shaped to any desired size by placing it in a metal cone, where the rapid withdrawal of heat from the metal causes a shrinkage in the crayon corresponding to the inner diameter of the cone.

The crayon is applied over the lesion from five to fifty seconds, the length of time and the pressure employed depending on the depth to which it is best to freeze. For example, a deep-seated nevus, rich with blood-vessels, would require the maximum time and pressure, while the removal of powder granules from the face, the extreme minimum.

Immediately on removing the crayon a white depression is seen, which rapidly fills in, and in a few minutes the treated area swells and a wheal is formed, which attains its maximum in twenty-four hours. The serum may then be let out of the vesicle, and a crust forms which should not be disturbed until it suppurates of its own accord in ten to twelve days. A pale pinkish cicatrix is seen which rapidly fades, and is soft and pliable.

The pathology of the reaction, according to W. A. Pusey,[1] "is the production of a relatively deep, sharply defined inflammatory reaction in living tissue by sudden intense freezing," a reaction which can be controlled from stimulation to destruction with the production of an interstitial sclerosis, to an immediate destruction of masses of diseased tissue in the skin. The dermatologists have taken advantage of this, as shown by the numerous cases reported treated by this method. Five cases will show its range of applicability:

Case 1.—Mrs. C., aged eighty. Epithelioma of forehead the size of a silver dollar, treated for two months with *x*-ray with slight improvement. Carbon-dioxid snow applied over the entire area for eight seconds at a

[1] Med. Rec., N. Y., 1910, lxxviii, 691.

sitting, each section receiving three applications at a treatment. After four such treatments, covering a period of six weeks, it has completely healed and has remained so up to date (three months).

Case 2.—Miss B., aged eighteen. Burned about neck and chin by gasoline explosion. Neck and chin a mass of irregular, constantly contracting cicatrices, bobstay from point of chin to sternum. After four applications of carbon-dioxid snow chin covered with a smooth pliable scar, bobstay entirely removed.

Case 3.—Infant D., aged three months. Nevus of wrist. Carbon-dioxid snow applied for thirty seconds. Two months after site of nevus could be made out with difficulty.

Case 4.—Mr. R. Face sprinkled with powder granules, Carbon-dioxid snow applied with small pointed crayon over site of each granule, using slight pressure for four seconds. Slight wheal formed and powder granule was removed with crust ten days later. Skin apparently normal. Tattoo-marks can be removed in the same way. There is some tingling after application, such as would be felt in the ears after exposure to cold. Rarely there is pain for one to two hours.

Case 5.—Mr. B. Hands and face burned with x-ray, with here and there formation of nodules, which scab and discharge. Scabs curetted off and carbon-dioxid snow applied for fifty seconds, with complete healing, though with some scarring.

CHAPTER XXXIX

PREPARATION OF THE PATIENT

It may seem somewhat out of order in a book on postoperative treatment to go into details in regard to the matter of the preparation of the patient for operation. The importance of preparation and the immense influence which proper or improper preparation exerts, however, on the course which the patient will follow after the operation seem sufficient excuse.

The literature which deals with this subject gives an immense variety of detailed advice and instruction. Each individual surgeon is likely to be persuaded that this or that particular procedure has been the essential in his successful practice. The rules laid down differ so widely that one must conclude that the only good rules are general ones, deduced from the experience of many men, applied and varied by common sense to suit each case. In discussing this matter of preparation, then, it is not here meant to be arbitrary, except in matters of principle, but the general directions here given may be followed by one who has yet to develop his own peculiar experience, with the assurance that every detail will bear the pragmatic test, namely, that "*it works.*"

It is a trite observation that every surgeon of a general hospital, particularly where there is a large accident clinic and other emergency work, cannot fail to notice that, taken by large, the emergency cases, operated as they are without preparation beyond that immediately preceding operation, seem to do about as well after operation, in the way of comfort and complications, as the patients who have been through a long course of preparation. We have noted this so many times that we are led to believe that that part of preparation which includes preoperative starvation and routine catharsis is often overdone, that starvation weakens and increases the liability to shock and acetonemia, that many patients unused to cathartic medicines suffer irritation of the intestine and notable general depression from their use. Such preparation, moreover, renders more likely the occurrence of intestinal paresis, with distention and nausea, than no preparation at all. Nor does there seem to be any reason, in theory or practice, why a patient more or less starved and purged should better endure the strain of operative treatment than one who is well nourished. On this point Ochsner[1] says: "As a rule, long-continued preparatory treatment leaves the patient in a much less favorable condition for a surgical procedure than a very short and simple preparation, which serves to put the kidneys, the skin, and the alimentary canal in condition favorable to elimination of the waste products. . . . His strength is not impaired by confinement, and his nervous system has not suffered by looking forward to the operation for a long time. Some years ago I had an opportunity to observe the effect of waiting for a number of days, and sometimes for several weeks, to allow the patient to get into a more favorable condition for operation, and I am positive that, as a rule, the practice is bad."

CATHARSIS

For the Elective Operation.—The patient is told to take a slightly increased dose of his usual cathartic morning or night, the day before, if he has the cathartic habit. If customarily he has not required cathartics, he should take from 3 to 10 gr. of extract of cascara sagrada at bedtime the second night before operation. If the patient is of the type that yields more kindly to morning salts, he should be directed to take one or two Seidlitz powders, or 1 to 3 dr. of effervescent sodium phosphate, or a dose of some natural or artificial aperient water on two or three successive mornings instead. The night before operation a simple enema of soapsuds (strong soap) should be given. None should be administered on the morning of operation unless the case calls for surgery of the rectum.

For the Emergency Operation.—Frequently, to aid in arriving at a diagnosis in emergency abdominal conditions, an enema has to be given. In case this has not been done, and provided there is no surgical contra-indication, an enema should be administered, if time permits (and usually there is ample time while preparation of room, instruments, and other things is going on). This is desirable, if for no other reason than because by it we can start our operative convalescence with a clear lower bowel, hardened masses of feces being much easier to remove before operation than after; and, furthermore, if the patient must be stirred up, it is more desirable to do it before operation than after. The enema to be chosen in abdominal cases should be either the compound turpentine, the milk and molasses, or the warm glycerin. (See p. 172.)

[1] Clin. Surg., 1902, 13.

DIET

For the Elective Operation.—It is obviously undesirable in all abdominal cases to have much stomach or intestinal contents present. In preparation, therefore, the patient should, for three or four days before operation, have sufficient food to keep up a feeling of normal strength and no more; the diet should be limited in quantity and variety and should consist of simple, easily digestible material. The diet list should not contain milk, woody vegetables, or any other food which leaves a voluminous residue. Throughout the day before operation strong broths—beef, chicken, or mutton—with, possibly, a little wine and water, should be given. On the morning of operation, at any time preceding two hours before the starting of anesthesia, black coffee, plain tea or sherry, or whisky and water in small quantity, may be given as a stimulant to body and spirit. Exception will have to be made to this rule, of course, in case of operation on stomach or duodenum.

The diet in emergency operations cannot, of course, be controlled.

Experience seems to show that a considerable increase in *water-drinking* for some time before operation is desirable. The urine is increased thereby, and, to a certain degree, the excretion of body waste must be increased also. *Baths* contribute to this same end. A thoroughly clean skin must be an asset in elimination after operation. The day before operation, then, the patient is to be given a warm tub-bath or a thorough sponge-bath if unable to leave the bed. In women, where no contraindication—such as virginity—exists, a vaginal douche of 2 to 4 quarts of hot water, containing 1 drachm of sodium bicarbonate to the pint, should be given.

An attempt should be made, if time and circumstances permit, to have the *teeth* and *mouth* clean, even if the services of a dentist are necessary. There can be no question but that a clean mouth lessens the probability of postoperative parotitis. We believe also that, as postoperative throat and lung complications are better understood, stricter attention will be paid to mouth cleanliness. In the study of a recent epidemic of noma[1] the following conclusions were reached:

"Any uncared for mouth, particularly in a sick child, may contain bacillus fusiformis and spirochæta gracilis. In such a mouth these organisms may be found without ulceration or in the lesions which have been described as stomatitis gangrenosa, Vincent's angina, and noma. Any of these conditions,

[1] Crandon, Place, and Brown, Boston Med. and Surg. Jour., 1909, clx, 473.

including the extensive gangrene and sloughing of so-called noma, may be different stages of the same disease, which may be, therefore, considered as not necessarily a specific disease, but the successful ingress of mouth bacteria into tissues rendered non-resistant by uncleanliness and preceding disease."

FIG. 121.—NOMA.
Bacillus fusiformis and spirochæta gracilis, normal inhabitants of the mouth. The disease appears in neglected mouths after infectious diseases.

Examination of the urine, chemical at least, should be made in all cases, not that the presence of certain urinary abnormalities would preclude a necessary operation, but that a knowledge of the condition of the avenues of elimination should be had in anticipation of any postoperative complications. The twenty-four-hour amount of urine should be known also, if possible.

Geraghty Test.—The importance of the routine preoperative urinalysis for renal impairment has already been stated. Certain other tests have been devised for the purpose of estimating that of which no urinary analytic method gives us definite information, namely, the functional capabilities of the kidney. Of these, the best known have been the methylene-blue, indigo-carmin, rosanilin, and phloridzin tests.

An accurate determination of the functional power of the kidney is of value to the surgeon in many ways. The decision as to the advisability of operating in the presence of renal impairment from chronic disease will be aided by finding whether or not the damaged organs may be expected to bear the temporarily increased load which the operation will throw upon them. In considering a nephrectomy, for instance, the surgeon's responsibility will rest much more lightly if he knows not alone that there is another kidney, but that it is sound enough to do double duty.

Recently a method has been originated by Rowntree and Geraghty[1] which, though reasonably simple in technique, offers a degree of accuracy not obtainable with any of the others. It has been used by careful observers in a sufficient number of cases to make it safe to draw certain preliminary conclusions. It consists in the hypodermic injection of a fixed amount of phenolsulphonepththalein, noting the time which passes before it first appears in the urine, collecting the urine for an hour after its first appearance, and by simple color comparison determining the percentage of the dose given which is present in the urine.

Phenolsulphonephthalein is a soluble red powder, giving in alkaline solutions a brilliant purplish color. It is not toxic, and in slightly alkaline solution it is not irritating. Administered subcutaneously it normally appears in the urine within a few minutes, and practically all the drug given is eliminated through the kidneys in two hours. The length of time necessary for excretion enables us to draw conclusions as to the ability of the kidney as an excretory organ.

The patient to be tested is catheterized, and the catheter left in the bladder. Six mg. of the drug in alkaline solution (ampoules containing 6 mg. per cubic centimeter can be obtained) is then injected intramuscularly. The catheter is allowed to drip into a test-tube or other receptacle containing a few drops of a 25 per cent. solution of sodium hydroxid. The interval between the injection and the time of the first appearance of color in the test-tube is carefully noted. The urine is then collected for one hour, its quantity is made up to 1 liter by the addition of water made distinctly alkaline with sodium hydroxid, and a portion is filtered for comparison with a standard solution containing 6 mg. per liter. For this purpose one can use the Dubosc colorimeter, or the modified Hellige hemoglobinometer, both expensive, or one can make up, as suggested by Cabot and Young,[2] a rack holding a series of ten test-tubes containing solutions of 5, 10, 15, and 20 per cent., etc., of the drug, up to 50 per cent., and, using a similar test-tube for the sample, compare its color directly with these. The standard solutions are practically permanent if they contain an excess of alkali, and the test-tubes are stoppered and sealed with paraffin. The reading by this improvised scale is correct to within 2 per cent. of the Dubosc reading.

An accurately graduated syringe is necessary. The patient can drink water as he desires at any time before or during the test. Blood in the urine will interfere with the color; in this case the urine should be boiled to

[1] L. G. Rowntree and J. T. Geraghty, Jour. Pharm. and Exp. Therap., 1909, i, 579.

[2] Boston Med. and Surg. Jour., 1911, clxv, 549. See also Goodman and Kaisteller, Surg., Gyn., and Obstet., Jan., 1911; Eisenbrey, Jour. Exp. Med., Nov., 1911.

coagulate the blood, and then filtered. Highly concentrated urines affect the color, changing it to orange; if necessary, new standard solutions must be made up for comparison, using the patient's normal urine instead of water.

To test separately the functional capability of each kidney, catheters are passed into one or both ureters for a few inches, left in place, the injection made, and the urine separately collected. There are several sources of error: (1) The presence of the catheter may occasionally cause reflex anuria, with consequent delayed excretion. (2) There may be leakage about the urethral catheters; to prevent this the largest catheter practicable should be used, having a "whistle" tip, and the amount of urine in the bladder after the removal of the catheters should be figured in. (3) Blood not uncommonly appears toward the end of the hour from congestion of the ureter caused by the catheter.

The following table of findings is based upon the article of Cabot and Young, and an unpublished paper by Dr. H. B. Loder:

Normal individuals show the characteristic color in from five to fifteen minutes; from 38 to 60 per cent. is excreted in the first hour, and from 15 to 25 per cent. in the second hour.

Acute Nephritis.—Severe cases show a marked diminution of the percentage excreted in the first hour.

Chronic Nephritis.—The time of appearance is delayed, even to forty-five minutes, and the first hour's excretion may fall as low as 10 per cent. A very low or persistently falling percentage is evidence of impending death.

Cardiorenal Cases, so-called.—This test enables the observer to decide whether heart or kidney affection is the more important element. Cardiovascular cases, on the contrary, exhibit practically normal renal function.

Obstruction from prostate shows delayed appearance (average about twenty-two minutes) and slowed excretion (average output in first hour about 26 per cent.). If the findings improve under treatment, constant drainage, forced fluids, and an appropriate diet, the kidneys are shown to be not hopelessly damaged. Ether operation is contraindicated in any case showing an output of less than 20 per cent. during the first hour; such cases have been found to develop uremia with uncomfortable frequency.

Obstruction from Chronic Stricture.—The findings are not far from normal, averaging fifteen minutes for appearance, and 37 per cent. for first hour's output.

Surgical Diseases of the Kidney.—The diseased kidney shows delayed and diminished output, in relation apparently to the amount of tissue destroyed. In cases of unilateral disease the test will give evidence of the functional power of the kidney to be left behind, and in a case of bilateral surgical disease it will show the relative working value of the two kidneys.

Preparatory stimulation, in the form of drugs, tonics, and massage, must vary with each case; they may be the deciding factors in the outcome.

The value of a complete *history* and thorough *physical examination* cannot be overemphasized. Such a routine may seem irksome and footless, but by it facts of the greatest clinical importance are brought out, often enough to make the value of complete acquaintance with the patient unquestionable. Another advantage derived from complete examination, as Ochsner[1] says, is that—"If the surgeon knows that all his cases are to be examined thoroughly by an equally competent colleague or assistant, he is not so prone to become careless in his personal examination as his work accumulates." Complete examination again and again brings forth a possibility we are apt to forget, namely, that a patient may have simultaneously two diseases.

FIELD OF OPERATION

Except for the warm bath the night before, it is undoubtedly better not to prepare the field until immediately before operation. This is true for the following reasons: (1) Shaving or scraping may cause minute wounds in which the native bacteria of the skin will develop over night. (2) The heat and moisture which are present under a preparatory dressing may be enough to cause the pouring forth and propagation of skin bacteria from pores and hair-follicles. On the morning of operation all hair in the vicinity of the proposed wound should be removed by careful shaving or by the application of a depilatory paste.

Depilation vs. Shaving.—Arbitrary decision as to the relative values of shaving and depilation of the field of operation cannot be made. Some surgeons, notably Robert T. Morris, are strongly in favor of removal of hair by caustic applications. Shaving long before the operation—the day before, for example, as is done in many hospitals—is undoubtedly bad practice. As just stated, minute wounds are sure to be made by the nurse or orderly who does the shaving, because of the contour of the parts to be shaved, the delicacy of the skin, and the shrinking movements of the patient. These minute wounds on many patients will show signs in twelve hours of mild inflammation, small hyperemic areas in which staphylococcus albus is to be found. If, in addition, the old method of moist applications over night in preparation has been used, the spread of this infectious process will be en-

[1] Clin. Surg., 1902, 13.

couraged. If shaving, therefore, is to be done, it should be done only just before operation. Most of the depilatory pastes are germicidal as well, and, therefore, are to be commended.[1]

An efficient depilatory, simple to prepare, is that of Boudet:

Calcii caustici pulveri (fresh unslaked lime)	10.0
Sodii sulphid[2] (crystals)	3.0
Amyli (pulverized starch)	10.0

These ingredients are separately pulverized, mixed, and kept in a bottle dry When needed for use, enough water is added to form a thin paste. This is spread on the part to be denuded about ⅛ in. thick by means of a wood or glass spatula. At the end of five minutes the paste is washed off with sterile water, after which the usual preparation proceeds.[3]

Then follows the important part of the preparation, namely, the scrubbing with soap and water. Short of positively injuring the skin, the scrubbing can hardly be overdone. Except in regions such as

[1] A complete list of formulas may be found in Paschkis, Cosmetik für Aerzte, Wien, 1905, pp. 256, 257.

[2] Barium sulphid may be used equally well.

[3] Robert T. Morris, Amer. Jour. Surg. Gyn., June, 1903, xvi, 179:

"When the depilatory has just been wiped away from the skin after about five minutes' application, the melted hair and superficial loose epithelium comes away, together with any dirt that lies within the area acted upon. The skin is then as sterile, apparently, as it would have been after the labor and prolonged methods of preparation, and we have entirely avoided the disturbance caused by shaving. The time-saving element in itself is of consequence. I have taken the hair from an entire leg in less time than it would have taken to shave a tenth part of it, to say nothing of the fact that the leg was all ready for operation without further antiseptic preparation. We can plaster the depilatories evenly over the skin without regard for their entrance into the open wound, as the germicidal influence of the sulphites will counterbalance any irritating effect.

"The manufacturers of depilatories advertise them as harmless. This is not true. They are about as capable of harmful influence as are carbolic acid and bichlorid of mercury, and need to be used with as much care as we employ with these two standard antiseptics. In removing the hair from the vulva, for instance, the mucous membranes of the labia are sometimes irritated by the depilatories unless we first brush the mucous membranes with a little sterile oil for protection from plastering the whole vulva with the paste. On the skin of some patients the depilatories have the effect of taking off small, superficial patches of epithelium, so that one will often need to brush these spots with sterilized oil. Nurses are apt to dislike the staining of the nails from the action of sulphids when preparing a patient for operation, but one can, with a little care, avoid staining the finger-nails.

"On the whole, however, the use of germicidal depilatories is such an advance over the older methods of preparation of the skin of the patient that I believe it to be the coming method, and my nurses and assistants would not like to go back to the troublesome methods that are as yet in common employment."

scalp, axilla, pubes, hands, or feet, the scrubbing-brush should not be used; it is too harsh. The person who does the preparation should have his own hands thoroughly cleaned by a soap-and-water scrub, and may, indeed, well wear sterile gloves. For preparation of the field strong soap containing pulverized pumice may be used, or any strong soap wrapped in one layer of gauze to give it a rough surface, vigorously scrubbing it up and down and round, following some systematic plan of motions. At the same time, at intervals, as directed by the scrubber, a second assistant pours, from not too great a height, hot tap or sterilized water from a pitcher. By this means the dirty, soapy water is continuously being washed off and the same water is hardly used twice. Dipping the scrubbing hand back and forth into a basin is a slack method. Instead of wrapping the soap in gauze, a handful of cut gauze and tincture of green soap may be used. In any case, enough actual lather should be raised to indicate that all the grease in the soap and on the skin has been saponified. The soap is now thoroughly washed off with continued libation of sterile water. A small amount of ether may now be used if the surgeon thinks best to remove any fat or grease which has been left on the skin. Whether this step is taken or not, 70 per cent. alcohol is next applied and thoroughly scrubbed all over the field, using a sterile sponge of gauze. Assurance is made doubly sure if at this stage Harrington's solution is used.[1] An alcohol saturated pad is now left over the site of incision while the sterile sheets, towels, and other coverings are being placed over the patient. This is removed by the surgeon at the moment of incision.

In the scrubbing particular attention should be paid to the region

[1] Dr. Charles Harrington, of Boston (Trans. Amer. Surg. Assoc., 1904, xxii, 41, et seq.), made a careful comparative study of all the antiseptics used at present, and as a result of that study devised a mixture which, on experimentation, proved to combine the greatest germicidal action with the least irritation:

Corrosive sublimate	0.8 gm.
Commercial alcohol (94 per cent.)	640.0 cc.
Hydrochloric acid	60.0 cc.
Water	300.0 cc.

This mixture contains corrosive sublimate, 1: 1250, in a solution made up of 6 per cent. hydrochloric acid and 60 per cent. absolute alcohol. Sixty per cent. alcohol will destroy staphylococcus aureus in four minutes; 10 per cent. hydrochloric acid is equally effective, and 1: 1000 corrosive sublimate will kill it in three minutes. Why a combination containing all these substances, but with lesser proportions of the acid and salt, is so much quicker in its action than any one of them alone, is an interesting question of physical chemistry. But such is the fact. After giving the hands an ordinary wash and soaking in the solution two minutes, all culture tests, even under the nails, are sterile.

of the umbilicus, which is to be very thoroughly washed with a cork-screw motion, to the folds under pendulous breasts, and to the groins, especially if the abdomen is pendulous. If the skin in any of these areas is eczematous, the operation should be postponed, if possible, until the condition has been cleared up. If the operation must go on, and these areas come at all within the field, they should, for the time being, be sealed with absorbent sterile gauze and the whole covered with collodion. This also applies to blistered areas where escharotics, plasters, or hot-water bags have caused breaks in the skin. If operation is imperative through such area, the region may be scraped with a curet and just before operation painted twice over with tincture of iodin. Then, in addition, a whole sheet is placed over the area and incision made through sheet and skin. Whatever is thereafter inserted into the wound does not rub over this questionable area of skin.

This method of preparation by soap and water scrubbing remains as efficient as it ever was, but experience of the last two years seems to have brought forth a method more simple and, at the same time, more efficacious, namely, the use of tincture of iodin.

J. E. Cannady[1] reported his technique of preparation wherein he follows the usual scrubbing by the sponging over with tincture of iodin. The method as now employed, laying emphasis on the fact that the skin should not be wet with water before the iodin, was first proposed by A. Grossich.[2] Gibson[3] and many other writers have reported experiences with it. A. Bogdan[4] has contributed further to the subject by adding benzine to the preparation.

Noguchi[5] undertook extended experimental and clinical investigations into the value of the method as described by Grossich, and recommends it highly from both the bacteriologic and clinical standpoints. The pharmacopeal tincture should be used, as more potent than any dilution or combination. An excess should be avoided, as it may cause trouble. The operation may be started two minutes after one coat has been applied, to allow for drying. It should be rubbed in gently. A second coat is of little, if any, advantage. The use of soap and water as a preliminary, or for shaving, is of no disadvantage, provided that the skin is dried before the application of the iodin. By this method, however, all of the bacteria of the skin are not destroyed, and for that reason some

[1] Jour. Am. Med. Assoc., 1906, xlvi, 1102.
[2] Centralbl. für Chir., 1908, xxxv, 1289; 1910, 737.
[3] Ann. Surg., 1911, liii, 106.
[4] Centralbl. für Chir., 1911, xxxvii, 73.
[5] Archiv. f. klin. Chir., 1911, xcvi, 494.

prefer the older technique in cases where absolute asepsis is a desideratum, as in operations exposing joint surfaces. It should not be used in operations for thyrotoxicosis, and its applicability to operations on mucous membrane and for skin-grafting has not yet been determined. Occasionally a susceptible skin will show some acute eczema following the application, and this is particularly likely if adhesive plaster is applied. The wound heals as readily as with other methods, and the scar is usually insignificant. On the whole, according to Noguchi, the iodin method is better as a means of disinfection of the operative field than any previously employed.

The *improved technique of preparation* of the field of operation now stands as follows: When feasible the whole body, or at least the field of operation, is thoroughly washed with soap and water the day before operation. Shaving may be done at this time. On the day of operation water should not touch the area involved. If shaving must be done, it should be done dry. The patient, thoroughly anesthetized, is on the operating-table in position for operation. An area much larger than the mere field of operation is thoroughly wiped over with benzin, using two or three gauze "wipes." This clears off all grease and coarse dirt from the skin. Care must be taken not to let benzin run down on dependent parts, such as the back, in an abdominal operation, lest from lying wet with benzin a burn result.

The benzin dries quickly and the area is next wiped over with gauze saturated in tincture of iodin. Some of it should be poured into the umbilicus in abdominal cases. This coating of iodin dries spontaneously and should not be covered in with towels until quite dry.

The method is simple, inexpensive, and more certain in its surgical cleanliness than soap and water. In the preparation of areas hard to clean or already much lacerated by injury this method is at its best. Blistering or actual burns are seen only in cases of especially sensitive skin, notably in blondes, but should not appear oftener than 1 in 300 cases. Gangrene of toes in lacerated wounds first treated with iodin has been observed.[1]

A valuable note recently published by Tinker and Prince[2] calls attention to the fallacy in the belief that clinical results alone are a test of the value of any method of skin disinfection:

1. The skin of people accustomed to habits of reasonable personal cleanliness is not apt to be badly infected. This was shown in the

[1] Hindenberg, Münch. med. Woch., 1910, lvii, 1465.

[2] Surg., Gyn., and Obst., June, 1911, p. 530: Fallacies Regarding Skin Disinfection with Special Reference to Iodin Method.

Russo-Japanese War, when soldiers, it is said, were required to take a full bath and put on clean clothing before going into battle.

2. The ordinary bacteria with which we come in contact under ordinary conditions are of a low-grade virulence. The bacteria on the floor and ordinary objects are too cold, lack moisture, and are not surrounded by suitable culture-media. This explains why many men are able to get fairly satisfactory results in surgery with relatively faulty aseptic and antiseptic technique.

3. Common, slightly resistant bacteria ordinarily giving wound infection are used in the laboratory in testing the value of any antiseptic. Thus, Staphylococcus aureus and albus, Bacillus coli and pyocyaneus are killed by many weak antiseptics. This fact makes it possible for a surgeon to get clean wounds from 90 or more cases out of 100. Although the resistant spore-forming bacteria are relatively infrequent, it should be evident that *our methods must be so reliable that resistant spore-forming bacteria*, such as Bacillus tetanus and B. anthrax, *shall be certainly destroyed.* J. Lionel Stretton[1] reports a death from tetanus after iodin preparation occurring in a series of 300 clean cases.

It seems to us, therefore, according to our present light, that *preparation of the field of operation should include:*

(1) A thorough bath the day before, if possible.

(2) Gauze scrubbing with benzin after patient is arranged on operating-table.

(3) A thorough application of tincture of iodin, to be allowed to dry five minutes.

(4) The application of a gauze pad soaked in Harrington's solution over the line of incision, to be left in place at least two minutes.

PREPARATION OF SPECIAL AREAS

Scalp.—For all scalp wounds, removal of wens, and such minor matters, if surgeon and patient are willing to give up enough time for thorough scrubbing, little if any shaving need be done. The scrubbing must be thorough, however, with strong soap and a brush, the hair carefully separated in the region to be treated, and the work then carried on through a hole cut in a towel or sheet. The benzin-iodin method is quicker and as efficient. If no shaving has been done, a cocoon dressing cannot be applied, but an alcohol or Harrington solution pad will have to be put on after sewing.

For all operations on the skull itself complete shaving of the head

[1] Brit. Med. Jour., 1910, i, 1350.

must be done, because, if for no other reason, one can never tell how extensive an operation may be necessary. It is always easy, however, to induce the patient to allow shaving by telling him that the cosmetic effect of complete removal of the hair is better than partial shaving.

The Region of Beard and Eyebrows.—The beard or mustache, when the operation involves these regions, might better be entirely removed, but even to this rule there may be exceptions, and a perfectly clean operation may be done, if the reasons are sufficient, through a bearded area.

It will rarely be necessary to shave the eyebrows, inasmuch as the hair is so short and so sparse that it should be perfectly cleanable, and the absence of an eyebrow, even for a short time, is a rather important cosmetic matter to a sensitive person.

For a mastoid operation a zone of scalp behind the ear, ½ to 1 in. in width, should be denuded of hair.

All other hairy areas of the body should be entirely denuded of hair in preparation for any operation.

Mouth.—Though complete asepsis of the mouth is probably not attainable, much may be done. Most of the cleaning, however, is mechanical, since antiseptics of sufficient strength to be efficient cannot be used with safety. If it is possible, the teeth should be thoroughly cleaned by a dentist and bad teeth either filled or removed. An excellent antiseptic to be applied to gums at the line of contact with the teeth, the commonest site of mouth infection, is the following:

℞. Zinci iodidi }
Iodi } .... āā ʒss
Glycerini ....q. s. ad ℥ij.

This is applied with a brush or cotton-stick intimately round the base of each tooth. The mouth should be washed by the patient every hour or two for two days preceding the operation. At the time of operation the whole mouth may be scrubbed out by the surgeon with boric acid, 4 per cent., or full strength liquor antisepticus, or some such cleansing fluid. Gargling is good as a mouth-wash, but absolutely without value for the pharynx, as may be proved by any one who will gargle with a staining fluid and then examine the mouth. The stain will not go, as a rule, beyond the anterior pillars.

The **nose** similarly should be cleansed by the surgeon at the moment of operation.

Vagina, Cervix, and Genital Region.—Here, too, the most valuable cleansing is mechanical. On the table a douche should be given, thoroughly distending all the folds, then the whole cavity scrubbed out with soap and water and gauze, the manipulations not being too rough. Another douche follows.

Few women know how to take *an efficient vaginal douche.* Most nurses know little about it, and many doctors let their directions end, "Take a hot douche morning and night," without any details.

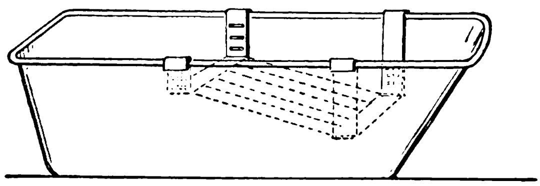

FIG. 122.—VAGINAL DOUCHE.

Hammock of canvas suspended on metal side-bars in bath-tub, designed to give proper elevation of pelvis. The shoulders are supported on the lower cross-piece, the buttocks on the higher, and the feet may conveniently rest on the rim of the tub at its lower end.

Most women take a douche sitting, in which position the walls of the vagina are entirely pressed together by the weight of the viscera. The cleansing fluid under these conditions cannot at all distend the folds and the douche must fail more or less in its purpose. Some women take douches lying on the bed-pan. This is a better position, but even taken in this way, the woman is likely to be partly reclining on three or four pillows till the body is really inclined downward toward the buttocks, with the same compression of the vagina. The fluid wets her clothing, the bed, and the floor, and does not reach the parts for which it is intended.

A vaginal douche should always be taken lying on the back, with the buttocks raised at least 6 in. above the level of the shoulders. Such a position may be obtained by a specially devised hammock which may be hung in a bath-tub [1] (see Fig. 122), or, more simply, the douche may be taken lying on the floor with a douche pan, but under the douche pan a pad or pillow of rubber or stork-sheeting, filled with excelsior, the whole sufficient in height to lift the buttocks well above the level of the shoulders. In this position the vagina bellows out, the fluid injected distends it thoroughly, comes in contact with every part, and insures all the benefits of moisture, heat, and medication to vagina, cervix, and pelvic floor.

Rectum.—On the table, under anesthesia, is the time for rectal cleansing, and then only after eight or ten minutes have been taken to slowly and thoroughly dilate the sphincter ani to a thoroughly paretic condition. Under these conditions irrigation with salt solution, with

[1] Boston Med. and Surg. Jour., 1908, clix, 795.

the tube inserted not over 6 in., thoroughly cleans rectum and sigmoid.

Bladder and Urethra.—So many of the operations in this region are for obstructive conditions of the urethra, it is frequently not possible to wash out either bladder or urethra. Where it is possible it should be done with warm boric-acid solution, 2 per cent., in and out several times.

FIG. 123.—BURN RESULTING FROM A SELF-ADMINISTERED DOUCHE OF UNDILUTED CREOLIN. (Case of Dr. N. R. Mason; photograph loaned by Dr. R. D. Hildreth.)

Hands and Feet.—These regions with thickened skin, so much more exposed than other parts to sources of infection, should be prepared for operation by long-repeated soaking in hot soapy water, or, better still, soapy water with the addition of a little chlorinated soda (liquor sodæ chlorinatæ). Hands or feet, soaked for half an hour every four hours the day before operation, or, in any case, two periods before, can have all the overthickened, macerated epidermis then scraped off. The benzin-iodin method or iodin alone poured into a fresh accidental wound immediately will insure against all infections except tetanus and anthrax. Harrington's solution alone destroys these infections. Peroxid of hydrogen is also valuable.[1]

[1] A. Delcourt, New Orleans Med. Jour., Sept., 1910.

PART II

CHAPTER XL

OPERATIONS ON THE HEAD AND FACE

SCALP WOUNDS

Aseptic Wounds.—The primary gauze dressing of a large wound may be removed on the third day and, if there appears to be no sepsis, a cocoon substituted. On the eighth or tenth day the cocoon and the stitches are removed.

Septic Wounds.—If, after the first twenty-four hours, there is considerable throbbing, pain, or increasing tenderness, it is probable that some grade of infection is present. The dressing should be removed, perhaps a stitch or two removed to let out retained serum, and wet dressings applied. A culture may be taken. Infection of scalp wounds sometimes is fulminating in character. The appearance of edema about the eyes or behind the ears, together with headache, vertigo, and perhaps delirium, should be looked upon as an indication of grave import. In such cases the wound should be laid freely open and other drainage wounds made. (See Septic Wounds, p. 257.) The general treatment of septicopyemia (see p. 284)—bed, ice-cap, wet dressings, stimulation, and, in appropriate cases, vaccine therapy—should be begun at once.

Septic Wounds with Necrotic Bone.—Scalp wounds going down to the bone, when septic, are characterized by a profuse purulent discharge, due, in frequent instances, to the presence of necrotic bone. When this process of necrosis occurs, it will continue from ten to sixteen weeks and end by the separation of the superficial plates of dead bone, which is followed by prompt healing. Probably very little, if any, time is saved by operative attempts to remove the dead bone before it is ready to separate.

TREPHINING AND BRAIN OPERATIONS

It is assumed that the dura has been sewed over the brain so far as possible. Drainage is best made with rubber dam. This serves to carry away the steady ooze of blood and serum which takes place at the operative site during the first twenty-four hours. Its removal then is advisable in order that the normal intracranial tension may be gradually restored. This tension in septic cases, with careful hemostasis, is never sufficient to interfere with primary healing, and, at the same time, it exerts a salutory pressure on the brain, which tends constantly to extrude through the wound, and helps also to prevent direct adhesion between the scalp and the dura or brain beneath it by the formation of soft connective tissue.

In cases of osteoplastic resection by the DeVilbiss cranial bone-gouge, or by any other method which has for its purpose the preservation of the bone-flap, prolonged suppuration is the only sign by which we can conclude that the bone-flap is not alive. Secondary operation becomes necessary.

Trephined cases may have several pillows almost immediately after ether recovery, but should be kept in bed and restrained from all muscular effort for two weeks. Straining at stool should in particular not be allowed.

Complications and Sequelæ.—(1) *The anesthetic may not be well taken.* "If there is no contra-indication, $\frac{1}{4}$ gr. of morphin before operation is desirable, since the amount of anesthetic will be then cut down. The morphin also contracts the arterioles of the brain and diminishes bleeding. In unconscious cases, of course, neither the morphin nor anesthetic is needed. If the shock is not profound, and there is no other good reason against chloroform, this anesthetic should be used—first, because, contrary to ether, it produces cerebral depression, and, second, because there is less vomiting. Anesthol is taken well in cerebral cases." [1]

(2) *Postoperative hemorrhage* may appear, often, apparently, started up by vomiting. If it is from cerebral vessels, little can be done beyond packing; if from the dura or sinuses, a secondary operation must be done at once to control the bleeding; if from the diploë, it may be controlled by plugging with bone wax or the hot drippings of a candle.

(3) *Shock* may be profound, and should be combated on general principles.

(4) *Edema of the lungs* is likely to follow long anesthesia.

(5) *Hernia Cerebri.*—This may occur (*a*) immediately, during the operation, where there exists much intracranial pressure which it has not been possible entirely to relieve. It may appear (*b*) later, as the result of an intracranial collection of serum or pus. If such a collection is then drained and the pressure relieved, the brain may be held in with

[1] Jacobson and Steward, i, 314.

a piece of sheet silver or lead. Actual hernia of the brain should, of course, be distinguished from false hernia, which is due to a so-called red softening of the brain, or is composed of granulation tissue. Real hernia of the brain, if it is not reducible under slight and sustained pressure, should be treated by resection of the entire mass at the end of two or three weeks. False hernia cerebri should be treated like granulation tissue, cut off at once, and further growth checked by pressure and caustics, if necessary, while epidermatization is being encouraged.

(6) *Infection* is particularly liable to occur in brain cases, partly because of the traumatic etiology of a large proportion of conditions necessitating operation upon the skull, and partly because of the difficulty of establishing and maintaining complete asepsis during a cranial operation. If general symptoms manifest themselves immediately, it is either a diffuse encephalitis or a meningitis and proves rapidly fatal. Most free drainage and general treatment for septicopyemia are the only resources. Many cases may now be cited of successful operative treatment of apparently hopeless meningitis.[1] After drainage is established, saline infusion of 500 cc. should be done two or more times six to twelve hours apart.

REMOVAL OF THE GASSERIAN GANGLION AND OTHER NERVE RESECTIONS

The wounds after these operations should all heal by first intention. Prolonged stay in bed is uncalled for. Pain may appear in corresponding parts on the other side of the face and demand sedatives for the first few days.

Paralysis of the eyelids calls for protection of the conjunctiva at first until the eye learns to roll itself under cover. The conjunctiva should be washed out with 2 per cent. boric-acid solution or sterile water every hour or two. Drooling from the paralyzed corner of the mouth irritates the skin, but control of the mouth to a degree to prevent escape of saliva is soon resumed.

EXCISION OF THE UPPER OR LOWER JAW

Packing of iodoform or other kind of gauze which was put in at the end of the operation should be removed at the end of twenty-four hours. The patient is best kept, after ether recovery, in approximately a sitting position, to facilitate drainage downward and forward. The cavity

[1] G. Krebs, Therap. Monats., Berlin, 1910, xxiv, No. 5.

should be washed out with an alkaline antiseptic, or, if not too painful, it may be better cleansed by means of gargling on the part of the patient himself. Food should be given through a tube for the first few days.

Complications and Sequelæ.—(1) *Prolonged shock* may appear, though it is rare. This is to be treated in accordance with the principles already laid down. (See p. 91.)

(2) *Hemorrhage.*—If it resists the use of adrenalin or ice, packing should be tried; if necessary, the wound must be opened and the bleeding point found and plugged or tied.

(3) *Sepsis.*—Some degree of infection must always occur; it may amount to an erysipelas. This complication calls for the usual treatment. (See p. 288). If the tumor removed was sarcoma, erysipelatous infection is welcomed. (See Chapter LIII.)

(4) *Bronchopneumonia* very often appears, especially in aged patients, from inhalation of blood, pus, or food, and is not infrequently the secondary cause of death. Preventive treatment is the most important—namely, careful antiseptic preparation of the mouth before operation and great care in preventing choking and cough during feeding. The mouth and wound should be thoroughly cleansed by irrigation and with gauze and forceps at least every four hours and after each meal.

(5) *Recurrence of the Tumor.*—Attempts should be made to prevent recurrence of the tumor, depending upon the type of new-growth present. At the present writing, our only resource in sarcoma seems to be the Coley serum (see Chap. LIII); in carcinoma, *x*-ray therapy (see p. 378).

If the excision, after thorough healing, seems to lead to the hope that success has been attained in its object, the problem of apparatus to fill out the contour of the face and to provide for chewing is one that the surgeon must refer to dentists skilled in such work.

TUMORS OF THE PAROTID

If none of the greater radicles of the duct have been cut, the wound or wounds should heal by first intention. The stitch or stitches may come out with perfect safety on the fifth day. The patient may be up as soon as the effects of the ether are over.

Complications and Sequelæ.—(1) *Facial Paralysis.*—The facial nerve may have been cut by mischance or it may have been cut necessarily to allow of removal of the growth. After-treatment consists only in protecting and cleaning the conjunctiva of the paralyzed eye until it is accustomed to the new conditions. Later, nerve anastomosis may be indicated (see p. 628).

(2) *Parotid Fistula.*—Sections of the gland may be temporarily isolated by operation, and within a week or ten days—perhaps somewhat longer—reëstablish drainage by their normal ducts. If, after a sufficient interval, it becomes evident that a definite fistula has formed, a seton of coarse twisted silk is put into the fistulous opening, through the cheek into the mouth cavity, and tied in a loop out through the mouth. From time to time this is pulled through until the opening is well established into the mouth. It is then removed; the edges of the skin wound are freshened and sewed up.

ENUCLEATION OF THE EYE

Immediately following enucleation there is considerable hemorrhage for a minute or two. As a rule, this gradually ceases; it may, very rarely, be necessary to use pressure at the apex of the orbit. There is ordinarily but little bleeding after four or five minutes. The orbital cavity must be irrigated at once with sterile water, normal salt solution, or with a 3 per cent. solution of boric acid, until all clots of blood are removed. Clean up the eyelids and surroundings, and then introduce about ½ dr. of some simple antiseptic ointment inside the eyelids. This prevents the secretions from gluing together the lid margins. Over the closed eyelids apply numerous layers of sterile gauze cut in small squares, making in all a pad about 1½ in. thick, extending from the brow to the cheek, and from the nose to the temple. This should be held in place by a 2-in. monocular roller-bandage, applied snugly but not tight enough to produce discomfort.

The following day the patient may sit up out of bed. The bandage is removed, and the margin of the eyelids cleansed with small sterile gauze sponges or cotton balls wet in a 3 per cent. solution of boric acid and then redressed in the manner described above. More or less reaction in the form of ecchymoses and swelling of the lids will be observed at this time, although in a few cases it is hardly noticeable. It is usually a little more marked when a glass or gold sphere has been implanted in Tenon's capsule, but all signs usually disappear in about two weeks.

The dressing should be changed once daily, preferably in the morning. The bandage may be omitted in three or four days after simple enucleation, and in six or seven days when a sphere has been implanted. After this period, cleanse the cavity and lids with a solution of boric acid three times a day and apply an ointment to margin of lids at bedtime.

Remove the silk conjunctival suture in six or seven days; after this the patient may be discharged from the hospital. Occasional cleansing with a solution of boric acid to remove any secretion which may form is the only subsequent treatment necessary. A single eyeshade may be worn for cosmetic effect until a glass eye can be fitted. This may be done as soon as the wound has healed and the discharge ceased and all swelling has disappeared. As a rule, it is better to wait three or four weeks before having the artificial eye fitted.

Rarely a button of granulation tissue forms at the center where the cut edges of the conjunctiva meet. This should be snipped off with scissors.

CANCER OF LIP

For small growths the ordinary V-operation is closed in a vertical line, in case there is much tension, by two through-and-through sutures, besides the necessary number of silk or silk-worm gut for approximation of the edge. The wound is cleaned and painted twice over with compound tincture of benzoin and a cocoon. The wound should be dressed daily, inside and out, by painting with benzoin. No cocoon is necessary after the third day. The silver tension sutures should not be removed until after the seventh day.

Of all the plastic operations for cancer of the lower lip, where the removal of the entire lower lip is necessary, we like, best of all, Grant's.[1] This operation, where two sliding lateral flaps are used, needs two tension sutures in the middle line.

OTHER PLASTIC OPERATIONS ON THE FACE

It is somewhat difficult to deal with this matter solely from the point of view of after-treatment, since common sense must dictate the specific treatment for special cases. In general, however, by position or by the application of plaster straps, all tension must be kept off the sutures so far as is possible. The wound itself might better be not closed in by any dressing, but rather left exposed to the air, and frequently cleaned with alcohol or painted with the compound tincture of benzoin or some such application.[2] The stitches will have served their purpose in most instances by the sixth day, and should be removed then in order to avoid forming stitch scars.

Hemorrhage must be thoroughly stopped, since a relatively thin layer of blood-clot may prevent a plastic flap from adhering. Firm

[1] Jour. Am. Med. Assoc., 1905, xlv, 962.

[2] *Antiseptic Varnish:*

Iodoform or aristol (thymol iodid) } Glycerin }	āā 1 part
Tinct. benzoin. comp.	4 parts.

pressure, therefore, for an hour or two, even if it has to be applied continuously by a nurse's hand, may be necessary. Too much detailed care can hardly be given in these important cases. From the beginning, when, as Treves[1] says, "Each flap must be gently handled, carefully adjusted, and most tenderly and precisely sutured," up to the sixteenth to the twenty-first day, during which time there must be no tension, strict cleanliness must be maintained. During the early restlessness after operation and during sleep it is safest even to overdo the application of harness, straps, or other apparatus to prevent sudden movements which may disturb the flaps.

Skin-grafting.—Where this procedure has been used, in addition to plastic flaps, for special care see p. 633.

[1] Oper. Surg., 1892, ii, 3.

CHAPTER XLI

OPERATIONS ON THE MOUTH, NOSE, AND PHARYNX

HARE-LIP

THE difficulties of feeding a child after this operation have been somewhat exaggerated. After the operation a piece of gauze or some antiseptic varnish (see p. 403), or both, is applied over the wound, and all side-pull on the wound is prevented by a dumb-bell-shaped piece of zinc oxid plaster. The crinolin covering adherent to that part of the plaster which crosses the lip itself is so left that the plaster does not stick to any part of the lip, but only to the cheek. The upper lip is necessarily so crumpled together by this plaster application that sucking would be impossible, even if it were best for the lip for other reasons. The child must be fed, then, with a small spoon, put well into the mouth. The mother's milk should be drawn and given if possible. The child is first given water, just as any ether patient would have it, but if it is weak on account of poor general condition or from shock, the milk should be offered within three hours of the operation. Bottle-feeding—a large nipple is advantageous—may be resumed in three days; breast-feeding at the end of ten days, the breasts being kept active during the interval.

Sutures should be removed, in part, as early as five days—all by ten days. At the moment of their removal all tension on the lip must be prevented, and a new butterfly plaster applied at once, as before, in order that the newly formed scar shall not be subjected to strain and widen. This butterfly is worn up to three weeks.

Complications and Sequelæ.—(1) *Asphyxia.*—In the younger infants this calamity, unless carefully guarded against, may frequently occur. It cannot be better described than in the words of Mr. Jacobson:[1] "One point of great importance is not alluded to in surgical works, and that is, that in some cases of hare-lip death from dyspnea may take place very soon after operation. Thus, where the cleft has been a large one and the upper lip when restored is tight, where it overhangs the lower, if the nostrils are flattened and partly closed by the operation, owing to the tension of the parts, so little breathing space

[1] *Loc. cit.*, 410.

may be left that temporary interference with respiration may occur, with grave and even fatal results before the breathing can be accommodated to the altered circumstances and before the parts dilate and stretch."

(2) Many children die after this operation, particularly the young ones. For that reason it is probably best, despite the clamors of the parents, to postpone the operation for this deformity until the child is from six to nine months old. This rule, of course, does not hold if the child cannot well nourish itself on account of the deformity. Many of the infants that die under this operation are of the marasmic type that rarely live, operated on or not.

(3) Hemorrhage may be serious, especially in a weak infant. Properly placed stitches should hold the coronary arteries. Apart from the primary dangers of hemorrhage any considerable collection of clot under the lip or between the edges leads to non-union. The fauces may even fill up with blood-clot, and, unless the child is watched carefully, death ensues from suffocation.

(4) Bronchopneumonia is liable to occur, as in any infant after etherization, and particularly after mouth operations.

CLEFT-PALATE

A small injection of morphin may be given immediately after the operation, but no food should be allowed for three hours, only a little ice being given to suck. For the first forty-eight hours diluted milk or barley-water only should be allowed, nutrient enemas being given if needful; all feeding is done with a spoon; the child is weaned. After this yolks of eggs, arrowroot, broths, soups, and, in about ten days, light food of other kinds if the child is old enough. The hands should be secured for the first few days. If the patient's temper and intelligence allow it, the mouth may be regularly washed with boric acid or salt solution. In any other case it is best to leave the wound quite alone. The nurse should devote herself to preventing the child from crying and to keeping the patient amused. Whenever it is possible, the child should be taken into the fresh air after the first two or three days. "There should be no hurry to remove the sutures, which, if not of silk, may remain for seven or ten days in the soft, and an almost indefinite time in the hard, palate. No one should be allowed to look at them either early or often. It is well for the operator to keep out of the child's notice for the first ten days." It is now a well-established custom, in America at least, to operate upon these infants within the first six months, as soon as the child has a hold on life.

"To make this subject of after-treatment at all complete a few words must be said about the improvement of speech after the cleft has been surgically cured, and the occasional need of an obturator. Even after a complete closure of the cleft much awkwardness of speech is liable to remain, this being, of course, most marked the older the patient is. Parents are often greatly to blame for the little trouble they will take to further the success of the surgeon's efforts, and this refers in many cases to those who have not the excuse of ignorance and toilsome life of the poorer classes. They too often act as if, because the cleft is closed, no further responsibility rests with them. Again, the patients being usually children, without thought as to the future, and satisfied with the improvement in their deglutition, present many difficulties. Not only has the child to be taught the right way of using its organs of speech, but wrong habits, especially nasal and guttural tones, have to be unlearned. This is only to be brought about by means of systematic lessons and practice gone through regularly day by day for months and even years. No plan will be found better than that recommended by Mr. W. Haward, Clin. Lect., 'On Some Forms of Defective Speech.'[1] The instructor should sit directly facing the pupil; the pupil is made to fix his attention thoroughly upon the face of the teacher, and to copy slowly his method of articulation. This should be displayed by the teacher in an exaggerated degree, every movement of the lips and tongue being made as obvious as possible to the pupil, and the more difficult sounds or movements prolonged for the purpose. Thus, for instance, suppose the word 'sister' were to be practised, the teacher, having filled his chest with a long inspiration, would open his lips and draw back the angles of the mouth, so that the pupil could see well the position of the tongue against the teeth; he could then prolong the hissing sound of the 's' and, finally, separating the teeth as the sound of the 't' in the second syllable issues, allow the pupil again to see the position of the tongue as the word is ended. Or, for another example, take the word 'lily.' Here the teacher would separate the lips and teeth, so that the tongue would be seen curved upward, with the tip touching the hard palate; the word would then be pronounced with a prolongation of each syllable, the teeth and lips being kept open, so that the uncurling of the tongue and its downward movement are clearly seen. So, again, in teaching the proper method of sounding such words as 'wing' or 'youth,' much aid is given by keeping the lips somewhat separated, so that the relation of the tongue and palate can be made manifest. The pupil must be made to fill his chest,[2] and then to imitate as closely as possible every movement and sound of the teacher; and this may sometimes be assisted by making the pupil feel with the finger as well as observe with the eye the relative movement and position of the teacher's tongue and palate. There should be no other person in the room to distract the pupil's atten-

[1] *Lancet*, 1883, i, 111.

[2] Opening the mouth widely and learning to keep the tongue down on the floor of the mouth are two points to be early and strenuously insisted upon. The patient should practise them before a looking-glass.

tion. It is best to continue the exercise for a short time only, and to repeat it frequently, rather than fatigue the child by a long lesson; and it is a good plan to take an ordinary elementary spelling-book and to mark the words which the pupil finds most difficult to pronounce,[1] so that these may be especially practised.

"With regard to the question of obturators and vela, in cases where it has been found impossible to close a very wide cleft, or where it is evident that even after a successful operation the palate will be so tense and short as to be quite unable to touch the pharynx, and so shut off the nose from the mouth, an obturator may be required."[2]

This matter should be referred to a dental surgeon of experience.

Complications and Sequelæ.—(1) *Vomiting,* if excessive or if by chance something solid comes up, may cause the wound to separate and the operation to fail.

(2) *Tension* may cause sutures to cut through and let the wound separate. The only treatment of this naturally is preventive, and is, therefore, a matter to be considered at the operation.

(3) *Hemorrhage* after operation is very rare in children, but must be watched for in adults.

(4) *Sepsis,* curiously enough, merely from mouth bacteria, may be disregarded, but infections of such nature as arise from scarlet fever, measles, or diphtheria are serious, and will usually result in at least partial failure of the operation. At the slightest appearance of a suspicious membrane in the mouth diphtheritic antitoxin should be given, even before a bacteriologic report can be obtained.

(5) *Diarrhea.*—This complication may appear as a part of the shock of operation or it may be due to any of the usual causes. The bowels should be cleaned out with small doses of calomel or with castor oil, and the food should be modified and sterilized according to the age and condition of the patient.

For a masterly article on Cleft-palate and Hare-lip the reader is referred to a monograph under that title by W. Arbuthnot Lane, M.S., F.R.C.S., of Guy's Hospital, published [3] in London in 1908.

EXCISION OF THE TONGUE, PARTIAL OR COMPLETE

The chief problems which arise after this operation are, to keep the mouth clean and to nourish the patient. The practice of Jacobson [4] before this operation is excellent. He teaches the patient to wash the

[1] Especially those containing the letters t, b, d, k, g, s, z, and l (Rose).

[2] Jacobson and Steward, The Operations of Surgery, 1902, i, 444, 445.

[3] Med. Pub. Co., Limited. [4] *Loc. cit.,* p. 467.

mouth thoroughly with some antiseptic, such as carbolic acid 1:80, boric acid, or some of the alkaline antiseptics. The patient also "gets used to feeding himself with a drainage-tube attached to a feeder spout and passed by himself to the back of his throat."

At the completion of the operation the cut surface is painted with compound tincture of benzoin or a solution of zinc chlorid (gr. x–℥j). The patient is given ice to suck, and nourishment is given as necessary in liquid form through nutritive enema. If the patient has learned how beforehand, he will be able, after the usual post-ether nausea has passed, to feed himself by the feeder-tube passed to the back of his throat. The mouth and wound must be inspected and thoroughly cleaned at least every three hours during the daytime. The patient must be made to sit up as soon as possible and his position must be continually altered.

Complications and Sequelæ.—(1) *Bronchopneumonia* and *lobar pneumonia* are the great causes of failure after this operation, the former due to direct inhalation of infected material. Care of the mouth, the sitting posture, and general early activity are the preventive measures.

(2) *Hemorrhage.*—Early hemorrhage is rare. Secondary hemorrhage is unusual if the mouth has been kept clean. Arterial bleeding in the conscious patient can only be controlled by the immediate application of hemostatic forceps and all the patient's courage will be necessary to endure their remaining *in situ.*

(3) *Edema of the glottis* may follow during any of the first days from extension of infection, and must be met by scarification, intubation, or tracheotomy.

(4) *Suffocation* may be caused by the stump of the tongue falling back against the epiglottis. This is so liable to occur that it is probably best always, at the end of the operation, to leave a stout silk loop sewed through the stump hanging 2 or 3 in. out of the mouth.

RANULA

"In operating for the relief of ranula the object to be attained is either to establish a new communication between some portion of the ducts of the sublingual glands involved and the cavity of the mouth or the complete removal of the entire gland. The simplest method to re-establish a connection between the ducts of the gland and the cavity of the mouth is through the use of a seton. By applying a large-sized silk suture transversely across the ranula, and tying this loosely so that it does not have a tendency to cut away the intervening portion of the mucous membrane, one can frequently secure the growth of epithelial cells in these openings and the cavity of the mouth becomes continuous.

After this has occurred, at both the point of entrance and exit of the suture a new suture may be introduced through the same openings and tied more tightly, so that the intervening tissue may become absorbed slowly. The opening formed between the cavity of the ranula and the mouth will thus become continuously lined with mucous membrane and presently a permanent opening will be established. This, however, will not occur in every case, and it may become necessary, later, to remove a considerable portion of the tissue between the cavity of the mouth and the ranula." [1]

In our experience the silk seton through both sides of the tumor gets foul from mouth contents and secretions, induces inflammation, and tends to cut itself too rapidly to establish a permanent duct or ducts. Better than silk, therefore, is an ellipse of silver wire, or, better still, because it is stiffer, gold wire, may be used. A piece of gold wire is passed through and bent into the shape of an ellipse and the ends need not be twisted. Motion of the tongue moves the wire enough to establish openings, but does not cause the wire to cut through.

ALVEOLAR ABSCESS

Incisions of the gum tend to close rapidly. Closure may be delayed by means of iodoform wick or packing, which is rarely indicated, or by the simple procedure of dipping the knife-blade in 95 per cent. carbolic. Ordinarily, syringing or irrigating is never required unless there is present septic periostitis or osteomyelitis (hydrogen dioxid should not be used). If the constitutional symptoms persist, these are to be thought of as well as empyema of the antrum of Highmore.

If the incision is within the mouth, *as it should be whenever possible*, the patient should be supplied with some pleasant mild antiseptic, such as liquor sodii boratis compositus (Dobell's solution) or liquor antisepticus alkalinus, and instructed to rinse the mouth out every two hours, at the same time exerting gentle pressure on the cheek over the tumor to assist in drainage. Lying on a hard pillow upon the affected side will act similarly. With these precautions it will very rarely be necessary to reopen an abscess.

The tooth which gives origin to the abscess can usually be determined by tenderness elicited by pressure on its crown. If it is in bad shape, it should be removed. If the dentist advises, it should be sterilized and filled, if necessary.

In case of a sinus through the check, which heals with a disfiguring scar, a tenotome should be passed under the scar to separate it from

[1] Ochsner, Clin. Surg., 1902, p. 318.

the underlying bone or tissue, and paraffin injected to restore the contour of the face. Long-standing sinuses—internal or external—usually speak for a sequestrum. If internal, the dentist can usually relieve them. If external, the source of the discharge is likely to be in the maxilla itself, and radical measures should be taken to remove necrotic bone.

PARAFFIN PROSTHESIS FOR DEFORMITY OF THE NOSE AND OTHER PARTS

The danger most feared in this procedure, particularly if the paraffin be used hot, is the immediate one of embolism, followed by thrombosis of the ophthalmic vein, with consequent blindness. Nevertheless, in all the literature there are only three cases.[1] This possibility should always be considered when advising this operation. When the calamity

FIG. 124.—PARAFFIN PROSTHESIS. Deformity resulting from abscess of septum; before treatment.

FIG. 125.—PARAFFIN PROSTHESIS AFTER TREATMENT.

occurs, there is no treatment. When cold paraffin (melting at 115° F.) is used, however, screwed in by the ingenious syringe of Dr. Beck, as modified by V. Mueller & Co., of Chicago, the danger is at a minimum —so small that we do not hesitate to advise the operation in cases of notable deformity.

After the injection the injected mass is molded into the desired shape and a compress, wrung out in iced witch-hazel, laid over the nose at intervals for the first twenty-four hours or longer. There is some reaction in the way of swelling and tenderness which, unless true sepsis develops, should subside after forty-eight hours. If the wound or the

[1] Harmon Smith, Laryngoscope, St. Louis, 1908, xviii, 798.

paraffin cavity becomes infected, as a rule, it will not heal until the last bit of paraffin is either forced or curetted out. The operation should not then be attempted again for at least three months.[1]

Sometimes this method leaves an obvious foreign body which is more noticeable than the original deformity. On this account the procedure should not be used unless there is a definite and serious cosmetic indication.[2]

NASAL POLYPI AND SPURS

Adhesions.—Special care should be observed in operating within the nose to prevent adhesions, which are the result of two wounded surfaces coming into apposition. This condition may occur after the most painstaking technique, on account of the extreme narrowness of the nasal chamber. The nose should be examined by the surgeon daily, and any tendency to adhesions carefully noted and the apposing surfaces separated with the nasal probe. After drying the surfaces collodion may be painted on and aristol blown over the raw mucous membrane. In some cases a strip of gauze, covered with thin rubber dam, may be laid between the septum and the turbinate, or an intranasal tampon, made from Bernay's sponge, may be found of great service. This dressing should be changed daily until healing has taken place. If possible, packing in the nose after an intranasal operation is to be avoided, as it has a tendency to check the natural drainage and favor sepsis. It is advisable to place in the vestibule of the operated side a small plug of aseptic absorbent cotton, thereby protecting the wound from impurities from the atmosphere. This may be changed from time to time and left out altogether after twelve hours. It is preferable not to use washes in the nasal chambers for several hours after an operation, as bleeding is sure to follow from disturbance of the cut surface by dislodging of clots. At the end of twelve hours Dobell's solution, or liquor antisepticus alkalinus, may be used, diluted one-half with warm water.

Nasal Hemorrhage.—This is a frequent after-result of intranasal surgery. It is always advisable to define clearly the location from which the bleeding arises, whenever this is possible, and not to pack the nose except as a last resort. Cold towels should be applied externally, and cracked ice may be used in the mouth and several small pieces placed in the nose. Absolute rest should be insisted upon and all coughing and sneezing avoided. If simple measures do not stop the

[1] This subject of expulsion of foreign bodies has been carefully studied by H. V. Baeyer, Beit. z. Klin. Chir., Tubingen, 1910, lxx, 350.

[2] F. Strange Kolle, Subcutaneous Hydrocarbon Prostheses, New York, 1908.

bleeding, the nose may be packed with sterilized sauze soaked in adrenalin, or a cigarette pack made with sterilized cotton or gauze, with a thin dental rubber layer outside to prevent, temporarily, adherence to the mucous membrane.[1] In most cases it is only necessary to pack either the anterior or middle portions of the nose, but in a few exceptional cases it is necessary to pack the posterior cavity. This may be best done after so shrinking the turbinates with a 4 per cent. cocain in 1 : 1000 adrenalin solution, so that as much room as is possible may be gained to allow thorough and careful work. Several long strips of sterilized gauze are carried backward, through the anterior nares, with Hartman's long-bladed nasal forceps, to the posterior space (where it is advisable to have the finger as a guide to prevent the packing coming in contact with the pharyngeal wall) and the nostril is firmly filled with the gauze. This packing should not be allowed to remain in the nose for a longer period than twenty-four to forty-eight hours. In removing the packing great care should be exercised to prevent renewed bleeding. If rubber dam or Cargile membrane has been used, there is no tendency for the shreds of gauze to adhere to the mucous membrane. With the plain gauze dressing it should be thoroughly wet with dioxid of hydrogen and removed slowly and carefully.

Packing the postnasal space is undesirable on account of possible sepsis or infection of the middle ear through the Eustachian tubes. If hemorrhage demand such a procedure, it is best done, not by means of Bellocq's cannula, but by passing a soft-rubber catheter through the nose and into the mouth, and tying to this one end of a piece of suture material, to which a tampon is attached. This is drawn through the nose and the tampon rests in the postnasal space. The other end of the suture material comes out of the mouth and is tied to the nasal end and rests over the ear. The nares is packed anteriorly if necessary. This plug should not remain *in situ* longer than twenty-four hours, and, after removing, the parts should be cleansed with Dobell's solution diluted to one-half strength.

ANTRUM OF HIGHMORE

After a radical antrum operation (opening both through canine fossa and lower meatus) the gauze may remain in place for forty-eight hours, and be then removed and the antrum washed out by a glass syringe and rubber tube or catheter passed into mouth wound, the wash coming out through the nose. Dobell's solution, one-half strength, some other alkaline preparation, or normal saline solution may be used. This procedure should be repeated daily until no trace of pus can be

[1] M. D. Stevenson, Jour. Am. Med. Assoc., 1910, liv, 1864.

seen. After one week the cavity should be inspected and probed to find if any areas of diseased mucous membrane or carious bone exist. If it is desirable to allow the wound in the mouth to remain open, it should be repacked and the wick changed every second day. When the mouth wound closes, the washing, if more is necessary, is done through the inferior meatus. If necrotic areas of bone are found, they should be gently curetted, after applying 5 per cent. cocain in 1:1000 adrenalin solution, and then touched with 50 per cent. silver nitrate solution. Any associated or secondary atrophic rhinitis or polypoid condition of the nose must be coincidentally treated.

Destruction or injury of the superior dental nerve, with resulting death of three or more teeth, should not occur after a careful operation, unless there be an anomaly in the situation of the nerve with relation to the canine fossa.

FRONTAL SINUS

Cold compresses should be applied constantly to lessen postoperative edema and ecchymosis. External dressings should be changed in twenty-four hours and the covered eye bathed with saturated solution of boric acid. The drainage-tube should be left in position for forty-eight hours, and after its removal the sinus should be syringed with Dobell's solution, one-half strength. The tube should be replaced and the treatment repeated daily for two weeks. After this, if the pus has disappeared, the tube may be left out. If necessary, a silver tube may be used, which should be worn until every trace of discharge has ceased. If the sinus has not been packed, it may be washed out in twenty-four hours with warm normal saline solution or saturated solution of boric acid.

For some time patients may complain of diplopia if the pulley of the superior oblique muscle has been interfered with. This gradually passes off in a week.

A certain amount of numbness on the forehead upon the affected side may occur. This also disappears in a short time.

The discharge may cease in a few weeks, or it may take months to complete the cure. If unsightly scars or depressions persist, paraffin prosthesis may be employed.

REMOVAL OF ADENOIDS

The patient should be made to lie on the side, and should be carefully watched for the vomiting of blood, which is sure to occur. Should the bleeding be excessive, as it may be if the curet has cut into the mucosa, or has left pieces half cut off, or if the child is a bleeder, or if the growth is malignant, the patient should be sat up and an application of 1:1000 adrenalin solution made to the site of operation. If three or four applications of this do not stop the bleeding, a tampon of gauze, with a piece of silk tied around the middle, may be prepared, a nasal forceps passed through an anterior nares, the mouth-gag placed in position, the silk attachment on the tampon passed with the finger into the postnasal space, seized then by the nasal forceps, and the silk drawn out through the nose, thus bringing a tampon of appropriate size into full pressure in the postnasal space. Monsell's solution is another styptic which may be used.

Occasional oozing, small in amount, may continue so long that, at the end of ten or twelve hours, the child is largely exsanguinated. For this the nurse must be on the watch, and measures such as those given are then to be taken. Many instances of death from particles of adenoid tissue or blood in the trachea have been noted, though, perhaps naturally, few have been reported.[1]

The patient should be in bed one to three days, or longer if there is fever, and should not go out-of-doors in wet or very cold weather within a week after the operation.

Ice-cream and cracked ice relieve pain, and a mild embrocation, such as oleum gaultheriæ and linimentum saponis, equal parts, may be applied to the muscles of the neck if stiffness occurs. A laxative should be given twenty-four hours after the operation, to clear the stomach and bowels of any blood that may have been swallowed and not expelled from the stomach by vomiting. The diet should be limited for the first twenty-four hours to cold liquids or semisolids. Eisenzucker tablets (saccharated red oxid of iron) of 3- or 5-gr. doses are agreeable to children, and should be used when anemia exists.

Nasal obstruction in many cases seems greater for a few days than before operation, due to the swelling and inflammation of the nasopharynx. Nose-breathing should improve in from four to seven days, but the vicious habit of mouth-breathing, especially in older children, can be corrected only by repeated admonition, which almost amounts to "nagging," during the day, and possibly by the use of a four-tailed chin bandage to hold the mouth shut at night.

Complications and Sequelæ.—(1) *Bronchopneumonia* from inhalation of blood or vomitus.

(2) *Sepsis,* shown by excessive purulent excretion and possibly by general symptoms. This is best treated by irrigation through the nose into the mouth with some alkaline antiseptic, such as Dobell's solution, half strength, liquor antisepticus alkalinus, or normal salt solution.

[1] Jacobson and Steward, i, 372.

(3) *Earache*, due probably to infection through the Eustachian tube, either directly during operation or by unwise use of the nasal douche. This is less likely to occur if the fossæ of Rosenmüller have been thoroughly cleansed out with the finger during operation. The ice-bag or hot water should relieve this in most instances. Paregoric or Dover's powder will best relieve severe pain. If the drum membrane bulges, paracentesis should be done early.

In some cases after removal of the adenoid tissue the catarrhal deafness does not clear up without treatment. In these cases a few Politzer inflations are necessary. In more chronic cases the turbinates may require cauterization, either with the actual cautery or some chemical cautery, of which trichloracetic acid is the best.

(4) *The cervical lymph-nodes may swell* and become painful. They usually do not suppurate, and the condition calls for no treatment beyond the application of an ice-bag or a hot-water bag if that seems more soothing.

(5) The possibility of the appearance of *diphtheria* immediately after operation should always be kept in mind.

(6) *Deformities of the chest* may be to some extent overcome in young patients by proper breathing, gymnastics, and out-of-door exercises, the causal condition having been removed.

(7) A *thick, stuffy*, and nasal quality to the *speech* may remain for some time after the operation, especially in children who have had nasal obstruction for some time. This may be overcome by lessons in proper voice production.

(8) In some cases a *mouthy voice*, improperly called "nasal," may be due to slight temporary paresis of the muscles of the palate, brought about by their being stretched at the time of operation. This usually quickly disappears and the voice becomes natural. If there is a paretic condition of the soft palate, small doses of strychnin and cold gargles should be tried.

REMOVAL OF TONSILS

This operation in the adult, from the point of view of suffering and of possible complications, is a serious one; in the child, it is much less so. The same general directions for the after-treatment hold as for the operation for the removal of adenoids. Locally, relief from pain is best obtained by the use of ice constantly applied and by insufflation on the site of operation with orthoform powder. This may be done every half-hour if necessary. Gargling increases the pain; the use of lozenges is not advised because the necessary swallowing causes pain.

Hemorrhage.—Bleeding may continue from the moment of operation (see p. 89), or may take place as a true secondary hemorrhage any time up to the tenth day. If adrenalin or Monsell's solution fail to check it, the tonsillar fossæ should be examined carefully with a strong reflected light, and the anterior pillars retracted to see if the bleeding point can be detected. In some cases the base of the tonsil or ragged edges of tonsillar tissue have been left, and after a thorough removal the bleeding ceases. If a bleeding vessel can be seen, it should be grasped with a hemostatic forceps and a suture applied. Sometimes the mere twisting of the forceps on the vessel will stop the bleeding. If these measures fail, the tonsil hemostat may be used, and,

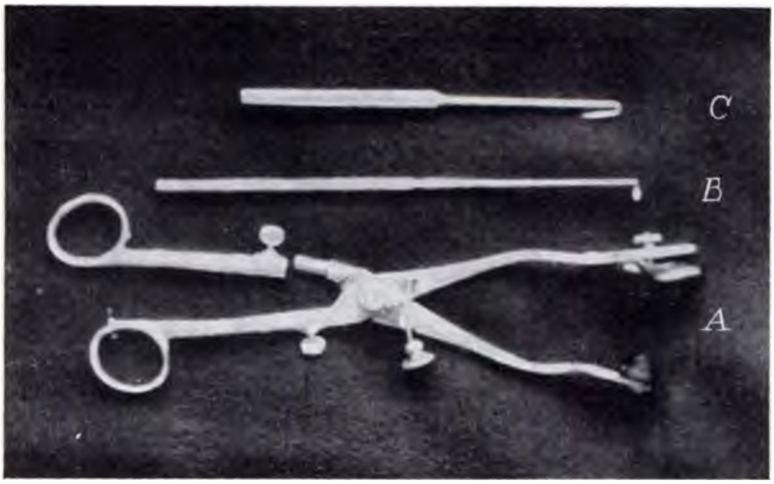

FIG. 126.—INSTRUMENTS FOR TONSILLAR HEMORRHAGE.
A, Mikulicz-Stoerk tonsillar clamp, with detachable handles; *B* and *C*, needles for sewing together the pillars (Yankauer).

as a last resort, the pillars of the tonsil may be sutured together (see Fig. 126), and, if unsuccessful, the external carotid must be tied.

Diet.—Anything that the patient desires he may take, but experience shows that liquids or semisolids very cold are the least irritating forms of nourishment. Cold water, orange-albumin, custard, sherbet, and ice-cream are to be recommended. The pain on swallowing will last from four to ten days.

TUMORS OF THE TONSIL

If the removal has been solely through the mouth, the same care is taken as in operation on the tongue. (See p. 408.) If, in addition, there is a wound in the neck, with drainage from the pharynx, drainage gauze should be kept in not more than twenty-four hours, after which drainage should best be allowed to maintain itself, provided the wound is kept thoroughly clean. The dressing should be replaced as often as it is wet; the skin about the wound should be painted with compound tincture of benzoïn to preserve it from maceration. Feeding should be done by esophageal tube for between two and three weeks. "The patient's feeding himself should be forbidden as long as any attempt at this causes choking or coughing, owing to the danger of fluids entering the air-passages" (Jacobson). The patient should be up and out of bed as soon as possible.

PERITONSILLAR ABSCESS

It is assumed that no surgeon will be content with mere incision of the abscess of quinsy sore-throat. If, through the incision, the exploring finger breaks down all dividing walls and all cell-like accessory cavities, making the abscess into one, drainage will take care of itself. The tip of a glass syringe may be introduced through the wound every two or three hours after ether recovery, and the cavity thus washed out with warm myrrh or some alkaline antiseptic solution. This should be done for twenty-four to seventy-two hours, only when the patient is awake. Gargling does no good and is very uncomfortable.

The patient may take for nourishment whatever he can swallow without too much pain. Usually semisolids at room temperature, such as mush, blanc-mange, curds, and jellies, are swallowed the easiest.

Complications and Sequelæ.—(1) *Septicopyemia* may result in patients much reduced or in cases inefficiently opened. Diphtheria may be present coincidentally or may appear during convalescence.

(2) Delayed or secondary *hemorrhage* should never occur, unless due to anatomic anomaly.

RETROPHARYNGEAL ABSCESS

Most of these cases are in children under five years of age. It is assumed that the operation has been a vertical pharyngeal incision on one or both sides; that the incision has been very free; that, as in the case of peritonsillar abscess, all septa have been broken down by the finger; that the operation has been done in the Rose position.

The mouth should be opened wide and inspected every few hours to see that drainage is free; that the wound has not sealed up and pus collected within it. Washing out the wound is not necessary, but every effort should be made to keep the mouth thoroughly clean.

Complications and Sequelæ.—Bronchitis or bronchopneumonia make the commonest complication. The most important treatment is, naturally, prevention by having the operation done in such position that no pus is inhaled and by subsequent mouth cleanliness.

Whether acute or chronic, retropharyngeal abscess is extremely likely to cause edema of the glottis and suffocation. An ice-collar is a good prophylactic against this danger. If the incision is made through the mouth and drainage is inefficient, an external incision along the posterior border of the sternomastoid may be made.

Septicopyemia may occur and generally with fatal result. The usual general treatment applies.[1] (See Chapter XXVI, p. 284.)

[1] M. A. Goldstein, The Laryngoscope, St. Louis, 1908, xviii, 46.

CHAPTER XLII

OPERATIONS ON THE NECK

TRACHEOTOMY

After this operation the patient should be put in the position in which he can breathe best. This should be determined by experiment in a given case. Most cases, however, breathe best reclining at about 45°, with the head somewhat back. The tape which holds the tube in position must be tight enough to hold in the tube during coughing, but should not be so tight as to constrict the neck, for this not only induces the natural discomfort of venous congestion in head and face, but tends to cause the lower end of the tube to press against the inside wall of the trachea. Some patients at first or during the night may find relief in an atmosphere laden with hot-water vapor (so-called steam). Where the coughing is continuous, where the secretion from the tube is very thick and stringy, where the patient continually gets cyanotic, in spite of the tube being clear, steam should always be tried. For the purpose of confining the vapor, any of the usual devices for holding mosquito-netting over the bed may be used, or a special one may be made by tying four uprights to the legs of the bed; over such uprights a sheet is dropped as a canopy, leaving an aperture into which the vapor may be carried directly from the mouth of the tea-kettle over an oil-stove, or through a pipe, a steam radiator, or any other device which may be at hand. Such apparatus is most often necessary where intubation has failed in diphtheria and tracheotomy has been necessary.

Ordinarily the room should be kept at 65° to 70° F. Over the mouth of the tracheotomy-tube should be placed 5 to 10 layers of gauze wet with boric acid or some such mild antiseptic. This wet gauze serves to moisten the air inspired, and to make it less irritating to the bronchi. The amount of gauze should not be enough to interfere with free breathing. The inner tube must be removed and cleaned as often as necessary—probably every hour or two at first. A solution of sodium bicarbonate will best clean the secretions off the tube, though if an aluminum tube is used, it must not be washed in alkalis. If removing the inner tube does not relieve obstruction, a long, narrow feather (such as that from a hen's wing) should be inserted deep into the outer tube and removed with a twisting motion. A nurse should always be present and waking for at least the first twenty-four hours after tracheotomy. At the same time, it should be remembered that the care-taking, especially cleaning of the tube, may be overdone, just enough to prevent the child getting sleep, the most important remedy.

Feeding is sometimes a difficult problem. As after all operations, at all times, unless there is a definite reason, these cases should not be wakened for feeding. On the other hand, swallowing at first, before the patient is used to the tube, may be so uncomfortable that it is difficult to induce the patient to take sufficient nourishment. Liquid feeding through the mouth should be tried. If it fails, nourishment may be carried on by nutrient enemas or by esophageal tube; the latter method is so apt to frighten small children that it should be avoided whenever possible. (For details of Esophageal Feeding, see p. 148.)

Removal of the Tube.—In general, this should be done as early as possible. Not only is there danger of ulceration of the trachea from pressure of the inner end of the tube, but the longer the person uses the tube, the more difficult is it for him to resume breathing by the natural passages.

"*Conditions Which Impede the Removal of the Tube.*—(1) Prolonged formation of membrane. The longest possible period for this is probably about ten days. Patience and support are the main indications in the treatment here. (2) The larynx is crippled like any other inflamed part. (3) The air-tube is closed by granulations, usually above the cannula. More common than these is obstinate swelling of the mucous membrane. Here the tube must be removed and astringents and caustics carefully applied from below, with the aid of an anesthetic if necessary. (4) Closure of larynx by deep ulceration cicatrizing after detachment of membrane. In such a case, with the aid of an anesthetic, the larynx must be opened up by probes of increasing size and laminaria tents introduced from below, and later on by the use of MacEwen's tubes. (5) Paralysis of the dilating cricoarytenoidei postici or spasmodic action of the closing muscles, arytenoidei or cricoarytenoidei lateralis, from fear, excitement, or during effort.[1] (6) The commonest

[1] In a case in which one of us had performed tracheotomy, and was watching the child for the first few hours after the tube had been dispensed with, most urgent symptoms came on during the slight straining which accompanied an action of the bowels, the patient falling off the night-stool onto the floor apparently lifeless. Artificial respiration restored the child, and the case did well.

cause of inability to dispense with the tube is probably due to the rapidity with which the larynx falls into abeyance when a child is allowed to breathe through a tracheal cannula, the patient at this age being not intelligent enough to understand the importance of dispensing with the tube, and perhaps too young to care to talk, or, if older, not realizing the need of again using its voice while all its wants are supplied. With the above condition are coupled a nervous dread of having the tube removed and paroxysms of temper and struggling which rapidly produce embarrassed breathing. Any organic mischief, such as adhesions in the larynx, is, I think, extremely rare, and granulations above or below the tube are more often talked of and given as a reason for inability to dispense with the tube than really seen" (Jacobson and Steward, p. 490). Where repeated efforts to get the child to resume natural breathing fail, the O'Dwyer cannula should be inserted, unless there is organic obstruction to this procedure. The O'Dwyer tube should also be removed experimentally every day or two, with the idea of dispensing with it as soon as possible. But even when laryngeal breathing is restored without the tube, the child must be closely watched, especially at night, and the tube inserted at a moment's need.

Complications and Sequelæ.—(1) *Hemorrhage.*—Immediate hemorrhage is usually venous, the result of the congestion of asphyxia, and stops as soon as breathing is well established. No particular effort need be made to stop it. Occasionally, an artery in the thyroid isthmus is cut and must be tied. Hemorrhage after some days may come from ulceration of the trachea from pressure of the tube; preventive measures should make this impossible. The tube should be only long enough to enter the trachea and curve around until its axis is parallel with that of the trachea. A tube long enough to reach the sternal notch may ulcerate into the arch of the aorta. The tube should be as large and as short as possible. It should be of the same size throughout, without tapering. The inner tube should project a little beyond the outer one. The collar of the tube should stand out as little as possible from the neck.

(2) *Sepsis of the Wound.*—Such a wound is never entirely aseptic. The collar of the tube should be held from the wound by a few layers of gauze split to straddle the tube. The wound should be kept sweet with compound tincture of benzoin, eucalyptus vaselin, or some other antiseptic emollient.

(3) *Emphysema.*—This complication is usually the result of a faulty operation. Either the incision in the trachea is not in the same plane with that in the soft parts, or the incision in the trachea is too small for

the tube and immediate efforts at breathing pump the soft tissues full of air.[1]

(4) *Ulceration of the Trachea.*—This is due to a cannula which is too long or which has a wrong curve. This condition is to be suspected if the expectoration after three or four days is streaked with blood, or if the outer tube, on examination, shows a black patch on the anterior aspect of the lower end. If the tube is still needed, it should be trimmed or a different one tried.

(5) *Suppuration* may rarely take place in the mediastina. This is indicated by the signs and symptoms of profound torpidity, labored breathing, and substernal pressure and pain. The only treatment is a well-performed operation, such as trephining of the sternum.

LARYNGOTOMY

The vertical incision in the pharynx above the tube should be left unsutured, with a slight packing of antiseptic gauze in it. The foot of the bed should be raised for the first twenty-four hours, to overcome the tendency of the drainage to run down into the trachea. The usual care of the tracheotomy tube should be maintained. (See p. 420.) Feeding should be carried on by nutrient enema or esophageal tube unless the latter is particularly painful or obnoxious to the patient. Solid food should be taken very early, since it frequently may be well taken by natural means even better than by liquids. The sutures holding the end of the trachea and of pharynx to the skin must be removed if they are non-absorbable at about the fifth day, as they tend to become folded under and difficult to reach.

The question of a permanent apparatus which shall serve as an artificial pharynx in these cases is a complicated and special one. In general, such an appliance consists of two arms, one going down, the other up, with a common exit at the site of the operation wound. In such a tube various ingenious valve-like arrangements are provided to allow of respiration and speech.

[1] Mr. Jacobson (*loc. cit.*, 493) quotes the conclusions of Dr. Champneys as follows: (1) "Emphysema of the anterior mediastinum, often associated with pneumothorax, occurs in a certain number of tracheotomies. (2) The conditions favoring this are division of the deep cervical fascia, obstruction to the air-passages, and inspiratory efforts. (3) The incision in the deep cervical fascia downward should not be longer than needful; it should on no account be raised from the trachea, especially during the inspiratory efforts. (4) The frequency of emphysema probably depends much on the skill of the operator, especially in inserting the tube. (5) The dangerous period during tracheotomy is the interval between the division of the deep cervical fascia and the efficient introduction of the tube. (6) If artificial respiration is necessary, the tissues should be kept in apposition with the trachea, and any manipulations performed without jerks."

Complications and Sequelæ.—(1) Shock may be very great, apparently analogous in nature to that frequently seen following the slightest laryngeal operations. (2) The usual tracheotomy dangers, with relation to blocking of the tube, etc., exist. (3) Bronchopneumonia. This danger, due to inhalation of septic matter, blood, and food, is great, and is present for at least the first two weeks. (3) Sepsis, possibly extending deep into the neck or into the thorax, can be met only by constant care.

INTUBATION: INDICATIONS, TECHNIQUE, AFTER-TREATMENT

When laryngeal stenosis becomes acute, and from the symptoms it is evident that the patient's life is in danger from asphyxia, immediate operative relief is necessary. In such cases outside of a hospital tracheotomy would ordinarily be the only operative procedure possible. In a hospital intubation may be considered, particularly if the cause is suspected to be laryngeal diphtheria, or, in other acute cases, if some one skilled in intubation is at hand. Where there is no immediate urgency, intubation may be chosen if the patient's condition contraindicates the shock and loss of blood which may be consequent to tracheotomy. In the case of gradually increasing obstruction resulting from new-growth, tracheotomy is unquestionably the better choice. If there is any question of aspirated foreign body as the cause of obstruction, intubation is most decidedly to be avoided. If the case be appropriate for either intubation or tracheotomy on the grounds as stated, and the patient is an adult, the difficulty of intubating adults would incline one to tracheotomy rather than intubation.

In the operative treatment of obstructive laryngeal diphtheria, in hospitals where constant supervision by nurses and physicians experienced in the technique of intubation is the rule, the choice between tracheotomy and intubation would ordinarily be in favor of the latter. The statistics since the advent of antitoxin show that this agent has reduced the mortality in both these methods of procedure. At the South Department, Boston City Hospital, the intubation mortality for the last three years has averaged about 20 per cent. In the fever hospitals of London, where tracheotomy is the operation of election, the mortality has been about 35 per cent. While it is difficult to make comparison of cases operated in different countries, the consensus of opinion in this country, based on statistics of mortality and experience in the conduct of cases, is that intubation should be the operation of election in laryngeal diphtheria.

Under the following conditions, however, tracheotomy may be elected: First, when no one experienced in the technique of intubation is available; second, in the home, where constant skilled supervision is impossible; third, in the case of some adults having extensive swelling of tissues of the neck, when experience would indicate that intubation might be difficult or even impossible. Tracheotomy becomes the operation of necessity in any case when, for one reason or another, intubation fails to relieve or when the tube cannot be introduced on account of the stenosis.

Indications for Operation in Laryngeal Stenosis.—There are all grades of laryngeal stenosis. In the extreme type the symptoms and signs are so obvious and urgent that relief by operative procedure will not be delayed. The patient presents a picture of never-to-be-forgotten agony from air-hunger. He tosses about in the bed in vain effort to obtain sufficient air. The skin is dusky and covered with perspiration, the mouth opened, the ala nasi dilating and contracting, the sternocleidomastoid muscles in a state of spasm, the supraclavicular, substernal, and intercostal tissues retracted at each attempt at inspiration. *Expiration is quite as difficult as inspiration,* and the abdominal muscles become hard and contracted in their efforts to aid the diaphragm in expelling the air through the narrowed larynx. Aphonia may be complete or attempts at phonation may result in short, high-pitched squeaks; the cough as commonly heard is short, rasping, and "croupy." Beyond this stage of cyanosis there is apt to be one of unconsciousness unless operation is performed. The exertion has been so great that the heart has failed and we have a state of pallid asphyxia, the patient pulseless, the jaws set, and the musculature generally in the state of spasm; then comes relaxation, and death rapidly ensues. If the patient is first seen in this grave condition, intubation, reinforced by hypodermic stimulation, artificial respiration, and oxygen, will often cause him to regain consciousness, with eventual recovery.

Other acute conditions besides diphtheria which may cause sudden stenosis of the larynx should here be mentioned. In peritonsillar abscess associated with extensive swelling edema of the glottis may occur and require operative interference. The same may be said of severe types of tonsillitis. Enlarged cervical glands may produce constriction of the trachea and operative relief be necessary. In the latter case tracheotomy is apt to be indicated; in the others, intubation should be considered.

Technique.—The patient should be wrapped in a blanket and taken to the operating room. Here there should be laid out for instant use instruments and accessories calculated to meet any emergency.

Several intubation tubes of each size should be kept attached to as many introducers, a tracheotomy set, oxygen, solutions for hypodermic stimulation, and a sterile syringe should be at hand.

The intubation instruments follow closely in their design those originated and perfected by O'Dwyer, and are very satisfactory in use. The so-called improvements over these instruments are usually the opposite. The tubes are of metal, either nickel or gold-plated, or of rubber molded about a small metal tube. The metal tubes are less fragile than the rubber and are consequently more commonly used. The rubber tubes are preferable in cases where the period of intuba-

FIG. 127.—OPERATING-ROOM, BOSTON CITY HOSPITAL, SOUTH DEPARTMENT.

A, Tubes and introducers ready for use; *B*, tubes in cloth holder, with obturators; *C*, gags; *D*, blanket, folded, ready to be opened to receive patient; *E*, large safety-pins for pinning blanket about patient; *F*, stimulation tray (in case); *G*, sand-bag, to place under neck; H, gag for immediate use.

tion is for one reason or another prolonged, and where the heavy metal tube might eventually produce pressure necrosis. The tubes are molded in such a manner as to produce no undue pressure at any point, and at the same time are equipped with a flange to prevent slipping into the larynx, and a fusiform enlargement, at about the middle, in order that they may be less easily expelled from the larynx when the patient coughs. They are made in several sizes according to the age of the child for which they are intended. Some manufacturers mark on each tube the limits of age between which the tube is applicable; others provide a metal scale by which this information may be obtained. The common sizes are for the ages of one to two years, two to four, six to eight, and ten to twelve, and several adult sizes, the latter generally of rubber. Each tube has extending the full length of its lumen a hinged piece of

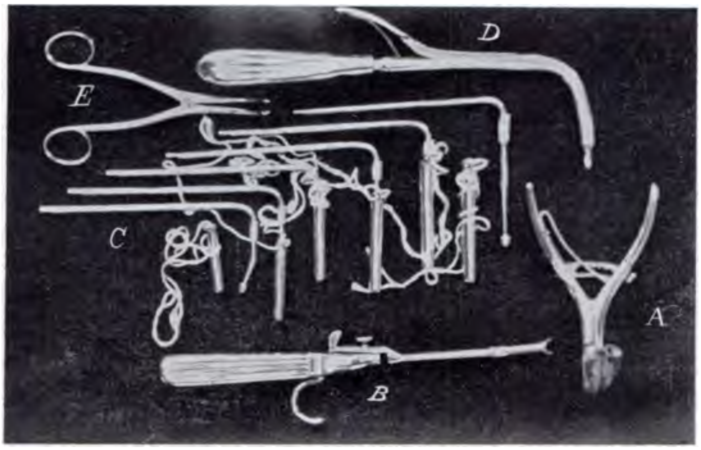

FIG. 128.—INSTRUMENTS FOR INTUBATION.
A, Mouth-gag; *B*, introducer; *C*, tubes and obturators; *D*, extractor; *E*, tracheal dilator.

metal termed the *obturator*, and from which the tube is easily disengaged when it is inserted into the larynx. This obturator, with the tube upon

FIG. 129.—INTUBATION.

it, fits into the so-called *introducer*, which is merely a metal handle for the manipulation of the tube. There is a small hole drilled through the head or flange of each tube, through which a loop of silk thread is passed. This silk loop should be the full length of the handle, or about 6 inches.

The *extractor* is a metal instrument with a tapered and curved beak which fits into the lumen of the head of the tube, and when the beak is expanded by pressing the lever, the tube is firmly engaged and may be extracted. The gag may be seen in the illustration. Tubes of shorter dimension than those described are often useful and may be had on special order. Others with a built-up flange or head are sometimes useful where there is much edema in the tissues above the vocal cords.

The patient is laid upon the operating table and is wrapped in a blanket, the arms held to the side, the blanket being pinned about the

FIG. 130.—EXTUBATION.

neck and over the body tightly, so that the arms and legs are fixed. Underneath the neck should be a sand-bag. The back of the head should rest near the edge of the table. The table should be heavy and without casters. A nurse stands at the patient's left, ready to restrain and prevent any movement; the operator stands at the right, and at the end of the table is the first assistant, who is to steady the patient's head and hold the gag. He inserts a wooden gag between the teeth, opens the mouth sufficiently to introduce the metal gag, and with this widely separates the jaws. The plates of the gag should be wrapped with adhesive plaster and should rest on the molar teeth. The introducer is grasped by the operator in his right hand, the silk thread is passed over his little finger, and his thumb is pressed against the upper surface of the handle. The forefinger of his left hand he inserts into the mouth, hooks forward the epiglottis, and with the finger-tip touches the vicinity of the right arytenoid cartilage. The back of the finger would approximate the posterior wall of the pharynx, and the side of the finger would be about on a line with the vocal cords. In the brief time during which the finger is being inserted, the introducer, with the tube affixed, is introduced into the mouth in the median line and the end of the tube is made to follow the forefinger as a guide. The end of the tube slides over the epiglottis, and, guided by the forefinger, reaches its tip and is directed against the vocal cords. The handle of the tube is then elevated so that it is in a vertical position or slightly beyond vertical. This brings the tube about in a line with the direction of the larynx. The tube should then be disengaged by the *forefinger*, and thus the tube is loosened from the obturator. The tip of the forefinger on the head of the tube pushes it gently into the larynx, at the same time releasing the tube from the obturator The introducer is removed from the mouth, and at the same time, by means of the forefinger, the tube is pushed further into the larynx until the head is well seated.

The loop of silk thread is carried to the corner of the mouth, passed over the left ear, the gag removed, and the patient at once set upright. If the tube is in the larynx, the patient at once coughs in a peculiar manner, breathes easier, cyanosis and other signs of dyspnea disappear. If the tube is not in the larynx, instead of improvement in the condition the breathing is apt to be worse; the cough will still be high pitched, and the patient may even collapse. If by chance the tube is in the esophagus, the string will shorten as the tube goes down. There should, however, be no question as to the location of the tube, since the examination by the forefinger should have given information as to whether or not the tube is properly in place. The child should be watched carefully for a few minutes, and if the breathing is comfortable and easy, should again be placed in a recumbent position, the gag reinserted, the forefinger of the left hand placed upon the head of the tube in the larynx, the silk thread held with the right hand, cut by an assistant, and removed.

It is not uncommon to have the breathing immediately cease when the tube is inserted. This may be because the tube is not in the larynx, but this question among experienced operators rarely comes up. It is usually caused by the aspiration of a piece of membrane into the tube, which, of course, should be at once removed and cleaned. Often, after the tube is removed, the patient may, after a series of spasmodic coughs, eject large pieces of membrane. The breathing may in this way be so much relieved that it will be unnecessary to reinsert the tube. On the other hand, reinsertion may be very urgent, and it is well always to have two or three tubes of each size at hand, that in such an emergency there shall be no delay such as might be caused by cleaning a tube.

Again, it may happen that the tube is pushed into a mass of membrane and secretion and does not pierce it. This is a grave condition and respiration stops. If the tube is removed, the chances are that considerable loosened membrane will be coughed up, and upon reinsertion of the tube breathing may be much easier. In such a case the tube is apt to plug, and repeated intubation and extubation may be necessary.

Further, the tube may loosen a flap of membrane from the wall of the larynx, which will act as a valve against the end of the tube, allowing inspiration, but preventing expiration. Suspecting this, a short tube of the French type may be tried.

In certain uncommon cases the tube may fail to relieve, because the membrane not only covers the trachea, but reaches into the finer branches of the bronchi, or there may be, in addition to moderate amount of membrane, a capillary bronchitis. In either case intubation will fail, tracheotomy will be performed, and no improvement from either will result. Such cases rarely get well and require maximum doses of antitoxin from the start.

Occasionally where the passages of the nose are occluded by membrane and edema, and likewise by swelling of the tonsils and the adjacent tissues, the anterior atrium of the pharynx is practically occluded, and dyspnea arises resembling closely that produced by laryngeal obstruction. Intubation in this case will obviously not relieve, and tracheotomy may have to be resorted to unless, after swabbing the throat as free as possible from secretion, mouth-breathing is restored.

After-care.—The after-care of intubation cases is extremely important. Such cases should be grouped together so that they can be constantly watched, for it is not uncommon for a child to cough up its tube at almost any time and for immediate reintubation to be necessary. If the tube is coughed and swallowed, such a complication is of no serious consequence. In case there is much loose membrane and the tube is repeatedly obstructed, it may be well to leave the silk thread, so that the nurse may extract the tube in case it is suddenly blocked and the child lacks expulsive cough of sufficient force to expel the tube. If the child repeatedly expels the tube, a larger size may be used, or to avoid a series of emergencies, tracheotomy may be necessary.

Gradual occlusion of the tube may occur from the accumulation and drying of secretion in its interior. This may be suspected if the respiratory murmur gradually becomes higher pitched and the abdominal muscles harden at each expiration, even though the color remains good. The nurse should be taught to recognize this condition, so that the tube may be removed and cleaned before serious dyspnea results.

Feeding.—Feeding (see also Chapter XIII, p. 148) in intubation cases is rarely a serious problem unless the tube is retained considerably longer than in the average case. Ordinarily, bread and milk, custard, soft-boiled eggs, etc., are swallowed with very little discomfort. The patient often coughs excessively. Semisolid foods are apt to produce less cough than liquids. The most serious complication not directly connected with intubation is bronchopneumonia. The treatment should be carried out, eliminating drugs so far as possible. The most favorable thing that can happen is that the patient cough up the tube and no longer require it.

At the end of four days, however, if this does not occur, the tube should be removed, although it may be necessary immediately to reintroduce it. The arrangements of the patient are the same as for intubation. The *extractor* is grasped lightly and the beak follows forefinger to the head of the tube. As it touches the metal the impact will be felt, and the beak is moved about cautiously until it drops into the opening of the tube. The lever of the extractor is then pressed, thus firmly engaging the beak in the tube. The tube is elevated from the larynx, the forefinger being placed beneath the head or flange of the tube to prevent it slipping from the extractor during removal, and the whole withdrawn, carrying the tube upward and forward in the arc of a circle. If the child breathes well during the first twelve hours, the tube will ordinarily not require reinsertion.

Retained Tubes.—It sometimes happens that the patient repeatedly develops signs of stenosis whenever the tube is removed, indefinitely repeated reintubation has become necessary, and, finally, it is found that the tube must be worn continuously or intermittently. Fortunately, such cases are rare, perhaps 1 per cent. or less of the total of intubated cases. The immediate cause is, in the vast majority of cases, the contraction of scar tissue at some point where it obstructs the breathing. This scar tissue is in the site of an ulceration, produced by pressure of the tube, or by the diphtheritic membrane, or at the point of some trauma, due to faulty technique. The latter should be preventable. To eliminate pressure necrosis the tube should be removed in all cases at the earliest possible moment, even though it has to be reintroduced at once. The mortality in the retained tube cases is commonly due to bronchopneumonia. If the patient lives, intermittent intubation must be practised for a long time, with the hope that eventually the tendency of the scar tissue to contract will be overcome.

ESOPHAGOTOMY

If the wound in the esophagus is at all clean cut, such as after the removal of a foreign body, the wound should be closed with chromic catgut and the neck wound drained down to these sutures, best, probably, with rubber dam or a soft-rubber tube, held in place by a stitch holding it to the skin. Secretion from the wound is likely to be a form of a profuse, thin, yellow discharge with a yeasty smell. The wound, therefore, calls for frequent dressings. For the first seven days it is probably best to feed the patient by nutrient enemas, giving only a little ice or hot water by mouth. If the enemas are not held and nourishment is urgently needed, the patient may be fed by stomach-tube.

Complications and Sequelæ.—*Sepsis.*—These wounds are always infected and frequently present large sloughs and vile discharge. In some cases as a result of operation, and in all cases where the foreign body has already ulcerated through, the mediastinum is infected and may pour forth large quantities of foul pus. Immediate through-and-through drainage must be established or a fatal result ends the case shortly. A soft-rubber tube with many fenestrations in the lower 3 inches of it should be inserted through the neck wound down alongside the esophagus as far as it will go. A flexible uterine sound within the tube will make this deep insertion feasible. The patient should be in bed with the foot so elevated that mechanical drainage is favored. The wound must be thoroughly wiped out, every hour if necessary, and kept dressed with salt and citrate solution twenty-four hours, later, with weak chlorinated soda, myrrh wash, or tincture of iodin.

ESOPHAGEAL DIVERTICULA

Whether the diverticulum has been treated by amputation and suture or by inversion by means of a string,[1] rubber-dam drainage is left in down to the esophageal wound. The second day the drain is removed and the wound is wiped out with tincture of iodin, and thereafter similarly every day.

Proctoclysis is maintained forty-eight to seventy-two hours if bearable. Sups of hot water are given every two hours on the second day. Beginning the second day after ether-nausea is passed, a small

[1] Mayo Clinic Papers, 1910, 37.

stomach-tube is passed for the purpose of feeding. If this procedure is very distressing or induces retching, feeding may be carried on for the first five days by rectum.

PARTIAL THYROIDECTOMY

Anesthesia.—Dr. Halsted[1] says: "I am not convinced that very light general anesthesia with ether, skilfully given by an expert anesthetist for only fifteen or twenty minutes, is less safe, even in the gravest cases, than local anesthesia plus the prolonged operative period and its attendant nerve strain. In operations for exophthalmic goiter the general anesthesia should be administered only by an expert.

"A nurse trained in the pre- and postoperative care of cases of Graves' disease should be in charge, and the patient should have a private, quiet room. We have knowledge of no analogous disease and of no toxemia comparable to that which follows operation upon people afflicted with hyperthyroidism. It is, therefore, particularly difficult for the uninitiated to realize how critical is the condition of so many of these patients until, as a demonstration, a death has been experienced.

"**Water.**—As so impressively pronounced by Dr. Mayo at his clinic, saturation of the patient with water must be accomplished in one way or another. The surgeon must not accept excuses that water could not be given by mouth because it hurt the patient to swallow, and not by the intestine because the guttatim injections were expelled, unless the patient is uncontrollable; in such event proper resort to subcutaneous infusion must be had."

C. H. Mayo[2] says: "After the operation the patient is given 1 quart of saline slowly per rectum. This is repeated twice within the next twelve hours. Should intestinal relaxation be present, we consider the salines of sufficient importance to give them subcutaneously in all severe cases. The precordial ice-bag may steady a rapid heart; atropin checks excessive perspiration, and morphin quiets restlessness. Death from operation seldom occurs after the first twenty-four hours."

As to chilling or freezing the neck before and after operations for Graves' disease, Dr. Halsted remarks, "It had not occurred to me at first that excessive cold applied to the neck in these cases, particularly after operation, might delay the processes of repair and absorption and thus bridge over the period of greatest danger—the two or three days

[1] William S. Halsted, M. D., and Herbert M. Evans, S. B., Ann. Surg., Oct., 1907, xlvi, "The Parathyroid Glandules: Their Blood-supply and their Preservation in Operation upon the Thyroid Gland."

[2] Surg. Gyn. and Obst., 1909, 602.

succeeding operation. Its employment was very imperfectly tested in three instances, but in all with beneficial results, it seemed to me, although one of the patients, desperately ill before the operation, did not recover. In no instance, unfortunately, did we succeed, with the inadequate appliances at our disposal, in doing much more than slightly cool the surface of the skin. In one case, thirty-six hours after operation, the pulse, which had been steadily rising until it reached 180, dropped 30 beats a minute within one and one-half hours of the application of the cold. In another, a good night's sleep, the first in

FIG. 131.—THYROTOXICOSIS. Bilateral enlargement and exophthalmos, before operation. Pulse 170 to 216.

FIG. 132.—THE SAME CASE AFTER OPERATION. Tumor and exophthalmos gone. Pulse 100 to 120.

weeks, seemed to be attributable to the application of cold to the neck. It is quite possible that harm rather than good might be done by ineffectually applied ice-bags. They might serve as a poultice if, for example, swathed in protecting flannel, or if negligently attended to. The danger of reaction, too, must be constantly borne in mind—the reaction following either a brief or a prolonged use of the cold. Therefore, no time should be lost in changing the packs, and ultimately the cold should gradually be withdrawn. I doubt the ability of the rubber ice-bag to produce a degree of cold sufficient for the very ill cases, or the non-conducting rubber should, perhaps, be so thin that rents would hardly be avoidable. In some cases a degree of cold low enough almost to freeze the skin might be necessary. Possibly to be considered as a method of treatment for desperately ill cases is an unclosed wound constantly irrigated with water of the desired temperature.

"I am convinced that the toxemia is not simply due to the absorption of the thyroid secretion. Otherwise, might not the gravest cases of exophthalmic goiter be safely treated by total excision of the thyroid gland? It is my belief that the toxemia incident to wound healing is badly borne by the subjects of hyperthyroidism. On several occasions, soon after thyroid lobectomy, I have seen prompt and great improvement follow the liberation of a dram or even a few drops of reddish serum from the wound. Moreover, the typical postoperative toxemia may, it seems, follow operations of other kinds upon patients afflicted with Graves' disease. Absorption takes place continuously during the process of repair, even in wounds which are 'dry' and healing throughout by first intention. Thus it seems to me quite reasonable to hope that something, perhaps much, may be accomplished by the adequate employment of cold. The entire neck, fore and back and sides, and from chin to chest, might be made so cold in the serious cases as to arrest for a time, more or less completely, the process of absorption and possibly of healing.

"Furthermore, if absorption from the wound is, even in a measure, responsible for the toxemia so badly borne, the area of the wound surfaces must be a factor influencing the result, and, if so, there would be in this an indication for as small a wound as feasible in certain cases. A vertical skin incision to avoid reflection of a flap might be tested, and less complete division of the muscles at their attachment to the hyoid bone might suffice for the liberation, in the manner described in this paper, of the superior pole. The operation of ultraligation might thus be effected through a hole just large enough to permit the delivery of the lateral lobe of the thyroid gland."

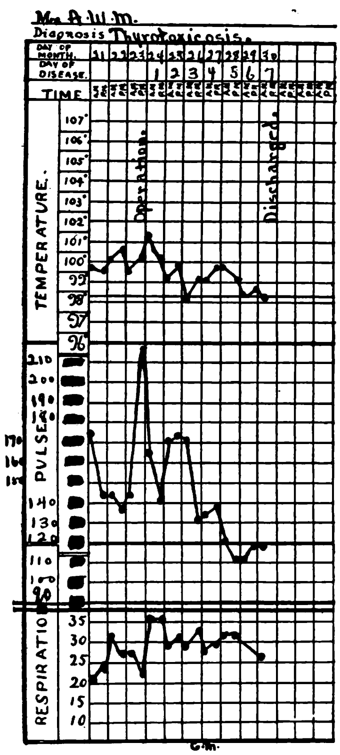

FIG. 133.—THYROTOXICOSIS.

Right (the larger) lobe and isthmus of thyroid tumor removed. Pulse 216 at end of operation. Rogers-Beebe serum and also bromid of quinin used during convalescence. (See also Figs. 131, 132.)

Complications and Sequelæ.—(1) *Hemorrhage.*—Bleeding may be so general, so difficult to localize, and so difficult to control by hemostatic forceps that one may be forced at the operation, or at any time during the first forty-eight hours after operation, to pack the capsule with gauze and, possibly, even to sew, temporarily, the capsule over the packing. To wet the packing with adrenalin (1:1000) makes it more efficient.

(2) Much handling of the gland during its removal may, apparently, squeeze into the wound an amount of thyroid secretion sufficient to cause symptoms of *thyroidism*.[1] For this reason, rubber-dam drainage should always be used at the lower end of the vertical part of the wound.

(3) *Injury to the Recurrent Laryngeal Nerve, Asphyxia, Aphonia.*—The inferior laryngeal nerve may be wounded in the operation, or injured by pulling or contusion during operation, or may be later compressed by the scar. It may already have been injured before operation. The cricothyroid branch of the superior laryngeal may suffer any of these injuries. Dyspnea and aphonia arising from any of these causes need not always be permanent.[2] Any of these nerve injuries

[1] "'I take it that squeezing the gland may help to liberate secretion contained in the follicles, and that the same may escape into the wound from the lymphatics in the divided capsule around the severed isthmus, the lymphatics being the normal channel for absorption of the secretion. If the condition from which these patients suffered is to be regarded as thyroidism, and not, as Mr. Horsley has said, athyroidism, then every possible source of contamination of the wound with thyroid secretion should be avoided. I cannot recommend that the safe grasp of the gland should be altogether given up; but I believe that it may be rendered harmless by first ligating the isthmus, and exercising caution in the operation, handle the gland carefully, and at once, on the barest suggestion of the train of symptoms referred to, open up the wound, irrigate it, and fill with dry, aseptic, absorbent wool.' In the first of the two cases related by Mr. Paul in the paper mentioned above, which ended fatally just two and a half days after the operation, the wound at the necropsy contained fluid of a very watery character. Believing that the grave symptoms were due to absorption of thyroid secretion, Mr. Paul, when his second case began to show symptoms which were a repetition of the first, about twenty-four hours after the operation, opened the wound and filled it with a dry salicylic wool. This was followed by a marked improvement, but only for a time. During the second night after the operation the patient 'became worse than ever; the temperature was 104.8° F., the pulse almost uncountable, the respirations 36. I removed the plug of wool, and found it saturated with watery discharge, replaced it with dry wool, and left instructions that it was to be changed as often as it became moist, which proved to be about every two hours. The following day she was better in every way. The day after the temperature was only just above normal. and continued so until convalescence was established, but the pulse and respirations wore down more gradually.'

"While I never squeeze the gland, but limit the handling of it to shelling it out from adjacent important structures, and while I have never seen the watery secretion described by Mr. Paul, the course of the case has, on three or four occasions, so closely resembled that described by Mr. Paul, that I cannot doubt the explanation which he gives of this insidious and sometimes fatal complication is the correct one" (Jacobson and Steward, i, 532).

[2] "In a woman, aged twenty-five, suffering from suffocating dyspnea, the operation was followed by aphonia, which lasted for three months, and by complete paralysis of the cords. The operation was performed with great care, and there is no reason to think that

are liable to occur where the tumor is large, is very closely adherent, very broad in its base, when it extends around the trachea and esophagus, or when it is malignant.

(4) *Collapse of the Trachea.*—This is rather a complication during operation than after it. It may be due to a real defect of the rings posteriorly, or may be due solely to great pressure of the tumor toward the middle line during enucleation. To speak of it is to suggest immediately its treatment.[1]

(5) *Sepsis.*—Infection of the thyroidectomy wound is likely to develop, particularly where the tumor dips down behind the sternum, because of the difficulty of adequately draining this region. Careful and frequent dressings are, therefore, indicated.

(6) *Myxedema (Athyroidism, Cachexia Strumipriva).*—This condition, following thyroidectomy, has now received adequate explanation through the researches of Halsted, and the first treatment of it is necessarily preventive, namely, to avoid removal, with the tumor, of the parathyroid glandules.

(7) *Tetany (Tetania Parathyreopriva).*—Tetany following the extirpation of a simple goiter was first described by Nathan Weiss,[2]

either of the recurrents was cut, but it is possible that they were bruised or stretched; however, in four months the cords regained movement and the voice was fully restored.

"In the second case, aged twenty, a hard, mobile tumor, the size of a walnut, was attached to the isthmus by a narrow pedicle, and the gland itself, though apparently somewhat hypertrophied, was not prominent, but, when exposed, it was found that the tumor had a broad attachment to the isthmus, and that the two lobes of the thyroid were greatly hypertrophied, closely embracing and compressing the trachea; it was, therefore, thought desirable not only to remove the tumor, but also to dissect out the whole gland. When recovering from the effects of chloroform, the patient was suddenly seized with cyanosis and threatening asphyxia, and though she partially recovered, on the next day there were aphonia, dysphagia, and uninterrupted dyspnea, and she died asphyxiated in the evening. Both recurrent laryngeals had been cut, and the upper end of the left one was included in a ligature.

"In June, 1894, this being my fifteenth case of removal of the isthmus and one-half of the thyroid, I met with this complication, which was, however, not permanent.

"The patient was aged thirty-five, the subject of an ordinary solid bronchocele, of large dimensions, the right lobe being 7 inches long. The voice was decidedly weak before the operation, but while this presented no difficulties and was not accompanied by any cyanosis, dyspnea, etc., it was followed by marked aphonia, the voice being almost reduced to a loud whisper. The right vocal cord was now found to be motionless. Complete recovery had taken place when the patient was last seen in April, 1895. I have recently (February, 1899) seen the patient again, on account of a Colles fracture. Her voice is good, though a little weak. Since 1895 she has been following her occupation as a cook." (Jacobson and Steward, i, 533, 534.)

[1] T. C. Witherspoon, Surg., Gyn., and Obst., 1911, xii, 185.

[2] Volkmann's Samml. klin. Vortr., 1880, vii, 1696.

He ascribed the condition to the congestion resulting from the ligation of numerous vessels during the operation. A. v. Fisberg[1] believed it due to too extensive removal of the parenchyma.

F. Pineles,[2] in 1906, clearly demonstrated that tetany is the result of injury or removal of the parathyroid glands, and does not occur if the parathyroids are avoided in doing the operation. A review of the 32 cases reported in the literature is to be found in an article by X. Delore and H. Alamartine.[3]

Theodore Kocher[4] states that tetany occurs much more commonly after extirpation of the thyroid for Graves' disease than for simple goiter.

Tetany develops from a few hours to four weeks after operation. The seizures are characterized by tonic flexions, chiefly of the wrist and fingers, sometimes by convulsions. The lower limbs, face, and diaphragm are not commonly affected. In severe cases there is high fever, dyspnea, and the signs of profound intoxication (vomiting, diarrhea, albuminuria).

This complication is not, as a rule, fatal. When death does occur it is the result either of contracture of the diaphragm, spasm of the bronchi, or intoxication of the medulla. More commonly the case becomes chronic and goes on with occasional muscular spasms, formications in the extremities, a little dyspnea, tachycardia, and hyperexcitability to electric and mechanical stimuli. If all the parathyroid tissue has not been removed, hypertrophy of the remaining portion may take place and recovery ensue.

The treatment in the acute stage consists in the administration of morphin, bromids, or chloral (5 gr. an hour for five doses). In the subacute and chronic stages little can be done. Thyroid extract is valueless. Recently, Lowenthal and Wiebbrecht[5] and E. Bircher[6] have reported cases successfully treated with Freund and Redlich's parathyroid extract, which is prepared from the parathyroids of cattle in a manner similar to thyroid extract. The value of this treatment has yet to be determined.

The only treatment of this lamentable complication that is known to be of value is the surgical implantation somewhere in the body,

[1] Beitr. z. klin. Chir. Festschr., Billroth, 1892.
[2] Archiv. f. klin. Med., 1906, lxxxv, 491.
[3] Revue de Chir., 1910, xlii, 540.
[4] Cor.-Blatt. f. Schweiz. Aerzte, 1898, xxviii, 545.
[5] Med. Klinik., 1907, iii, 1012.
[6] Ibid., 1910, vi, 1741.

the rectus abdominis being a convenient place, of human or animal parathyroid glandules.[1]

The prophylaxis of tetany consists in the careful avoidance of the parathyroids in the performance of the operation. The subcapsular ligation of the thyroid vessels, with or without partial thyroidectomy, as described by C. H. Mayo,[2] seems best fitted of all operative procedures to preserve these important structures. W. S. Halsted and H. M. Evans,[3] in an admirable article, have shown that the parathyroids lie usually behind the thyroid gland and are just extracapsular. Both the superior and inferior parathyroids are supplied by branches arising usually from the inferior thyroid artery, but occasionally from an anastomotic arch between the superior and inferior thyroids. Thus, it is seen that if the posterior capsule of the gland is preserved, and the thyroid arteries ligated with great care to avoid interference with the blood-supply of the parathyroid bodies, tetany following the extirpation of goiter will be prevented.

Specific Cytotoxic Serum for Thyrotoxicosis.[4]—The serum is made by inoculating rabbits or sheep with the pure proteids from the human thyroid gland.

The serum is always given by hypodermic injection, and we have chosen the arm as the site of injection because it is more convenient for the patient and because the local reaction causes less trouble in this region and may be treated more readily. The upper arm just below the deltoid should be carefully cleaned and the injection made subcutaneously, but not intramuscularly, in order to avoid too rapid absorption. In 95 per cent. of the injections the local reaction consists only of an area of hyperemia and slight induration which may be somewhat tender on pressure for a few hours. It quickly clears up, and in thirty-six to forty-eight hours the arm is perfectly normal. The indurated area may in some instances be three or four inches in diameter, and occasionally the whole arm has become edematous from the shoulder to the finger-tips. Such a reaction is unpleasant, but fortunately it is a rare complication, and if the arm is wrapped in a wet dressing, the reaction subsides without unpleasant after-effects. The exact nature of the

[1] W. H. Brown (Ann. Surg., 1911, liii, 305) artificially produced a parathyreopriva in a dog, cured it by implantation of one parathyroid, later removed this body from the dog and the animal died within twenty-four hours in tetany. In other words, these parathyroids are essential to life and their loss can only be made good by their reinstatement.

[2] Surg., Gyn., and Obst., 1909, viii, 602.

[3] Ann. Surg., 1907, xlvi, 489.

[4] John Rogers and S. P. Beebe, The Treatment of Thyroidism by a Specific Cytotoxic Serum, Mütter Lecture, College of Physicians, Philadelphia, Dec. 13, 1907.

reaction in any given case cannot be foretold because the matter of personal idiosyncrasy of the patient is an exceedingly important factor. It is best, therefore, to start with a small dose and to determine the nature of the reaction in each case before the full therapeutic dose is attempted. As has already been stated, the very acute toxic cases take the serum better than the mild cases, and with them it may be best to keep hot applications on the arm for half to three-quarters of an hour after the injection, and gently massage the area about the point of puncture. Unless some quite unusual condition results, no further treatment is necessary, for the condition subsides promptly. If a second injection is made before the reaction from the first has subsided, a more decided reaction is produced in the second instance and the area of the first injection is again excited. The local reaction is, therefore, of value as a guide in the determination of dose and frequency of administration. The two arms should be used alternately as the site of injection.

The general reaction likewise shows considerable variation. In a large percentage of cases there is no disturbance whatever; there may be, however, a slight rise in temperature, accompanied by nausea, some restlessness, and perhaps some increase in the tachycardia. Rarely the patient may vomit and all the symptoms of the disease be temporarily exaggerated. If the serum is given too frequently or in too large doses, both the local and the general reactions become more severe. The serum must never be pushed in the presence of a progressively increasing reaction. Serious consequences may arise if this precaution is not observed. If, during the course of treatment, an unusually severe reaction has been obtained, it is best to allow a somewhat longer interval before the next injection, and at the same time to reduce the dose.

The relation which the specific treatment bears to the surgical treatment is naturally of much interest. The list of 141 patients includes 8 who have had some surgical procedure for the condition. To summarize these cases, 5 patients tried serum first without benefit and later died as a result of operation; two were operated on before the serum treatment with good result and were later treated successfully with serum for a recurrence of the disease, and the last was benefited considerably by serum treatment preliminary to a completely successful operation. As far as these figures go it would seem that if a case cannot be benefited by serum, it may be dangerous to operate; and also that, if an operation is likely to be successful, serum may also be successful. It appears to be true that the type of case which can be completely cured by operation is a type favorable for serum treatment.

Conclusions.—This work is the first attempt to treat disease in the human subject by means of a specific cytotoxic serum, and our conclusions, subject to revision as experience increases, are as follows:

1. The serum has a specific effect in neutralizing the toxic action of the thyroid secretion.

2. As a therapeutic agent it gives results which cannot, in many cases, be attained by any other medical means.

3. Not all cases presenting symptoms of thyroidism can be treated successfully with serum, because not all cases are purely hypertrophic in origin.

4. The rapid amelioration of symptoms in the acute toxic cases, similar in most respects to the well-accepted instances of neutralization of toxin by antitoxin, is a weighty argument in favor of believing the symptoms to be due to the toxic effects of hyperthyroidism.

5. The beneficial results of combined treatment, especially in the older cases, indicates a dysthyroidism as well as hyperthyroidism as a factor in the production of symptoms.

EXCISION OF LYMPH-NODES OF THE NECK

After extensive dissections, the first dressing may be covered with a layer or two of plaster-of-Paris bandage for immobilization. If there were no pus spilled in the wound, it should heal by first intention. If the wound has been contaminated with pus, it may be closed, except for a small space at its lower end, and drained with a rubber-dam or spiral drain, but if the cavity is clean and dry at the end of operation, it may be merely packed with iodoform or formidin gauze. This packing or drain is usually left in place three to five days. At the end of that time the drain is removed, the cavity swabbed out with full-strength tincture of iodin, the skin about the wound being protected with ointment, and the cavity may be packed again, but, better still, exposed without any covering to direct sunlight for as many hours as possible each day.

Tonsils and adenoids should be removed at the time of neck operation if possible. Syrup of iodid of iron should be started at once and continued in maximum doses for at least a year, combined with general good hygiene.

Injury to the Spinal Accessory Nerve.—A portion of the nerve may be necessarily removed in a large mass of lymph-nodes, and this misfortune may befall any patient in the hands of the most skilful surgeon. The nerve emerges from the posterior edge of the sternomastoid muscle at about its middle. This nerve may be identified by its position in the outer border of the trapezius at the top of the supraclavicular triangle. If the nerve injury is recognized, repair can be done at once, usually with good results. Unsutured, an atrophy of the trapezius and a dropping of the shoulder are likely to follow. If not recognized at once, a secondary suture operation should be undertaken as soon as may be.

Pulmonary tuberculosis is connected with tuberculous nodes of the neck less frequently than has been thought, thus, E. S. Judd[1] reports 649 patients operated upon for this condition in fifteen years, of which 19 have since died of pulmonary tuberculosis, and 9 of tuberculosis elsewhere; 10 of the patients had phthisis at the time of operation.

The cannula designed by Briggs is often valuable in the case of isolated abscesses in regions where cosmetic results cannot be disregarded. It consists of two surfaces of silver, curved laterally, bent outward, and joined at the angle. The cut through the skin being made ($\frac{1}{8}$ inch), the knife is pushed into the abscess. Upon its withdrawal the cannula is inserted as in Fig. 134. When the joint is reached, the external arms are closed. This reverses it. The internal arms open, dilating the tissues in the vicinity of the cut and retaining the cannula within the cavity, while the external arms come together and make a tube (Fig. 135). A projection at the end of each external arm prevents it from falling into the abscess-cavity, and it is fixed *in situ*.

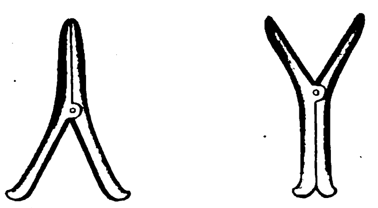

Fig. 134. FIG. 135.
FIGS. 118, 119.—BRIGGS' SELF-RETAINING DRAINAGE CANNULA (ENLARGED).

It is removed by seizing one of the external arms and withdrawing it until the hinge is reached, when, by spreading, it is again as in Fig. 118, and easily slides out. This cannula can be cleaned and sterilized, and gives free, continuous, and, if necessary, permanent drainage through a skin-cut of barely $\frac{1}{8}$ inch. It reduces the cut to an undoubted minimum, gives surgical drainage, and leaves the least possible resultant scar.[2]

INCISION AND EXCISION OF CARBUNCLE OF THE NECK

If a crucial incision only is made, the wound then calls for the general treatment of a septic wound.

[1] Mayo Clinic Coll. Papers, 1910, 523.
[2] F. M. Briggs, Boston Med. and Surg. Jour., 1895, cxxxii, 433.

If the more modern method of complete excision of the carbuncle is employed, the problem becomes within twenty-four hours merely that of a large granulating wound. Such a wound should be cleaned twice a day at least, this being one of the places where hydrogen dioxid works well. Small suppurating points or bits of slough in the margin of the wound must be carefully removed and the region disinfected. The dressing consists of a pad, wet for the first three or four days with salt and citrate, and later with glycerin or balsam of Peru laid within the wound. The dressing is held on by means of a bandage, the upper margin of which is held up and prevented from gaping from the neck by pinning it to a tape skull-cap, as in Fig. 136.

FIG. 136.—CARBUNCLE OF THE NECK. Tape skull-cap to which dressing is held by pins. This avoids bandage over the head and also avoids gaping of dressing from the neck.

General treatment counts for much in these cases. The patient should be out-of-doors from the first, if it is feasible. General stimulation should be free and close attention paid to elimination. To prevent recurrence serum treatment may be resorted to. (See Chapter LII.)

BRANCHIAL CYSTS AND SINUS

These epiblastic remains may appear in positions corresponding to any one of the four gill-clefts, from the level of the ears to the root of the neck. Eradication usually calls for extensive dissection. Even after such dissection, however, at the end it may be found necessary to leave a portion of the epithelial lining, to be destroyed later by successive cauterizations. In any case, it is attempted to heal these wounds by granulation. They are, therefore, packed at first and are treated as aseptic granulating wounds. They may take months to heal.[1]

MASTOIDITIS

Ordinarily, shock is slight after a mastoid operation and pain is usually not severe enough to demand an anodyne. If it does occur during the first twenty-four hours, the external dressing should be carefully examined to see if the pinna has been twisted, and reapplied.

[1] M. Chevasser, Rev. de Chir., Paris, 1908, xxxvii, 411.

After twenty-four hours, if pain is present, the skin-flaps should be examined for possible infection or swelling and tension of the sutures. Sutures should be removed if too tense. The patient may complain of a soreness or stiffness of the muscles of the neck on the operated side, due to partial or complete separation of muscular attachments from the mastoid tip. This condition quickly subsides, but it may be necessary to strap adhesive plaster over the neck to assist in keeping the muscles at rest.

The length of time that the first dressing should be left undisturbed depends on several conditions. If the temperature remains normal or but slightly elevated, pain absent, and the dressings dry, sweet, and clean, the wound should not be disturbed for five or six days after the operation. Saturation of the dressing with exudate or blood, causing foul odor or great stiffness, is a cause for early change of dressing.

FIG. 137.—BANDAGE PROPERLY APPLIED TO HOLD DRESSING IN PLACE AFTER MASTOID OPERATION.

Extreme gentleness should be exercised when removing the gauze from the wound. If the dressing has to be removed before the sixth day, it is apt to be adherent and cause pain if force is used in removal. Wetting the gauze will so dislodge the adherent threads that their removal causes no pain. After the fifth or sixth day the dressing is usually wet from the excretions and may be removed without pain. Irrigation of the wound at the first dressing is seldom necessary. All dry blood or excretion should be softened and removed by wet pledgets of cotton. Boric acid should be insufflated into the wound cavity, sterile strips of gauze applied loosely, and a roller bandage applied over the fresh dressing. The subsequent dressings may be made every twenty-four to forty-eight hours, depending on the amount of discharge.

The open mastoid wound heals by granulation, and the gauze dressing should be used to prevent the wound closing too soon, as a sinus may result, leading to a diseased cavity. The granulations should be small and firm. If otherwise, they should be curetted or stimulated with balsam of Peru or, if necessary, with the nitrate of silver pencil. If unhealthy granulations develop on the edges of the incision in the skin, and partly close the entrance into the cavity, they should be curetted until entirely removed. If eczema develops about the skin during convalescence, it may be due to the use of iodoform gauze, and soon disappears after plain sterile gauze is substituted.

To avoid formation of scales and small crusts about the auditory canal or in the vicinity of the mastoid antrum, Wright's citrated saline solution may be used several times a week.

After a week, and in some cases on the fourth or fifth day, the patient may sit up in a chair and walk about the room. In radical cases the patient should stay in bed for one week, and longer if the dura or lateral sinus has been exposed.

Healing may be complete within a month. In some exceptional cases a shorter period is sufficient, or a much longer period may be required.[1]

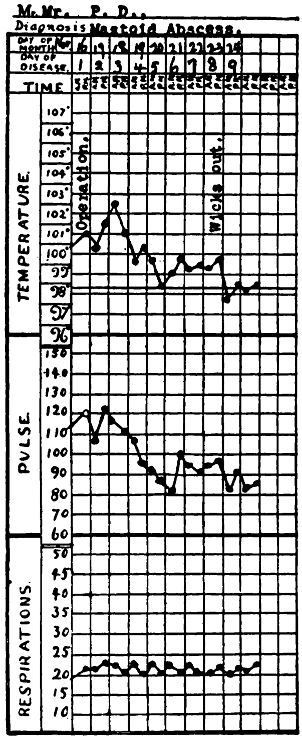

FIG. 138.—MASTOID ABSCESS.

Lateral sinus opened, packed with iodoform gauze. No apparent infection of internal jugular. Immediate drop of temperature when sinus-packing was removed.

Complications and Sequelæ.—(1) *Thrombosis of Lateral Sinus and Internal Jugular.*—This may follow accidental opening of sinus during operation (Fig. 138), or may result from advance of the infection. If redness, tenderness, or induration are observed along the descending line of the internal jugular, immediate operation should be done to tie the vein proximal to the clot.

(2) *Cerebral abscess* (*epidural* or *subdural*) is suggested by continuing fever without adequate apparent cause in the wound, intense headache, nausea, vertigo. Extensive operation is imperative if this diagnosis is reached.

[1] Hammond, Jour. Am. Med. Assoc., 1906, xlvii, p. 1645.

CHAPTER XLIII

OPERATIONS ON THE THORAX

AMPUTATION OF THE BREAST

UNCOMPLICATED, if it has been possible entirely to cover in the area with skin-flaps, the after-care of this operation should be only that of a simple incised wound. The best dressing after the complete operation is the double swathe—the first around the thorax, high in the operated axilla, the second swathe outside the affected arm, wide enough to be folded over the shoulders. This binds the arm to the side, gives good pressure on the dissected axilla, and at the same time fixes the arm

FIG. 139.—APPLICATION OF DOUBLE SWATHE AFTER BREAST AMPUTATION.

The under swathe exerts even compression and holds on the major part of the dressing.

FIG. 140.—APPLICATION OF DOUBLE SWATHE AFTER BREAST AMPUTATION.

The outer swathe brings arm in against the chest, holding the axillary part of the dressing, supporting the forearm and wrist.

(Figs. 139, 140). In many cases there is so much oozing that it seems best at the end of operation to insert a rubber-dam drain through the posterior part of the axillary flap. This drain should be removed at the end of twenty-four to forty-eight hours. These patients may suffer greatly from thirst, due to loss of blood. They should sit up on the day after operation, unless the prostration of shock or hemorrhage forbids. Stitches out on the tenth day.

Complications and Sequelæ.—(1) *Skin-grafting.*—Primary skin-grafting at the time of operation is being done constantly more and more, as surgeons observe that most local recurrences are in the skin. For treatment of the wound which has been grafted, see p. 633. On the other hand, the best cosmetic efforts should be made which are consistent with thorough removal.[1]

(2) *Embolism*, arising in the axillary or subclavian vein, is always a fearful possibility. This is practically always fatal.

(3) *Injury to the thoracic duct* has been repeatedly observed. (See p. 279.)

(4) *Secondary hemorrhage*, due nearly always to sepsis, is seen now constantly less often. If outside pressure fails to arrest it, a few stitches are removed and packing is tried. This failing, however, the flap must be turned back with all precautions and an effort made to catch and tie the bleeding vessel.

(5) *Recurrence in the Scar.*—The advisability of immediate treatment of these scars by exposure to the x-ray or carbon-dioxid snow should be considered. (See pp. 378 and 381.)

EXCISION OF BENIGN TUMORS OF THE BREAST

These cases should present only a small incised wound, made preferably at the periphery of the breast, where the scar will not show.

FIG. 141.—BREAST-BANDAGE.

A folded towel is doubled into a **V** of which one arm goes above the breasts and one below, meeting in the opposite axilla. The angles are pinned to the respective ends of a folded towel behind the back. The folds are connected between the breasts; shoulder-straps are applied (Boston Lying-in Hospital).

FIG. 142.—BREAST-BANDAGE.

To exert still greater pressure an extra towel may be pinned across from axilla to axilla. Absorbent cotton is tucked in here and there to equalize the pressure.

Firm pressure should be maintained for four or five days to prevent the cavity filling with blood or serum. Stitches are taken out in eight

[1] J. Wiener, Am. Surg., 1909, l. 837.

to ten days. If it has been possible to make a beveled incision, the wound can be held together by plaster straps, and there will be no stitches to remove and practically no scar to be found.

FIG. 143.—BREAST-BANDAGE.
Rear view, to show application of shoulder-straps.

ABSCESS OF BREAST

No amount of good after-treatment will make up for an inefficient operation in this affection. Drainage wounds, it is fair to say, are frequently insufficient in size, and are not made at the places best adapted for drainage. The cavity should never be curetted. It should be distended by gauze packing (plain or chemically treated) at the time of operation. This should be removed at the end of one or two days, depending on the indication given by temperature or pain. The packing has now made the irregular cavity into a unit. At the first dressing the cavity may be filled with glycerin or balsam of Peru and a small wick or soft-rubber tube inserted. At each subsequent dressing the wound is wiped out with gauze, the same emollient and stimulating preparation as before poured in, and a small drain used. Salt and citrate dressings with judicious use of Klapp's suction cups,[1] with or without vaccine therapy, may cause rapid subsidence of the process. All the time a tight swathe and the position of the body are to be used to favor thorough drainage. Extensions of the process must be met by further incision. A thoroughly infected breast may be drained by a circular incision one-quarter to one-third of the circumference of the base of the breast, breaking down all cavities into this incision. The

[1] R. L. de Normandie, Boston Med. and Surg. Jour., 1909, clx, 601.

same after-treatment is used. Large suction cups may be obtained for the application of the Klapp treatment of passive hyperemia to the breast if indications arise.

The patient should sit up as soon as possible, and every means, physical and psychologic, should be used for legitimate stimulation. In cases of small abscess, and in cases where the patient, within a day or two, gets distinctly better, the flow of milk may be maintained in the other breast and nursing shortly resumed.

EMPYEMA

A soft-rubber bobbin or spool, a tube from $\frac{1}{2}$ to $1\frac{1}{2}$ inches long, on each end of which is a lip or flange (Fig. 144), is the best apparatus for maintaining free pleural drainage. It is self-retaining, reaches through the parietal pleura, and no further. The inner end, unlike the common

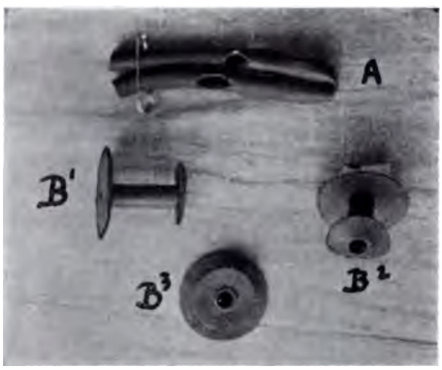

Fig. 144.—Empyema. Forms of Drainage-tubes.

A, Double fenestrated soft-rubber tube; B^1, B^2, B^3, soft-rubber drainage bobbins and flanged tubes of different lengths.

drainage-tube, does not reach and injure the lung. If a fenestrated drainage-tube is used, a safety-pin at right angles through the outer end will prevent the tube from slipping into the pleural cavity (Fig. 144).

It seems best not to wash out the pleural cavity, though some surgeons do it. It is apparent that each time the washing fluid is passed in the same hydraulic conditions as in the original empyema are reëstablished for the moment, and then drained off. This alternation must be to a degree shocking. A very voluminous dressing of sterile pads should be applied and held by a swathe. These pads require changing usually within the first hour, and perhaps every two or three hours in the first twenty-four. After that, the amount of drainage may become rapidly less. The patient should be placed in bed with the drainage hole down; that is, he is placed on the affected side with a slight inclination backward, the first criterion in posture, however, being the position in which breathing is least difficult. The tube must frequently be probed with a sterile instrument or finger to see that it has not become plugged with fibrin or blood-clot, and should be kept in position in any case about a week, and if drainage is then profuse, still longer.

These patients should be carried almost immediately out-of-doors and best sitting up. If adequate protection and nursing can be provided, they should sleep out-of-doors. Lung exercises, such as deep breathing and blowing fluid from one bottle to another (Fig. 145), should be started as early as the end of the first week. In a patient who is at all intelligent, as soon as he has the strength a tube may be sealed (Fig. 146) in the

FIG. 145.—EMPYEMA.
Arrangement of bottles whereby patient increases lung capacity and lessens open cavity.

wound (say at the end of two weeks), and in the end of this tube the patient himself, from time to time, perhaps five or six times a day, inserts an ordinary suction-syringe bulb and pumps (Fig. 147) from the pleural cavity both air and pus, thus partially establishing a vacuum. This procedure favors lung expansion and is a great aid to rapid convalescence.[1] The Bier hyperemic cup is of great value, used daily from the time of removing the tube till the sinus is healed.

The duration of drainage in these cases varies with the condition of the patient, the amount of pleural or lung disease, and the surroundings. Dust-free air, as in the country or at the seashore, together with maximum sunshine, are the best tonics.

Complications and Sequelæ.—(1) *Lack of Free Drainage.*—If the characteristic fluctuations of the chart persist after operation

[1] C. E. Tennant, Am. Surg., 1910, li, 84.

(see Fig. 22, p. 63), an encapsulated empyema, not drained by the operation, is to be suspected. Sometimes a finger can be introduced through the wound to break up the adhesions and so drain such a cavity; at other times, a second opening must be made. The possibility of

FIG. 146.—EMPYEMA.
Sealing in a tube, through which at intervals negative pressure is produced by a reversed syringe-bulb.

empyema on the other side, although rare, must always be kept in mind. Should this arise, immediate operation might best be attempted

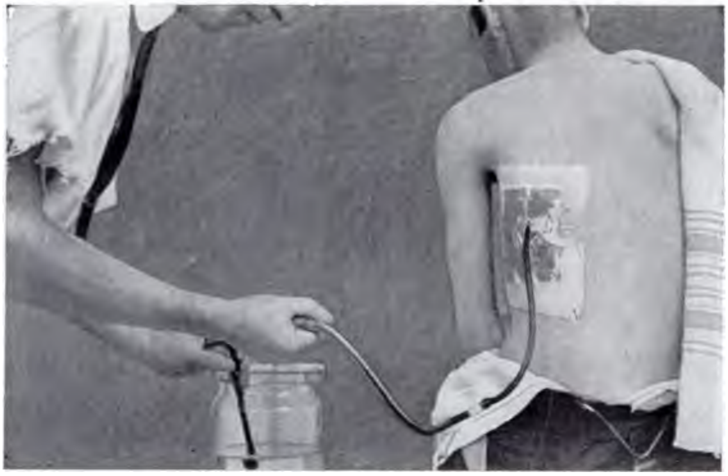

FIG. 147.—EMPYEMA.
Suction used to encourage lung-expansion.

in the negative pressure cabinet. It may be conservative to carry the operation along for a time by aspiration of the second side until the lung on the first side has expanded somewhat.

Encapsulated empyema, which is not reached by operation, apart from the chance of death from toxemia, may at any time rupture into a bronchus or through the diaphragm into the peritoneum or into an adherent colon.[1]

(2) *Sepsis* in the wound is always present, and is of little importance, unless the pus burrows into the layers of the chest-wall. This is more liable to happen if the opening has been made so far back toward the tip of the scapula as to go through the latissimus dorsi. Any such spread of infection must be drained.

(3) *Subcutaneous emphysema* may occur if the inner end of the tube slips, or the tube gets plugged and, at the same time, there is a wound in the lung sufficient to allow air to be forced into the pleural cavity with each inspiration.

(4) *Cardiac Dilatation.*—Collapse and death due to this condition are most likely to occur at the moment of escape of pus during the operation, particularly in left-sided empyema, when the heart has been dislocated toward the right and suddenly assumes its normal position. Preventive treatment is, of course, the most important. The pus in left-sided operation, with dislocation of the heart, should be allowed to escape slowly, the cardiac condition being followed closely at the same time with stimulants at hand.

(5) *Necrosis of Rib.*—The cut ends of the rib or, in simple pleurotomy, the edge of rib exposed, may become necrotic, beginning with destruction of its periosteum. No active measures of treatment should be undertaken until the empyema itself has practically stopped discharging. At such a time—namely, eight to thirteen weeks—the dead bone surface will probably separate itself and then heal over.

(6) *Cerebral abscess* is spoken of as a possible complication of empyema. There is, apparently, little in the literature to support this view. In abscess of the lung, however, we find a not infrequent association with cerebral abscess.

(7) *Chronic Sinus and its Sequelæ.*—Where failure to heal seems to depend upon failure of the lung to reëxpand, treatment by valve or

[1] One of us recently saw a case of this sort with Dr. W. W. Harvey, of Boston. The right chest had been flat to percussion, but an hour later became tympanitic, and at the same time great relief of all symptoms appeared, accompanied by a thin yellow diarrhea. Three days later a new collapse occurred, with profuse discharge from the trachea of thin, yellow, foul-smelling material and symptoms as of drowning. At the same time distention of the abdomen appeared, increasing, apparently, with almost every breath. Autopsy two hours later showed an encapsulated empyema, ruptured, first, through diaphragm into transverse colon, and, second, into a large bronchus. Every deep inspiration, favored by valve-like action of the torn lung, served to blow up the colon.

suction apparatus is indicated (Fig. 147). This is especially of value in the more chronic cases. Emil Beck's bismuth paste (see p. 277) gives good results also. Paste No. 1 is injected every day while active suppuration continues, enough to keep the cavity filled, and held in by a gauze plug. No. 2 is used to fill the sinus after pus ceases to form. The general septic condition is relieved almost at once, the discharge becoming sterile in a short time. Bismuth poisoning is very rare, but may occur. Such poisoning is treated by injection into the cavity of olive oil at 110° F., which dissolves the paste and facilitates its escape.[1]

Deformity of the chest is usually temporary and yields to treatment, but long-continued discharge from the cavity is not infrequently followed by chest deformity and scoliosis of a severe type, permanent and sometimes extremely severe.

(8) *Actinomycosis.*—Ochsner[2] says: "In the United States empyema caused by an infection with the ray-fungus is not so very uncommon, and should constantly be borne in mind as one of the possibilities, especially as the treatment must be entirely different in case actinomycosis is present. This condition can be recognized by the presence of little yellowish flakes in discharge from the empyema which contain the characteristic ray fungus, easily demonstrated by microscopic examination.

"In cases suffering from actinomycosis it is important to bear in mind the fact that this disease is curable by the administration of very large doses of iodid of potash. Small doses are of little benefit. It seems necessary to saturate the blood thoroughly with this drug in order to destroy the parasite. The method consists in the administration of 60 to 90 gr. of iodid of potash in a glass of warm milk an hour after meals, three times a day, followed by a pint of hot water. In this way the drug can be given in these large doses without causing any marked disturbance. It is used for three days in succession, then the patient is permitted to rest for the same period of time, when the administration is again repeated. After about six weeks of treatment these cases usually recover perfectly unless an undrained abscess be present. In such case some of the parasites seem to remain where the drug does not reach them, and from that point a reinfection may take place; consequently, it is wise to repeat the treatment a number of times after permitting the patient to rest for a month or two, when he has arrived at what is considered a complete cure."

[1] A. J. Ochsner, Ann. Surg., 1909, l, 151.
[2] Clin. Surg., 1902, 272.

ABSCESS OF THE LUNG

The abscess cavity, draining through the external wound, should be washed or wiped out with tincture of iodin, unless too much coughing is caused by it, or menthol and eucalyptus, or some mild antiseptic and deodorant, often enough to control the bad odor. A soft tube must be maintained to the very depth of the cavity to insure healing from the bottom. The external opening tends to heal before the lung cavity is obliterated. If this happens, bronchitis or bronchopneumonia follows at once.

THORACOPLASTY

(Estlander's Operation; Schede's Operation)

After this operation, which is supposed to favor the collapse of the firm chest-wall enough to obliterate a pleural cavity into which the lung will not expand, there are no special directions for the care of the wound. The wound is packed with gauze, and the cavity which remains is sponged every day or two with full-strength tincture of iodin, which acts in these cases almost as a specific. This operation is not usually performed until every effort is made to aid the lung to expand.

For details as to recent progress of lung surgery under positive and negative pressure, reference is made to:

Samuel Robinson, Ann. Surg., 1908, xlvii, 185; Jour. Am. Med. Assoc., 1908, li, 803; Trans. VI. Internat. Cong. Tuberc., 1908, 73. Samuel Robinson and G. A. Leland, Jr., Surg., Gyn., and Obstet., 1909, 255; Willy Meyer, Ann. Surg., 1910, lii, 34; F. Sauerbruch and S. Robinson, Ann. Surg., 1910, li, 320.

OPERATIONS ON THE PERICARDIUM

A punctured wound of the pericardium, as from a trocar for relief of effusion, is sealed at once with cotton and collodion. Where pus is present, with the trocar as a guide, a free incision is made and drainage maintained through a soft-rubber tube held, to prevent slipping in or out, by a stitch through it and the skin. The inch or more of tubing which is within the pericardium should be fenestrated, and after the dressing is applied drainage of the cavity may be materially aided by keeping the patient lying face down as much as possible.

Cardiac stimulation should be used in these cases only for reason, for it should be constantly in mind that the heart may be doing its best.

GUNSHOT AND STAB WOUNDS OF THE CHEST

"In the treatment of gunshot or stab wounds of the chest it is, first, important to determine whether there is dangerous bleeding from the intercostal vessels or from the internal mammary artery. The former can easily be exposed, clamped, and ligated. The latter, being located near the sternum, between the costal cartilages and the pleura, is in a position in which it is difficult to ligate without fear of causing pneumothorax by opening the pleura. The fact that this vessel is given off from the subclavian artery makes the hemorrhage very formidable, and the fact that it is located behind the costal cartilages makes a hemorrhage into the pleural cavity more likely than an external hemorrhage. In case of bleeding from the internal mammary artery it is necessary to bear in mind the fact that the costal cartilage can be easily cut with an ordinary scalpel and that the external wound is of no importance, consequently a large external wound should be made over the costal cartilage of the next rib about the point of injury; this cartilage should be carefully cut away for a distance of at least an inch over the point at which it crosses the artery, and then a fine stitch should be passed around the artery and tied. The danger from trying to perform this operation through a small external wound is very much greater than it is if ample space be secured by making a large external wound.

"The hemorrhage from these two sources having been disposed of, the next important point is to secure, as nearly as possible, complete rest of the chest-walls. This can best be accomplished by applying a plaster-of-Paris jacket, extending from the lower border of the ribs up over both shoulders. The patient will immediately begin to breathe by using the diaphragm alone, and the irritable hacking cough will in most cases subside, and, therefore, the patient will stop pumping blood from the lung tissue into his pleural cavity. If empyema follows through an infection caused by the injury, it should be treated according to the method which has already been detailed.

"This point should be borne in mind above all things—that under no condition should a wound of the thorax be examined with a probe, because probing is one of the chief sources of infection. If plaster of Paris is not available, or if the patient does not seem sufficiently strong to bear its application, a protecting cast can be constructed in a few minutes by winding long strips of rubber adhesive plaster, from 2 to 3 inches in width, about the entire chest, beginning at the border of the ribs and working upward until the whole chest and shoulders are covered. Several layers of this plaster may be applied to advantage. It is surprising how quickly a patient, who has not been able to rest for a moment on account of the irritation due to the motion of his chest-walls, will become quiet and fall asleep after one or the other of these jackets has been applied. Cases which have so far advanced that the danger of new hemorrhage is over, but in which the blood in the pleural cavity is not absorbed, should be aspirated through a trocar or drained by open incision or treated like an empyema." [1]

If the symptoms are not those of hemorrhage, the wound is to be cleaned and sealed. Mechanical rest and morphin are used to diminish the respiratory excursion and to lessen the chance of secondary hemorrhage.[2]

[1] Ochsner, Clin. Surg., 1902, pp. 277, 278.
[2] See also A. Vander Veer, Ann. Surg., 1909, l, 158.

FIG. 147, *a*.—EHRENFRIED APPARATUS FOR THE INTRATRACHEAL INSUFFLATION OF AIR AND ETHER. A method of advantage in certain operations on the mouth, face, and neck.

CHAPTER XLIV

OPERATIONS ON THE ABDOMEN

OMPHALITIS

THIS condition varies from a simple inflammation, following eczema of the navel, up to a large abscess. Occasionally a case appears in which the urachus has persisted. In any case, elliptical excision of the umbilicus is indicated down to its base, but, if possible, not into the peritoneum. The cavity remaining is wiped out with tincture of iodin and packed with plain or medicated gauze.

Complications and Sequelæ.—(1) *Extension of the infection* may follow along the suspensory ligament of the liver and result in a large abscess appearing after a protracted course of fever. This abscess is situated on the under aspect of the liver and comes toward the surface external to the gall-bladder. It must be drained.

(2) *Urinary Fistula.*—A persistent urachus may have given rise to the omphalitis, coming to the surface perhaps late in life, as do bronchial cysts. In a case of this kind, perhaps a week or a month after operation, immense quantities of pus will be seen in the urine, without renal or cystic symptoms. This may persist two or three days and then cease, but at the same time a continuous leak of urine will be discovered at the navel wound. These two conditions may alternate indefinitely. After a reasonable time (two to four weeks) if the fistula does not close, a radical operation, seeking to dissect out the remains of the urachus, should be made.

(3) *Umbilical hernia* is a possible after-effect, unless the wound after healing is kept reinforced by straps or corsets for at least three months.

GASTRO-ENTEROSTOMY

"On being placed in bed a glass female douche point is passed just above the internal sphincter and attached to a gravity bag filled with half-strength normal salt solution. The elevation should not be greater than 6 inches. A small stream passed into the rectum is easily absorbed without irritation. One or two quarts are taken up in an hour. The patient is then placed in a semisitting posture. Beginning at sixteen to twenty hours, an ounce of hot water is given every hour; this is rapidly increased, and in thirty-six hours the usual experimentation with liquid feeding is instituted. Rectal feeding is unnecessary."[1] The patient may get up on the fourth to tenth day, according to his strength.

Recent investigations[2] have established the fact that a gastro-enterostomy opening will not functionate unless there is some obstruction to the normal outlet at the pylorus. This is due to the fact that the pylorus is situated at the most dependent part of the stomach, that peristaltic action directs the stomach-contents toward the pylorus, and that peristalsis tends to close the anastomotic opening. If there is temporary closure of the pylorus from spasm, as in cases of gastric ulcer, the gastro-enterostomy opening will remain patent until the normal acidity of the gastric juices has been attained.

After every competent gastro-enterostomy, bile and pancreatic secretion will be found in the stomach, in amounts depending on the style of operative procedure and the sufficiency of the opening. In cases of permanent closure of the pylorus, this finding will persist, and, so far as present observations go, it does not seem to interfere appreciably with gastric digestion and nutrition. If it disappears, it means that the pylorus is resuming its function, under the encouragement of the neutralized hyperacid gastric juices.

Complications and Sequelæ.—*Peritonitis* is rare with a surgeon skilled in the technique. If it develops, the wound must be opened, the cavity wiped out, and drained at site of operation and elsewhere if it seems best.

Delayed hemorrhage should be equally unexpected.

Acute *intestinal obstruction* or *gastric dilatation* may occur from kinks or adhesions. In a case of Bloodgood's[3] a loop of jejunum was found caught in the fossa of Treitz.

Persistent vomiting, not obstructive, persisting partly from habit, may be a serious sequel of operation. The treatment varies from stomach starvation to giving the patient whatever he wants. A case of ours vomited everything until she demanded and got broiled beefsteak.

If the vomiting does not stop, and bile is found in the vomitus, the surgeon must conclude that a *vicious circle* has been established, whereby, on account of a kink or valve fold at the enterostomy site or ob-

[1] W. J. Mayo, Five Hundred Cases of Gastro-enterostomy, Ann. Surg., 1905, xlii, 641.

[2] See especially W. B. Cannon and J. B. Blake, Ann. Surg., 1905, xli, 711, and W. B. Cannon, Boston Med. and Surg. Jour., 1909, clvi, 720.

[3] Ann. Surg., 1903, xxxviii, 806.

struction beyond, all the bile and pancreatic juice is flowing back through the gastro-enterostomy into the stomach. In the early days of the operation, when a long loop (9 in.) was used, this was frequent. At present, with the jejunal loop of minimum length or with the Roux operation, this is less likely to occur. The only treatment is a secondary operation to modify the first.

Jejunal and Gastrojejunal Ulcer.—The possibility of such ulceration following this operation should always be in the surgeon's mind. A very thorough research on the subject has been made by Herbert J. Paterson, of London.[1] He reports 2 cases and has collected 61 others. Of these, nearly one-third were found in the line of anastomosis, due, therefore, probably to technical failures in the operation itself. For example, one case shows the ulcer to be the result of an impacted Murphy button; another, of a retained silk suture; a third shows infected hematoma in the suture line. He summarizes the views as to the causes of these ulcers after gastro-enterostomy thus:

I. Hyperacidity, normal flow of bile and pancreatic juice.

II. Normal acidity or hypersecretion, normal flow of bile and pancreatic juice.

III. Normal acidity, diminished flow or diversion of bile and pancreatic juice.

IV. Normal acidity, normal flow of bile and pancreatic juice. Toxic agent other than HCl.

V. Infective processes.

Research on the first two of these causes has been made by Dr. Charles Bolton.[2] He says: "It appears that any strength of HCl above the normal can act as a protoplasmic poison for the gastric cells and will add its quota to other devitalizing influences and assist in bringing about self-digestion."

It is true that it has been asserted that the inner row of stitches in the anastomosis on animals seems to have little influence on the healing. The mucous membrane around the margin sloughed, leaving an ulcer which covered over in about three weeks. If this were true on the human, every case is followed by a gastrojejunal ulcer. Mr. Paterson believes, in our judgment rightly, that in humans primary union is possible through the sterilizing of the gastro-intestinal tract in preparation and the completely aseptic technique. He is supported in this belief by the fact that microscopic examination from recent anastomoses have not shown such sloughing. He holds, further, that "regurgitation of bile and

[1] Ann. Surg., 1909, l, 367.

[2] Trans. Royal Soc. Med., Dec., 1908, Path. Sect., p. 54.

pancreatic juice, which takes place into the stomach after simple gastro-jejunostomy, must be favorable to the union of the apposed surfaces by diminishing the acidity of gastric contents as they pass through the opening." He declares that in 24 per cent. of the recorded cases jejunal ulcer has followed operation of the Y-type (Roux operation). Paterson's conclusions on the subject seem worthy of quotation.

"The necessity for prolonged after-treatment in cases of gastrojejunostomy has perhaps not received the attention which it deserves. My rule is to advise all patients whose gastric contents have been hyperacid before gastro-jejunostomy, to avoid meat in any form for six months at least, and until such time as examination shows that the gastric acidity is subnormal. The immediate relief which is experienced by patients on whom gastrojejunostomy has been performed, tempts them to indulge in food unsuited to the condition of the gastric mucosa. In most cases in which gastrojejunostomy is necessary, the mucous membrane is chronically inflamed, and many months must elapse before it is restored to a healthy condition.

"Some surgeons, in their dread of jejunal ulcer, have maintained that gastrojejunostomy is contraindicated in gastric ulcer with hyperacidity, except when the ulcer is near the pylorus and is causing symptoms of obstruction. Others have even suggested that unless there be gastric stasis, gastro-jejunostomy is useless in the treatment of gastric ulcer. I believe this teaching to be retrogressive. For some years I have been advocating the view that gastrojejunostomy is not a drainage operation.

"The success which follows this operation in cases of gastric ulcer is due, not to drainage, but to the physiologic effects of the operation in diminishing the acidity of the gastric contents, and this diminution follows gastro-jejunostomy irrespective of the situation of the ulcer."

Wm. J. Mayo[1] reports 1141 gastrojejunostomies, in which, so far as knowledge could be obtained, not a single case developed true jejunal ulceration, and he adds: "Nor have any such cases come to our clinic where gastrojejunostomy had been performed by any other surgeon."

GASTROSTOMY

In this operation, whatever type has been used, either the simplest or one of the complex ones, in which an attempt is made to establish the valve-like opening, it is well to leave a tube tied in through the gastrostomy at the end of operation in order that for feeding the first few days the abdominal wound need not be disturbed. This tube of soft rubber, held from slipping for the time being by a single catgut stitch, comes out of itself at the end of a week or ten days. After this a funnel or stomach-tube with funnel is passed into the gastrostomy opening at

[1] Coll. Papers, 1910, 61.

each meal time. Through the opening then is introduced at the appropriate time first the usual postoperative diet, very rapidly increasing to the full limit of the patient's digestion. If the esophageal obstruction has been so complete that the patient suffered severely from thirst before the operation, half a pint of warm normal salt solution may be poured into the stomach through the feeding-tube at the end of the operation, and this should be repeated every half-hour until the thirst is satisfied. If he has been able to drink before operation, he may be allowed to do so afterward if this causes no distress; otherwise, fluid is to be given through the feeding-tube only. After a time the absence of irritation may cause the obstruction to be less complete, and then the patient again will be able to take liquids by mouth. The ideal preparation of food for a gastrostomy is in the patient's mouth, and there are many instances in the literature reported of patients who chew their food, subject it thereby to salivary digestion, and by their enjoyment of it stimulate gastric digestion. They then eject the food, well chewed, into the funnel, whence it passes, if the opening is big enough, directly into the stomach.

"Almost invariably these patients gain rapidly in weight and strength, because the enforced rest of the stomach and intestines has usually placed these organs in a condition in which they can thoroughly digest an abundance of food. I have repeatedly observed these sufferers gain sufficiently in strength in a few weeks to enable them to do hard manual labor, which they continued to do until the carcinoma had implicated some other important organ, either by invasion or by the formation of metastases.

"It is, of course, necessary to explain to the friends of the patient that this operation cannot result in a cure of the disease, but that it can simply give temporary relief. This relief, however, is so great, and the risk in obtaining it is so slight, that it is an operation which can be very strongly recommended. Aside from the distress due to hunger, and especially to thirst, patients afflicted with obstruction of the esophagus suffer pain but slightly, consequently the relief given by this operation is relatively very complete."[1]

In benign stricture of the esophagus a bougie should be passed at least once a month during the remainder of the patient's life, in order to prevent a late contracture, which may otherwise come on so gradually that the patient does not recognize it until so far advanced that it is difficult to dilate it again.

[1] Ochsner, Clin. Surg., 1902, pp. 179, 180.

Complications and Sequelæ.—I. Intense *pain* on the introduction of food into the stomach. Several instances of this have been noted, but it seems as if in each case the cause may have been lack of fine division or grinding of the food or the too rapid attempts to take full diet after many weeks or months of starvation.

II. *Acute gastritis* is really an exaggerated form of what has just been noted. It is an acute gastric indigestion following lack of careful gradation in extending the diet list after long fasting.

III. *Inanition and Exhaustion.*—The operation may be postponed until the patient is in such a state that he is too weak to rally.

IV. *Sepsis* may appear after any such operation either in the form of a general peritonitis or as localized abscess between the stomach and the liver, or on the other side behind the spleen.

GASTRECTOMY

This operation, after the results of hemorrhage and shock have been met, presents only the problem of feeding. If the loss of blood has been considerable, transfusion may be done, and in practically every case saline under the breasts is to be used. Food is given on the second or third day with much less hesitation than formerly. For example, Ehrlich[1] recommends the following diet: First day, tea, red wine, broths; second day, bouillon with bits of meat; following days, chopped chicken, beef, lamb, potato soup, eggs; seventh day, ordinary diet, but made up of things easy to digest.[2] W. J. Mayo's recommendation, however, is more conservative than the German method, and we believe it to be safer. He[3] maintains the patient in a semisitting position and continues proctoclysis at least twenty-four hours. If there is much debilitation he gives 10 to 15 minims of camphorated oil hypodermically every four hours for several days. A nutrient enema is given every twelve hours for the first three or four days. Hot water may be taken by mouth from the first unless it induces vomiting.

Total gastrectomies take their nourishment in small amounts at short intervals; thus, the case of Schlatter[4] took food every three hours at first, and in the fourth week was taking a full variety of food. Eight months after the operation this case was eating like any healthy person.

[1] Rév. Française Méd. et Chir., 1905, 761.
[2] A. Monprofit, La Gastrectomie, Paris, 1908, 119.
[3] Coll. Papers, 1910, 116.
[4] Beit. z. klin. Chir., 1898, xix, 757.

Gradual increase in the amount leads, apparently, to a dilatation of the region near the union of esophagus and duodenum.[1]

Complications and Sequelæ.—(1) *Constipation.*—For a time, at least, there is a greatly diminished gastric digestion, and a considerable quantity of material usually digested in the stomach is, therefore, passed on to the intestine without alteration. The resulting constipation is usually not of long duration.

(2) *Diarrhea* may appear for exactly the same reason.

(3) *Stasis.*—When feeding is first begun after operations near the pyloric end of the stomach, motility of the stomach may be so much diminished that stasis with decomposition of food will appear. This should be suspected if there is a distressed feeling or sensation of weight in the stomach region or vomiting of fetid material. Indeed, sometimes high fever may be the only symptom. For this the stomach should be washed out. The tube should be passed very gently, and after it enters the stomach region, the water pressure should be very low. Nothing approaching distention should be permitted.

(4) *Persistent Vomiting.*—Vomiting which continues after ether recovery may indicate blood or secretion in the stomach-pouch, and may be relieved by very gentle lavage.

(5) *Infection.*—The possibility of this ranges from infection of the abdominal wound up to general peritonitis, and calls for no treatment not already outlined.

PYLOROPLASTY

Finney[2] quotes Robson as follows:

"*Concerning Points in Favor of Pyloroplasty.*—(1) Regurgitation of bile into the stomach is prevented.

(2) Secretion of hydrochloric acid, when it has been excessive, becomes normal.

[1] Dr. Harvie, of New York (Ann. Surg., March, 1900, p. 344), reports a case of gastrectomy where duodenum and esophagus were united by direct suture. The patient was a woman, aged forty-six, who had had gastric symptoms for eighteen months before operation. On examination a rounded tumor could both be seen and felt. The operation was rendered difficult by adhesions both in front and behind the stomach, practically the whole of which was infiltrated and thickened. The entire stomach was removed and the cut surfaces of esophagus and duodenum united by means of sutures. The entire time consumed, from the first incision until the abdomen was closed, was one hour and five minutes. There was little or no loss of blood. Subsequent progress was most satisfactory, nourishment being given by the mouth on the eighth day. The patient left the hospital six weeks after the operation after taking a dinner consisting of roast beef, mashed potatoes, ice-cream, cup of coffee, and one glass of milk. (Quoted by Mr. Jacobson, vol. ii, p. 326.)

[2] Johns Hopkins Hosp. Bull., 1902, xiii, 157.

"(3) If the secretion of hydrochloric acid has been diminished or absent before operation, it remains *in statu quo* after operation.

"(4) If there has been primary gastric atony, peristalsis is but little improved.

"(5) This function improves rapidly, or reaches perfection, if the muscular contractility has been normal or increased and when the obstruction was due to fibrous stenosis or pyloric spasm.

"(6) In all such cases evacuation of the stomach is accomplished in its physiologic period, except in rare cases, and these only in the first months after operation.

"(7) Capacity of the stomach always decreases, but rarely becomes as small as normal.

"(8) The pylorus recovers tone.

"*Points of Difference Between the Results of Pyloroplasty and Gastro-enterostomy.*—(1) The absence of regurgitation of bile, and hence absence of any biliary influence on the gastric secretions.

"(2) The function of the stomach is not accelerated, hence the difficulty the stomach has in reaching its normal size.

"(3) Slight or negative result obtained by pyloroplasty in abstract from primary gastrectomy compared to the positive results from posterior gastro-enterostomy."

Finney now continues:

"Accumulated experience has proved that it is unnecessary and often harmful to put patients through a long course of preliminary treatment. Cleaning the mouth and teeth carefully with antiseptic washes and the administration of sterile food only will quickly render the stomach-contents innocuous. The treatment carried out in all my cases was as follows:

"For two or three days before the operation the mouth and teeth were carefully cleaned with carbolic solution and only sterile liquid food and water administered. The stomach was irrigated night and morning just before operation with boiled water. No food at all was given by mouth for twelve hours preceding operation. Cultures were taken from the stomach-contents in three of the cases and two were found to be sterile. The abdominal wound is closed without drainage. Nothing is given by mouth for the first thirty-six to forty-eight hours. Enemata of salt solution and coffee are given every five hours for the first twenty-four hours, after which time nutrient enemata are alternated with the salt solution. Water in small quantities is allowed early. On the second or third day albumin in teaspoonful doses is administered, and, if borne well, broths and milk are rapidly added.

"Patients are not required to lie flat on the back, but are encouraged to turn, and even allowed to be propped up in bed very soon after the operation."

Jianu[1] reports 2 cases of *edema of the legs* following operation for pyloric obstruction. The urine showed chlorin retention: before operation the diet was of milk (chlorin poor); after operation the diet was chlorin rich. The edema resulted from the retention of chlorin before the system could adjust itself to excrete the increased amount.

GASTROPLICATION

This operation is to be done only in the very rare cases of so-called idiopathic dilatation of the stomach accompanying gastroptosis. Since these cases will usually yield to lavage and general health improvement, the operation is not frequently performed.

Farquhar Curtis[2] says: "If the surgeon should chance to overlook some cause of pyloric obstruction, his patient will be sure of cure if he survives the operation, whereas gastroplication will be useless if pyloric obstruction exists."

PYLORECTOMY

Whether direct suture of the first portion of the duodenum to the stomach has been made, or closure of the cut ends with gastrojejunostomy, the shock is profound, and the principal attention during early after-treatment is directed to meet this condition. Beyond that, the care is practically the same as in gastrojejunostomy. (See p. 457.)

PERFORATED GASTRIC ULCER

In these cases, even though the operation has been performed within a very few hours after the perforation, drainage is to be employed. This drainage is not established so much because of actual infection of the peritoneum, but the mere escape of gastric contents sets up an irritation which reduces the resistance of the peritoneum and gives every favorable condition for the spread of an infectious process. Tube drainage, preferably of the spiral type, should go down to the site of the closed ulcer, and also to the region of the right kidney and over behind the spleen. If the effusion of gastric contents has been general, it will probably be wise also, through a suprapubic incision, to drain the pelvis. These cases, if the perforation has been found and closed, may be given water at the end of twelve to eighteen hours; in small amounts at first, lest vomiting appear. At the end of twenty-four hours feeding by rectum should be begun. A nutrient enema (see p. 140) should be

[1] Wien. klin. Woch., 1910, xxiii, 994.
[2] Ann. Surg., 1900, xxxii, 49.

given every eight hours with a mild soap-and-water cleansing enema two hours before the morning nutritive. As in the case of all drainage, the watchful "let alone" policy is here also to be followed. The wicks are to be started about the fourth day and extracted on the sixth or seventh day, although at any time before then it may be necessary to remove the wicks if there is apparently any retention of pus behind them. With the extreme danger of residual abscess in some fossæ, or up under the dome of the diaphragm, continued drainage should be maintained until the temperature is normal and the pus has practically disappeared. Klapp's suction-bulbs or syringe (see p. 267) may be used with advantage. Feeding by stomach should be postponed four to six weeks if the rectum will endure nutritive enemas for so long a time. The starving stomach during this period, particularly as ulcerated stomachs are usually hyperacid, may be the source of attacks of heart-burn, repeated perhaps several times daily to a distressing degree. Sodium bicarbonate ½ dr. in one-half cup of water, will give temporary and sufficient relief to the symptom, and may be repeated many times with no bad effects. Practice as to time of beginning stomach-feeding after perforation varies widely.

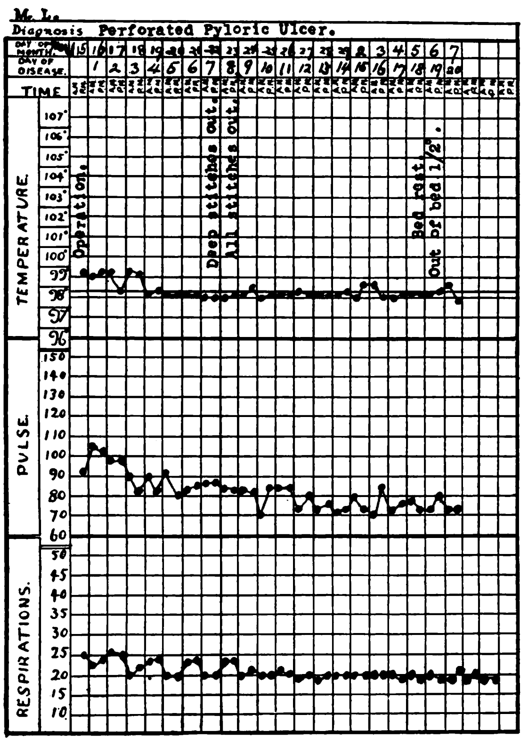

FIG. 148.—PERFORATION OF PYLORIC ULCER.
Operation eight hours later. Stomach-contents diffused throughout abdominal cavity. No septic reaction.

For example, Dr. Jos. A. Blake [1] remarks on a case of perforated ulcer as follows:

"Albumin-water was given on the day after operation. On the third day the patient was given whole milk that had been coagulated with rennet and the curd then beaten with an egg-beater and pressed through cheese-cloth, there then being no possibility of large curds forming in the stomach. This form of milk, devised by Dr. Walter Martin, has been used with great success in several postoperative stomach cases, and is far more palatable than peptonized milk."

[1] Ann. Surg., 1908, xlviii, 130.

When full diet is resumed after operation for perforated gastric ulcer, we allow the following liberal diet, the list including all things which the patient may eat. The important rule should be not what he eats so much as his method of eating. We direct that the food shall be taken dry and that each mouthful shall be chewed till it is fluid. The quantity will then regulate itself: too much will not be eaten.

DIET-LIST AFTER HEALING OF GASTRIC ULCER, TO AVOID RECURRENCE.

SOUPS:
- Purees and creams:
  - Barley,
  - Rice,
  - Pea,
  - Potato,
  - Tomato,
  - Asparagus,
  - Celery.
- Thick soups:
  - Vegetable,
  - Noodle,
  - Julienne,
  - Vermicelli,
  - Fish soups.

FISH:
- Broiled,
- Boiled.

OYSTERS:
- Raw,
- Panned,
- Broiled,
- Stewed,
- Scalloped.

MEATS:
- Boiled,
- Stewed,
- Roasted,
- Broiled,
- Hashed,
  - Beef,
  - Mutton,
  - Mutton chops,
  - Lamb,
  - Lamb chops.

POULTRY:
- Chicken,
- Turkey,
  - White meat,
- Squab.

EGGS:
- Soft boiled,
- Poached,
- Scrambled,
- Omelet.

MILK:
- Unskimmed,
- Skimmed,
- Buttermilk,
- Cream,
- *Boiled milk,*
- *Pasteurized.*

BUTTER.

VEGETABLES:
- Starchy:
  - Rice,
  - Peas,
  - Lima beans,
  - Potatoes,
    - Baked,
    - Boiled,
    - Mashed.

GREEN VEGETABLES:
- Tomatoes,
  - Stewed,
  - Baked,
- Lettuce.

BREAD:
- Stale,
- Toasted,
- Pulled,
- Zwieback,
  - White flour.

CEREALS:
- Corn meal,
- Hominy,
- Arrow-root,
- Tapioca,
- Cornstarch,
- Farina,
- Sago,
- Macaroni,
- Spaghetti.

SPECIAL:
- Beef-juice,
- Clam-juice,
- Scraped beef,
- Beef-tea,
- Albumin-water,
- Milk toast,
- Toast-water,
- Barley-water,
- Gruel,
- Irish moss,
- Flaxseed tea,
- Milk-punch,
- Eggnog,
- Koumiss,
- Wine whey,
- Wine whey,
- Caudle,
- Broth with egg.

PUDDINGS:
- Blanc mange,
- Cup custard,
- Junket,
- Rice.

ICE CREAM:
- Vanilla,
- Chocolate,
- Fruit flavors.

WATER ICES:
- Orange,
- Lemon,
- Sherberts.

CAKE:
- Plain.

JELLIES:
- Lemon,
- Wine,
- Fruit.

SUGARS:
- Cane-sugar,
- Honey,
- Molasses,
- Confectionery.

FRUITS:
- Oranges,
- Melons.

Stewed:
- Apples,
- Peaches,
- Pears,
- Plums,
- Apricots,
- Cherries.

NUTS:
- Peanuts.

BEVERAGES
(on empty stomach only):
- Cocoa,
- Grape-juice,
- Mineral waters.

PERFORATED DUODENAL ULCER

In cases operated on within ten hours the peritonitis is here as in gastric perforation, also largely irritative and chemical rather than septic. We prefer to err on the side of conservatism and, temporarily at least, drain down to the site of the sutured perforation.

The after-treatment is identical with that of gastric perforation (*vide supra*).

COLOSTOMY

This subject is a difficult one to discuss solely from the point of view of after-treatment, since so many possible conditions and complications may be present, depending frequently upon the great possible variety of operations.

If the operation has been a deliberate one, that is to say, not an emergency, or if the emergency is so moderate that it has been decided to do the operation in two stages, the bowel presenting at the wound, whether left or right, may be opened by a small puncture of the knife, or burnt through with the Paquelin cautery, without anesthetic, any time after six hours. The skin round the wound should be painted with compound tincture of benzoin or smeared with zinc oxid ointment, or both. A small pad of gauze or absorbent cotton will do for a dressing while the patient is still in bed. When the patient gets up, special devices must be used to maintain cleanliness.

The method above employed—namely, sewing the gut to the peritoneum—is far from being the best practice at present. The use of the Paul tube is much to be preferred.

The glass tubes are made in two sizes. That used for the colon measures 4½ inches in length by ½ inch in diameter, has a double rim at the bowel end and a single rim at the distal end, and is bent at a right angle. The tube for the small intestine (Fig. 149) is as light as is consistent with sufficient strength. It measures 3½ in. by ½ in., and is bent at a right angle at the distal end. In either case, the end with the double rim is introduced into a small incision made in the loop of the intestine, drawn out, if possible, and safely cut off with aseptic gauze packing. A purse-string suture of linen thread or silk is sewed into the wall of the gut. An incision is made within the circle of the suture. The tube is then inserted and secured by tying the purse-string. The loop bearing the tube is now dropped back into the peritoneal cavity. Feces from the tube are received through a rubber tube, and conveyed into a bottle hung on the side of the bed. Two objections have been made to

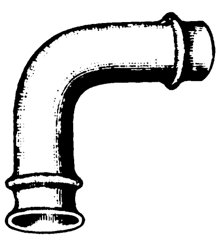

FIG. 149.—PAUL'S TUBE.

[1] Brit. Med. Jour., 1891, ii, 118.

the use of these tubes. One, that it is difficult to insert the tube without letting the feces escape over the wound. This is certainly true when the intestine is distended and the feces fluid. If, however, the loop to be opened is emptied into an adjacent bowel, and temporarily clamped if possible, the introduction of the tube is greatly simplified; otherwise, the operator may safely trust to drawing out the bowel as much as possible and isolating it with gauze. The other objection is that the ligature may cut its way through too quickly, "especially if the bowel is much congested. Thus the tube may be loose in two or three days; but it not infrequently remains for a week firmly adherent, partly because some of the circulation becomes reëstablished behind the ligature, and partly owing to the copious exudation of lymph, which covers

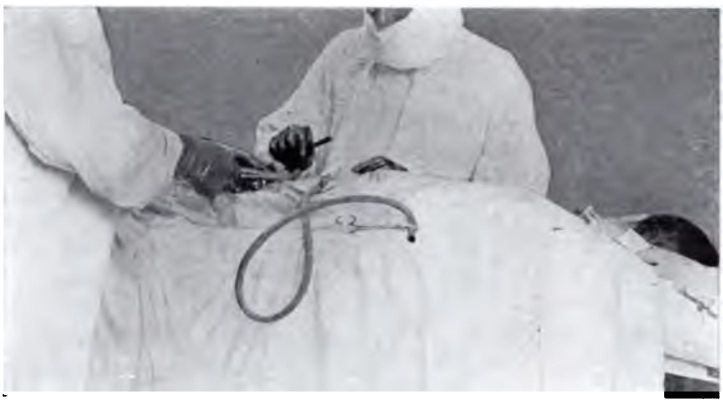

FIG. 150.—COLOSTOMY.

The Paul tube has been tied in the cecum, with rubber drainage tubing previously attached, a hemostat on the end for transit from operating-table to bed.

the bowel to the very end, quite concealing the ligature. The use of a purse-string suture to fix the tube in the bowel, and the prevention of undue tightness in tying in the tube, will help to lessen this trouble."[1]

The Paul tube comes out with gentlest traction or even by itself at the end of five or six days, leaving a well-formed and controllable artificial anus. If now a small and efficient device be applied, such as that effected by H. B. Jackson (see Fig. 151, p. 473), this opening can be kept under good control, particularly if the muscles have been opened by the muscle-splitting or McBurney type of incision. Another method, also simple, is the use of a small pad, conical in shape, held in position by a truss. If the wound is low, particularly in a more or less prominent or pendulous abdomen, a well-fitted spring truss, exerting only slight pressure, will serve well.

[1] Jacobson and Steward, ii, 226.

If the opening in the bowel is too large, the mucosa may prolapse, exposing a moist, excoriated, bleeding, cauliflower-like mass on which it is difficult to keep any dressing. If the opening in the bowel is too small, repeated dilatation by the finger or some opener of the glove-stretcher type may be necessary.

Feces beyond the colostomy, whether it be right or left side, may be cleared out from time to time by enemas passed through a small catheter, provided the stricture or disease for which the operation was done is not absolute. If this is not feasible, into the distal bowel should be passed, through the colostomy, either a thorough rapid salt-water irrigation, or, if this does not suffice to cleanse the gut, any one of the approved irritative enemas (p. 172). By this method the gut may be efficiently cleaned throughout.

Complications and Sequelæ.—Where this operation has been done for obstruction due to malignant disease, *death* may follow despite treatment *from exhaustion and toxemia*—(1) due to the absorption of toxic matter due to the obstruction and to the shock of operation, particularly if there has been much pulling on the gut; (2) due to peritonitis from extravasation of feces or to actual suppuration. "Often it is not due to the operation, but to the want of it at an earlier stage. Thus, the distended bowel may have given way just above the obstruction; often it is that weak spot, the cecum, which is found perforated after the stress of distention"[1]; (3) due to bronchopneumonia, such as may be looked for in any aged patient who has had ether. If this operation has been done for acute peritonitis (an excellent procedure), and if all goes well at the end of ten days, the patient may be given an anesthetic in bed and a few No. 1 chromic catgut sutures taken in the rent in the cecum. If the patient's condition is good, there is no advantage in waiting longer.

Small intestine may escape between the drained gut and the edges of the wound during a fit of coughing or straining. This must be thoroughly cleaned and returned, best under an anesthetic, but still in bed. When omentum protrudes, it should be left, but it should be fastened to the skin by sutures and cut off in two or three days. Bowel sewed to the abdominal wall under tension may tear away from its attachments and begin to empty itself into the peritoneum. This calls for immediate and thorough operation. The small intestine may strangulate between the edge of the colon and the parietes. This may happen at any time, near or remote, after the operation, particularly

[1] Jacobson, i, 101.

in case of a median enterostomy, a very dangerous procedure, to be done only under greatest urgency.

A doctor, keen observer and ingenious, suffered from general peritonitis for which, among other things, cecostomy was done. He made a good recovery, the fecal fistula remaining open, however. It remained open nearly a year, largely because the doctor was too busy to take the time to have it closed. The following is his story from the subjective point of view:

The routine care of a colostomy wound presents several features not generally encountered in ordinary open wounds. The amount of the discharge is great, particularly repulsive, and is likely to be very irritating to the skin, either from putrefactive products or from free digestive ferments. Then, too, the wound is likely to remain open so long that the patient frequently assumes the upright posture, and may even become an active individual before the hole in his side closes.

It is then essential that, immediately after a colostomy has been performed, particularly if it is located high in the colon, or the contents of the bowel are putrefying, or in any way seem likely to become the source of irritation, an effort must be made to protect the skin. Accordingly, until the dermal resistance has been determined, the dressing must be changed whenever soiled, even if it be as often as once an hour. Of the remedies generally used to prevent irritation of the skin, tinctura benzoinatus compositus is probably the best. At the first dressing it should be painted on over a generous area about the wound with a camel's-hair brush, the skin having been previously cleansed with alcohol and dried. One coat dries quickly and is nearly as effective as two, but if the second is applied, it must be dried ten to fifteen minutes before the dressing is applied, else the latter will stick to the benzoin and the additional protection will be nullified. A coating of benzoin will often last a number of hours, frequently as many as twelve, but it should be renewed whenever it begins to come off. If the skin is unirritated or unbroken, the application of the benzoin is painless, but if either condition prevail, or any of the benzoin enters the wound, an intense burning sensation, lasting fortunately but a minute or two, immediately supervenes. This disagreeable feature, however, can be shortened to a few seconds by briskly fanning the field as soon as the application is made. If these two precautions are carefully observed, there should be little difficulty in keeping the skin from becoming irritated. If, however, for any reason it becomes so sore that it is deemed best not to apply the benzoin, a free use of zinc oxid ointment, or, better still, an ointment such as the following, together with extreme caution in quickly removing the discharge, will soon relieve this distressing condition:

"℞.	Zinci oxidi	ʒj
	Bismuthi subnit	ʒij
	Amyli	ʒiv
	Ung. aquæ rosæ[1]	℥ij.

Often allowing the skin to be exposed to the air while covered with ointment seems materially to assist in quieting irritation.

When the intestinal contents are normal, the skin will generally maintain its integrity with only a little ointment smeared on at the time of dressing, but it should be borne in mind that with any tendency to diarrhea, intestinal putrefaction, or if cathartics are used, the skin breaks down (probably in the latter case from digestive action) with marvelous rapidity. I recall a case of cecostomy which had been getting on well for a long time where the skin became nearly raw within three hours of taking a dose of castor oil. It might be proper, however, to add that in this case the intestines contained little or no food, so that it was pure intestinal secretion that was poured out.

The problem of the control of the discharge is often somewhat difficult. Within a few moments enough material may be poured out in successive gushes to soak through or escape from under a large dressing, to the great annoyance of the patient. While he is in bed, the annoyance is comparatively slight, as he may be surrounded by such dressings and clothing as can be easily removed, but when he assumes an upright posture, it will be found well-nigh impossible, even with an elastic belt, to hold a dressing to the side firmly enough to keep the intestinal contents, if it be at all liquid, from running down between the skin and dressing before it is absorbed by the latter. Furthermore, if the dressing is held firmly against the abdominal wall with nothing but a swathe or elastic belt, it will slip and pull sufficiently with respiration and the various movements of the body to irritate the edges of the wound, perhaps already more or less inflamed and eroded by the discharge. Both of these difficulties may be overcome in a large measure by the following device:

Take three pieces of zinc oxid adhesive plaster, 2 to 3 in. in width and about 3 in. long, and sew on the back two heavy dressmakers' hooks, about $\frac{3}{4}$ in. from one end of each strip. Place these strips, *a*, *b*, *c* (see Fig. 151), radially about the wound, so that *a* shall be di-

[1] A better preparation is made by substituting white petroleum oil for the almond oil called for by the U. S. P.

rectly below and the hook ends of each plaster shall be about $1\frac{1}{2}$ to 2 in. from the opening. As any discharge that reaches the plasters soils them and tends to work them loose, it is well to stick on a guard strip of plaster, *x*, $\frac{1}{2}$ to $\frac{3}{4}$ in. wide, and lapping onto the ends of the plasters *a*, *b*, *c*.

These may be removed frequently without disturbing the main plasters, and thereby saves considerable time to the attendant and discomfort to the patient. If, when the main plasters are removed, they are first moistened with ether, they will come off without pulling and consequently without pain or injury to the epidermis.

The plasters having been placed, a dressing can be put on over the wound, filling the space between the hooks, and a lacing passed from the hooks on plaster *a* to each of the hooks on plasters *b* and *c*. This will serve a triple purpose—to hold the dressing next the wound without

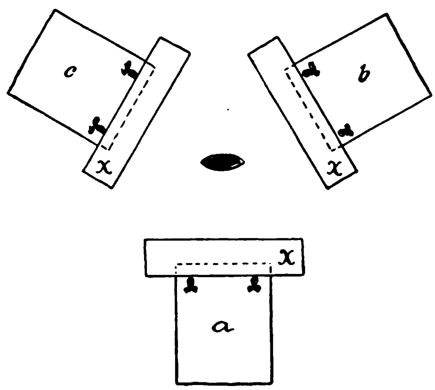

FIG. 151—DIAGRAM TO SHOW ARRANGEMENT OF ADHESIVE PLASTER STRIPS USED IN MAINTAINING A DRESSING IN AMBULATORY COLOSTOMY CASES.

a, *b*, *c*, Squares of plaster to which are sewn dressmakers' hooks. *x*, *x*, *x*, guard strips to prevent moisture working under main plasters.

slipping, and sufficiently firmly along its lower border to check the discharge from running down rapidly, and so escaping absorption from the large dressing of absorbent cotton placed over and below the dressing just described, and which is held in place by a swathe, with or without an elastic belt. Finally, in case there is no obstruction of the bowel, and it is desired that the wound should close, this form of dressing is particularly advantageous, inasmuch as it draws the edges of the wound together, thereby assisting in the healing. In such case, if the intestinal contents are normal, the plasters should be brought nearer the wound and as much pressure placed over the opening as the tissues will bear. Four strips of plaster instead of three, placed opposite each other, will be found more effective for this purpose.

As to the care of the wound itself, little is required that is not required by other open abdominal wounds. After the tube has been removed or has come away, a sterile dressing should be used for a few days, after which plain gauze and absorbent cotton are all that are needed. Granulations may require trimming down either with scissors or caustic. If, when the wound has closed down to a fistula, it is packed at each dressing with the ointment previously mentioned (which at body temperature remains firmer than most ointments with a petroleum base), the edges are less likely to become sore, and the discharge does not seem to make its escape as readily as when no ointment is used. This latter statement, of course, has reference only to those cases where there is no obstruction.

From what has been said about loose and irritating discharges it will be evident that the diet must be so arranged as to be easily digested, and a moderate degree of costiveness will give rise to less local disturbance than will the opposite condition of the bowels.

In conclusion it may be said that the successful treatment of a cecostomy wound requires much patience on the part of the physician and patient, and constant intelligent attention on the part of the attendant. Given these, the patient, so far as the wound itself is concerned, may be kept tolerably comfortable and may even lead a moderately active life.

JEJUNOSTOMY

This is a very rare operation, and has the disadvantage of causing leakage high in the alimentary tract, with escape of digestive fluids of the greatest importance to nutrition. It has been done for cancer of the stomach where other operations are impossible.[1]

The operation is performed in two stages: after the gut has become firmly adherent to the abdominal wound it is opened, three or four days after the first operation, and the patient is fed by funnel into this opening. The feeding is done by giving a meal of about 10 ounces every four hours, half of it being directed upward toward the duodenum, the other half downward toward the ileum.

INTESTINAL END-TO-END ANASTOMOSIS, OR CIRCULAR ENTERORRHAPHY

The tendency in this operation is constantly toward less apparatus and more simplicity. The choice of operation at the present day lies, perhaps, between Connell's method[2] of direct suture, Murphy's button,[3]

[1] E. Hahn, Deut. med. Woch., 1894, xx, 557.
[2] Jour. Amer. Med. Assoc., 1901, xxxvii, 952.
[3] New York Med. Record, Dec. 10, 1892.

and Mayo-Robson's[1] bobbin of decalcified bone, with every advantage in favor of the first if time permits.

Enterorrhaphy by circular suturing must be admitted to be the ideal operation from its simplicity, the entire absence of any special apparatus, and the fact that no foreign body is left behind to give trouble. Comparison between Murphy's button and other methods of resection in the series of 226 cases of resection of intestine for gangrenous hernia, collected by Gibson,[2] is, on the whole, to the advantage of Murphy's button; for in the 63 cases in which Murphy's button was used, there were 14 deaths, or 22 per cent., while in the remaining 163 cases, in which various other methods were used, there were 44 deaths, or 27 per cent.

The after-treatment varies little from that of gastro-enterostomy (p. 457). A wick is left going down to the site of the intestinal wound. This is removed on the third day. Water is given from the first. Rectal feeding is begun at the end of the first twenty-four hours and continued to the end of sixty hours at least. If there are then no signs of general or local infection of the peritoneum, liquid diet, ½ to 2 ounces every two hours by day, are begun and rapidly increased in amount if no complications arise. While the rectal feeding is maintained, the bowel should be cleansed daily (p. 140); when feeding by mouth is resumed, the bowels should be moved by enemas only till the fourteenth day.

Complications and Sequelæ.—(1) *Sepsis or gangrene at point of union* may show itself either in a general peritonitis or as a localized abscess at the site of the intestinal operation, with possibly a fecal fistula (p. 471).

(2) *The Button May Not Pass.*—If no symptoms arise, this need not disturb doctor or patient. The button may make difficulty in passing the external sphincter; it may cause obstruction in the gut and call for intervention. It should come away by the fourteenth day. If it does not pass, nothing but symptoms of obstruction would warrant further operation.

ABSCESS OF LIVER

After the abscess-cavity has been thoroughly opened, a large gauze wick is packed into it, other wicks draining the fossa below the liver and walling off the general peritoneal cavity. The wound is covered with a large sterile gauze dressing and the patient kept on the right

[1] Brit. Med. Jour., 1896, i, 451.
[2] C. P. Gibson, Ann. Surg., 1900, xxxii, 486, 676.

side in bed to encourage free drainage. The outer layer of gauze is reinforced whenever it becomes necessary. The wicks are removed on the fourth day and replaced, being changed daily thereafter, and shortened at each dressing. They are left out when the discharge from the wound ceases to be purulent and the sinus has closed to a depth of 3 in. When there is a discharge of bile, the edges of the wound must be kept smeared with some protective salve, such as stearate of zinc ointment. The stitches, if any, are removed on the tenth day.

The general principles of after-treatment to be followed do not vary in the main from those in any celiotomy. These patients are always extremely sick, and stimulation forms an important part of the after-care. When recovery takes place, the stay in bed will depend largely upon the patient's condition, seldom being less than four weeks. The patient should be kept in bed until the temperature has been normal at least a week and until the sinus has well closed down.[1]

Complications and Sequelæ.—*Septicopyemia* is extremely common and usually fatal. Peritonitis or empyema and septic pneumonia may have developed before operation from rupture of the abscess either into the peritoneal cavity or through the diaphragm. The treatment of these complications is described in the appropriate sections.

Secondary hemorrhage may occur and necessitates repacking the wound in the liver with a firm gauze pack. Failure to open up all the abscess-cavities in the liver is probably the most common complication and the most frequent cause of death after this operation. This is usually unavoidable. All that can be done at the time of operation is to explore the abscess-cavity as thoroughly as possible and try to open all pockets. If after operation there is still elevation of temperature which shows no downward tendency, it is at least worth while thoroughly to explore the sinus again and endeavor to find an unopened abscess.

A *biliary fistula* frequently develops, but spontaneous closure is the rule.

HYDATID CYST OF THE LIVER

The operation for this condition may be done in one or two stages. If the latter, the liver over the tumor is sewed to the abdominal wound, and the tumor is then, or three days later, incised and drained. Hemorrhage from the cyst wall, at the first moment of relief of tension, is met by packing. The cavity will have to be packed firmly and may take many months to heal. It may well be wiped out every two or three days with full strength tincture of iodin.

If the operation is completed at one sitting, the cyst is opened and

[1] A. B. Herrick, Surg., Gyn., and Obst., 1910, xi, 472.

drained and its lining removed so far as possible. The cavity is packed with sterile gauze, and another gauze wick is passed into the abdomen below the liver to wall off this region. These wicks are both removed on the fourth day and replaced by a single wick into the cyst cavity. The dressing is then done daily, the gauze drain being shortened each time. When discharge from the sinus is reduced to a minimum, and its depth does not exceed 3 in., drainage is omitted. Stitches are removed on the tenth day.

The general principles of after-treatment are the same as after any celiotomy. The length of stay in bed will depend upon the rapidity with which the wound closes—usually about three weeks.

Complications and Sequelæ.—Infection is to be met by free drainage. Secondary hemorrhage is to be controlled by packing the liver wound firmly with gauze.

Biliary fistulæ close spontaneously, and require only that the skin about the wound be kept in good condition by smearing it twice or three times a day with 10 per cent. stearate of zinc ointment.

GALL-BLADDER AND BILIARY PASSAGES

Bevan's incision (Fig. 152)[1] is, in our experience, by all odds the best, the most favorable for exploration and drainage, and most efficient for after-care. This is the so-called S-incision, a main vertical arm with an extension at the upper end inward and at the lower end outward if necessary. Preliminary to the after-treatment of gall-bladder operations, it should be noted that undoubtedly surgeons remove gall-bladders which had better be drained, and it is here appropriate, therefore, to insert remarks on the place of cholecystectomy.

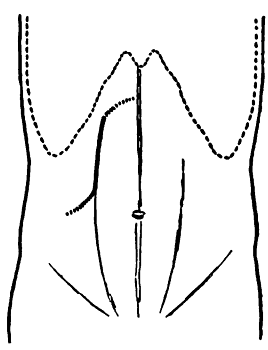

FIG. 152.—BEVAN'S INCISION FOR OPERATIONS ON GALL-BLADDER AND BILE-DUCTS (KEEN'S SURGERY).

"(1) Certain lesions in themselves *demand* removal of the gall-bladder whenever possible. Such are new growths and gangrenes. (2) Certain other lesions of the gall-bladder *are better treated* by cholecystectomy.[2] These are the contracted and inflamed gall-bladders with thickened walls. All gall-bladders which do not permit easy and efficient drainage should be extirpated, for in such gall-bladders the risks of drainage are quite as great as the risks of extirpation, and the one great advantage of retention is im-

[1] M. H. Richardson, Ann. Surg., 1899, xxx, 17.
[2] Med. News, New York, 1903, lxxxii, 17.

possible—retention of the biliary reservoir to fulfil the functions of that reservoir, and to permit, if necessary, renewed drainage in future years. (3) Drainage is preferable in the dilated and infected gall-bladder, which, however, is neither gangrenous nor to any great extent changed—the slightly thickened gall-bladder containing gall-stones and infected bile. This gall-bladder will, after drainage, become normal, and, therefore, capable of fulfilling the functions of a gall-bladder. Through it the biliary passages will become effectually drained, after subsidence of the temporary swelling about the cystic duct. (4) As a rule, drainage rather than extirpation is demanded in acute cholecystitis with severe constitutional symptoms, when the gall-bladder is dilated, or at least not contracted, and when it is not gangrenous. (5) In chronic cholecystitis, with dilatation and thickening of the gall-bladder, especially when a stone is impacted in the cystic duct, extirpation is the preferable operation, unless the stone can be dislodged backward into the gall-bladder, in which case drainage is, if not preferable, quite as advantageous as extirpation. (6) In simple gall-stones, without visible evidence of infection or chronic changes incompatible with restoration of function, simple drainage of the gall-bladder is indicated. (7) In chronic pancreatitis, whether associated with gall-stones or not, drainage through the gall-bladder is indicated. Cholecystectomy is unjustifiable, for immediate drainage is essential. Furthermore, reopening of the biliary passages may, in the future, be required."

The after-care of cholecystectomy is similar to that for cholecystotomy, which follows.

CHOLECYSTOTOMY

A piece of rubber tubing, in diameter $\frac{1}{3}$ to $\frac{1}{2}$ in., with fairly stiff walls, rounded at the end, with one or two windows cut near the proximal end, is inserted into the wound of the gall-bladder. It is long enough to reach to the deepest part of the gall-bladder. It is held in by a purse-string suture of catgut, placed far enough from the edge of the gall-bladder wound to allow invagination of the gall-bladder wall round the tube. This invagination is done in order that after removal of the tube in due time the invaginated serous surfaces will approximate and heal. This procedure is supposed to shorten to a notable degree the duration of the biliary fistula. A Paul tube (p. 468) of small diameter may be used in the gall-bladder instead of rubber. It is held in with a catgut purse-string suture. Deep in the flank, or in any other region where bile or other possibly infective matter has reached during the operation, a wick or some other form of drain is placed. The skin wound is entirely closed except for these wicks and for the gall-bladder drainage-tube. The tube is now insured against pulling out by motions of the patient by fastening it to the skin, as it emerges, with a single stitch.

A voluminous dressing is applied, and the swathe is so pinned that the tube emerges between two safety-pins where the ends of the swathe proximate. A hemostatic forceps is snapped on the end of the drainage-tube until the patient reaches the bed. The drainage-tube is then connected by a glass tube to a long rubber tube hanging over the edge of the bed into a bottle fastened to the bed-frame. Siphon drainage is then established.

McArthur recommends (as does also Matas[1]) connecting periodically a saline drip to the tube in the gall-bladder to allow water to find its way into the duodenum by way of the cystic duct, thus at one time to allay inflammation of the common duct, to restore its patency, and to get a larger quantity of fluid high into the intestines. This may be valuable in any very septic case of cholecystitis or choledochitis.

The dressing is changed as often as it is stained. The tube is left in the gall-bladder for a period varying from three days to two weeks, depending on the amount of cholecystitis originally present and persisting. Whenever, after the third day, the temperature becomes normal, the drainage-tube is removed. The dressings then have to be changed with great frequency at first. The skin is preserved against maceration and irritation by the application of compound tincture of benzoin, sterile zinc ointment, or some such emollient. The fistula will remain open for a period varying from ten days to many weeks and even months. They always eventually close if the common duct is patent and if no malignant disease is present. The patency of the common duct is to be proved by investigation at the time of operation, and by the presence of bile in the stools.

The patient has five pillows on the second and third day and may get up in seven to ten days. These patients are so often fat and very thick-walled that one should be relatively conservative in getting them up. Too much emphasis has been put upon the statement that ventral hernia is relatively rare in the upper quadrants. Some of the worst herniæ seen are through gall-bladder incisions. The stitches should come out on the tenth to twelfth day. The bowel should be moved from the first with calomel and the alkaline salts. If after such mild purging for a week or ten days no bile appears in the stools, it may be assumed that the common duct remains or has become blocked, and ultimately further operation may be necessary.

If the patient walks, a fitted belt may be desirable to hold on the bile-stained dressing. Toward the end of the drainage the discharge will appear in spurts, much one day and then none perhaps for two or three days, then drainage again, etc.

[1] Surg., Gyn., and Obst., 1911, xii, 185.

Anemia should be treated; fats and milk should be diminished or absent in the early diet. Regular daily exercise, under a gymnasium instructor, is to be begun at the end of three months, if the scar is firm. The daily use of artificial Carlsbad or some similar salt, and the periodic use of calomel are advised to maintain duodenal cleanliness and to prevent possible recurrence of cholecystitis.[1]

Complications and Sequelæ.—(1) *Hemorrhage*, delayed or secondary, is not infrequent in jaundiced cases and in cancer of the gall-bladder.

(2) *Peritonitis* may result from escape of infected bile during operation.

(3) A *stone not found* during operation may get loose from deep in the gall-bladder and block the drainage-tube or the common duct, and symptoms of obstruction may reappear.

(4) *Persistence of jaundice* and clay-colored stools mean common-duct obstruction due to duodenitis, choledochitis, impacted stone, or cancer.

(5) *Persistent Fistula.*—Ordinarily, the discharge of bile ceases in from two to four weeks. It may persist many months. In such a case the skin only should be kept open with a short piece of stiff rubber tubing with a safety-pin as a cross-piece. Exploration as to the cause, assuming that there be no signs of common-duct obstruction, should be postponed at least a year.

(6) *Hernia Through the Scar.*—Though this wound is so high in the abdominal wall, we have seen some of the worst hernias through it, one containing practically all the intestines and omentum. The importance, then, of preventive measures is obvious.

(7) *Typhoid fever* has been observed shortly after this operation, the patient being probably, at the time of operation, a bacillus carrier.[2]

CHOLECYSTENTEROSTOMY

With the improved technique by which the common duct can be reached to remove obstructions in any part of it the operation of connecting the gall-bladder and the intestine is now rarely necessary. Performed with either a Murphy button or by direct suture, it calls for no special after-treatment. A temporary drain goes down to the site of operation, to be removed, if there is no leak, within two or three days.

[1] E. M. Stanton. Jour. Am. Med. Assoc., 1911, lvii, 441: End Results in Gall-bladder Surgery.

[2] L. Arnsperger, Med. Klin., Berlin, 1910, vi, No. 36.

Complications and Sequelæ.—(1) The possibility exists of *infection of the ducts* and the liver from the intestine. The chance of this may last a long time. This has been proved in one case,[1] where death occurred fifty-three days after the operation, and was found to be due to infection of the biliary passages in the liver, exhibiting numerous abscesses. The escape of intestinal contents into the gall-bladder can with certainty be prevented only by short-circuiting the intestinal contents by an entero-anastomosis.

(2) *Contraction of the opening* may take place whatever method is used, unless the opening is made very large.

(3) *Hemorrhage* from the wall of the gall-bladder is distinctly possible, especially if malignant disease is present. If packing fails to stop such a hemorrhage, the actual cautery should be tried.[2]

(4) *The Button May Not Be Passed.*—In such a case it probably falls back into the gall-bladder and may there cause no inconvenience.

CHOLECYSTGASTROSTOMY

No special directions are necessary for this rare operation. The bile is in no way injurious to the stomach, nor does it interfere with digestion.[3]

[1] Rickard, Bull. Soc. Chir., 1894, xx, 592, quoted by Jacobson.

[2] Shephard (Ann. Surg., 1893, 581) reports a patient aged thirty-six, who had a biliary fistula resulting from a previous cholecystotomy for jaundice, pain, etc., performed four months previously, when no stone was found. Owing to the annoyance of the continual discharge of bile, the abdomen was opened again by an incision internal to the old fistula and a mass of malignant disease was now found involving the pancreas and duodenum. It was decided to unite the gall-bladder with the colon instead of the duodenum "as being easier and more rapid, and quite as beneficial." The button was introduced without very much difficulty, a purse-string suture being first inserted. Owing to the thickness of the gall-bladder there was some puckering, and the parts did not come together without considerable pressure on the button. On dropping back the bowel and gall-bladder with the button there was no contraction, and the parts seemed to be in accurate apposition and to lie comfortably. It was decided not to close the fistulous opening, as it was felt that this would close of itself. On the morning of the fourth day (the patient having gone on well in the interval) blood was found to be oozing from the gall-bladder and the abdominal wound. In spite of gauze packing this continued and the patient passed into a state of collapse. On opening the abdominal wound it was found that the hemorrhage came entirely from the gall-bladder. The button had cut through the thick and friable walls and could be easily seen. To remove the button it was necessary to incise both gall-bladder and bowel and unscrew the button. It being useless to reinsert the button, it was decided to sew up the openings in the gall-bladder and colon. A fresh oozing took place about twenty-four hours later, and the patient sank. A partial necropsy showed that the obstruction of the common duct was due to malignant disease of ribs and pancreas.

[3] Moynihan, Brit. Med. Jour., 1901, i, 1136.

CHOLEDOCHOTOMY

After this operation the surgeon may either close the duct by suture or may drain the duct by rubber tube. On the whole, at the present date, drainage is the usual course. This drainage may be direct or indirect: direct, if a small soft-rubber tube is put through the wound in the common duct, entering the duct and bending upward toward the liver, held in place by a single fine catgut suture. The tube passes upward toward the hepatic duct about an inch. If the opening in the common duct is large, it may be made smaller by a stitch or two to fit fairly well the drainage-tube.

"The tube is stitched in by a single catgut suture which picks up the wall of the common duct a little outside the edge and passes through the tube. So long as this stitch holds,—seven to ten days,—the tube will remain in place. In addition to this tube another drain is necessary on the outer side of the duct. For this I prefer a rubber tube split longitudinally, with a fine gauze wick. The tube lies to the outer side of the duct in the kidney pouch; it may be brought out of the abdomen incision or made to present in a stab wound of the loin—preferably the former. A third tube, to lie to the inner side of the duct, is occasionally necessary. The gauze wick projects about 2 inches from the inner end of these tubes. These tubes are left in from three to ten days, as seems necessary. There is no advantage in removing them early." (Moynihan, Gall-stones, 1904, p. 342.)

Drainage is indirect when the wound in the common duct is closed, and the drain is left either in the gall-bladder or in the stump of the cystic duct if the gall-bladder has been removed. I think it is conceded that the best surgeons agree that suture of the common duct is "always unnecessary and sometimes harmful."

"If it is deemed prudent, the common duct may be closed by suture. This is done by a continuous stitch from end to end of the incision in two layers. It is important to avoid wounding or penetrating the mucosa, as any suture which gains access to the lumen of the duct may form the nucleus of a calculus. When the wound is securely closed, a split rubber tube, with a gauze wick, may be passed down to the duct as a matter of precaution in the unlikely event of any leakage ensuing." (Moynihan, *loc. cit.*, 343.)

CHOLEDOCHOSTOMY

This operation is done intentionally for enormous cyst-like dilatations of the common duct, the opening in the cyst being sewed to the peritoneum.[1] The after-treatment is that of cholecystotomy.

[1] Russell, Ann. Surg., 1897, xxvi, 692.

CHOLEDOCHENTEROSTOMY; CHOLEDOCHECTOMY

These operations also call only for a carefully placed wick in relation to the line of sutures as a temporary safeguard.

CHOLEDOCHODUODENOSTOMY

This operation[1] calls for no special directions in after-care. The temporary preventive drainage is placed down to the site of operation as a matter of safety.

"One point cannot be too frequently nor too strenuously emphasized; that is, that drainage is the secret of success in gall-bladder surgery; it is always an advantage, often imperative. In cases of cholangitis, as made manifest by fever or jaundice, or both, and of pancreatitis, drainage must be practised and should be maintained for a considerable time." (Moynihan, p. 354.)

DUODENOCHOLEDOCHOTOMY

In this operation, first done by McBurney in 1891, the duodenum is opened and the termination of the common duct in the second portion of the duodenum exposed. After the stone is removed the split ampulla is not sewed. It is rather an advantage to leave it open. If the stone, however, lay in the second portion of the duct, the opened duct will have to be fastened again to the duodenum. The duodenum is then closed, and a spiral drain is put down to the line of suture for temporary drainage.

HEPATICODOCHOTOMY

This operation needs only to be mentioned and reference made to a single characteristic case.[2]

"Incision in upper right linea semilunaris. The gall-bladder was found empty and flaccid, the ducts were palpated, and a stone was felt deep under the liver in the hepatic duct. The stone could not be pushed along the duct nor crushed with the fingers. No stone was felt in the common or cystic duct. After separating numerous adhesions, the stone was shoved between the thumb and forefinger of the left hand and pulled out from its deep position. Adhesions and duodenum were pushed aside until the stone appeared between the fingers, with only the peritoneum and the wall of the duct covering it. The field of operation was packed with gauze to prevent contamination with bile, the duct was incised, and a stone the size of a robin's egg extracted. The duct was closed at once with catgut sutures, a second row of silk sutures, including the peritoneum, being placed outside; the duct was held with the fingers and very little bile escaped. A drainage-tube and gauze were packed

[1] Thienhaus, Ann. Surg., 1902, xxxvi, 928.
[2] Elliot, Ann. Surg., 1895, xxii, 86.

down to the sutured duct; the duct did not leak, and the second day the gauze drain was removed. On the fourth day the abdominal wound was completely closed by provisional sutures. The patient was well in three weeks."

HEPATICODOCHOSTOMY

In this operation the hepatic duct is opened and sewed into the abdominal wound.[1] Drainage in these cases is intended only until the flow of bile can be reëstablished into the intestine at some later operation. No particularly new features in after-treatment are noteworthy.

HEPATICODOCHOLITHOTRIPSY

In this operation[2] the stone is crushed in the hepatic duct by the fingers, and this procedure is usually incidental only to operation on some other portion of the biliary system. No special after-treatment, therefore, is to be noted.

GUNSHOT AND OTHER INJURIES OF THE ABDOMEN

It is to be assumed that all gunshot wounds of the abdomen shall have exploratory operation. This is true in civil life, at least. Treves found in the Boer war,[3] it is true, that many cases of abdominal gunshot wound which had undoubtedly suffered intestinal injury, endured prolonged exposure, and tedious transportation, yet recovered without operation. Treves went so far as to conclude that it is impossible to operate in cases in which the abdomen is traversed above the umbilicus, owing to the multiple character of the injuries, while cases in which the abdomen is traversed below the umbilicus get well without operation. He advises operation only when the bullet has escaped, so that its course is known, and when the general condition is good and there are signs of abdominal hemorrhage continuing. These conclusions, however, refer only to wounds produced by bullets, such as the Mauser, which does not spread on impact, is of small diameter, and travels with great velocity. One surgeon[4] found that Mauser abdominal injuries, when not immediately fatal, have been followed by a recovery in more than 60 per cent. of cases under expectant treatment.

In civil practice, however, every penetrating wound of the abdominal wall is to be explored. An attempt is made first to stop

[1] Leonard Rogers, Brit. Med. Jour., 1903, ii, 706, quoted by Moynihan.
[2] Baillet, Bull. et Mem. Soc. de Chir., xxix, 1194, quoted by Moynihan.
[3] Brit. Med. Jour., 1900, i, 1156.
[4] Spencer, Med. Annals, 1901, quoted by Jacobson.

hemorrhage. Then a systematic search for injuries of the viscera is made, but with as little evisceration as possible; that is, the intestine examined is returned to the cavity as the next loop is pulled out. Wounds in the alimentary tract are closed by linen thread or silk suture in every instance, unless by so closing a kink is produced; in other words, resection is avoided when possible. Drainage should be instituted in all cases into both kidney pouches, into the pelvis, and down to the exact region of any sutured gut about which the surgeon has the least doubt of viability. If the lesser omentum has been opened by bullet or operation, and especially if there is the slightest possibility of wounds of the pancreas, efficient drainage, which, indeed, amounts at first to packing, should be established.

In most instances the patient should be able to get on without nourishment for twenty-four to thirty-six hours. During this period, if possible, such peristalsis even as would be excited by mild enemas should be avoided, though distention is present and indication for enemas exists. At the end of this time rectal feeding should be begun, except in those instances where the large intestine was wounded. Rectal feeding need not continue beyond sixty hours after operation, except for injuries of stomach and duodenum. (See Gastro-enterostomy, p. 457.)

If there are no signs of peritonitis or leakage from the various repaired intestinal unions or from the pancreas, the wicks may be withdrawn in forty-eight hours. If for wicks the spiral drains (see p. 252) have been used, they can be extracted without much pain and without tearing adhesions. Except in injuries of the large intestine, as above noted, the bowels should be evacuated solely by means of enemas during the first ten days. Morphin should be used as little as necessary, and, preferably, always together with atropin.

CHAPTER XLV

OPERATIONS ON THE ABDOMEN (Continued)

THE RADICAL CURE OF HERNIA

THE dressing after operations for inguinal and femoral hernia should be bulky enough to give some compression to the wound, in order to prevent oozing of serum or blood, such as might collect be-

FIG. 153.—ABDOMINAL SWATHE AFTER CELIOTOMY, FRONT VIEW.
It is made to fit snugly by taking a "gusset" in each side with safety-pins. Folded towels are employed, one about each thigh, for perineal straps, and are pinned over the anterior superior spine.

tween layers of muscle. This dressing may be held on with collodion, but I have seen the skin, which in this region is especially thin and sensitive in some people, show irritation, even to the extent of blistering, after collodion applications. The dressing is better held on, therefore, with strips of zinc-oxid plaster and a swathe applied, as in Fig. 153, or with two T-bandages, the crotch pieces of the two being pinned or tied up over the groin on each side respectively; best of all, the dressing may be held on by a Cunningham hernia spica. (See Figs. 155-157.) There seems to me to be not enough advantage from the application of a broad gauze spica bandage (Fig. 158), over the dressing, to offset the possible dangers to newly sewed muscle layers during the manipulations necessary in the application of such a bandage. The

FIG. 154.—ABDOMINAL SWATHE AND PERINEAL STRAPS. SIDE VIEW.

same holds true of the plaster-of-Paris spica which some surgeons apply to maintain flexion of the thigh. Whatever form of outside dressing is applied, care should be taken that the testicles and scrotum are well supported and their blood-supply not interfered with, otherwise hematoma or gangrene may result. The patient should be put to bed, with the thigh slightly flexed by means of a pillow under the knee to avoid unnecessary strain on the lines of sutures. The patient should be kept practically horizontal; every means should be taken to avoid cough, efforts toward sitting up, or straining at stool; the bowels should be moved by enemas only for the first ten days for this reason.

The single intracuticular stitch should be removed about the tenth day. The patient should not get up before the fourteenth day, and

FIG. 155.—APPLICATION OF THE CUNNINGHAM HERNIA SPICA.

To one end of a strip of Shaker flannel 6 in. wide and 14 in. long is sewed a strip of zinc-oxid plaster of the same width and 24 in. long; at the other end of the flannel a piece 14 in. long. The application is started by so placing the midsection of flannel under the slightly flexed thigh and in the crotch that the short plaster end is carried over the dressing to the loin on the operated side; the long plaster end crosses the dressing to the opposite loin.

FIG. 156.—CUNNINGHAM HERNIA SPICA.

The two adhesive plaster strips cross over the dressing.

many surgeons make three weeks in bed the rule after inguinal herniotomy in men; he should avoid heavy lifting for three months if possible. In children under five or six years of age who are hard to control it is probably best to apply the plaster-of-Paris spica bandage outside the dressing to assist in immobilizing. These directions apply to all varieties of operation: the Johns Hopkins operation,[1] the Bassini

FIG. 157.—CUNNINGHAM HERNIA SPICA.
The long end being applied to the opposite loin.

FIG. 158.—APPLYING THE GAUZE SPICA DRESSING AFTER HERNIOTOMY.

operation,[2] the autoplastic suture method of McArthur,[3] and *femoral hernia*.[4]

[1] Halsted, Johns Hopkins Hosp. Bull., 1903, xiv, 208.
[2] E. Bassini, Arch. f. klin. Chir., 1890, xl, 429.
[3] L. L. McArthur, Jour. Am. Med. Assoc., 1904, xliii, 1039.
[4] Hayward W. Cushing, Boston Med. and Surg. Jour., 1888, cxix, 546.

Retroperitoneal hernia, whatever the operation,[1] calls for no special after-treatment except the general considerations of celiotomy and intestinal surgery.

After the operation for *obturator hernia*,[2] no special details of after-treatment are to be noted. The stay in bed should be the full three weeks.

Epigastric hernia[3] presents only the problems of simple celiotomy.

Interstitial hernia,[4] whether ventral or inguinal, calls for no detail of after-treatment different from those already given.

Umbilical hernia[5] is undoubtedly best treated by the operation of the type of Mayo. The dressing after this operation and that for *ventral hernia* should be held on, and all tension on the wound removed by the application of a large number of plaster straps in many directions, and also by a snugly pinned abdominal swathe. There is probably no increase of pressure if the patient sits partly reclining on a bed-rest, if such a position is more comfortable. The bowels should be kept freely open by enemas to avoid all straining at stool. The skin stitches are removed on the tenth day; the wound is kept reinforced by plaster straps for at least three weeks, and an abdominal belt is usually advised. The patient should be in bed at least eighteen days.

Complications and Sequelæ.—(1) *Pulmonary* or *cardiac embolism* are always fearful possibilities, more probably if a large hernia of long standing has been reduced or if a considerable mass of omentum has been tied off and removed. (See Large Incarcerated Hernia, p. 492.)

(2) *Sepsis* should be uncommon. It usually starts in or just under the skin, and should be checked at once by removing the skin-stitch and applying a series of wet dressings. Deep sepsis may require a thorough opening of the whole wound, sacrificing the cure of the hernia to preserve the life of the patient.

(3) *Persistent sinus* may follow sepsis. The sinus will be found to lead to a non-absorbable suture. If this does not come out in a few days, the sinus should be explored with a fine crochet-hook till the offending knot is found and extracted.

(4) *Recurrence of the hernia* may be seen as early as six weeks.

[1] B. G. A. Moynihan, Retroperitoneal Hernia, London, 1899, reviewed in Ann. Surg., 1903, xxxvii, 120.

[2] Schopf, Wien. klin. Woch., 1903, xvi, 8.

[3] H. A. Lothrop, Boston Med. and Surg. Jour., 1901, cxlv, 589–611.

[4] P. Berger, Revue de Chir., Paris, Jan., 1902.

[5] W. J. Mayo, Ann. Surg., Aug., 1901, xxxiv.

When so early, if not due to sepsis, the recurrence may be laid to poorly nourished, worn-out tissues, as in the aged, or to giving way of sutures. We believe catgut, except for superficial fascia, to be unsuitable for this operation. Pagenstecker linen thread, No. 14 twisted silk, kangaroo tendon, or silver wire [1] we believe to be more reliable.

(5) *Slough* or *gangrene of testis* will follow unnoticed or unrepaired accidental wounding of the vas or the formation of one or both new rings so tight as to shut off circulation in the cord. Unless the fault is discovered at the time of operation or within a few hours, the testis will have to be removed, either in pieces from the sloughing wound or as a whole, by formal operation.

Truss After Radical Cure for Hernia.—Drs. Bull and Coley say: "Personally, we never advise a truss in children after operation, and we consider the recumbent position for three montns entirely unnecessary. Our experience, based on a series of upward of 600 cases of hernia in children under fourteen years of age, has shown that two to two and a half weeks is ample time for the child to remain in bed. The subsequent history of these cases has been traced with scrupulous care, and some of them have been well upward of seven years. Even in adults we very seldom advise a truss after operation. There are, however, some cases in which a permanent cure will be more likely to be obtained if a support be worn after operation. Such cases are those beyond middle age, with poorly developed and flabby abdominal muscles and a superabundance of fat. We would also include cases in which hernia is of unusual size in adults past middle life."

It would seem reasonable, therefore, where an operation fairly satisfactory to the operator has been done, to await signs of recurrence before ordering a truss. Certainly the abdominal belt, with a plate in it pressing over the scar, is not to be advised. It causes local pressure ischemia, and, therefore, slow healing of the wound, and renders the abdominal muscles more flabby and more liable to stretch. A hernia patient should be advised to avoid strenuous exercise in a position such as would tend to open possible hernial orifices. For instance, he may be advised not to lift heavy things unless his knees are kept together; not to lift himself up by his hands, as in horizontal bar exercises or climbing a mast.

In children under two years inguinal hernia can frequently be cured by the use of a truss. For this purpose a *worsted truss* is to be advised because of the cheapness and cleanliness. When soiled, it can be changed and washed; it can be worn in the bath, and is less likely to irritate the

[1] J. Wiener advocates silver filigree. Ann. Surg., 1910, lii, 678.

skin than a spring truss. To apply such a truss the child is laid on his back and the hernia reduced, a half skein of white Germantown worsted is passed under the body at the level of the hernia, and is pulled through until the end on the side of the hernia just reaches the internal ring; the other end is passed through the loop of the first end, the bunch of worsted, made by looping one end through the other, is then adjusted firmly over the hernial opening, and the free end is passed under the crotch and fastened by a safety-pin or a bit of bandage to the middle of the part passed around the back. This truss should fit snugly, and should be worn at night as well as during the day. The success of this method depends upon the care with which the mother carries out instructions in regard to adjusting the truss frequently.

LARGE INCARCERATED HERNIA

The fatal issue in many of these cases is due to the sudden and marked increase of intra-abdominal pressure, especially limiting the function of the diaphragm, which follows the reintroduction into an abdomen, which has long since become too small to hold it, of a large mass of intestine and fatty omentum. If it seems best to operate these cases, they should be submitted for a considerable period, whenever possible, to a regimen that shall definitely reduce weight. By these means the mesenteric fat diminishes and the abdominal wall becomes thin.

The following history, which illustrates this point, is by the French surgeon, George Arnaud, who published in 1748 "A Dissertation on Hernias or Ruptures," quoted by Marcy (Ann. Surg., 1900, xxxi, 71):

"Mr. Boudon recommended to my deceased father a man of forty years of age and of a very strong constitution. He was extremely fat and 6 ft. 1 in. in height, French measure. His name was Mr. Tregneux, was an inhabitant of Clamsey, in the diocese of Auxerre. He had an hernia from his infancy, which had never reëntered. It was 32 in. in circumference at its lowest part, 19 at the ring, and 16 in length. For more than ten years his penis had been lost in the bulk of the tumor, so that the preputium formed a kind of depression like that of the navel, and in making water his urine was diffused over all the tumor, which was very troublesome to him. As he was a timber merchant, his business obliged him almost every day to ride forty or fifty miles on horseback, which induced him to invent a large cavity in the fore part of his saddle, in which he placed his tumor. Being at last reduced to such a condition that he could no longer follow his business, and being afraid that this disorder, no less terrible than insupportable, would soon put an end to his life, he determined to apply for relief. It was in 1726 that he was introduced to us. He found a great deal of comfort from the recent example, which my father and I gave him, of the cure of a similar disorder. He submitted to everything we prescribed, either for his relief or radical cure, but on condition, said he, that he should have a little to eat, for he was a prodigious glutton. Persons of this kind may observe a very strict regimen, even by eating a little. We may, therefore, recede from the general rule in their favor without any fear of doing harm, for their great appetite requires this kind of liberty. He was bleeded several times, then purged, and afterward used 12 or 15 baths. Twice a day I made strong embrocations of his abdomen with oil of melilot, and covered the whole tumor with a plaster composed of the emplastrum de vigo, prepared with a good deal of mercury, of the diabotanum, and the mucilages, and this I renewed every four days. We made him every morning take 10, 12, 15, or 20 gr. of mercur. dulc. He drank plentifully, and had four emollient and purgative clysters injected every day. Every four days we purged him with cassia, with an intention to evacuate the humors and prevent a salivation. This method succeeded very happily, for the evacuations lasted sixteen days, and were so copious that they every day redoubled the patient's astonishment.

"The tumor during this time had lost about three-quarters of its bulk, and more than a half of the remaining quarter we made to reënter by taxis, so that the hernia, being thus reduced to one-eighth part of its bulk, was in a condition to be contained in the hollow cushion of a truss. It afterward diminished insensibly for eight or ten days, during which time we took care to fill the cavity of the cushion, in proportion as the bulk of the tumor diminished. On the thirty-sixth day from the first venesection the parts reëntered all together and the testicle also. We then used a convex instead of the concave cushion. The patient in a very short time resumed his strength and flesh, and followed his business with a great deal more vigor than ever he had done. The first thing he did at his return home was to make his wife pregnant, with whom he had had no amorous converse for ten years before. He quitted the use of the truss eighteen months after; that is to say, in 1728.

"Twelve years after, he had occasion to come to Paris, where he called for me immediately on his arrival, rather to testify his gratitude than for any other reason; but as I did not know him, he put me in mind of everything that had happened in 1726. I examined the parts, which I found so firm and solid that one could have hardly imagined that he had formerly labored under an hernia. The skin of the scrotum was returned to its natural state, only it was very thick; and the bottom of the scrotum, which had approached to the ring on account of the herniary sac of the testicle, was fixed or glued over the ring. This portion of skin seemed to make a kind of stopper, which filled the cavity of it. But, though the disorder had no appearance of a relapse, I ordered the patient to wear a truss by way of prevention. The reason of which I shall afterward give in a particular instance. From this observation it is sufficiently evident that what at first appeared a paradox is a truth easily perceived by persons of penetration; but, as it may perplex the more ignorant and illiterate part of mankind, I shall, for their sake, render it still more intelligible by a method of reasoning as clear and perspicuous as I possibly can.

"The parts had insensibly accustomed themselves to this new abdomen which nature had formed for them. They had there fixed a permanent residence for themselves, whence it was impossible for them to remove on account of the adherences they had contracted. Without the methodical assistance afforded it was impossible that they should ever of themselves have reëntered the abdomen, but by the disposition into which they were put they were forced to resume their natural place, though they were lean and emaciated, yet when they were reduced, they resumed their former bulk, in the same proportion as all the other parts of the body resumed their flesh. Now they could not slip out again, after they were once in the abdomen, because they were become larger than the diameter of the ring, so that the patient must necessarily have been cured long before he left off the use of the truss. The following fable applied to this subject will more sensibly enable us to comprehend what hinders these sorts of hernias from reëntering and what obliges them to remain in the abdomen after they are reduced.

"'Into a wicker cask, where corn was kept,
Perchance of meagre crops, a field mouse crept;
But when she fill'd her paunch, and sleek'd her hide,
How to get out again, in vain she try'd.
A weasel who beheld her thus disturb'd,
In friendly strain the luckless mouse address'd,
'Would you escape, you must be poor and thin,
To pass the hole thro' which you entered in.'"

(Horace, Lib. I, Epist.)

After operation the patient should be sat up at once in bed with proper support to the wound, to diminish diaphragmatic pressure and to forestall the occurrence of thrombosis and pneumonia. An abdominal swathe should be worn for six months at least, and, in especially gross patients, permanently.

Cardiac embolism and thrombosis or pulmonary embolism are much to be feared, especially if the hernia was largely omentum and much was resected. For an illustrative case see Chapter IX, p. 114.

STRANGULATED HERNIA (INGUINAL OR FEMORAL)

The patient should be kept in such a position in the bed that there is little or no strain on the wound. It is theoretically good, at least, to have the buttocks slightly raised above the level of the trunk, in order that the reduced bowel may not lie in contact with the freshly sewed ring and so become adherent to it. The patient should be given water freely as soon as it can be borne by the stomach, but no voluminous food-masses should be taken in for at least a week, in order that the injured gut may have a chance to heal. The bowels should be moved by enemas only, in order that no violent peristalsis shall take place above the level of the injured gut. Even though such a wound as that of strangulated hernia is supposed to be aseptic, it should not be allowed to go a week or ten days without inspection; first, because the effort to reduce the strangulated gut or the spilling of the serous content, so often seen in the sac, may have infected the wound to some extent; and, second, especially if the patient be an elderly person, there may be no sign in temperature or pain to suggest sepsis, and yet examination of the wound shows a considerable and wide-spread infection.

After the first few days, if it has been possible at the time of operation to make a radical cure, the case should receive the usual after-treatment of a hernia operation. (See p. 486.)

If the condition of the gut was such that it seemed best to drain the wound, or if, as may be the case in strangulated femoral hernia, so much of Gimbernat's ligament had to be cut that there is little chance that an efficient closing of the defect has been made, it is well, while the patient is still in bed, to have him measured and fitted to a truss, with the idea of allowing him to get out and about for a time, and later, if necessary, have him come back for a secondary operation.

Complications and Sequelæ.—(1) *Peritonitis.*—This may be due to the operation having been done too late, infection taking place by actual rupture of the bowel or from transudation from the strangulated part, or from the reduction of hernial contents, bowel, or omentum, which seem to the operator to be viable, but are not so.

(2) *Sepsis.*—Local sepsis is fairly common in cases not operated within a very few hours. This complication calls for no special comment here.

(3) *The descent and restrangulation* of the bowel where radical cure was not attempted.

(4) *Obstruction* due to paralysis of the damaged intestine.

(5) *Unobserved reduction en bloc* of the hernia during operation, or multilocular hernial sac with a false reduction during operation from one part of the sac to another.

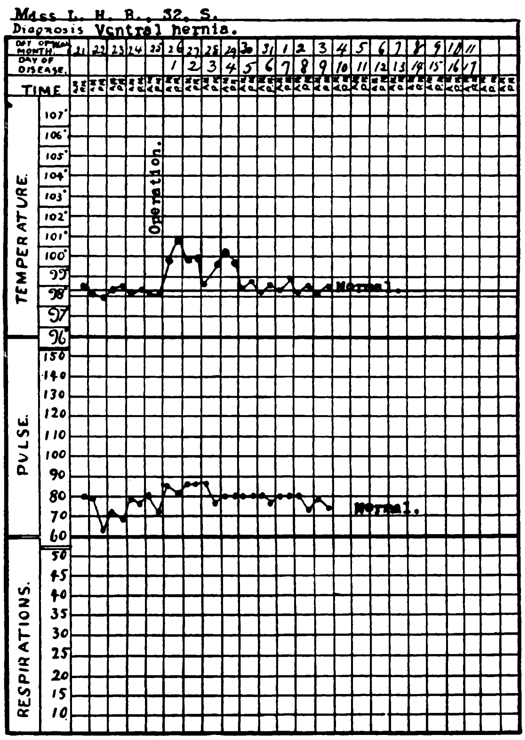

FIG. 159.—LARGE VENTRAL HERNIA. MARKED ASEPTIC REACTION.

Reduction "en bloc" is chiefly met in inguinal hernia owing to the slight surrounding adhesions of the sac and sometimes to the force used in attempts to reduce large herniæ. The sac, still strangulating its contents at its neck, is displaced bodily between the peritoneum and the muscles; or the sac is rent close to its neck and at its posterior aspect, and some of its contents are thrust through into the extraperitoneal connective tissues. The chief evidence of this occurrence is: though the swelling has disappeared perhaps completely, this has taken place without the characteristic jerk or gurgle. On close examination, though the bulk of the hernia has gone, some swelling is to be made out deep near the internal ring, and the symptoms persist in an intensified form. A second operation should be done immediately.

(6) *Obstruction of the intestine by adhesions* to the abdominal wall.

(7) *Cicatricial stricture of the gut* at the site of former strangulation.

These possible pathologic features must be in the mind of one who watches symptoms after operations for strangulated hernia.

OPERATIONS ON THE PANCREAS

Acute Pancreatitis.—The wound in this fairly uncommon and frequently fatal disease is packed with gauze, which acts, first, to stop bleeding, and, second, to establish a drainage tract. Drainage in cases of subacute pancreatitis, and often also in pancreatic cyst, is established by the so-called lumbar route; namely, through a loin incision in front of the left renal vessels.[1] Such a wound follows the route usually taken by nature when pancreatic suppuration points spontaneously. The wound drains freely assisted by gravity, and presents no technical peculiarities, if the first wicks are left in long enough to favor a large direct drainage opening. Alcohol bathing, zinc oxid ointment, and other means must be constantly employed to protect the skin round the wound from irritation and digestion.

Shock, sepsis, and hemorrhage are all here present, and are hardly to be differentiated in importance. The usual indications thus suggested must be followed. Most of the dangers should be over by the end of the fourth day, after which convalescence should be rapid.

The wicks should gradually be withdrawn and made smaller. If there is no contraindication, the sooner the patient is out of bed the better.

Complications and Sequelæ.—(1) Delayed and secondary hemorrhage are very common, owing to the extreme vascularity of the pancreas. This danger is so great that it may indeed be wise to exhibit large doses of calcium lactate (see Chapter VI, p. 71) in operative cases where the diagnosis is made and time permits.

(2) "In leakage of pancreatic juice into the parenchyma of the gland and the surrounding peritoneal structures consists a greater danger even than bleeding. The juice, even when sterile, does much positive damage, which also diminishes the resisting power of the tissues so that the mildest form of infection, ordinarily harmless, becomes of the gravest significance. Infection is liable to reach the injured area through the

[1] J. Ransohoff, Ann. Surg., 1910, li, 670.

pancreatic duct from the duodenum, in the same manner that it passes up the common bile-duct; fat necrosis and pancreatitis, both chronic and hemorrhagic, may be occasioned by trauma and hence may result from operation. Peritonitis is very liable to result from pancreatic leakage. This peritonitis may be aseptic, and is followed frequently by intestinal paralysis, leading to rapidly developing obstruction, which often so modifies the symptoms as to lead to a serious mistake in diagnosis." [1]

Chronic Pancreatitis and Pancreatic Lithiasis.—Operation for this condition is very rare. G. Link[2] reports a case wherein he carried the tail of the pancreas through the abdominal wall, removed the stones, and then drained the duct of Wirsung with a tube. The drainage was collected at the wound in a rubber condom.

Wounds of the Pancreas.—Any wound of the posterior stomach wall suggests that the same agent has made a wound of the pancreas. Such a wound, therefore, is always sought, and if found, is packed with a view to establishing drainage, because of the great danger of pancreatic leakage even through a small wound.

Drainage of Pancreatic Cysts.—These cysts are always drained, and such evidence as we have seems to show that some must be permanently drained, since, at least in those cases where many of the principal ducts of the pancreas communicate with the cyst, recurrence is almost certain and complete obliteration by drainage almost impossible. In Mr. Jacobson's case [3] the swelling reappeared about a year later, and is even said to have appeared a third time after the second operation.

Dr. M. H. Richardson[4] some years ago called attention to this liability to recurrence in drained pancreatic cysts:

"The patient was twenty-one. He had received a kick in the abdomen three years before, which had confined him to bed for three weeks. Ever since he had been liable to suffer attacks of epigastric pain. He had been markedly jaundiced, was emaciated, and suffered a good deal from nausea and depression. The swelling in the epigastric region was convex and uniform, and reached from below the tip of the ensiform cartilage to just above the umbilicus, and laterally to near the ends of the eleventh rib. The tumor gave the impression of being attached to some deep-seated structure. There was trasmitted impulse synchronous with the pulse, but not expansible.

[1] Von Mikulicz, Trans. Cong. Am. Surg. and Phys., 1903.
[2] Ann. Surg., 1911, liii, 768.
[3] Trans. Med. Chir. Soc., lxxiv, 455.
[4] Boston Med. and Surg. Jour., 1892, cxxvi, 441.

As the swelling had refilled after two previous tappings, and as the swelling and the patient's distress were steadily increasing, laparotomy was performed. An incision 3 in. long was made over the most prominent part of the cyst, 1½ in. to the left of the middle line, extending to within 1 in. of the umbilicus. The parietal peritoneum having been retracted to the margins of the wound, the lower edge of the liver could be seen moving with respiration in the upper angle, while the rest of the incision was occupied by a smooth reddish surface which bulged strongly forward. Taking this to be the front of the cyst, and having ascertained before the operation that the cyst was dull on percussion, I was about to leave this for twenty-four hours, to become adherent before it was incised. The result proved that, if I had done so, the scalpel would have passed through both walls of the stomach. Before dressing the wound I again scrutinized the surface of the supposed cyst, and thought I found evidence of involuntary muscular fiber, which threw doubts upon the swelling being a pancreatic cyst. When the supposed cyst was examined between the fingers, it proved to be the empty stomach, stretched very tightly over the subjacent cyst. To get at this the stomach was drawn upward, that it might be packed away above under the liver; but here an embarrassing difficulty arose. As I pulled up the stomach, it was tightly jammed between the bulging cyst behind and the parietes in front; the omentum came up into the wound in front of the cyst. The tension on the parts was so great, owing to the rapid increase in the cyst, that there was no room above in which to pack away the omentum. Pushing this to either side, already fully occupied, I pulled down the stomach again. I accordingly drew the greater part of the omentum out of the wound,[1] some of which was tied with catgut, and cut away; most of it was left heaped up on the abdominal walls on either side of the incision. One or two fine catgut sutures retained the omentum in position. I next scraped through the two layers of the omentum, and exposed the surface of the cyst for a space the size of a quarter. There was thus a somewhat conical passage leading from the abdominal incision, through a mass of omentum, down to the anterior surface of the cyst. This last was very vascular, and so tense that it was not thought advisable to put in a guide suture. The patient passed through the next twenty-four hours fairly well. At midnight, August 23d, symptoms of collapse set in (hemorrhage probably took place at this time into the cyst, a complication which must always be probable, owing to the very vascular surroundings); the patient's pulse at 2 A. M. had run up to 163, and his condition pointed to a fatal ending at no distant date. At 3 A. M. I passed a fine trocar into the cyst, and drew off 12 oz. of deeply blood-stained fluid under very high tension. The sac was then incised and a large drainage-tube inserted. A marked improvement at once set in. A slight discharge of dark, treacley fluid necessitated changing the dressing twice a day at first. The wound was all healed in two months."

[1] "On another occasion I should divide the omentum by the transverse colon."

SPLENECTOMY

This operation has been done[1]—(1) for large wounds of the spleen from gunshot or other injury; (2) for cyst, though this rare condition if drained will always heal; (3) for movable spleen; (4) for malignant disease[2]; (5) for persistent malarial tumor; (6) for splenic anemia or leukemia. Of all these indications, the most favorable is that of injury. Otherwise healthy persons with spleen removed seem to live on for years in perfect health, with no physiologic changes to be observed, even in the blood.

The Mayos[3] have had 10 splenectomies with 9 recoveries. One was lymphosarcoma, alive and well three and one-half years after operation; 1 tuberculosis of spleen; 4 were cases of splenic anemia, 2 were Banti's disease, of whom 1 died; and 2 were enlarged spleens of unknown origin. The 4 splenic anemia cases had pain in the long bones at intervals for several months after the operation.

	May.										June 7.
	22	23	24	25	26	27	28	29	30	31	
White count	21,200	20,300	24,000	13,000	12,800	12,850	26,900	20,200	24,800	33,500	28,500
Red count		1,696,000	3,924,000	4,484,000	4,296,000	4,280,000	4,152,000	4,304,000	4,568,000	4,208,000	4,336,000
Polynuclears (per cent.)		83	87	89	82	73	80	83	84	93	
Lymphocytes (per cent.)		3	3	8	13	17	11	4	7	5	
Eosinophiles		4	1	0	2	11	0	0	0	0	
Large mononuclears (per cent.)		10	9	3	3	9	9	13	9	2	
Mast-cells		0	0	0	0	0	0	0	0	0	
Normoblasts		0	0	0	0	1	0	1	1	0	
											Abscess of lung.

Complications and Sequelæ.—(1) *Secondary hemorrhage* has been repeatedly observed, and apparently in every case it has been due to retraction of one or more vessels from the pedicle. In such cases the pedicle has been tied when tense or each ligature has taken in too great a portion of the pedicle. Hemorrhage may take place, due to general ooze from the cavity in which the spleen was adherent or from adherent omentum. Should the stasis at the end of operation be in any way unsatisfactory, the cavity must be packed for twenty-four to forty-eight hours.

[1] J. Collins Warren, Ann. Surg., 1901, xxxiv, 521.

[2] C. Bush, Primary Sarcoma of the Spleen, Jour. Am. Med. Assoc., 1910, liv, 453.

[3] Coll. Papers, 1910, 491.

(2) *Sepsis.*—There is no particular liability to sepsis after splenectomy. There have been some observations which seem to show that the spleen is at least one of the organs which is important in the work of resistance against bacteria, but it is "proper to conclude that the removal of the spleen does not alter particularly the individual susceptibility to infection, and that its functions in this respect, if they do actually exist on its removal, are readily taken up by other organs."[1]

May 22, 1907, one of us (L. R. G. C.) operated upon F. A. R., thirty-six, male, spleen ruptured in an automobile accident. Splenectomy was done; drainage left in forty-eight hours. Convalescence was complicated by abscess of left lung, which to some extent must have modified the blood-count. The man recovered in due time and is active and well at the present day (Nov., 1911), with no apparent physiologic abnormality. The blood-counts are shown in table (p. 499).

APPENDICOSTOMY

This operation was first proposed by Keetley,[2] who suggested that by bringing the appendix through the abdominal wall and amputating the apex it might be used as a spout to relieve the distention of a case of obstruction occurring at a point below the cecum. The first operation was done, however, by Weir,[3] who used it for treatment in a case of ulcerative colitis. In brief, the appendix is brought out through a small incision, which must not be of the McBurney type, lest muscle contracture cause slough of the appendix. Care being taken to avoid twists or constrictions of the appendix, it is pulled out until the cecum is in contact with the parietal peritoneum.

Two or three days later, without anesthesia, the tip of the appendix is severed within ¼ in. of the skin and any bleeding point secured. The exposed mucous membrane is caught, pulled out a little, and fastened by one or two stitches to the edge of the skin. A rubber catheter is introduced into the cecum, and, if desirable, irrigation or other treatment can be given at once. If the lumen is small, it will readily dilate with a catheter. Immediate opening of the appendix at the first operation may be done, if necessary, with little danger. An illustrative case will probably best show the post-operative details of appendicostomy.

"A fish-hawker, aged twenty-six, who had been a soldier, and had had two attacks of dysentery, in Africa in 1900 and in India in 1906, complained of six to eight motions of blood and slime daily, without pain and with no

[1] J. C. Hubbard, Boston Med. and Surg. Jour., 1909, clx, 746.
[2] Brit. Med. Jour., 1894, ii, 1155.
[3] New York Med. Record, Aug. 9, 1902.

marked emaciation. His general condition was excellent; the sigmoidoscope showed considerable edema of the tissue, with marked inflammation of the mucous membrane and superficial ulceration, especially marked at places exposed to friction, such as the edges of the rectal folds.

"Appendicostomy was performed on July 23, 1907, by Mr. Swinford Edwards. Four days later irrigation was started, 6 pints of weak boric lotion being slowly allowed to flow through the catheter into the cecum. A moderate-sized vulcanite tube was passed through the sphincter for about 3 in. The inflow was regulated so as not to allow of too great distention, and abdominal massage along the course of the great gut employed. After about six minutes the lotion began to flow from the rectum, bringing with it fragments of feces. Before the outflow began, and when the patient's abdomen was distended and tense, the catheter was removed from the appendix, and though no protection against back-flow was taken, there was no trace of leakage, the muscular gut and the valve of Gerlach proving competent to prevent any escape of the lotion. After four days the lotion was changed to one of sodium bicarbonate (10 gr. to the ounce), and this was changed after two days more to one of protargol (4 gr. to 1 pint). The patient remained in the hospital one month, and was taught to conduct the irrigation himself. It was found that after a few days the rectal tube was unnecessary, the patient evacuating the lotion as soon as the colon became moderately distended. He was sent home with an abdominal plate, fitted with a flat, thin pad—a contrivance found to be unnecessary in subsequent cases.

"After two months of self-irrigation daily with 6 pints of protargol lotion he was again examined with the sigmoidoscope on October 29, 1907. The mucous membrane was found to be slightly inflamed, and there was still some edema of the submucous tissue, but no sign of ulceration. The patient himself stated that he was perfectly comfortable and at work; he occupied himself for half an hour every morning with the irrigation, and after that had no further trouble during the day. Throughout his diet was his usual one, and the only other treatment was the administration of $\frac{1}{8}$ gr. of calomel three times daily while in the hospital."[1]

The time necessary to leave open this fistula varies from one to six months in the treatment of ulcerative colitis.

Appendicostomy may be used instead of cecostomy for the relief of abdominal distention, as in peritonitis[2] or malignant disease. Thus, Dawson (*loc. cit.*) reports a case of Mr. Keetley's:

"The case was one of carcinoma of the greater curvature of the stomach, involving the transverse colon and causing obstruction therein. Appendicostomy was performed, and a few days later the lumen was gradually and successfully dilated until it admitted a No. 4 rectal tube. Through this the in-

[1] J. B. Dawson, Brit. Med. Jour., 1909, i, 78.
[2] E. W. H. Groves, Ann. Surg., 1909, l, 1334.

testinal contents drained well, the colon below the obstruction being emptied by enemata. Later the gastric carcinoma produced obstruction of the pylorus, with the usual signs of stenosis and dilatation of the stomach. Jejunostomy was then performed, through which the patient was fed. The patient lived for three and a half months, being fed directly into the jejunum and having the bowels evacuated through the appendix. Death ensued, but was unaccompanied by the distress of either gastric dilatation or intestinal obstruction."

Jacobs and Rowlands mention a case of volvulus of the cecum, operated on by Mr. Maunsell, in which, after unfolding the volvulus, he performed appendicostomy, the result being that he effectually anchored the cecum and so prevented a recurrence, and also was able to clear the large intestine of feces for the introduction of hot saline to combat shock.

This operation has been used also for amebic dysentery.[1] Mr. Keetley[2] operated upon a child aged a year and ten months for intussusception of the ileocecal variety. After the reduction, he performed appendicostomy, the advantages he claimed for the procedure being—(1) evacuation of bowels; (2) prevention of recurrence; (3) rest given to cecum; (4) facility of giving saline fluid.

Mr. Dawson's further suggestion is quite worthy of consideration: "This operation might be performed and the opening utilized for feeding. The unsatisfactory results of prolonged rectal feeding are so well known that the suggestion seems worthy of consideration. The operation *per se* is practically free from danger and allows nourishing fluids to be passed into the colon, whence there is considerable absorption. It can at least be safely assumed that the nutriment taken into the circulation would be greater than in the case of rectal enemata. The cases for which such treatment would be suitable are mainly those of ulceration or new-growth of the stomach, in which rest of that viscus is indicated."

APPENDICITIS AND ITS COMPLICATIONS

It is to be hoped that, as time goes on, more men will train themselves to do appendectomy[3] through the McBurney[4] incision, wherein the abdominal muscles are split rather than cut, making the so-called gridiron opening between the fibers. The advantages of this incision

[1] J. M. Anders and W. L. Rodman, Jour. Am. Med. Assoc., 1910, liv, 503.
[2] Brit. Med. Jour., 1905, ii, 863.
[3] It is appreciated that, etymologically, appendicectomy is the better word.
[4] Ann. Surg., 1894, xx, 38.

for all types of appendicitis, with few exceptions, have been set forth in several places[1] since McBurney's original paper.

[1] Among others, Crandon and Scannell, Boston Med. and Surg. Jour., 1905, cliii, 711.

"The muscle-splitting incision for cases of acute appendicitis, with abscess or without, we wish to advocate and to defend, and, to that end, we adduce the following experience and research:

"*Technique.*—The skin incision is so made that its middle is about three-quarters of the distance from the navel to the anterosuperior spine. The incision is nearly transverse—that is, it bisects the angle made by the external and internal oblique muscles as they cross each other.

"Fibers of the external oblique aponeurosis are recognized, a nick is made with the knife between two fibers and is enlarged by tearing, either with the knife-handle or with the fingers. This wound is then held open with retractors.

"Thick muscle-fibers of the internal oblique are now seen running nearly t right angles to the external oblique. A nick between fibers, as before, is followed by tearing open of this muscle, as well as the transversalis beneath it, and the properitoneal fat with the two fingers.

"After good retraction to the full depths of the wound, the peritoneum is lifted between two forceps, nicked and slit open transversely with blunt scissors.

"*Closing the Wound.*—Two or three continuous catgut stitches close the peritoneum.

"One catgut stitch holds together the separated muscle bundles of the internal oblique.

"One or, at the most, two catgut mattress sutures close the external oblique.

"One or two buried catgut stitches hold together the subcutaneous fat.

"An intracutaneous silkworm-gut or horsehair stitch closes the skin.

"*Temporary Drainage.*—As a precautionary measure, certain early cases of acutely inflamed appendix require drainage for twenty-four hours with gauze or rubber dam. For this purpose the wound is closed as before, except for a passage large enough to admit the drain and in addition one or two stitches of silkworm gut are put through the skin and external oblique. These stitches are left with their ends tied together, and when the drain is removed, are tied tightly to close the wound.

"*Prolonged Drainage.*—Cases which need drainage for several days or longer need no sutures unless the wound is larger than need be for the purpose of drainage.

"*Enlarging the Wound.*—By enlarging the cut or split in each plane in either direction, as seems necessary, the wound can be made large enough for all exploration desired."

Should it even be desired for any reason to open as far down as the pelvis it will be found that the limit to which the split in the oblique muscles and the transversalis approaches is the right linea semilunaris. When, therefore, in the splitting process this line is reached, one may then cut freely down the semilunar line, making the whole incision into a sort of trap-door. Through this a right tube or an ovary can be easily removed, and such a wound is easily closed.

The Right Rectus Incision.—"The rectus incision, so called, goes through the skin and anterior sheath of the right rectus, the muscle-belly is retracted toward the median line (by some operators the muscle-belly is split), the posterior sheath is cut through, and the peritoneum thus opened.

"The advantages which lie in this incision are that it can be made quickly; that it allows indefinite enlargement up or down; that it is more anatomic, less destructive, than the early method of oblique incision through everything.

"The disadvantages of the rectus incision are, in our opinion, (1) That the rectus muscle varies so much in width in different individuals, that incisions intended to be over the muscle-belly frequently come down directly on the linea semilunaris, making the whole incision direct through the abdominal wall, with no safeguard against hernia in cases drained.

I. *McBurney Incision. No Drainage.*—The intracuticular stitch of silkworm-gut or horsehair is tied over a pad of gauze which rests on the wound (Fig. 161). Outside of this are a few pieces of crumpled gauze, held on by zinc-oxid plaster. An excellent device to hold on the dressing is the zinc-oxid plaster straps and lacing (Fig. 162). The single stitch is removed on the tenth day, and all tension is taken off the incision by two or three narrow straps of plaster at right angles to the incision, dimpling it in. This constitutes the only dressing of such cases, and the plaster straps are left on or renewed until at least three weeks from the day of the operation.

It is assumed that no wound is closed at the end of operation where the appendix has showed on its surface any well-established acute peritonitis. Some surgeons have set the patient upright in bed within a few hours after operation. Except for purposes of drainage into the pelvis, as in the Fowler position (Fig. 171), I see no advantages from this procedure. Every patient is more or less prostrated by the ether and its after-effects, by the psychic effect of having faced an operation,

(2) That there is a considerable chance of wounding the deep epigastric vessels, with troublesome hemorrhage. (3) That, as McBurney says, the incision makes 'an overhanging shelf under which one is obliged to work.' (4) That this incision frequently opens into clean abdominal cavity, quite internal to the walled-off abscess; that this incision is internal to the plane of the mesenteric origin. It will be remembered that Monks (Ann. Surg., 1905, xlii, 554) has shown that the mesenteric origin serves to shut off the right iliac fossa to some degree from the rest of the abdominal cavity, allowing the fossa to drain first into the pelvis. Repeated cases show that the infection is confined to the region beneath and external to the cecum, and we believe it unwarrantable, therefore, to take the chance of being obliged to drain an abscess across a healthy gut, if such a procedure can be avoided. (5) In cases drained, the skin tends to retract, leaving a broad area of rectus belly to granulate in. (6) In cases drained the chance of hernia in the rectus incision is much greater than in the muscle-splitting incision.

"*The Muscle-splitting Incision.*—The disadvantages of this incision are that it cannot be made so quickly, that it takes a certain amount of delicacy of dissection and care, particularly if it is to be enlarged. (2) In cases of prolonged drainage much more care and dexterity is required in replacing the wicks and in maintaining the drainage. This, we believe, has been the main ground for objection to this incision. (3) A recent writer has said, 'The gridiron incision should never be used in operating for an attack of acute appendicitis. As one never can tell what the condition of the appendix is, there is danger in an incision which cannot be enlarged without serious damage to the parts.'

"With this we entirely disagree.

"The advantages of the muscle-splitting incision are: (1) That in most cases it opens directly over the seat of the disease; (2) that it is worth the care necessary to enlarge it properly, since even after prolonged drainage we can practically assure the patient that he will have no hernia. From the moment the patient leaves the operating table every movement involving contraction of the abdominal muscles tends to bring together the splits in these muscles and thus close the gridiron; (3) because of this tendency of the wounds to come together, stitches are of almost no advantage, and the surgeon is, therefore, never tempted to omit the safeguard of temporary drainage in doubtful cases."

and is more or less uncomfortable on account of pain or morphin. It does not seem that anything could be better for the patient during the first day than horizontal rest.

The morning after operation, if there is no fever, no notable disten-

Fig. 160.—Applying the Dressing After Appendectomy.
The long ends of the subcuticular stitch of silkworm gut are tied together over a folded sterile gauze strip, and the ends cut short.

Fig. 161.—Tying the Intracuticular Stitch Over a Gauze Sponge.

tion, and no great amount of pain, the patient should be set up in bed, and if he stands this well, he may get into a chair in the afternoon. On the second day the forenoon may be spent in bed and the time given up largely to the first high enema, the movement, and the exhaustion following it. In the afternoon of the second day and thereafter he may be up, and is to be encouraged to move about and become normal in all necessary functions as soon as possible.

FIG. 162.—LACED ADHESIVE DRESSING AS USED AFTER RIGHT RECTUS INCISION.
(Devised by Ernest W. Cushing, of Boston, in 1894, but originated by D. Laurentius Heister, Venice, 1750, Vol. I, p. 190.) (See also p. 201.)

II. *McBurney Incision. Temporary Drainage.*—In this division may be placed the cases where the appendix was deeply congested and showed fibrin on its surface, or presented any condition showing that

FIG. 163.—REMOVAL OF PERFORATED SHEET.
Hand holding the dressing in place.

inflammation had penetrated through the walls of the appendix, and the possibility exists that some infection may have taken place in the surrounding region. Such cases the conservative surgeon drains temporarily by means of a piece of rubber dam or a small spiral drain

(p. 252), closing the wound by sutures, leaving only room enough for the drain to emerge. Through the protruding drain there should be put transversely a sterile safety-pin, lest the drain slip into the wound during the tossing and turning of the first day after operation.

Such a temporary drain had best be left in thirty-six to forty-eight hours. If at the end of that time there is no notable discharge, and if the temperature is normal, or nearly normal, and has come down continuously since operation, the temporary drain may be pulled out and a provisional suture, which was put in and left in with its ends knotted at the time of the operation, may now be tied. If when this

FIG. 164.—APPLYING ADHESIVE PLASTER STRIPS, CRISS-CROSS, OVER THE APPENDIX DRESSING.

drain is pulled out there is a little secretion, or if there is the slightest doubt as to the depth of the wound being clean and without pus-formation, the short dressing forceps may be put into the wound immediately after the drain is withdrawn and then allowed to open while in the wound. Their spring will separate the lips of the wound a bit, and into this space may now be poured a dram or less of sterile glycerin or balsam of Peru. A small pad is put over this and the swathe or straps applied. The use of either of these agents serves a four-fold purpose—they prevent the wound sealing together prematurely, they are slightly antiseptic, they are stimulative, and they serve to shrink excessive granulations.

If one feels that there is some noteworthy infection in the depths of the wound, another small wick must be inserted where the first was withdrawn, and it may be even considered wise to remove a stitch or two in order to establish better drainage.

III. *McBurney Incision. Gangrenous Appendix or Abscess.*—In these conditions the best possible drainage is by means of a spiral drain with enough gauze preferably, in my opinion, saturated with iodoform 10 per cent., protruding, say, 1 to 2 in. below the end of the rubber, to form a certain amount of packing at the bottom of the cavity, whether there is a definitely localized abscess or whether the case is one where the abscess is forming; that is, where the "chicken-broth" fluid or pus is localized in the lower right quadrant. Such a drain, carefully placed, reaching to the limits of the region infected and in contact with the appendix stump, may be well left undisturbed for from two to six days. It is a common procedure to "start" the wick on the third or fourth day—that is, to pull it just clear of the granulations in which it has embedded itself—to pull it half-way out on the next day, and to remove it entirely on the day following. If there are no local signs, such as tenderness, spreading redness, bulging of the wound, exudation of pus round the wick, or if there are no general symptoms indicating lack of free drainage, such as rising temperature or pulse, or abdominal paresis, the wick should be left undisturbed until the time limit set. As long as it remains in place it is exciting conservative adhesions—it is establishing in the whole region one clean-cut cavity without partitions and subcavities, it is exciting granulation.

When the first wick is finally withdrawn from such an abscess cavity it usually must be replaced by another, as the amount of excretion of pus cannot be foretold in any given case. Where wicks have to be renewed, and closing in of the abscess cavity is to be encouraged, the size of the wicks should be successively reduced. In abscess cases, where granulation had already begun before operation, pus is small in amount during convalescence, and such a cavity may in a few days be filled with glycerin and allowed to collapse.

In cases where there were a lot of adhesions, much fibrin, or foul-smelling pus the first wick will have to be removed in a short time, perhaps as early as the third day, and perhaps renewed daily thereafter.

Where there is a definite, easily accessible cavity to dress, wiping out with a dry sponge often suffices. Where the cavity leads deep into the pelvis, and the daily pus is considerable in amount, there are instances where irrigation of the cavity with salt solution or chlorinated soda solution (1:80), using a slightly curved female catheter for irrigating nozzle, will best serve to clean the cavity. The danger cannot be overemphasized, however, if irrigation is used, that the fluid may not flow out of the wound freely enough, may back up and drain through adhesions into the general cavity, with serious results. Irrigation, then, is only for selected cases, and the onset of the least pain during its performance is a signal to stop.

In case much packing or several strips of gauze have been necessarily left in, their early removal is extremely painful and may give definite nervous shock to the patient who is at all sensitive. Other things being equal, the longer such wicks are left in, within reason, the easier they come out, because of the softening action of the pus around them. When such considerable amount of packing has to be removed early, therefore, particularly if the patient is one who does not stand pain well,—a child, for example,—it is probably best, with the help of a safe anesthetist, to give a few whiffs of nitrous oxid, ethyl chlorid, or chloroform, and pull them out all at once. If there is good reason why such an anesthetic should not be given, the packing may be got out by starting the wicks, pulling an inch or two out each day, and cutting it off, or, if the packing is composed of several narrow strips, by pulling one out at a time.

In the region of a drained abscess there should be for twenty-four hours practically no pain. If pain appears, it indicates lack of free drainage, and the wicks should be started or withdrawn and new smaller ones inserted. After this is done, the application of a hot salt and citrate (4 and 1 : 100) poultice, or even of the old-fashioned flaxseed poultice, may give great comfort and aid free drainage.

Some cases secrete an excessive amount of pus daily, and this amount must determine the frequency of the dressing. As a rule, once a day is enough. Some cases, however, may well be dressed every three or four hours. The "let alone" policy with regard to a well-placed wick is the best. There should be a reason for every dressing.

When the temperature is practically down to normal, even though a considerable amount of suppuration is still present, the patient may get up if the wound is well supported by straps or swathe. Getting the patient partially or wholly up is frequently the best stimulant to rapid convalescence.

IV. *Right Rectus Incision, Wound Closed.*—These cases, after they have been sutured by layers and the abdomen is supported well by zinc-oxid plaster straps or the laced straps (Fig. 162), call for no treatment different from a median celiotomy. The patient may sit up the day after operation.

Right Rectus Incision, Drained.—When, unfortunately, the surgeon has to drain through this incision, care should be taken at the first removal of wick or packing not to pull out a coil of small intestine, or even to bring such a coil above the level of the parietal abdomen, for such an occurrence makes ventral hernia much more likely. The wound should be constantly supported by straps, and, as the wick get smaller, the edges are pulled closer together at each dressing, until ultimately the complete approximation of the two granulating surfaces is attained. Undoubtedly the liability to hernia[1] in these cases is due primarily to lack of attention to just such details in the immediate after-care of the wound.

Complications and Sequelæ.—It is trite enough to say that no two cases of appendicitis are alike, the possible postoperative complications are so numerous.

(1) *General Peritonitis.*—See pages 174, 465, 468, 508, 509, and 517.

(2) *Intestinal Obstruction.*—If the abdomen does not distend, no effort should be made to move the bowels for the first twenty-four to thirty-six hours, perfect rest being the ideal abdominal condition. If at any time, however, distention becomes notable, an effort should be made to get rid of the gas. This distention may be due to a paresis of the bowel from toxemia or from a peritonitis of any grade. Until a good effort by means of a well-given and searching enema has been made, the distention need cause no worry. Obstruction may be due, however, to pressure of the packing or to newly formed bands or adhesions in the region of the appendix. I have seen several cases where the patient was not thoroughly cleaned out before operation, in which fecal impaction in the rectum was enough to cause obstruction after operation because the patient did not have strength to force the obstructing mass out.

(3) *Fecal Fistula.*—This condition may range from escape of pus with merely a fecal odor, up to the free discharge of evidently fecal material. It may be due to incomplete closure of the appendix stump by ligatures; to a slipping of the appendix ligature; to the presence of a lost or undiscovered fecolith in the bottom of the wound; or to a new break in

[1] From the Boston City Hospital records since 1880 we find 22 hernias. This does not represent all the hernias which have occurred, but only those which have come back for operation.

Total hernias through appendectomy scars	22
Through old-fashioned direct oblique incision	17
Through right rectus incision	5
Through muscle-splitting incision	0

These figures need no comment.

the wall of the cecum or ileum, due either to a continuation of the gangrenous process of the original disease, or to the careless removal of an adherent drainage wick. For treatment, see pp. 280 and 468.

(4) *Stitch Abscess.*—See Chap. XXIII, p. 253.

(5) *Abscess in the abdominal wall* near the region of the wound may appear in places where the muscle layers have been excessively separated during operation, or where the drainage gauze has become dried

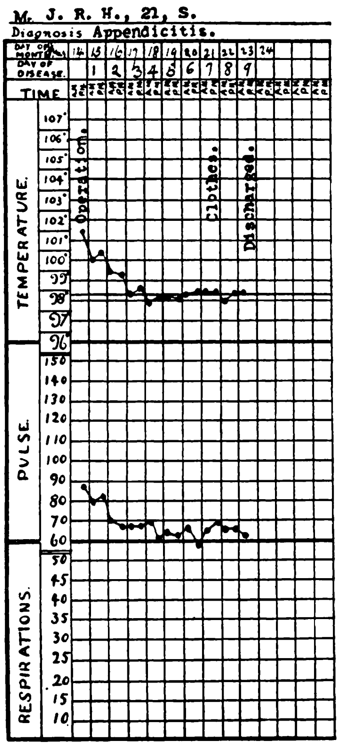

FIG. 165.—ACUTE APPENDICITIS WITHOUT DRAINAGE.

Rapid drop by lysis to normal.

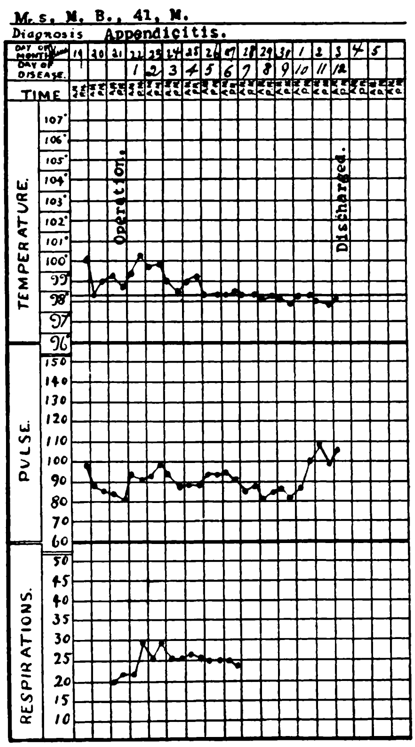

FIG. 166.—ACUTE APPENDICITIS.

Typical chart; rise of pulse on getting up and about.

and blocks the wound. The pus then burrows between the layers of the abdominal wall, sometimes extensively. Careful burrowing with the finger in the direction of the tenderness or swelling which indicates the abscess should establish drainage and so relieve the condition.

(6) *Lymphatic and Hepatic Infections. Subphrenic Abscess.*[1]—This complication occurs approximately in 1 case in 1000. The abscess may be within the peritoneal cavity or in the retroperitoneal tissue. If

[1] See also Chapter IX, p. 106 *et seq.*

intraperitoneal, the abscess may occupy only a small portion of the subphrenic space, either laterally, or in front, or behind. It may be located high up under the dome of the diaphragm. The intraperitoneal is far more common after appendicitis than the extraperitoneal. The infection travels along the inner or outer side of the colon, or toward its anterior aspect and the abdominal wall. Subphrenic abscess may follow an attack in which there has been no suppuration in or about the

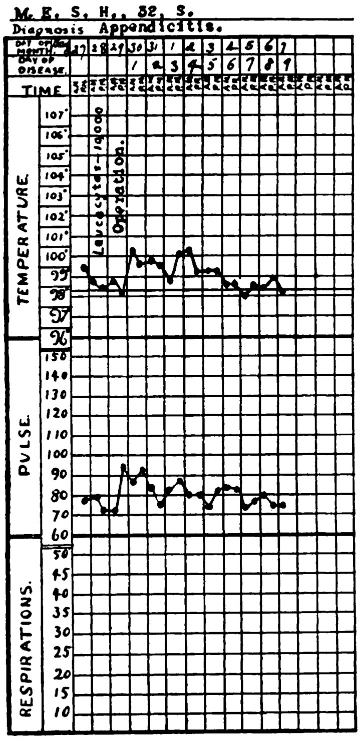

FIG. 167.—ACUTE APPENDICITIS DRAINED.
Typical chart, irregularities of temperature depending on efficiency of drainage and on catharsis.

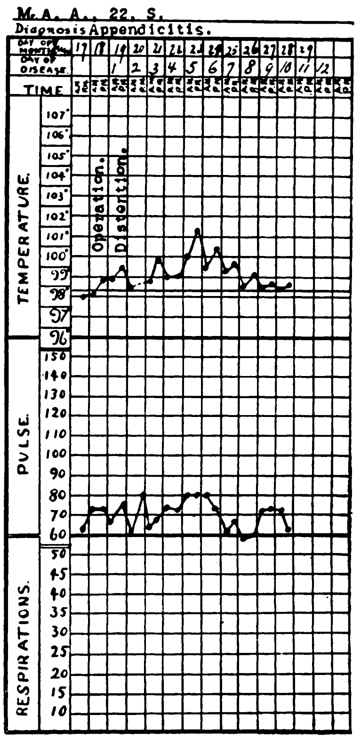

FIG. 168.—APPENDECTOMY AFTER THE ATTACK.
Temperature on the fifth day due to minute stitch abscess.

appendix. Following appendicitis it is usually situated on the right side. It may occur as a result of a general suppurative peritonitis. It is sometimes possible to trace a suppurative tract at autopsy from the appendix to the subphrenic region. The complication follows not infrequently in case the appendix is retrocecal. Subphrenic abscess may rupture into the lung. It is often complicated by pleural effusion, the presence of which is explained by the proximity of the subphrenic space.

Symptoms.—Persistence of high fever, rapid pulse, and other signs of deep-seated infection, in spite of thorough drainage of the primary appendix abscess. Dulness corresponding to the left lobe. The exploring needle presents pus which may be mistaken for an empyema. The acute form may come on in a few days. It may, however, be subacute or chronic.[1] The development and symptomatology of this complication may be shown by illustrative cases:

J. C. Munro[2]: "A girl of eighteen was operated upon within twenty-four hours from the beginning of an attack of acute appendicitis. The gangrenous appendix was removed and the wound was drained. There was no infection of the peritoneum beyond the immediate region of the appendix which lay posterior to the cecum. The mesenteriolum contained thrombi and was removed. For a few days the condition was satisfactory, when the pulse and temperature began to rise, and there was slight icterus, with definite hepatic tenderness. Exploration of the sinus showed a small abscess posterior to the peritoneum at the original site of the appendix. Improvement followed drainage for a week, when the symptoms of sepsis again appeared, and three weeks from the first operation a pelvic abscess not connected with the first wound was opened and drained. In spite of free drainage the patient did not improve, but began to show evidence of trouble in the upper abdomen. With more distinct signs as a guide, the abdomen was opened through an epigastric incision five weeks from the time of onset, and a foul subphrenic abscess to the left of the median line was drained. The patient did not improve, however, but steadily became more and more septic until death three weeks later."

Munro: "H. C. B., male, aged thirty-five years,[3] had had several attacks of severe abdominal pain and vomiting in the past six or seven years. Each time he had been a little yellow, but without chills, and the attacks lasted only a few days. Three days before entrance to the hospital he had a sudden, severe attack of appendicitis, followed by slight jaundice and a leukocytosis of 13,000. He was treated in the medical wards for a month, during which time he had occasional chills and high temperature, epigastric pain, progressive emaciation, variable jaundice, and leukocytosis increasing steadily up to 43,000. Examination showed a much emaciated, jaundiced, septic-looking man, with an enlarged liver, especially on the left, and doubtful tenderness over the appendix. Under ether, the abdomen was opened in the median line, above the umbilicus. One small, pinhead abscess was found on the anterior surface of the right lobe. The left lobe was uniformly enlarged, but on the under side there was a deep, slightly indurated swelling. This was opened and a cavity containing pus was found. Careful exploration of the right lobe failed to show pus. The

[1] Katz and Kendirjy, Rev. de Gyn. et de Chir. Abdom., Paris, 1908, xii, 469.
[2] Ann. Surg., 1905, xlii, 692.
[3] Boston City Hospital Reports, 1902, 146.

gall-bladder and neighboring region were normal. The appendix, subacutely inflamed, was removed through a small opening. The patient was in poor condition before the operation, but on the following day the temperature had fallen to normal and the pulse had fallen to 120. There was considerable discharge from the liver. Three days later the temperature remained down, but the pulse was rapid and weak, and he looked badly. Two days later he died.

"Autopsy showed between the spleen, stomach, left side of diaphragm, the liver, and posterior wall of the peritoneal cavity an abscess containing offensive, yellowish, semifluid material. All the mesenteric lymph-nodes were somewhat enlarged. One node was softened, and contiguous to it was a canal, that is, a mesenteric vein, with roughened yellowish wall admitting the little finger and communicating directly with the portal vein. On section through the left lobe, the portal veins were dilated and contained pus. In the right lobe, particularly toward the superior surface and the right, were numerous small abscesses, arranged in clusters, 3 to 5 cm. in diameter."

The next to the last case illustrates the subphrenic abscess alone; the last, both subphrenic and hepatic infections. Dr. Munro continues:

" There must be a considerable variation dependent on the individual, the type, and the amount of infection in the time required for the formation of pus in appreciable quantities. The clinical data on this point are very vague, but frequently there may be a wide variation in certain instances.

" The age at which these infections take place is limited mostly to young adults. According to statistics of Musser and others, children below fifteen are quite exempt from portal infections.

" Diagnosis of either the lymphangitis or the pylephlebitis that is secondary to appendicitis is at times impossible. In typical cases it ought not to be difficult. We ought to consider its probability in cases exhibiting sepsis, jaundice, hepatic tenderness.

" When the infection has attained the subphrenic space, the symptoms are more varied, and are frequently impossible of interpretation without exploration or operation. To quote freely from Grüneisen, we must regard the subphrenic abscess as a circumscribed peritonitis, and hence we often find acute, gradually increasing signs of peritonitis. At times there is only dull pain. At other times the disease comes on suddenly with collapse, chill, vomiting, severe pain, etc. Sometimes the course is very obscure and the picture of the disease is not clear. Pain is incessant. In most cases there is an elevation of temperature. On examination, we often find irregular, marked arching in the lower portion of the thorax of the diseased side. This does not behave in respiration in a normal way. The intercostal spaces are obliterated, widened, or bulged, and frequently painful on pressure.

"Lejars often found a characteristic point of very intense pain. The upper boundary of dulness often stands in a convex line, and above the dulness there is found normal lung resonance in case there is no pleural effusion. In some cases one can determine a marked change in the upper boundary of the dulness on inspiration. The change is small, chiefly because the diaphragm pressed upward is weak and lagging. If there is gas in the abscess, there is a clearly marked tympanitic zone to be recognized, which changes with the position of the patient. One finds characteristically, from above downward, first, normal lung resonance, below this a sharply bounded tympanitic zone, and then a dull area due to the presence of the pus. This three-layer arrangement in zones can almost be taken as pathognomonic. In left-sided abscesses the heart may be pressed somewhat upward, but not to the right, while in right-sided abscesses the heart is pressed very little toward the left. The liver and the stomach may be forced down to a considerable degree.

"The determination of pus by means of the exploratory needle is an important aid in the diagnosis of deep-lying pus-cavities. Puncture is best made in the region of the most marked dulness through the ribs, and in the region where, in case of finding pus, one would eventually operate. One must often make more than one puncture. In one case Grüneisen reports 36 trials at several sittings." The *x*-ray may be a valuable method of locating these abscesses.

To diagnosticate a typical case of portal phlebitis should not be very difficult. One of Munro's cases illustrates significantly the characteristics of the early stages.

"T. S., female, seventeen years old. Ten days before entrance had an attack of sudden, sharp pain in the region of the umbilicus, with vomiting, which continued for two days. Four days before entrance she began to have dull, continuous pain below the costal margin, followed by chills and sweating. The white count was 8800. She was in the hospital two days before operation, and grew distinctly worse during that time. There was very slight jaundice, noticeable only on careful examination; fulness through the right hypochondrium into the flank, with spasm and tenderness over the liver. There was nothing to call attention to the appendix except a distinctly local tenderness on deep pressure without spasm.

"Diagnosis of portal phlebitis following appendicitis was made, and under ether the abdomen was opened over the right lobe of the liver, spasm persisting even under anesthesia. On the upper surface of the right lobe there were three or four groups of small abscesses. These were incised and the liver itself opened up freely with the director and finger, but no more abscesses could be found. The left lobe was normal in size. Various punctures were made elsewhere in the liver without obtaining any more pus. Through a second abdominal opening a foul abscess cavity surrounding the appendix was opened and drained. Two days later the appendix wound was clean and sweet. Foul pus was escaping from the liver and the packing was removed without hemorrhage. On the fourth day after operation patient was more or less delirious, with considerable discharge from the liver, which seemed to be mostly bile, and the next day she died."

To sum up the symptoms: Jaundice is usually present in some degree. Chills are apt to come on early. Pain in the hypochondrium is characteristic and of diagnostic importance, usually preceding the jaundice or accompanying it. There may be vomiting or diarrhea. The liver may be found somewhat enlarged and tender, and sometimes enlargement of the spleen is to be noted. The temperature is irregular and frequently makes wide excursions. The pulse is rapid and may be dicrotic. In the acute forms there may be somnolence and coma, or delirium.

Drainage must be established. For subphrenic abscess the ninth rib is resected in the mid-axillary line. If the pleura is opened by this procedure the parietal and diaphragmatic layers are sewn together. After suture of the costal and parietal pleuræ allow thirty-six hours to elapse before incising the diaphragm, unless at the time of operation the two layers of pleura were infiltrated and adherent to each other, in which instance an immediate incision is made. If the diaphragm bulges up against the pleura, no air will enter upon incising the costal layer. If, on the other hand, the border of a lung can be seen moving freely up and down, it will be safer to suture the two layers and make incision through the diaphragm from thirty-four to thirty-six hours later. Drainage is maintained by rubber tubes or rubber bobbins, and if it is efficient the symptoms should abate directly. Multiple abscess of liver and portal phlebitis are, at present, practically hopeless conditions.

(7) *Suppuration in Other Distant Places.*—Such complications may arise as a result of a pyemia or suppurative endocarditis, either of which may complicate appendix abscess, particularly if not efficiently drained. Separate abscesses may appear, through the insufficient exploration at time of operation or due to inefficient after-care in respect to drainage. Collections of pus, for example, may appear in the loin, about the kidney, under the liver or diaphragm, or in the pelvis. The possibility of such an occurrence should always be in mind. They are suggested by persistent or rising fever, by pain here or there, by the septic facies. Undrained pus in the pelvis will be suggested by frequency of micturition or by "bearing down" in bladder or rectum. Rectal or vaginal examination should establish the diagnosis. Appropriate operative intervention should be made.

(8) *Empyema on the right side* has been observed,[1] due probably to extension of a subphrenic abscess.

(9) *Iliac or Femoral Thrombosis and Phlebitis, Thrombophlebitis.*—This complication is not common, but seems frequently to appear in the simple cases, where least expected.[2] It comes most often between the tenth and fourteenth days in debilitated subjects[3], commonly in the left leg, and subsides harmlessly in a few days. For details of onset, course, and treatment, see Part I, Chapter IX, p. 114.

GENERAL PERITONITIS

Many cases called general peritonitis are not actually general[4] in extent. So true is this that we strongly believe that the surgeon should not, with certain exceptions, put his hand through the infected peritoneum or intestines which present in the wound, bathed in seropurulent fluid or pus, and then force the hand in all directions through the intestines for the mere purpose of finding out whether the inflammation is general or not. For the same reason it seems to be poor pathology and bad surgery to wash out an inflamed peritoneum unless there is every sign that the disease is truly general. In other words, in many cases an unwalled peritonitis is kept local by anatomic structures, as in the right lower quadrant.[5] The fact that there is no wall of adhesions limiting a peritoneal exudate does not mean that the process is generally distributed throughout the cavity.

It is assumed, therefore, from the point of view of after-treatment, that all exudation has been sponged and wiped out with great care and thoroughness, and that the necessary number of drainage-tubes or wicks have been placed in one or more incisions thoroughly to drain[6] the pelvis and any other fossæ which were evidently affected. In certain cases, wicks or tubes will be put in through an incision in the vaginal vault.

The patient is returned to bed and placed in the exaggerated Fowler's position (Figs. 169–172), which directs the gravitation of all fluids toward the pelvis. This nearly erect position has the greatest possible value. It has been lately noted in general peritonitis after typhoid perforation.[7]

[1] G. R. Fowler, Treatise on Appendicitis, Phila., 1894, 62.
[2] W. Meyer, Ann. Surg., 1901, xxxiii, 605.
[3] A. Sertoli, Gazz. degli Osped. e. della Clin., Milan, 1909, xxx, 121.
[4] A. G. Gerster, Ann. Surg., 1910, li, 490.
[5] G. H. Monks, Ann. Surg., 1903, xxxviii, 574.
[6] Though Deaver now says, "When in doubt, don't drain," Ann. Surg., 1910, li, 480.
[7] P. Wroth, Ann. Surg., 1909, l, 842.

Large quantities of saline solution are to be passed into the rectum by the drop method. (See p. 45.) A tube with three or four openings

FIG. 169.—FOWLER POSITION.
A pillow rolled in a sheet makes the bolster.

FIG. 170.—FOWLER POSITION.
Bed ready: a brace for the feet, a bolster for the buttocks, a comfortable slope of pillows, the head of the bed elevated on tables.

is introduced about 4 in. into the rectum. This tube comes from a syringe-bag full of salt solution, which feels somewhat warm to the hand (105°–110° F.). The bag is placed just barely above the plane of the rectum, and the snap so placed on the exit tube that the water emerges from the end about 3 drops a second. The saline can be ab-

FIG. 171.—FOWLER POSITION.

As improvised in private house. Patient properly supported by bolster made of a pillow rolled in a sheet under the buttocks. Feet braced against a board. The angle of elevation of the trunk thus attained is such that all fluids gravitate into the pelvis.

sorbed by the bowel at about this rate (1½ pints per hour). By this means, during the first twenty-four hours, 6 quarts may be introduced.

FIG. 172.—INADEQUATE FOWLER POSITION.

Patient, not supported, has slipped down in bed; head and shoulders alone are elevated. Bag for rectal saline too high, its tube too long.

In especially desperate cases intravenous saline infusion may be given before and during operation—up to 4 pints in the course of two hours.[1]

[1] R. Bertelsmann, Deut. Zeit. f. Chir., 1910, cvii, No. 113.

Food and drink are withheld by mouth to limit peristalsis. If hot water is well borne, however, it may be given. Enough morphin is given only to make life bearable.

Stimulation is to be given as necessary. For extensive vomiting, gavage is to be practised. Distention and intestinal paresis are to be met with the details already given. (Chap. XV, p. 165.) Cecostomy, at this writing, seems to be an essentially life-saving procedure in general peritonitis. It is our practice to introduce a Paul tube (p. 421) into a cecostomy wound at the time of operation. Drainage is established into a bottle at the side of the bed. Through this tube gas and fecal matter pour; distention, which is mainly in the large gut, as a rule, is relieved, and through the tube once or twice daily the large intestine is washed out with salt solution. A milk and molasses, or a compound turpentine enema, given as usual per rectum, is followed by copious discharge through the cecal tube. If general peritonitis supervene after other operations, the cecostomy may be done under cocain anesthesia[1] without difficulty.

If the wicks have been well placed, they should not be disturbed for many days. It should be constantly remembered that after twenty-four hours siphon drainage stops, but that the wicks are still valuable in aiding the localization of diffuse processes.

TUBERCULOUS PERITONITIS

These wounds should not be drained. Because of the nature of the disease and the general condition of the patient, the wound may be slow to heal, and, for this reason the stay sutures should not be removed until the fourteenth day, and the wound should then be supported with extra care by plaster straps. Local tuberculosis may develop in the scar.

From early in convalescence the patient should have the general treatment of tuberculosis. He should sleep out-of-doors or as near to that condition as possible. He should be slow to get up, and his exercise, gradually increasing, should be used, as it were, medicinally. Theoretically, each period of activity will cause a certain amount of lymphatic absorption either of toxins or of live bacilli. Hence, exercise reasonably used should serve gradually to increase the individual's resistance through his specific antibodies.

The prognosis, if the peritoneum is the only part involved and the environment can be controlled, should be good, and in from two to six months the case may usually be considered as "arrested."

[1] G. Volterrani, Riforma Med., Napoli, 1910, xxvi, 246.

Complications and Sequelæ.—*Bursting of the wound* may occur, as has been already suggested, because of the diminished healing power of the tissues (see p. 189).

A *tuberculous sinus* may be established if any part of the wound gives way. Tincture of iodin swabbed in thoroughly every day or two, together with direct sunlight, if it be feasible, should help such a sinus to heal promptly except in very bad cases.

Acute miliary tuberculosis may rarely follow operation in advanced cases.

CHAPTER XLVI

OPERATIONS ON THE VAGINA, UTERUS, AND ADNEXA

INCOMPLETE PERINEORRHAPHY AND THE REPAIR OF RECTOCELE[1]

THE external genitals are douched with warm sterile water or salt solution from a pitcher or douche-bag after each movement of the bowels and after each urination. The labia majora are gently spread by the sterile fingers of one hand in order to allow the entire perineal body to be thoroughly cleansed. The vagina is not entered and the nose of the pitcher or the douche-tube is not allowed to come in contact with the parts. The drops of fluid remaining on the genitals after the douche are lightly absorbed by touching the tissues with dry gauze, doing this lightly several times until all moisture has been removed. No rubbing movements are employed. The perineum is dusted with a powder consisting of equal parts of compound stearate of zinc and boric acid. Dry sterile gauze is then placed on either side of the stitches, and the stitches are flattened and pressed into one of the groins surrounded by the gauze. A tight T-bandage is employed.

The patient is not catheterized unless she is unable to pass her urine; if necessary, the catheter is passed every eight hours. Unless extremely uncomfortable, the patient is allowed to go for the first eighteen to twenty-four hours after operation before resorting to the use of the catheter.

The bowels are kept free by the administration of 10 to 15 grains of extract of cascara, night and morning, beginning on the morning following the day of operation. In case the bowels do not move daily by means of the cascara, an enema should be given in order to secure a daily evacuation, taking care to pass the rectal nozzle along the *posterior* wall of the rectum. Soft-solid nourishment is given until the bowels move, and then full diet is allowed.

The patient is allowed to lie in any position, but should not be permitted to turn herself. Tying the legs together and placing a pillow

[1] An operation for the repair of a rectocele always includes perineorrhaphy.

beneath the knees are unnecessary, unless they add to the comfort of the patient. When upon her side, the back should always be supported by

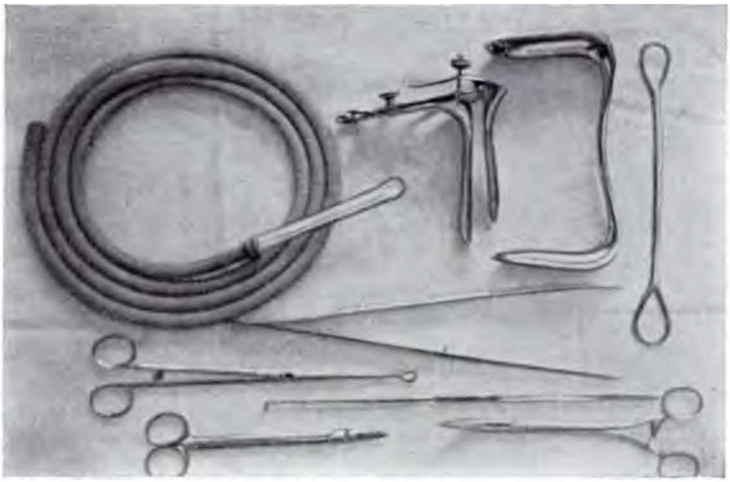

FIG. 173.—VAGINAL DRESSING SET.

a pillow crowded in behind it, in order to diminish any tension on the stitches from the weight of the body.

The stitches are removed in ten to fourteen days. The patient is allowed to sit up in bed with a head-rest on the fourteenth day and to

FIG. 174.—VAGINAL DOUCHE.
Patient in position.

get up out of bed on the seventeenth day. She can walk about on the eighteenth day.

Complete Perineorrhaphy.[1]—The after-treatment, as already described for incomplete lacerations of the perineum, is carried out with certain additions and modifications.

The bowels should be moved the next day after the operation in the following way: On the morning after the day of operation an ounce of castor oil should be given by mouth; twelve hours later an oil enema, consisting of 8 oz. of warm sweet oil, should be given by means of a rectal syringe. If the surgeon has any doubt about the ability and experience of the nurse, he should give the enema himself. The syringe-tip must be passed with extreme care into the posterior part of the anal opening, and then very gently along the posterior wall of the bowel to avoid the rectal sutures. The oil should be introduced slowly, and then the syringe must be withdrawn with the same caution which was

Fig. 175.—Vaginal Douche.
Introducing the nozzle.

used in its introduction. The patient is instructed to allow the movement to occur gradually and to make no straining efforts. It may be necessary for her to remain upon the bed-pan for an hour or even longer before an evacuation occurs. In case the desire to move the bowels is felt after receiving the castor oil, before the enema has been given, then the enema should be given at once. After this the bowels must be kept freely open by licorice powder, given in doses of 1 or 2 teaspoonfuls morning and night. No straining at stool is ever permissible, and if at any time the patient experiences difficulty in defecation during the first two weeks following operation, an oil enema must be given with the precautions above described.

A liquid diet without milk is given until the bowels move. After

[1] We wish to commend particularly the simple and efficient operation of C. M. Watson, Surg., Gyn., and Obst., 1911, xii, 576.

the bowels move, a soft-solid diet is allowed, but milk is restricted to a minimum because of the character of the residue which it leaves in the feces.

The stitches are removed on the fourteenth day. The patient is allowed to sit up in bed with a head-rest on the twenty-first day and to get up out of bed on the twenty-fourth day. She can walk about on the twenty-fifth day.

The Repair of Cystocele.—No irrigations are necessary after a cystocele operation, in the absence of a vaginal discharge, beyond a careful cleansing of the external genitals with a sterile fluid after each movement of the bowels and urination. In the presence of a vaginal discharge, however, a vaginal douche should be carried out every twelve hours in the following manner: A glass vaginal douche-tube is passed carefully for its entire length over the perineal body, hugging it tightly, the irrigating fluid being allowed to flow during the introduction. In the removal the precaution is likewise observed to keep the nozzle in close approximation with the perineal body. In the event of a vaginal discharge, after the combined operation for cystocele and laceration of the perineum, the douche-tube must be passed with great caution along the middle of the introitus vaginæ, at a point equidistant from its anterior and posterior angles. Such a vaginal douche should precede the irrigation of the perineum.

The patient should be placed upon the bed-pan three hours after the operation, and then be given the bed-pan every three hours in the hope that she may pass her urine. But this she is rarely able to do. The bladder should not be allowed to become distended. It is seldom possible for the patient to go more than nine to twelve hours without the occurrence of painful distention, and after this operation the catheter should not be withheld more than six hours. Catheterization, if necessary, should be carried out once in four hours for three days, then once in six hours for three days, and then once in eight hours until the patient can be induced to urinate spontaneously. Before resorting to the use of the catheter, after any gynecologic procedure, persistent efforts should be carried out to encourage the patient to pass her urine herself—*i. e.*, by hot compresses to the abdomen, thighs, and vulva, pressure over the bladder, trickling of sterile water over the introitus, the production of the sound of running water in the room, and lying on the face. Occasionally a hot enema may have the desired effect.

The bowels are kept free by compound licorice powder and enemas as above described.

Soft-solid diet is advisable until the bowels move, and then a full diet may be allowed. During the entire convalescence it is well for the patient to drink water copiously. In the event of the complication of vesical irritation supervening in the convalescence the patient should be given cystogen, 5 gr. three times daily, and large quantities of cream of tartar water should be administered.

As the stitches are entirely of catgut, it is unnecessary to remove them. The patient is allowed to sit up in bed with a head-rest on the fourteenth day and to get out of bed on the seventeenth day. She may walk about on the eighteenth day.

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C. P. Noble, Kelly-Noble, Gynecology and Abdominal Surgery, 1907, i, 350.

E. McDonald, Lacerations of the Perineum, Surg., Gyn. and Obst., 1908, vi, 47.

T. J. Watkins, The Operative Treatment of Cases of Extensive Cystocele and Uterine Prolapse, Surg., Gyn. and Obst., 1909, viii, 47.

VESICOVAGINAL FISTULA

The after-treatment of a vesicovaginal fistula is of the greatest importance in determining the success of the operation. Constant drainage is maintained by a self-retaining catheter, which is removed, cleaned, boiled, and replaced twice daily. Each time that the catheter is replaced the bladder is irrigated with warm 4 per cent. boric-acid solution, allowing not more than 4 ounces to enter the bladder at once, so avoiding undue pressure upon the stitches. Once each day the patient is placed in the Sims posture, the posterior vaginal wall being retracted by a Sims speculum, and the stitches are gently irrigated with sterile water. The anterior wall is then gently wiped, or, better, patted dry, using sterile absorbent cotton in preference to gauze because of its softer texture, and then carefully powdered with equal parts of compound stearate of zinc and boric acid. The vulva is covered with a sterile pad. Constant drainage is continued until the tenth day. The stitches are removed on the fourteenth day, most conveniently with the patient in the Sims posture.

The patient may sit up in bed after the stitches are removed and get out of bed on the fifteenth day.

The bowels are moved by a suds enema the morning after operation, and are then kept open by extract cascara sagrada, 10 gr., or some other laxative, at night, an enema being given whenever the bowels do not move freely with cathartics. After each movement the perineum should be irrigated with sterile water, care being taken that none of the fluid enters the vagina, and the vulva is covered with a fresh sterile pad.

Water is given as soon as the patient is out of ether. By afternoon of the same day the patient is able to take light nourishment—some form of broth with crackers or toast, and the following morning may resume her usual diet.

Hexamethylamin, 10 gr. three times a day, as a prophylactic against cystitis, may be given during the first ten days. Twenty grains of potassium acetate may be given with each dose, and the patient should drink 2 quarts of cream of tartar lemonade (see p. 567) daily between meals, in this way promoting a continuous irrigation of the bladder with a dilute, non-irritating fluid.

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RECTOVAGINAL FISTULA

The operation for this condition should not be undertaken until the bowel has been thoroughly cleaned out and the vagina rendered as clean as possible, otherwise the most careful after-treatment may not be able to avert failure.

The vagina is irrigated twice daily with sterile water, keeping the douche-nozzle as close to the anterior wall as possible. The vulva is covered with a sterile pad. The stitches are removed on the tenth day.

The bowels must be kept loose and the intestinal contents soft from the beginning. All enemas are to be avoided. The morning of operation the patient is given 1 ounce of Epsom salt. This is repeated the following morning, and thereafter ½ ounce is given every morning for ten days. After the tenth day, the bowels must be kept loose, but some other cathartic, such as cascara or the compound cathartic pill, may be employed.

The diet must be liquid, without milk, from four days before operation to the tenth day. From the tenth to the fourteenth day a soft-solid diet may be taken, and, beginning with the fifteenth day, full diet may be resumed.

The patient may sit up after the stitches are removed and get out of bed on the twelfth day.

EXCISION OF THE VULVA

Excision of parts of the vulva may be indicated for malignant disease—elephantiasis, pruritus, kraurosis, or tuberculosis. It is, as a rule, possible to close the incision with silkworm-gut sutures. Owing to the impossibility of preventing the urine and feces from soiling the dressing the parts should simply be kept clean and dry, and covered with a sterile pad. After each defecation or micturition the wound should be irrigated with sterile water, and dusted with compound stearate of zinc and boric acid, equal parts. The patient should be kept in bed until the stitches are removed on the seventh day. Diet need not vary from that ordinarily taken by the patient.

EXCISION OF URETHRAL CARUNCLE

Outside of rendering the urine dilute and non-irritating, this operation requires no special after-treatment. The patient should take 20 gr. of potassium acetate three times daily, and should be instructed to drink 10 glasses of water daily.

Hemorrhage occasionally occurs, and will be controlled by a No. 00 catgut stitch in the mucous membrane. This may be taken with the variety of needle designed for the repair of a vesicovaginal fistula, under cocain anesthesia, obtained by placing a crystal of cocain hydrochlorid in the urethra and allowing it to dissolve.

VULVOVAGINAL ABSCESS

The abscess should always be opened upon the inner surface of the labium. The abscess cavity is tightly packed with sterile gauze and the vulva is covered with a sterile pad. The packing is removed the following day. This may be done either in the Sims or dorsal posture. After the packing is out, the vulva should be washed off four or five times daily with an antiseptic solution. The patient is to wear a pad as long as there is any discharge. She may get up as soon as she is completely out of ether. When the tenderness about the labium has subsided, treatment of the gonorrhea should be continued or instituted.

In the rare cases in which a vulvovaginal abscess is successfully dissected out without rupture, the incision should be closed with silkworm gut. The stitches are washed off after each micturition or dejection, and the vulva kept covered with a sterile pad. The patient may get up the next morning, but should remain in her room until the stitches are taken out on the seventh day.

Hemorrhage is the one complication to be looked for. If it occurs after an abscess has been incised, it is treated by a larger and firmer packing. When it occurs after an abscess has been dissected out, it may give rise to a large hematoma in the labium. A moderate amount of ecchymosis always occurs after this operation, and may usually be disregarded, but if the whole labium becomes swollen and tender, the stitches must be removed, the clot evacuated, and the cavity packed for twenty-four hours.

CYST OF BARTHOLIN'S GLAND

All that has been said concerning the dissection of a vulvovaginal abscess applies to the removal of a cyst.

VAGINAL SECTION (COLPOTOMY) FOR DRAINAGE OF PELVIC ABSCESS

The pus-cavity is firmly packed with a large strip of sterile gauze, or, if there are two distinct cavities, a separate packing is passed into each. The vagina is also packed, and the vulva covered with a sterile pad. The patient is put to bed in Fowler's position. At the end of forty-eight hours, or sooner if there is a marked rise of temperature, the packing is removed under primary anesthesia and replaced by a sterile gauze wick or a wick to each pus-cavity if there are two. No packing is now needed in the vagina. The dressing is changed every other day. After the seventh day the sinus may be irrigated with 1 : 800 chlorinated soda solution at each dressing. The sinus is drained by wicks until it has closed in 2 in. in depth, and the temperature is normal. The Fowler position is maintained forty-eight hours.

The patient is given water as soon as out of ether. Liquid diet is started the next morning, soft solids the second day, and full diet the fifth.

The bowels are opened by calomel the night after operation, followed by an enema the next morning.

The patient may sit up in bed at the end of a week if the temperature is normal, and may get up after the wicks are left out.

Complications and Sequelæ.—*Backing Up or Faulty Drainage.*—This is the most common complication. It is manifested by a sudden or steady rise in the temperature, often accompanied by a chill and vomiting, usually by abdominal pain. There is some tenderness, occasionally some spasm, and sometimes a palpable mass in the lower abdomen. The patient is given primary ether, and two fingers introduced into the sinus, which is dilated until the pocket of pus is felt as a round, fluctuant mass, which is then broken into and evacuated. Then other pockets are searched for, and the whole sinus thoroughly dilated and packed. After this the patient should be treated as though she had undergone a second vaginal section.

Peritonitis.—If, after a vaginal section, the temperature and pulse rise rapidly, the abdomen becomes distended, more tender and more rigid, and vomiting increases, the development of peritonitis may be suspected. In such an instance the patient is given primary ether, the packing withdrawn, and the cavity explored. If communication is found with the peritoneum, it should be carefully enlarged and a rubber drainage-tube passed into the peritoneal cavity. If a large enough tube or a double tube is used, little difficulty will be experienced in keeping it in place. This tube may be left *in situ* for four or five days unless it becomes clogged or slips out, in which case it should be cleaned and replaced. The patient should now be treated exactly as after a celiotomy for general peritonitis—high Fowler position, continuous rectal saline, etc.

The greatest difficulty lies here in the diagnosis of beginning peritonitis, for after all vaginal sections there is some reaction, characterized by a higher temperature for twelve to twenty-four hours, with considerable tenderness and spasm. The rise in pulse-rate, combined with abdominal distention and persistent vomiting, are the most important aids in the diagnosis. *Under no circumstances should the abdomen be opened*, for we have in the vaginal opening the best possible mechanical provision for drainage. Furthermore, in the large majority of cases we shall be dealing with a somewhat localized pelvic peritonitis, and to open the abdomen may result in breaking down some of the walling off and scatter the process throughout the abdomen. If the patient will not recover on vaginal, she will not on abdominal, drainage.

Hemorrhage.—Hemorrhage is seldom sufficient to give trouble. The only treatment is to remove all the gauze from the abscess cavity and repack firmly, with a firm vaginal pack in addition.

Injury to the Rectum.—This is more likely to occur in opening small than large abscesses. The diagnosis will not be made until the first dressing, when the fecal odor will be detected on the packing. All packing must be omitted and the vagina kept clean by sponging twice a day with chlorinated soda solution (1:800) until the fifth day, after which douches of the same solution are given twice daily. An enema of salt solution is given every day, and the bowels are kept moving from above by catharsis. Spontaneous closure is the invariable result.

After this operation there remains for a considerable time a great deal of induration throughout the pelvis and a more or less profuse vaginal discharge. For the double purpose of depletion and cleanliness the patient should take hot 1:800 chlorinated soda douches in the recumbent position, with the hips elevated, twice a day. Depletion with a glycerin tampon three times a week should also be practised.

In many cases a symptomatic cure will be effected even though traces of the inflammation remain on pelvic examination. In others, sooner or later, symptoms return and celiotomy will then have to be done. It must always be remembered that vaginal section has its chief usefulness as a life-saving operation in cases of pelvic abscess where celiotomy and removal of the appendages would be extremely dangerous, and makes possible the removal of the source of trouble later, when it can be done with little risk.

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E. B. Young, An Analysis of Twenty-one Cases of Pelvic Abscess Treated by Vaginal Section, Boston Med. and Surg. Jour., 1907, clvi, 76.

VAGINAL SECTION FOR REMOVAL OF THE APPENDAGES

This is done in preference to celiotomy by some surgeons. The after-treatment does not vary from that after vaginal section for pelvic abscess, except in the dressings and in the greater rapidity of convalescence. If the appendages have contained pus, the dressing is identical. After the removal of an extra-uterine pregnancy, of ovarian cysts, or chronically inflamed tubes, the vaginal vault is sewed up except for a short space through which is inserted a small gauze drain. The vagina is lightly packed with sterile gauze. This wick and the vaginal gauze are changed on the second day and removed for good on the fourth day, except in case of an extra-uterine with rupture, or tubal abortion into a walled-off cavity, in which event the drainage is maintained until the cavity closes down, the wick being changed every other day. Fowler's position is maintained until after the second dressing.

The patient may sit up on the seventh and get out of bed on the tenth day.

Complications and Sequelæ.—*Injury to the rectum and peritonitis* are rare. The treatment is the same as described under vaginal section for pelvic abscess.

Hemorrhage is more common than after pelvic abscess, and is to be treated by drawing the stump of the amputated appendages down through the vaginal opening by means of volsella or double hooks, and picking up the bleeding point, which is then ligated if possible, or if not, the clamp is left on for forty-eight hours.

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VAGINAL HYSTERECTOMY

Dressing.—*Ligature Method.*—At the completion of the operation, a gauze wick is passed up into the pelvis through an opening which is left in the vaginal vault, and the vagina packed firmly with sterile gauze. The vulva is covered with a sterile pad held by a T bandage. The patient is put to bed in Fowler's position. Unless there is a sudden or marked rise in temperature, this dressing is left undisturbed until the fourth day, when it is removed and replaced. The dressing is now changed every other day, the size of the wick being decreased as the sinus closes down, and as soon as the sinus ceases to discharge, the wick is omitted entirely. The Fowler position is maintained until after the second dressing, or longer if there is profuse discharge from the sinus. No irrigation is permissible before the eighth day.

FIG. 176.—VAGINAL HYSTERECTOMY. CLAMP METHOD.
Clamps held apart and in place by gauze.

Clamp Method.—At the end of the operation a firm gauze packing is carried up into the pelvis through the opening in the vaginal vault, and the vagina packed in such manner that each clamp is separated from the others by gauze. The handles of the clamps are all tied together outside the vulva, and gauze wound between and round them (Fig. 176). They are then covered over with a large pad, wrung out in some antiseptic solution, and outside of the whole a piece of oiled silk is tied on. The oiled silk and the antiseptic pad are changed after each evacuation of the bowels or bladder. The clamps are removed under primary anesthesia at the end of forty-eight hours, the sinus rewicked, and the vagina packed. The treatment from this point does not differ from that after the ligature method, except that convalescence is slower and less satisfactory.

Stay in Bed.—The patient may sit up in bed on the twelfth and get out on the fourteenth day.

Bowels.—The bowels should be moved by 3 gr. of calomel in divided doses the night following operation and an enema the next morning. They should then be kept open by daily catharsis, compound cathartic pills being a satisfactory agent.

Diet.—As soon as the patient is out of ether hot water, and shortly cold water, may be given her. Early the next morning she is started on hot broths. As soon as she is absolutely free from nausea, generally by the morning of the second day, or, where the clamp method has been employed, the third day, soft-solid diet may be begun. Chicken is added on the fourth day and full diet is begun on the fifth.

Bladder.—The patient should be catheterized before the dressing is introduced at the end of the operation, and if bloody urine is found, an injury to the bladder should be searched for and repaired. In this event a self-retaining catheter is kept in the bladder during the first ten days, being removed, cleaned, boiled, and the bladder irrigated twice a day. Where there has been no injury to the bladder, the patient may be allowed to go until the bladder begins to be distended if unable to void urine herself, and then urination is encouraged by hot fomentations to the pubes and running water. If these fail, the catheter may be employed. In every case $\frac{1}{4}$ gr. of morphin should be given subcutaneously before the patient leaves the table, and, where the clamp method has been employed, this will probably be necessary every four hours, as the pain is usually intense.

Complications and Sequelæ.—*Hemorrhage.*—The ends of the broad ligaments are brought down into the vagina after being seized with a volsellum forceps, and the bleeding point found, clamped, and ligated. If ligation is impossible, or the patient is in a very poor condition, the clamp is left in place for forty-eight hours. In some instances it will be necessary to include the whole end of the broad ligament in the clamp.

Sepsis.—The employment of vaginal drainage and the Fowler's position are directed to the prevention and control of infection, so that no material change in the after-treatment will be made if infection does occur. If there is a sudden or steady rise of temperature to 103° or 104° F. before the fourth day, the wicks are changed immediately, as this indicates faulty drainage. Where there is a great deal of purulent discharge from the sinus, irrigation with a solution of chlorinated soda may be employed after the first week.

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OPERATIONS ON THE CERVIX UTERI

Under this heading will be considered trachelorrhaphy and the various plastic operations for dysmenorrhea, such as Dudley's, Reynolds', Pozzi's, and others.

It may be appropriate to say a word about the method of suturing the cervix in trachelorrhaphy. The sutures may be of silver wire or catgut. The former will give the better cosmetic result, but catgut is much easier to use and gives satisfactory results in everyday practice. If wire is used, it is drawn through the cervix in a silk carrier. A regulation cervix needle of the Sims or Emmet type is used. Each stitch enters the vaginal surface of the upper lip and passes underneath the denudation, emerging in the edge of the strip left undenuded to form the wall of the cervical canal. It then reënters the edge of this strip on the posterior lip, and emerges again on the vaginal surface at a point opposite to the original point of entrance. The first stitch is placed near the inner and outer angles of the denudation, and each successive stitch enters and emerges nearer the external os. On the vaginal surface the stitches should enter and emerge $\frac{1}{4}$ in. from the edge of the denudation. They should be tied without too much tension.

The after-treatment of these several operations is identical. Before leaving the table the vagina is douched with sterile water and then swabbed out with gauze, all blood-clot being carefully removed. The vagina is douched daily with sterile water. Silver-wire stitches should be removed at the end of two weeks. This is most conveniently done with the patient in the Sims posture, the wire being picked up with a long clamp and cut with long-handled scissors. When catgut has been used, unless the patient is a virgin, operated for dysmenorrhea, she should report at the surgeon's office at the end of three weeks, and the ends of the stitches picked off the cervix with a long-handled clamp. The object of this is to stop the vaginal discharge which is kept up by their presence.

The patient can take a light meal, consisting chiefly of soup or milk, the evening after operation, and the following morning may be put at once on full diet.

The bowels are regulated by mild laxatives and enemas when necessary.

The patient may sit up on the ninth and get up on the tenth day.

Complications and Sequelæ.—*Hemorrhage* occurs with great rarity, but may develop where deep denudation has been necessary to remove all scar tissue. A firm gauze pack is placed against the cervix, and if this fails to stop the bleeding, the stitches must be removed and new ones so taken as to control the bleeding vessels.

Injury to a ureter is a more or less theoretic complication, and could only occur either due to an atypical anatomy of the ureter or a considerable lack of technique in operating.

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CURETTAGE FOR ABORTION AND MISCARRIAGE

When the patient is in a hospital, the uterus should not be packed unless there is considerable bleeding. If the patient is in a private

FIG. 177.—FIRST STEP IN PACKING THE VAGINA.

Curved clamp feeding gauze from left hand. Two fingers of left hand dilate vagina.

house or at a distance, it is the part of safety to pack firmly the uterus and vagina. The pack is removed the next day and the uterus and vagina left empty. No vaginal douches are to be given before the tenth day.

FIG. 178.—SECOND STEP IN PACKING THE VAGINA.

Tip of curved clamp has carried gauze to vault.

The bowels are to be opened by an enema the morning after operation, and are kept open by the daily administration of cathartics.

FIG. 179.—PACKING THE VAGINA THROUGH A SPECULUM.

Gauze introduced to vault.

Six hours after operation the patient is able to take nourishment in the form of broth or milk. The following morning she is started on soft solids and the third day on full diet.

She may sit up on the ninth and get up on the tenth day.

Complications and Sequelæ.—*Hemorrhage.*—When the uterus is left empty, it sometimes becomes necessary to pack some hours

FIG. 180.—PACKING THE UTERUS.
Weighted speculum; cervix held by bullet-forceps; curved clamp introduces gauze to fundus.

later to control hemorrhage. When the uterus has been firmly packed, serious hemorrhage is impossible. Sometimes after removal of the

FIG. 181.—REMOVING GAUZE PACK FROM UTERUS.
Fingers of left hand in vagina.

packing a slight hemorrhage starts up. If this does not cease within a few minutes, the uterus should be repacked with sterile gauze. This may be removed twenty-four hours later with perfect safety.

Infection.—Many cases of miscarriage are slightly infected before operation, as is shown by a moderate degree of temperature. This, as a rule, drops to normal within twenty-four hours after curettage. Occasionally, within from twenty-four to forty-eight hours after operation, there will be, with or without a chill, a sudden rise of temperature to 103° or 104° F. This is usually due to a clot blocking up the cervix, and if left to nature, the clot will usually be expelled and the temperature will drop to normal again within twenty-four hours. If, however, the temperature does not begin to drop within twelve hours, the cervix should be gently dilated and the uterus washed out with four quarts of sterile water. If the temperature still persists, a culture should be taken from the interior of the uterus with a Doederlein tube, and if a growth

FIG. 182.—INTRODUCING THE INTRA-UTERINE (LEONARD) DOUCHE-TUBE.

is obtained, a vaccine should be prepared from it. The vaccine treatment of puerperal infection is as yet experimental, but the operator is not justified in leaving untried any treatment which may aid the recovery of the patient. (See Chapter LII.) The uterus should then be washed out as before, and this time the uterine cavity should be packed with a gauze sponge soaked in 70 per cent. alcohol. This is repeated daily until the temperature begins to fall, or the uterus shuts down so that the douche-tube cannot be inserted. When the temperature does not drop after the curettage, the uterus should be washed out immediately after the packing is removed, after which the case should be conducted as described above.

When the miscarriage has been voluntarily induced, a culture should be taken before curettage, because infection is likely to be virulent, and a vaccine should be ready for early use if emptying the uterus does not bring about a drop in temperature.

In addition to the local treatment, general measures are of great value. The patient should be kept out-of-doors during the day, no matter whether winter or summer. Strychnin sulphate, gr. $\frac{1}{30}$, and whisky may be given every four hours. Nourishment should be forced—eggs, milk, cereals, broths, and meat being allowed, no matter how high the temperature.

The pelvis should be examined every third day at least during the course of the fever, so that any abscess in the broad ligaments will be detected and may be opened. Localized foci which may develop in

FIG. 183.—INTRA-UTERINE IRRIGATION.

any organ from pyemia should be watched for and treated. The commonest of these are pneumonia, endocarditis, and joint infections.

General Peritonitis.—This usually follows perforation of the uterus in the attempt at criminal abortion, but may result from accidental perforation by a curet in the hands of a skilful operator.

The best treatment is vaginal drainage by posterior colpotomy, as described in the section on Pelvic Abscess (p. 529), followed by the Murphy treatment, Fowler's position, continuous rectal saline, etc.

Pelvic Abscess.—(See p. 529.)

Salpingitis.—Salpingitis due to puerperal infection is commonly unilateral. It usually develops in the second week of convalescence, and is characterized by an elevation of temperature, with pain, tenderness, and spasm over one or both lower quadrants of the abdomen.

The treatment is rest in bed, liquid diet, free catharsis, hot flaxseed poultices to the abdomen every two hours, and hot douches twice daily. The acute process will subside in seven to ten days, and salpingo-oöphorectomy may be done later if the tube remains enlarged.

Perforation of the Uterus.—Any surgeon who hâs curetted many uteri has probably perforated at least one. Frequently there is absolutely no ill effect. The occurrence is recognized by the curet suddenly passing into the uterus up to the handle. When this happens, the curet should be withdrawn and all further maneuvers stopped. The patient is put to bed in the Fowler position. The pulse is recorded every half-hour for twelve hours and a four-hourly chart is kept for three days. Fortunately, this accident seldom happens until the uterus is nearly or quite empty; in fact, it usually results from an overdesire to get the uterus clean, so that there will be no need to pack the uterus. If there is much bleeding, however, the uterus should be packed lightly and carefully. If there is a steadily rising pulse, the abdomen should be opened and the perforation in the uterus closed, and injury to the intestine sought for. The abdomen should be closed with a wick to the point of injury. A provisional stitch may be inserted at the site of the drain. After forty-eight hours the wick is removed and the stitch tied.

If, after the uterus has been accidentally perforated, there appears upon the four-hourly chart a steady rise of temperature and pulse, together with increasing pain and tenderness in the lower abdomen, celiotomy should be performed at once. The uterine wound should be sewed up and the pelvic cavity drained. If peritonitis is found, the regulation Murphy treatment is instituted.

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HYDATIFORM MOLE

After removal of an hydatiform mole the uterus is tightly packed to control hemorrhage. This packing is removed at the end of twenty-four hours. The same general rules apply to the immediate convalescence as to that after miscarriage. The chief complications are hemorrhage, perforation of the uterus, infection, and the development of a chorio-epithelioma. The first three require no discussion in this section (see p. 535).

Chorio-epithelioma.—J. W. Williams[1] states that 50 per cent. of all cases of chorio-epithelioma develop after hydatiform mole. Therefore, every patient from whom a mole has been removed must be kept under observation for from six months to one year. Repeated hemorrhage from the uterus demands exploration with the curette and microscopic examination of the scrapings. If these present evidence of chorio-epithelioma, immediate radical operation offers the only hope of cure.

CURETTAGE FOR ENDOMETRITIS OR ANTEFLEXION

These will be considered together because their after-care is, for the most part, identical. When the operation has been performed for endometritis, the uterus is simply wiped out with dry sterile gauze, then with gauze saturated with Churchill's tincture of iodin, and left empty.

Where an anteflexed uterus has been dilated and curetted, the internal os is kept open by means of a stem pessary. The uterus is carefully wiped out with dry sterile gauze, the pessary inserted and stitched in place by three silkworm-gut stitches through the holes in the flange and the cervix. The vagina is left empty. This pessary is removed at the end of ten days. The patient is placed in the Sims posture and the cervix exposed. The sutures are cut with long-handled scissors, and after this the pessary can be made to slip out by very slight traction upon the flange.

The bowel should be opened by enema the morning after operation, and kept open by daily catharsis. Six hours after operation the patient may take some hot broth or hot milk. The next morning she returns to full diet. The patient may sit up on the sixth, and get up on the seventh, day.

Complications.—Perforation of the uterus may occur. An old salpingitis which has lain dormant for some time may be lighted up by a curettage. What has just been said about these conditions under curettage for miscarriage apply here also.

SYMPHYSIOTOMY

After the delivery of the child the bladder is catheterized, and if bloody urine is withdrawn, an injury to the bladder is looked for and repaired. When the open method has been employed, the pubic ligaments are united and the skin wound closed with a small gauze drain in the lower angle. With the subcutaneous method no sutures are possible except one or two in the skin at the upper opening. In the latter case

[1] Obstetrics, p. 492.

a gauze wick is passed into the lower opening. After either method a sterile gauze dressing is applied and held in place by adhesive straps. A strong canvas belt extending from just above the crests of the ilia to 6 in. below the trochanters, and well padded with cotton over the prominences, is buckled about the pelvis. The patient is put to bed with a sand-bag beneath each trochanter. The wound is inspected at the end of forty-eight hours, and the wick left out unless suppuration occurs. Stitches are removed on the tenth day. The vulva is kept covered with a sterile pad, and is irrigated with sterile water after each urination or defecation.

Catheterization should be employed at the end of twelve hours if the patient does not urinate spontaneously, and every eight hours thereafter if necessary.

The bowels are moved by castor oil on the evening of the second day and kept open by daily catharsis if necessary.

The diet is liquid for forty-eight hours; soft solid on the third day; chicken added on the fourth, and full diet begun on the fifth day.

The care of the breasts and other details of management of the puerperium do not differ materially from those after any obstetric case. The patient is kept in bed four weeks, and wears a firm belt about the pelvis for three months. At the end of this time she is able, as a rule, to resume her ordinary habits of life.

Complications and Sequelæ.—*Infection.*—Uterine infection, which is extremely common in the cases requiring symphysiotomy, is manifested and treated no differently from sepsis after any other method of delivery, as described in the section on Miscarriage. Infection of the wound is also common and is treated the same as any other infected wound. An absolutely afebrile convalescence from symphysiotomy is almost unknown.

Hemorrhage from the venous plexus behind the symphysis is always present at operation, and sometimes is not controlled by the sutures and dressing, but requires packing.

Injury to the bladder is a frequent complication. It should be discovered at operation and repaired. If this is not done, a urinary fistula develops. Whenever the bladder is injured, whether repaired or not, constant drainage by means of a self-retaining catheter should be instituted, and the catheter removed, cleaned, boiled, replaced, and the bladder washed out with 6 ounces of 4 per cent. boric-acid solution twice daily. This is kept up for ten days. If the injury has not been repaired or repair is unsuccessful, the fistula must be closed by operation at a later day.

Perineal and *vaginal tears* are common and should be repaired. Their after-treatment does not vary from that described in the section devoted to them.

Injury to the sacro-iliac joints from too great separation of the symphysis results in severe backache and interference with locomotion. This is treated by a tight canvas or leather belt, which must be worn for from six months to a year. A plaster-of-Paris jacket may be necessary for a time.

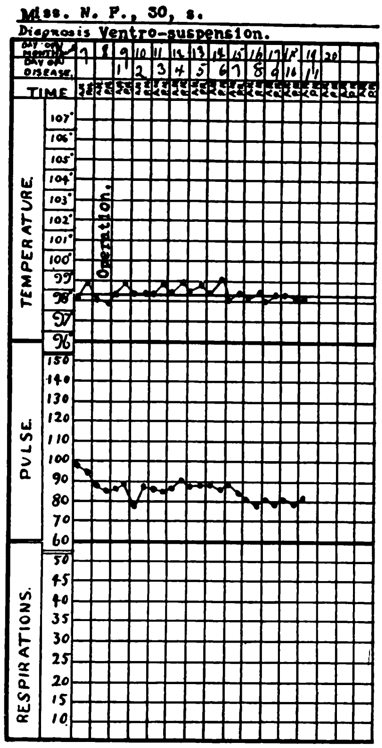

FIG. 184.—VENTROSUSPENSION. SLIGHT ASEPTIC REACTION.

Hematoma of the labium from hemorrhage from the prevesical plexus is common. Even very extensive ecchymosis and moderate-sized hematomas are cared for by nature. When a hematoma develops excessive size or persists after ten days or two weeks, it should be incised, its contents evacuated, and the cavity packed.

Failure of union at the joint, with considerable mobility of the pubic bones, resulting in a permanent impairment of gait, occasionally follows this operation.

Cystitis is common, especially where the bladder has been injured. For treatment, see Chap. XIV, p. 157.

PUBIOTOMY

What has already been said about symphysiotomy applies in the main also to pubiotomy. The convalescence, however, is more rapid and freer from complications. The patient is able to get out of bed on the twenty-first day instead of at the end of four weeks, and normal locomotion is possible much sooner than after symphysiotomy.

The same complications occur, but less frequently. Failure of union seems to make no appreciable difference in locomotion, as a firm fibrous union takes place in these cases.

The belt may be omitted at the end of four weeks, instead of being worn for three months, as in symphysiotomy.

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OPERATIONS FOR RETROVERSION AND LESSER OPERATIONS ON THE APPENDAGES

For the sake of convenience I have grouped together the numerous abdominal operations for retroversion and the minor operations on the appendages, such as resections of the tubes and ovaries and removal of small ovarian cysts, since the general principles of after-treatment are practically identical, and the several operations are frequently combined.

Dressing.—Such cases are practically, without exception, closed tightly in layers, and a thin dressing of sterile gauze held by adhesive straps or laced plaster (Fig. 162, p. 506) is placed over the wound. The stitches are removed on the tenth day.

If an operation for displacement of the uterus has been done, the patient is not allowed to sit up in bed until the twelfth day, or to get out of bed before the fourteenth. On the other hand, if only the appendages have been operated upon, she may sit up before removal of the stitches and get up on the seventh day.

The general after-treatment and complication do not vary from those of any of the simpler celiotomies.

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OVARIOTOMY

The after-treatment of removal of uncomplicated simple cysts, even of large size, is identical with that described for the lesser operations upon the appendages. These constitute the majority of ovariotomies.

Drainage is required only when there have been many adhesions of the cyst to the walls and floor of the pelvis, as a result of the separation of which a large oozing surface is left behind which cannot be controlled by sutures; whenever there has been infection, either in the cyst contents or the peritoneal cavity; after the removal of malignant tumors where there is ascites, and when a dermoid cyst has been accidentally ruptured in removal and its contents have escaped into the peritoneal cavity. An oozing surface requires a single gauze pack making firm pressure against it. Where there has been ascites or infection, it is best to pass a drain behind each broad ligament, although the tumor may have been unilateral. Where a dermoid cyst has been ruptured, a single drain which passes down behind the stump of the broad ligament on the affected side and into the posterior culdesac is sufficient.

The simple exploration of the abdomen where a papillary adenocystoma is found, and, after evacuating the free fluid, the wound is immediately closed, does not require drainage, but if attempts at removal of the growth have been made, a wick should be placed behind each ligament. In some cases an ovarian cyst is so adherent as a result of peritonitis that it is impossible to do more than evacuate the cyst contents and remove part of the cyst-wall. In this instance a wick should be passed into the cavity of the cyst, and a second one into the abdomen just above the cyst, to wall off the pelvis from the general peritoneal cavity.

When the drainage has been simply to control oozing, a provisional through-and-through suture of silkworm gut is inserted at the time of operation at the site of exit of the drain. At the end of forty-eight hours the drain is removed and the provisional stitch tied. Healing by first intention is the rule. In any other case drains are removed on the fourth day, and, as a rule, can be replaced by a single small wick, which is left out altogether the following day. The edges of the wound are then brought together by adhesive strapping, and the dressing changed every other day, as by this time the edges of the drained area will be practically united.

Cases closed tight and those in which a provisional stitch is employed with success get up on the fifth day. Drained cases usually may sit up on the twelfth, and get up on the fourteenth, day.

Complications and Sequelæ.—The complications of celiotomy for this condition are the same as those for celiotomies in general.

Slipping of a Ligature on the Pedicle.—This occasionally occurs. The symptoms are those of secondary hemorrhage. The treatment is to reopen the abdomen and retie the pedicle.

Injury to the Bowel.—This complication may result from the separation of an adherent cyst from any part of the bowel. The injury should be repaired at the time of operation, and a gauze drain inserted to the injured area, to be removed on the fourth day. If a fecal fistula develops, the wicks are left out. The edges of the wound and the surrounding skin are smeared with stearate of zinc ointment. After the seventh day the fistula is irrigated twice daily with chlorinated soda in 1:800 solution. Spontaneous closure usually takes place in from two to three weeks. If the fistula shows no signs of closing down after six weeks, operative measures should be resorted to for its closure. (See also Chap. XXV, p. 280.)

Injury to Bladder or Ureter.—These complications occur only with extreme rarity. Their treatment will be the same as is described under Hysterectomy (p. 552.)

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SALPINGO-OÖPHORECTOMY FOR SALPINGITIS AND OVARIAN ABSCESS

Dressings.—Wicks may be necessary for either of two indications: first, after separating adhesions an oozing surface which cannot be controlled by sutures; second, whenever pus has escaped into the pelvis in the process of separating and removing the diseased organs. In the first instance a single wick is passed to the oozing surface, or one to each, if there is an uncovered area on both sides of the pelvis, and a provisional through-and-through silkworm-gut stitch is taken at the site of exit of the wick. At the end of forty-eight hours the wick is removed and the stitch tied. The wound is inspected again two days later, and if the stitch is found to be holding, the wound is not disturbed again until the tenth day, when all the stitches are removed.

When drainage is required because of pus, a wick is passed behind each broad ligament, if the operation has been bilateral, in such a way that the two meet in the posterior culdesac and emerge side by side in the lower angle of the wound. In this way the pelvis is walled off completely across. Where operation is performed only on one side, the drain should be passed behind the broad ligament and over into the posterior culdesac, and then brought out in the lower angle of the wound. The wicks are removed on the fourth day and replaced by smaller wicks, one running to each sinus. At the third dressing a single wick to the bottom of the pelvis is usually sufficient. After the temperature becomes normal, usually about the fifth day, this wick is shortened an inch daily, and when the sinus has closed to two inches in depth, it is omitted entirely. The wound is then filled with glycerin or balsam of Peru. The stitches are removed on the tenth day, but the dressing over the wound is changed daily until the sinus is closed. When discharge from the sinus has practically ceased, healing may be hastened by strapping together the edges of the wound.

When the uterus is removed with the appendages, the method of dressing is the same as when both sides have been removed without the uterus. The wicks are passed behind the stumps of the broad ligaments in the same manner, and brought together in the posterior culdesac, so as to cover over the stump of the cervix and make their exit from the wound in the same manner.

Sometimes after the temperature has once dropped to normal a sudden or gradual rise again occurs, accompanied by pain in the depths of the wound. This signifies backing up in the sinus, with formation of a pus-pocket. The treatment is to explore the wound with the finger under primary ether, dilating the sinus until the characteristic fluctuant feel of a pus-pocket is detected. Dilatation of the sinus is continued until the pus-pocket is entered and emptied. A drain is carefully passed to the bottom of the pocket and left undisturbed for forty-eight hours, after which it is changed daily, gradually being shortened as the temperature falls and the pocket closes in.

Stay in Bed.—When the abdomen has been closed without drainage, or where a provisional stitch has been employed, the patient may sit up in bed on the ninth, and get out of bed on the tenth, day. The stay in bed of the drained cases will naturally vary considerably. A safe rule to follow is not to let the patient out of bed until the sinus is closed above the level of the fascia, and then only with a firm adhesive strap upon the wound. Otherwise, the general rules for after-treatment of celiotomies apply to this operation.

Complications and Sequelæ.—*Injury to Bowel.*—Either the rectum, sigmoid, or small intestine may be injured in separating a densely adherent tube. If this is discovered at the time of operation, the injury should be repaired, after which an extra drain is passed especially to wall off the injured bowel. This drain is removed at the same time as the others. Enemas should be avoided if the injury has been to the rectum or sigmoid, and the bowels kept open if possible by catharsis alone. If a fecal fistula results, the drains must be omitted entirely and the skin about the wound smeared thickly with stearate or oxid of zinc ointment. After the seventh day the fistula is irrigated twice daily with 1:800 chlorinated soda solution, and a copious rectal irrigation with salt solution is given once daily. Spontaneous healing in two or three weeks is the rule in small fistulæ. It is not harmful, and, in fact, better for the health of the patient to get her out of bed at the end of three weeks, even if the fistula has not closed. If the fistula shows no signs of filling in after six weeks, it should be closed by operation.

Injury to the Bladder and Ureters.—These are very uncommon complications of the operations for salpingitis and ovarian abscess. They are usually caused by needle-pricks. If the injury is discovered at the time it is done, the bladder or ureteral wound should be closed in with several fine Pagenstecher sutures. The drain is then disposed so as to wall this area off from the peritoneal cavity. If the suture has been unsuccessful or the injury has not been discovered at the time of operation, the odor of urine will be found upon the wicks at the first dressing. In this case it will be difficult to avoid infection, but, so far as possible, the wound should be kept clean and the skin about it protected from maceration. Irrigation of the wound is contraindicated. The repair of the fistula must be deferred until the wound has become practically clean.

Phlebitis.—Thrombosis of the uterine, internal iliac, and common iliac veins in succession, while less common than after operations on the uterus, occurs with considerable frequency. (See Chap. IX., p. 114.) Its onset is usually in the second or third week. The symptoms are pain in the thigh, edema of the entire thigh and leg, and slight elevation of temperature. The treatment is rest and elevation by the use of a pillow and side splints. The patient is kept in bed for at least one week after all swelling has subsided—*i. e.*, a total period of six to eight weeks. Citric acid in 20-gr. doses three times a day may be given, though the citric acid treatment of phlebitis is still perhaps experimental. When the patient gets out of bed, she should wear a flannel bandage. There will be some swelling of the ankle, whenever the patient is on her feet a great deal, for six months or a year, and the bandage should be worn during this period.

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TUBERCULOUS SALPINGITIS

This deserves especial attention because the management of the after-care differs decidedly from that of other forms of salpingitis. At the operation all the tuberculous pelvic organs should be removed, including, in many cases, the uterus. The abdomen is then closed *without drainage*, because if drainage is instituted, the walls of the sinus become infected with tubercle and the sinus is likely to persist indefinitely. The patient should be got out-of-doors by the fifth day, and the regulation dietetic and hygienic measures for the treatment of tuberculosis instituted. After this time the case is to be regarded solely as one of tuberculosis and treated accordingly. The wound is inspected on the tenth day and the stitches removed. The time of getting up is to be governed by the temperature, as in any case of tuberculosis.

Complications and Sequelæ.—*Tuberculosis in Other Organs.*—Some involvement of the peritoneum is invariable except in the very earliest stage. Opening the abdominal cavity and removing the major focus of infection frequently is followed by cure.

Tuberculosis of the intestines, pulmonary tuberculosis, and general miliary tuberculosis are also frequent complications. In all cases it must be remembered that once the tuberculous focus has been removed as far as possible and the peritoneal cavity has been exposed to air, light, or whatever the agency is which is so effective in many of these cases, the case becomes one of tuberculosis instead of salpingitis and is to be treated accordingly.

Injury to the Bowel.—Large tuberculous tubes and tuberculous pelvic abscesses frequently become densely adherent to the rectum, and the pus burrows into the rectal wall. Under such circumstances injury to the rectum is unavoidable. This is the gravest possible complication. The friable condition of the rectal wall makes repair difficult. The omentum and sigmoid are usually adherent or involved with tubercle to such an extent that they cannot be brought down to cover over the weak place. Finally, with the tuberculous condition of the rectal wall itself, these factors all tend to the establishment of a fecal fistula, which becomes a tuberculous sinus, and is, therefore, likely to persist indefinitely until the patient, weakened by the disease and the fistula, succumbs.

If the rectum is injured, it should be stitched over as well as possible. A drain has then to be inserted; it should be placed not directly against the stitches, but a little higher up, so as to wall off the wounded part of the rectum, but to avoid direct contact with it, otherwise, removing the drain would increase the danger of fistula by breaking up adhesions. The local treatment of such a fistula is the same as for any other fecal fistula, but hygienic measures are of the utmost importance. Attempts at repair are practically hopeless.

Either the sigmoid or the small intestine may be adherent to a tuberculous tube or abscess and occasionally may be injured. The prognosis is more hopeful than when the rectum is injured. The treatment is identical, except that after the fistula has persisted for two months, an attempt at dissection of the fistula and even resection of the gut should be made.

Tuberculous Sinus Persisting After Operation.—The healing of a sinus which persists after a drained case is promoted chiefly by hygienic measures. The use of bismuth paste may be tried, but is seldom successful. Repeated applications of tincture of iodin give the best result locally. After six months, if it still persists, an attempt at dissection may be made. It must be remembered that bowel is frequently adherent at the bottom of the sinus, and that such a maneuver may result in a fecal fistula. It is in some cases better to leave the sinus altogether alone since, beyond the inconvenience of having to keep it clean and covered, the patient does not suffer. The treatment by the means of vaccine therapy is often beneficial. (See Chapter LII.)

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ABDOMINAL HYSTERECTOMY

Dressing.—After the supravaginal amputation of a myomatous uterus the abdomen is closed in layers without drainage, unless there is an amount of diffuse oozing which makes temporary packing necessary. The first dressing is done on the ninth day, and the stitches removed. The patient gets up on the tenth day.

After total extirpation of the uterus for malignant disease, drainage should always be employed. This may be effected either by a small wick passed into the vagina through a small opening in the vault, or by a small abdominal wick, according to the preference of the individual operator. In either case the wick is removed at the end of forty-eight hours and replaced by a smaller one, which is entirely omitted after twenty-four hours more. If abdominal drainage has been employed, the edges of the wound are strapped with adhesive plaster. The dressing is changed every other day. The stitches are taken out on the ninth day, and the patient may get up on the tenth day. After omission of the vaginal wick, nothing further is necessary, but a profuse vaginal discharge may be relieved by chlorinated soda douches (1:800) after the seventh day.

The management of bowels, diet, etc., does not differ from that after any celiotomy.

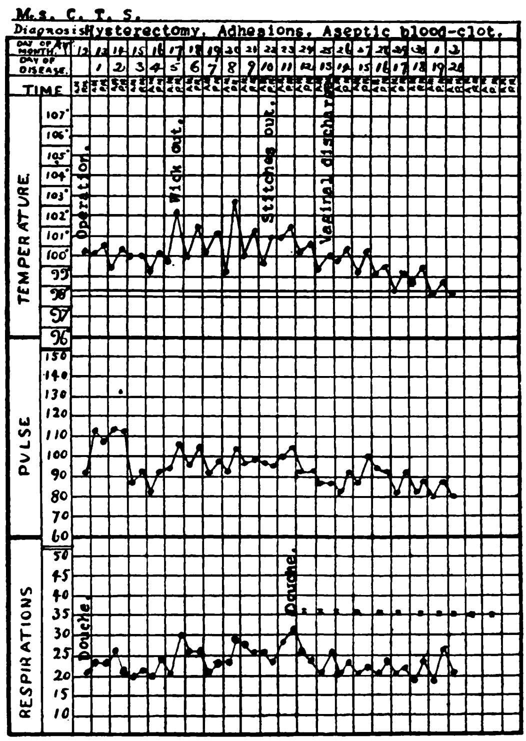

FIG. 185.—ABDOMINAL HYSTERECTOMY.

Unexplained continued temperature. On the thirteenth day decomposed clot discharged from the amputated cervical canal with immediate drop.

Hysterectomy, as an adjunct to the removal of pus-tubes, will be considered under that head, since the essential principles of after-treatment will be those of operations for salpingitis.

Complications and Sequelæ.—The complications common to celiotomies in general may occur after this operation. In addition to these, certain special complications deserve mention.

Pelvic Hematoma.—Blood from a slipped ligature or from an oozing surface may collect under the stitched pelvic floor, and give within a few hours great pain or signs of hemorrhage. Vaginal examination shows a bulging, boggy vault. Unless within a few hours the symptoms abate, the wound must be opened, the clot turned out, and the bleeding stopped. Slight oozing may give no immediate symptoms, but after some days slight continued temperature (Fig. 185) and constant pain will indicate a pelvic collection of serum or clot. Douches may lead to drainage, or it may be necessary to dilate the cervical stump to insure evacuation.

Ligation of the Ureter.—This accident may occur in either form of hysterectomy, but most frequently occurs during total extirpation. If only one ureter is tied off, there are, as a rule, no symptoms. Rarely there may be some pain in the region of the kidney. When both ureters are ligated, there is, of course, complete suppression of urine, and death rapidly ensues from uremia. If discovered in time, an attempt to undo the damage by operation should be made.

Injury to the Ureter.—This occurs not infrequently in the course of the radical operation for cancer of the uterus. If discovered at the time it is done, the injury should be repaired and a small gauze wick placed to the seat of suture, which is removed at the end of forty-eight hours, and left out. If the repair is unsuccessful or the accident is not discovered at the time of operation, urine is discharged from the wound when the wick is removed. In this event the wound is simply kept clean and the parts protected from irritation, the repair of the fistula being left until a later date. In the case of an abdominal fistula, these indications are met by wiping the skin about the wound with 70 per cent. alcohol twice daily, after which it is smeared with zinc ointment, and the whole covered with sterile gauze. Where vaginal drainage has been employed, the vagina is swabbed out with 4 per cent. boric acid solution twice daily. The skin about the vulva is smeared with zinc ointment and a large sterile pad worn over the vulva.

Injury to the Bladder.—This may be discovered at operation and repaired. In such a case it is safer to insert a self-retaining catheter and put the patient on constant drainage. This catheter is removed, cleaned, boiled, and replaced twice a day, and the bladder is irrigated each time with 4 per cent. boric-acid solution, using not over 4 ounces, so as not to throw much tension on the stitches. Constant drainage is maintained for ten days. A small gauze wick is inserted to the point of injury after the suture is completed. The wick is removed at the end of forty-eight hours and left out. Hexamethylamin, in $7\frac{1}{2}$-gr. doses three times daily, should be given to render the urine antiseptic.

When the injury is repaired and does not heal, the urine is discovered by its odor on removing the drain. In this event the same directions as for the care of a ureteral fistula are to be followed. In any case hexamethylamin (7½ gr.) three times a day should be employed as a urinary antiseptic.

Thrombosis of the Pelvic and Iliac Veins.—This complication follows hysterectomy more frequently than any other operation. It occurs usually during the second week of convalescence. It is manifested by swelling of the thigh and leg, accompanied by more or less pain and elevation of temperature. The treatment is elevation and immobilization by means of a pillow and side splints, such treatment to be continued until all swelling has disappeared. Pain is to be controlled by ice-bags and morphin. Citric acid in 20-gr. doses three times a day is considered theoretically as an aid in preventing coagulation, and should be tried. The patient must remain in bed for one week after all swelling has disappeared. When the pillow and side splints have been discontinued, the limb should be bandaged from the toes to the groin with a flannel or, better, an "Ideal" bandage. Some swelling of the ankle while the patient is on her feet will persist for from six months to a year.

Pulmonary Embolism.—This occurs as the result of dislodgment of a clot in the iliac vein, and generally results in death. It may happen at any stage of the convalescence, but is most common between the fifth and fourteenth days.

Myocarditis.—Arterial changes and myocardial degeneration are observed in a large percentage of fibroid cases, and after operation may cause considerable worry; 15 minims of tincture of digitalis three times a day should be given whenever there is cardiac irregularity after operation. All cases of sudden death after operation which are not due to pulmonary embolism can probably be ascribed to this condition.

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INOPERABLE MALIGNANT DISEASE OF PELVIS

In inoperable carcinoma of the uterus relief is demanded of four symptoms: pain, cachexia, hemorrhage, and discharge.

For *pain*, morphin furnishes practically the only relief. According to Maier,[1] however, aspirin is of great value, and this is worth trying first.

For *cachexia*, iron, arsenic, and strychnin, the hypophosphites, and the various bitters may be tried. Much of the loss of strength and flesh is due to absorption from the sloughing cancerous mass, and marked improvement often follows morcellation.

Hemorrhage and *discharge* may be considered together, for both are due to the same cause—sloughing of the growth. Morcellation with a sharp curette, followed by the application of the Paquelin cautery or 95 per cent. carbolic acid and alcohol, should be performed under ether. The resulting crater is packed tightly with iodoform gauze for forty-eight hours to control hemorrhage. This packing is then omitted and bidaily douches of chlorinated soda (1 : 800) instituted.

A sudden severe hemorrhage can practically always be controlled by a tight vaginal pack. Morcellation can be done, of course, only in cancer of the cervix. In carcinoma of the corpus, discharge and hemorrhage are somewhat less annoying, but frequently require curettage.

Of the methods which have been advocated as of possible value in *checking the extension of carcinomata*, the x-ray and radium may be mentioned as foremost. Owing to the anatomic location and the deep-seated nature of the growth, radium is to be preferred to the x-ray. Wickham and Degrais[2] have reported 2 cases where marked improvement followed its use; in 1 even to the extent of apparent cure. Radium is worth trying, but only in inoperable cases.

Trypsin was first suggested as a possible cure for cancer by Beard.[3] Graves[4] has used it in 6 cases of cancer (1 of the uterus and 5 of the breast). Although extension of the growth continued, injection of the ferment into a single nodule always caused that nodule to cease to grow and sometimes to disappear. Sloughing and pain were less noticeable under its use. Pusey,[5] on the other hand, reported unfavorable results: the development of abscesses at the site of injection and increase in cachexia.

Trypsin treatment is carried out daily. Injections are made by means of a hypodermic syringe directly into the growth, beginning with 5 mm. and increasing the dose gradually up to 60 mm. A few

[1] Therapeutic Gazette, 1908, N. S. xxiv, 460.
[2] Radium Therapy, English Translation by Dore, p. 283.
[3] Lancet, 1902, i, 1758.
[4] Boston Med. and Surg. Jour., 1908, clviii, 121.
[5] Jour. Am. Med. Assoc., 1906, xlvi, 1763.

drams of the same preparation are injected into the uterine canal, and 1 to 2 ounces diluted with 3 parts of water are left in the vagina, the outlet being plugged with cotton and the hips kept elevated for two hours.

Gellhorn[1] has obtained good results from the use of acetone. This hardens the growth, just as it hardens tissue in the laboratory, and gets rid of the hemorrhage and discharge. The cervix is first thoroughly morcellated. Treatment is begun on the fourth or fifth day after operation and repeated three times a week. The vulva and lower part of the vagina are first smeared with vaselin for protection against the acetone. The patient's hips are elevated on cushions and 1 to 2 ounces of pure acetone poured directly into the crater through a tubular speculum. The patient is kept in this position for half an hour. The acetone is allowed to run out through the speculum and a cotton tampon smeared with vaselin is introduced.

Inoperable or recurrent *sarcoma* may be treated with Coley's toxins of erysipelas and Bacillus prodigiosus. It will seldom be possible to make injections directly into the tumor, and subcutaneous injections must be employed alone. In a recent paper Coley[2] reports 3 cases of inoperable sarcoma arising in the pelvic organs apparently cured by this treatment. The technique is described elsewhere (p. 797).

CELIOTOMY FOR EXTRA-UTERINE PREGNANCY

A patient operated upon for unruptured tubal pregnancy is to be treated exactly as described for the after-care of the lesser operations upon the appendages. The complications to be met are the general ones to which any celiotomy may be subject.

When rupture or tubal abortion has taken place into a walled-off cavity before operation, a wick should be passed into this cavity and a provisional stitch inserted. The wick is removed in forty-eight hours and the stitch tied. The case is now treated as if sewed tight in the beginning.

When rupture has taken place into the general peritoneal cavity, the ruptured tube and the broad ligament should be tied off, the tube removed, and the peritoneal cavity thoroughly cleansed of clot. If the peritoneum can be got clean of practically all clot, the abdomen may be sewed up tight, but if much clot remains, and especially in cases where rupture has taken place several days before operation, a gauze wick should be passed into the pelvis behind the affected broad ligament.

[1] Amer. Jour. Obst., 1909, lix, 799.
[2] Surg., Gyn., and Obst., 1911, xii, 174.

A provisional stitch is also inserted. At the end of forty-eight hours the wick is removed and the stitch tied if there are no symptoms of peritonitis.

In the after-treatment of these cases we are dealing with patients in a state of profound anemia and shock, and immediate treatment should be carried out along the lines already laid down. (See Chaps. VI and VII.) If the patient passes safely through the first five days, she is then in condition to be treated according to the general rules for celiotomy patients. Some form of iron, preferably Blaud's mass, should be administered during the convalescence. The time of getting up will vary largely with the degree of anemia. Many patients may get up by the tenth day, and all by the end of two weeks, in the absence of complications.

Complications and Sequelæ.—Those mostly to be feared are ileus and peritonitis. As these are treated of in their respective chapters, nothing further will be said here concerning them. Other complications of anesthesia and celiotomy may occur, and should be dealt with by appropriate measures.

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CESAREAN SECTION

Dressing.—The abdomen is closed without drainage. A dressing of sterile gauze is placed over the wound. A folded towel is placed just outside of this above the fundus, and a tight swathe applied. A sterile pad is placed on the vulva and the patient is put to bed. The pulse is taken, and bleeding from the vulva looked for every fifteen minutes for two hours. The proper way to look for hemorrhage is not to pull the bed-clothes down and look at the pad, but to turn the patient slightly on one side and look at the sheet underneath. The blood gravitates into the bed, soils only the lower part of the pad, and cannot be seen by simply separating the thighs and looking down from above.

The vulvar pad is changed as often as soiled, and after each dejection or micturition the vulva is irrigated with sterile water, care being taken that none of the water enters the vagina, and a fresh sterile pad applied. This care is continued to the tenth day, after which an ordinary, non-sterile sanitary pad is worn and the irrigations stopped. After the tenth day a daily mild antiseptic douche may be given to clear out the lochia.

The wound is inspected on the tenth day and the stitches removed if healing has been normal.

Bowels.—The bowels are moved in forty-eight to sixty hours unless distention appears before then.

Diet.—Water is given as soon as out of ether. Liquid diet is started the following morning and soft solids the second day. Chicken is allowed on the fourth, and full diet on the fifth, day. The diet must differ from that given other celiotomies, in that it must consist largely of liquids throughout the convalescence in order to keep up a sufficient secretion of milk.

Bladder.—Every possible aid to natural micturition, such as hot applications to the thighs and vulva, trickling of hot antiseptic solution over the vulva, and, finally, a hot enema, must be tried before catheterization is allowed, because the pelvic congestion and increased vascularity due to pregnancy render the bladder more susceptible to infection. If the patient has to be catheterized, hexamethylamin, 7½ gr. three times a day, is to be given during the convalescence.

Breasts.—The baby is put to the breast the following day, nursing on alternate breasts at four-hour intervals for five minutes until the milk appears in abundance, when nursing is permitted every two hours for not more than twenty minutes. The nipples are washed off with 4 per cent. boric-acid solution before and after nursing, and covered with clean cold-cream between nursings. If the nipples become tender, 50 per cent. alcohol is substituted for the boric-acid solution after nursing and nursing is conducted through a nipple-shield. If the nipples become cracked, the cracks are painted daily with compound tincture of benzoin and the nipple-shield is used. If the breasts become caked, a tight breast bandage is applied.

Stay in Bed.—The patient may sit up on the twelfth, and get out of bed on the fourteenth, day.

Complications and Sequelæ.—(1) *Hemorrhage.*—A moderate postpartum hemorrhage occasionally occurs, and is rarely severe enough to affect the pulse. An extra dose of ergot is given hypodermically and the hemorrhage soon stops. A serious postpartum hemorrhage after Cesarean section is practically unknown. Hemorrhage into the peritoneal cavity is also a rarity, since no arteries are cut in the operation.

(2) *Acute Abdominal Distention.*—Greater or less degree of distention occurs after every Cesarean operation due to reactionary dilatation of stomach or intestines suddenly released from pressure. It may be a serious complication very resistant to treatment. If it

be due to stomach, for Diagnosis and Treatment see p. 183. If it be, as is more common, a dilatation of intestines, strychnin $\frac{1}{60}$ to $\frac{1}{30}$ gr. every four hours subcutaneously and a succession of enemas are to be given. Milk and molasses, the compound turpentine or ox-gall, 1 ounce to the pint, may be tried. If all fail and the condition becomes serious, as indicated by rising pulse, cecostomy may be necessary.

(3) *Infection.*—The uterine stitches occasionally become infected. This will result in slight foulness of the pads and a little elevation of temperature. Usually after a few days the stitch is discharged through the vagina and the temperature falls.

Septic endometritis is very rare in good practice, for the operation is always done before the patient has been long in labor, and the patient is not examined by unclean hands. The occurrence of either of these factors ought to contraindicate Cesarean section in the beginning, or should constitute an indication for a Porro operation rather than a conservative Cesarean section. If septic endometritis does occur, local measures are contraindicated on account of the wound in the uterine wall, and the treatment should be directed to increase the patient's resistance by forced nourishment and stimulation and by vaccine therapy. Whisky in half-ounce doses and strychnin in $\frac{1}{60}$-gr. doses every four hours may be given. A culture may be taken from the uterus and an autogenous vaccine prepared and used for treatment under direction of one expert in this matter. The patient should be out-of-doors if possible.

The development of peritonitis or pelvic abscess should be met by vaginal drainage if possible. If not, the lower angle of the wound may be opened and drainage secured through the abdomen. Further treatment of these conditions is as directed in other chapters.

(4) *Phlebitis.*—This is probably the most common complication of Cesarean section. It usually makes its appearance in the second week, and is characterized by a slight elevation of temperature and pain and swelling of one or, rarely, both lower extremities. The treatment is rest in bed with elevation and immobilization by a pillow and side splints. This is maintained for one week after all swelling has disappeared—*i. e.*, usually a period of six to eight weeks. Pain is relieved by ice-bags to the thigh and morphin. Citric acid in 20-gr. doses three times a day is given with the purpose of diminishing the coagulability of the blood. The value of this measure has not yet been finally determined.

Threatened Breast Abscess.—This also appears about the second week or later. It is characterized by a sudden rise of temperature, usually with a chill and a slightly reddened tender lump in one breast.

The treatment is: first, take the baby off the affected breast; second, open the bowels freely with Epsom salt; third, apply an ice-bag to the breast; fourth, support the breast and the ice-bag by a bandage. Usually the temperature begins to fall within twenty-four hours and tenderness gradually subsides. The baby is allowed to nurse on the well breast, and twenty-four hours after tenderness has disappeared and the temperature has been normal may be put back on the affected breast. A small lump may persist for a time, but in the absence of tenderness or elevation of temperature does not contraindicate nursing. The lump will gradually disappear. If, instead of quieting down, the temperature remains elevated and the lump becomes more tender, red, and indurated, it should be incised and the contents evacuated. The Bier treatment and vaccine therapy here have value.

(5) *Subinvolution.*—In an ordinary obstetric case the fundus uteri sinks below the symphysis about the tenth day. After Cesarean section, however, adhesions to the uterine scar frequently maintain the uterus in a position well up out of the pelvis, so that its presence on palpation of the abdomen does not in itself indicate that the uterus is subinvoluted. The diagnosis is made, therefore, on the character of the lochia. Normally, about the tenth day the lochia becomes pale and white. The persistence of bloody or brown lochia after this period indicates subinvolution, and should be treated by rest in bed and hot douches until the lochia becomes pale.

(6) *Other Complications.*—Besides these special complications, any of those common to all celiotomies may occur.

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EXTRAPERITONEAL CESAREAN SECTION

This operation, as introduced by F. Frank,[1] A. Doederlein,[2] and others, has attained great popularity in the German clinics.

[1] Archiv. f. Gyn., 1909, xxxii, 133.
[2] Centr. f. Gyn., 1909, xxxii, 121.

In Frank's method the uterus is approached by a transverse incision through fascia, muscles, and peritoneum just above the pubes, opening the abdominal cavity. The peritoneum on the anterior face of the uterus is incised transversely just above the bladder reflex, and dissected upward, exposing the lower uterine segment, and then stitched to the upper side of the incision in the parietal peritoneum. The uterus is then opened by a transverse incision and the child extracted by forceps. The uterine wound is then sewn up with catgut in clean cases, and the abdominal wound in layers with chromicized catgut, leaving a small gauze drain down to the uterine wound. In infected cases an iodoform wick is passed down into the vagina through the cervix, and another, through the uterine incision, is brought out through the abdominal wound. Sellheim's technique differs only in the use of the Pfannenstiel incision, and the dissection of the peritoneum from the bladder, entering the uterus without opening the peritoneal cavity. Doederlein makes a vertical median incision, and dissects through the paravesical tissue, retracting the bladder to the right and opening the uterus by a vertical incision without injuring the peritoneum.

Where drains are used they may be removed at the end of forty-eight hours, and replaced or not as the amount of discharge and the patient's temperature may determine. Where the muscles are cut transversely, as in Frank's operation, convalescence is delayed, the patient being kept in bed four weeks.

Complications and Sequelæ.—(1) *Infection.*—Since this operation is indicated chiefly in infected cases, this is frequent. Thorough drainage of the uterus and the wound must be maintained until the temperature falls to normal. Irrigation of the uterus through the incision may be carefully carried out. The chief reliance must, however, be placed on general measures—food, fresh air, iron, arsenic, strychnin, and alcohol (see p. 317).

(2) *Hemorrhage.*—Hemorrhage in the abdominal incision is to be treated by ligature of the bleeding point when possible. When, as more frequently happens, it is the result of a general ooze, it can be controlled by packing the wound tightly for forty-eight hours.

(3) *Injury to the Bladder.*—When discovered at the time of operation it should be repaired at once, and a small wick passed to the point of suture for forty-eight hours. Constant drainage by means of a self-retaining catheter should be maintained for ten days. This catheter must be removed, cleaned, boiled, replaced, and the bladder irrigated with 4 per cent. boric solution twice a day. Hexamethylenamin in $7\frac{1}{2}$-gr. doses may be administered three times a day.

When repair is unsuccessful or the injury is not discovered at the time of operation, urine is discharged from the wound when the wick is removed. In this event the wound is kept clean and covered with a sterile absorbent dressing. The skin may be smeared with a stearate of zinc ointment above the wound. If the fistula does not heal after a period of several weeks, operation should be undertaken for its repair.

Besides these special complications, any of those common to the classical Cesarean section or any other major operation may occur.

VAGINAL CESAREAN SECTION

Vaginal Cesarean section, introduced by A. Duhrssen[1] as a rapid method of emptying the uterus in eclampsia, placenta prævia, etc., has met with widespread popularity. The incisions in the uterus are closed with a continuous suture of catgut; the vaginal mucosa, with interrupted catgut, leaving a small drain to the vesico-uterine space for twenty-four hours. When the operation is done for placenta prævia it is wise to pack the uterus before suture. This pack may be removed at the end of twenty-four hours.

The after-treatment in general does not vary from that of any operative intrapelvic delivery, and the same general complications may occur. Certain special complications demand further mention.

Complications and Sequelæ.—(1) *Infection of the Wound.*—Any elevation of temperature during the early days of the puerperium demands inspection of the cervix, especially if pus is discharged from the vagina. Fever may be due simply to retention of the lochia from sewing up the cervix too tightly; and if the lochia are scanty the cervix may be dilated slightly and the uterine cavity washed out with salt solution. If pus is seen coming from the stitch-holes or the incisions, the sutures should be removed at once. If the incisions appear clean the case is presumably one of intra-uterine sepsis and should be treated accordingly.

(2) *Hemorrhage.*—Moderate hemorrhage always occurs during the operation, but it usually stops when the incisions are sewed up. Rarely it may be necessary to pack the vesico-uterine space. When the hemorrhage comes from inside the uterus the usual measures for postpartum hemorrhage—massage of the uterus, ice to the fundus, ergot, a hot intra-uterine douche, packing, and compression of the aorta[2]—should be employed.

(3) *Injury to the Bladder.*—This accident is uncommon and is

[1] Centr. f. Gyn., 1904, xxviii, 409.

[2] Momberg, Cent. f. Chir., 1908, xxxv, 679.

usually the result of faulty technique. If discovered at the time of operation and the patient's condition will warrant it, the injury should be repaired. In any case constant drainage of the bladder by means of a self-retaining catheter should be maintained for ten days, and hexamethylenamin given in 7½-grain doses three times a day. When a fistula persists for some weeks after delivery it should be repaired by surgical means.

OTHER OPERATIONS

Alexander's Operation.—See Inguinal Hernia, page 486.

Atresia of Uterus, Operation for.—See Trachelorrhaphy,[1] page 534.

Atresia of Vagina, Operation for.—See Colporrhaphy, page 522.

Fistula, Vesico-uterine, Operation for.—See Vesicovaginal Fistula, p. 526.

Gärtner's Canal, Abscess of.—See Vaginal Section, p. 529.

Imperforate Hymen, Incision of.—No after-treatment except possible dilatation.

Inversion of Uterus, Celiotomy for.—See Celiotomy, p. 550.

Inversion of Uterus, Vaginal Operation for.—See Operations upon Cervix Uteri, p. 534.

Myomectomy.—See Hysterectomy, p. 550.

Vaginal Cysts, Excision of.—See Colporrhaphy, p. 522.

ECLAMPSIA

Eclampsia is a condition with which the surgeon may meet at any time when dealing with pregnant women. Its onset is usually characterized by edema of the face and hands and headache. If the urine is examined, as it should be, it will be found at this stage to be scanty in amount, to contain from $\frac{1}{8}$ to $\frac{1}{2}$ per cent. of albumin, and numerous hyaline, fine granular, epithelial, and sometimes fatty casts. Blood is present in greater or less amount, together with renal epithelium. Dimness of vision from albuminuric retinitis is the next symptom to develop. Epigastric pain is the forerunner of convulsions.

The typical eclamptic convulsion is of short duration, seldom lasting over one minute. It begins in the external eye muscles, extends to the face, and then becomes general. It is clonic in character. As the convulsion subsides, respiration, which has become suspended during its acme, is reëstablished, breathing becomes stertorous, and the cyanosis gradually subsides. The patient may regain perfect consciousness, but, as a rule, passes into a noisy, restless delirium, which is interrupted frequently by further convulsive seizures.

[1] W. P. Graves, Boston Med. and Surg. Jour., 1910, clxiii, 753.

Before the onset of convulsions or the development of eye symptoms, medical treatment is imperative. The indications are, first, to decrease metabolism, especially nitrogenous metabolism, to its lowest possible state, and, second, to favor the elimination of toxins and waste products.

The patient is put to bed in a darkened room, on a liquid diet,[1] and given at once morphin ($\frac{1}{4}$ gr.) and hyoscin hydrobromid ($\frac{1}{100}$ gr.) hypodermically. This may be repeated as often as every four hours if necessary to keep the patient quiet.

The channels of elimination to be favored are the skin, kidneys, and bowels. The first is to be stimulated only by heaters and blankets. Hot packs and hot-air baths have cost many lives by their depressing effect. Pilocarpin is contraindicated because of the danger of edema of the lungs.

The renal secretion is to be stimulated by diuretics and the ingestion of large quantities of fluid, provided there exists no edema. A 2-quart pitcher of cream of tartar lemonade should be placed by the bedside and forced upon the patient until she has taken it all. Water may be introduced by rectum or subcutaneously. Diuretin (20 gr.) in combination with 10 minims of digitalis every four hours is by far the most effective drug for this purpose.

S. D. Jacobson[2] has advocated the continuous rectal instillation of sugar solution, on the theory that eclampsia is caused by the retention in the blood of sodium chlorid and other salts which the damaged kidneys are unable to throw off. On the same theory he contends that the saline infusions are harmful.

The bowels should be moved by the administration of 1 ounce of Epsom salt.

If, under this treatment, the patient shows no improvement at the end of forty-eight hours, she must be delivered. If severe eye symptoms develop, if epigastric pain appears, or if the headache and edema increase, she must be delivered at once. A single convulsion is an immediate indication for delivery.

When a convulsion occurs, a gag should be placed between the teeth to prevent the tongue from being bitten. Ether or chloroform should never be given. The convulsion is too short to allow the patient to inhale

[1] Jaeger (Deut. med. Woch., 1909, xxxv, No. 41) commends highly the withdrawal of salt and restriction of fluids in banishing edema and preventing convulsions. Milk contains too much fluid. Unsalted egg dishes and butter, rice cooked in milk, sago, baked potato, puddings, gruels with cream and sugar, vegetables, fruit, and weak tea but no coffee, should constitute the diet-list.

[2] Am. Jour. Obst., 1910, lxi, 871.

enough to do any good. Furthermore, respiration is practically suspended at the acme of the convulsion. Finally, when the convulsion is drawing to a close, the cyanosis is intense and the ether will, of course, displace a certain percentage of the oxygen which the patient needs badly. After the patient is fully out of the convulsion, she should at once be placed under ether and kept there to prevent more convulsions while preparations are made for delivery.

We believe strongly that any time after the sixth month eclampsia which does not yield to preventive treatment should have Cesarean section. This procedure has the advantages, first, of speed, and, second, that the abdominal cavity can be left full of salt solution, which is an ideal immediate treatment.

After delivery the stomach is washed out and 2 ounces of Epsom salt, 2 minims of croton oil, 30 grains of diuretin, and 10 minims of digitalis are introduced through the tube. A quart of salt solution is injected into the lower back or under the skin of the abdomen. Morphin ($\frac{1}{4}$ gr.) and hyoscin ($\frac{1}{100}$ gr.) are injected hypodermically and repeated every four hours unless the respiration drops below 10. Much of the toxin may be eliminated by bleeding. For this reason ergot is never to be given. Venesection should be practised when there is a full, high-tension pulse, 1 pint of blood being withdrawn and replaced by an equal quantity of salt solution.

Transfusion has been reported by G. W. Crile,[1] F. S. Newell,[2] and others. The value of this procedure has yet to be determined.

As soon as the patient is able to swallow, water should be continually forced upon her. Diuretin (20 gr.) and tincture of digitalis (10 min.) are given every four hours. If she remains unconscious, they are introduced through the stomach-tube, together with a pint of milk, every four hours, and 1 quart of salt solution is given under the skin at the same intervals. If the bowels have not been well moved before operation, they must be started by a compound turpentine enema immediately, without waiting for the purges to act.

Renal decapsulation in eclampsia was advised by G. M. Edebohls,[3] following his experience with this operation for nephritis, and a considerable number of cases have been reported by him and others. It is hard to justify this

[1] Hemorrhage and Transfusion, 1909, p. 519.
[2] Boston Med. and Surg. Jour., 1910, clxii, 213.
[3] Am. Jour. Obst., 1903, xlvii, 783.

procedure because eclampsia is not primarily a renal condition; and recent experimental work by H. Ehrenfest[1] has shown that after decapsulation there is a marked decrease in the urinary secretion for twenty-four hours. This fact alone contraindicates the operation in eclampsia.

If the patient has been delivered early, recovery usually takes place, manifested by returning consciousness, cessation of convulsions, increase in the secretion, and diminution of the pathologic elements of the urine. The patient is to be kept on milk diet until the albumin drops to $\frac{1}{10}$ of 1 per cent., when she may be allowed cereals, bread, and toast, but nothing else until the urine has cleared up entirely. The patient is usually able to get out of bed by the fourteenth day. In mild cases nursing is allowed, if there is any milk, after the third day. In the majority of these patients, however, the milk-supply is deficient or absent.

When, after delivery, the convulsions do not cease and the patient sinks more deeply into coma, death may be predicted with certainty.

Postpartum eclampsia is to be treated by the same medical measures as described for the antepartum. These cases commonly recover.

EARLY RISING AFTER LABOR

It may not be out of place here to say a few words on the subject of getting patients out of bed in the early days of the puerperium. Pfannenstiel[2] and E. Martin[3] were the first to carry out this custom in a considerable series of cases. Only absolutely normal cases were selected, and these were allowed to get up first at the end of fifteen to twenty-four hours after delivery, but were allowed only very light exercise. Their results were excellent. No case in either series developed thrombosis. Involution of the uterus proceeded normally, and strength returned quickly. Nevertheless, in spite of their good results, it must be remembered that the class of patients that make up the German clinics is very different from that which is met with in private practice in this country, and one must select with the greatest care the cases to get out of bed early.

[1] Surg., Gyn., and Obst., 1911, xiii, 296.
[2] Alvensleben, Centr. f. Gyn., 1908, xxxii, 1184.
[3] Monatschr. f. Geb. u. Gyn., 1908, xxvii, 248.

CHAPTER XLVII

OPERATIONS ON THE PENIS, SCROTUM, URETHRA, AND PROSTATE

General Considerations.—In all postoperative treatment it behooves the surgeon to conserve to the best of his ability the function of the eliminative organs, for faulty or disturbed elimination is likely to lead to disaster unless promptly alleviated. In genito-urinary work the attention paid to elimination must be doubled, because the chief eliminative system, the urinary apparatus, is involved by the operation and its function is already more or less impaired. The operation is performed with the intention of removing the cause of the functional impairment; the after-treatment must strive to restore natural function or, at least, preserve what is left. To this end the kidneys must be made to act freely and easily; their product, the urine, must be kept or made qualitatively normal, and given an unobstructed outlet; existing infection must be eradicated or subsequent infection prevented; and, last and always, the patient must be kept comfortable.

Renal Activity.[1]—Postoperative urinary suppression occurs more frequently after genito-urinary operations than after operations of any other sort. Its cause cannot always be determined, for infection does not explain every case. Suppression due to infection will be discussed later; the so-called idiopathic or reflex cases of suppression will here be considered. Many causes are assigned to explain this condition: poor general health, prolonged anesthesia and operation, shock, chronic nephritis, reflex irritation from the urethra, and so on. The thoughtful surgeon operates so far as possible only under the most favorable conditions, often delaying operation until he can improve the patient's general condition, and always operating as rapidly as safety permits; and nevertheless, in spite of every care, he often finds suppression threatening. It is a good plan, therefore, to anticipate trouble and to institute prophylactic treatment from the start. As soon as the patient's stomach

[1] See also p. 386.

permits, he should be encouraged to drink as much water as he feels that he can take. A kidney will excrete a large amount of dilute solution when it will balk at concentrated fluids. An excellent device to increase the intake of water is to give palatable drinks; none excels the simple cream of tartar water:

Lemons	2
Cream of tartar	2 drams
Hot water	1 pint
Sugar	q. s.

Keep a pitcherful at the patient's elbow and see that he drinks long and often. He will take much more of this than of plain water. Moreover, it has a slightly diuretic action and is stimulating to the kidneys.

The diet should be liquid for at least the first few days, bland and non-irritating, with a low salt and proteid content, to spare the kidneys. Once renal function is well established, the diet may be gradually increased. Meat and meat soups and extracts contain too much protein compounds to be safe and had better be avoided until later.

In spite of every care, suppression of urine may supervene. As a rule, the warning is ample. The only sure way to detect its onset is to measure the twenty-four-hour amount of urine *in every case*. This procedure is as simple as it is important, and should be faithfully carried out until satisfied that all danger is past. A steady decrease in the twenty-four-hour amount is a danger-signal worth observing. If this occurs, the patient should be kept in bed on a milk diet and given alkaline diuretics, such as the acetates, citrates, and tartrates, and cathartics until the bowels are freely open. These simple measures suffice to arrest a certain proportion of cases. A continued decrease in the twenty-four-hour amount calls for free watery movements and active diaphoresis. A poultice, which may be made of digitalis leaves, over the kidneys acts surprisingly well in promoting excretion of urine. All the usual treatment for acute renal disease must be promptly given—the case is desperate and calls for desperate measures.

Urine.—Most genito-urinary cases coming to operation are passing urine which possesses pathologic constituents. In the majority of cases the urine as it leaves the kidneys is nearly normal; it is the pathologic process lower down in the urinary tract that changes its character. Infection anywhere along the urinary tract adds to the urine pus, bacteria, blood, and local tissue-cells. Mechanical obstruction causes stasis and retention of urine, which gives rise to anatomic changes in the urinary tract, with concomitant alterations of function. The retained urine decomposes and ferments; a catarrhal condition of the mucosa results, with its profuse discharge of mucus. Such a condition readily favors infection, which sooner or later is bound to supervene. The operation supposedly removes the cause for the pathologic state of the urine, but the process may have gone on for a sufficient length of time to cause tissue changes which, in turn, serve to perpetuate the abnormal constituents of the urine.

As an infected or decomposed urine flowing over an operative wound is a real danger, the sooner the abnormal urine can be corrected, the better. To this end the free diuresis already advocated serves, by thoroughly washing out the urinary tract and by causing increased frequency of urination, to prevent retention. In addition, as a urinary disinfectant, hexamethylamin (urotropin), $7\frac{1}{2}$ gr. three times a day after meals, should be given as soon as the stomach will tolerate it. Owing to the slight renal irritation which this drug causes, it is well to omit it every fourth day. Continue the drug until the urine becomes normal. If the urine remains foul in spite of the antiseptic drugs and cystitis is present, wash out the bladder with some mild antiseptic, such as boric acid. Strong antiseptics may give rise to pain and make the cystitis worse. If, however, there is no improvement, a dilute solution of silver nitrate may be used (1:4000), increasing gradually up to 1 : 800. In washing out the bladder only 2 or 3 ounces of fluid must be injected at a time and allowed to run out again, this being repeated until the solution comes back clear. The fluid should have a temperature of about 100° F. The best apparatus is a soft-rubber catheter attached to a funnel, or a glass irrigating nozzle connected with a fountain syringe. (See also Chap. XIV, p. 154.) If the urine is strongly alkaline, benzoate of ammonium can be given in 10-gr. doses; if strongly acid, bicarbonate of soda in 10- to 20-gr. doses should be used.

Locally, much can be done to improve the urine. The field of operation is, as has already been stated, commonly the seat of a low-grade, but nevertheless persistent, infection, which it is the object of the operation to relieve, and that, too, in the presence of infected urine. As Francis S. Watson has epigrammatically expressed it, "Asepsis in genito-urinary work is drainage." All operative wounds, except in the rare clean cases where there is a fair chance for first intention, must heal from the bottom by granulation. There must be no chance for pocketing of infective material; no blind recesses to harbor small collections of urine; and, so far as possible, no uphill drainage.

Thorough frequent irrigations of all wounds with mild antiseptics serve to keep them clean and free of débris; gauze packs and wicks rarely stay placed in wounds discharging urine, and when they do, become plugs rather than drains. In many cases for the first few days the urine escapes by preference through the operative wound, which must, therefore, be kept unobstructed.

Unobstructed Natural Outlet for Urine.—Many genito-urinary cases come to operation for the relief of urinary obstruction. The operation relieves the difficulty, often, of necessity, by making a temporary artificial outlet for the urine as well as removing the obstruction in the natural outlet. During the process of healing, therefore, the natural passages must be kept wide open. Failure in this regard may mean that the

FIG. 186.—METHOD OF URETHRAL OIL-INJECTION BEFORE CERTAIN PROCEDURES.

operation is a failure; and in those cases where an artificial outlet has been made, this outlet will persist indefinitely as a urinary sinus so long as obstruction to the natural outlet exists. The means of keeping the urinary passages open will be taken up in detail later.

Infection.—Existing infection is best combated by the free diuresis, competent drainage, frequent irrigation, and administration of urinary antiseptics already described. The same measures serve also to prevent the occurrence of infection. In addition, the operative wound should be kept covered with a sterile dressing, frequently changed. Infection once started calls for more frequent irrigations and the relentless use of the knife. All the tissues must be laid wide open. Hot soaks in a sitz-bath are invaluable and comforting. Uncontrolled infections have a direful tendency to spread upward along the urinary tract, where the difficulty of combating them is doubled.

Comfort of the Patient.—Hardly anything more uncomfortable can be imagined than the postoperative genito-urinary case, with his urine constantly dribbling away, beyond his control, keeping his dressing wet and diffusing a rank odor of stale urine. Nothing can be too trivial to perform which will add an atom of comfort. Use large absorbent dressings and change them every hour if necessary. A little menthol or charcoal sprinkled in the dressing will disguise or absorb the odor markedly. Keep the edges of the wound and the surrounding skin smeared with zinc-oxid ointment to protect the skin, which easily becomes

FIG. 187.—CONVENIENT METHOD FOR PERINEAL DRESSINGS.

red, burning, and itching from the constant bath of urine. Bed-sores form quickly if the patient lies for hours in a wet dressing or a wet bed, and are difficult to heal.

CIRCUMCISION

The method of dressing whereby a roll of gauze is tied along the wound by the long ends of the interrupted catgut sutures is ingenious, but is not to be commended. This ring of gauze gets heavy and stiff with blood, gets foul in odor, and gets loose here or there irregularly, according as one or another stitch gives way. Interrupted catgut stitches should be used, cut short.

At the end of operation on an adult the glans should be covered with a plentiful mass of eucalyptus vaselin (5 per cent.), the region of the wound bandaged with a few turns of some kind of chemical gauze, held in place by a narrow adhesive strip, barely tight enough to hold it. An infant needs no fixed dressing. A mass of absorbent cotton should now envelop the organ, and the whole be held up by a T-bandage or some other modification of the jockey-strap. After each micturition more vaselin should be put on. The dressing should be entirely changed at least once in twenty-four hours.

For the first twenty-four hours the less the patient is on his feet the better. Sodium brómid (40 gr.) in a glass of water should be given to adults at bedtime the first three nights to avoid painful erections.

Complications and Sequelæ.—(1) *Hemorrhage* from a retracted vessel may take place, even to an alarming amount, in children. The bleeding point must be found and tied. Sometimes blood collects between the layers in the form of a hematoma. This should be opened and evacuated under aseptic precautions, otherwise the clot is likely to become septic and cause sloughing of the flap.

(2) *Sepsis* always appears to a mild degree. A considerable amount of swelling may be expected, and calls for no treatment unless accompanied by much pain. In this case the organ may be soaked in salt and citrate or warm myrrh wash. Spots of foul-smelling gangrene near the stitches are touched with carbolic acid followed by alcohol.

If the skin-flap has been cut too short, erections will be painful until the scar has stretched.

MEATOTOMY

This operation is usually done as a preliminary step to further operation on the urethra. Nevertheless, it requires some attention. The operation leaves a wound which is washed with urine at every micturition. There is scarcely any danger from absorption in so small an open wound, but a concentrated urine on the raw surface will smart and burn. It will add greatly to the patient's comfort, therefore, if vaselin be kept thickly spread in and around the meatus and if the patient be given alkaline diuretics by mouth for the first few days. Any dressing after the first bleeding has ceased is superfluous. Forty-eight hours after operation pass a sound (No. 30 French) through the meatus and repeat every other day until no bleeding follows.

Meatotomy exactly in the middle line we have known in two instances to destroy sexual appetite. If the incision is made slightly to one side of the frenum, there need be no apprehension on this score.

HYPOSPADIAS

The after-care of this operation calls for the greatest patience and attention to details. The soft-rubber draining catheter should be kept in position a week if possible. As a rule, however, the bladder of the child is intolerant of a catheter more than three days. At the end of that time, therefore, it is frequently necessary to remove the catheter and keep it in the new urethra only. The catheter must be taken out, cleaned, and passed into the bladder to draw the urine every three or four hours. Complete union of the full length of the wound is hardly to be expected at the first operation, but at each operation some gain should be made. The wound must be dressed two or three times a day, iodoform being invaluable.

EPISPADIAS

This rare operation presents no questions in after-treatment not covered in Hypospadias (*supra*). In each of these operations two objects are to be constantly in mind: first, that the external wound, the site of the old urethral opening, heals; second, that the new urethra be kept patent. The external wound is to be treated aseptically, like any clean wound. This wound will heal without the formation of a sinus provided the new urethra be kept patent. The slightest narrowing at any point endangers the breaking down of the operative wound, with the persistence of a troublesome urinary sinus. Sounds every other day, therefore, are the only remedy. After two weeks the interval between the passage of sounds may be lengthened to twice a week, then once a week, then once in two weeks, and so on, omitting them entirely at the end of a year.

HYDROCELE

Treated by Injection.—The use of iodin or plain phenol has fallen into disuse. Occasionally, injection of a mixture of equal parts of phenol, alcohol, and glycerin is used. The fluid is drained off with a medium-sized trocar, and from 1 to 3 drams of this mixture are injected in through the trocar still in place. The end of the trocar is now covered with the finger, and the scrotum gently manipulated to bring the fluid into contact with all the folds of the sac. At the end of about four minutes whatever fluid will run out is withdrawn, and the cannula wound is sealed with collodion.

Within two or three hours there are heat, pain, and swelling—a condition of acute hydrocele. The patient should be kept reclining twenty-four hours. Ice should not be used until it is estimated that enough inflammation has ensued to destroy the membrane lining the sac. The swelling usually lasts three to four weeks.

After Excision of the Sac.—The operation here assumed is that in which the major part of the sac is removed, leaving only enough margin on each side of the epididymis to fold back and be sewed over that region and the cord. The patient should be in bed at least three days, the scrotum well supported upon the pubes. Silk, linen, or catgut sutures in the skin are preferable to the stiff silkworm gut, for obvious reasons. Hematoma and sepsis are to be watched for. The wound should be healed in ten days. A suspensory should be worn for two months.

VARICOCELE

It is assumed that the operation which has been done is that in which a section of the varicose cord, excluding the vas and its vessels, has been excised, and the cut ends tied together to bring the testis into normal position. A dressing should be applied similar to that for inguinal hernia, taking particular care that the scrotum is efficiently supported. Uncomplicated, the scrotal wound should heal as any clean wound. The patient may get up at the end of a week, the scrotum being supported for two months in a properly adjusted suspensory.

Complications and Sequelæ.—*Hemorrhage.*—Bleeding may occur in the scrotum from the slipping of ligatures or, a still more serious matter, the proximal end of the cut cord has been known to retract through the canal and bleed into the abdominal cavity. This possibility should be in mind, and signs of hemorrhage in the scrotum or of internal hemorrhage should be met by an immediate secondary operation, opening up the region thoroughly until the bleeding end is found and secured.

Atrophy of the Testis.—This may occur even though the vas has not been injured, and a statement of its possible occurrence must be made to the patient before operation. It calls for no treatment.

Gangrene of the Testis.—This will occur if the vas is cut or if every artery is cut, though it is very difficult to cut all the vessels without injuring the vas, or it may be the result of a tight or improperly applied bandage. When this process begins, the wound opens and the sloughing testicle presents itself. It may be cut away as fast as it extrudes, without anesthesia, or, to save time, if it is evident that complete death of the testis is unavoidable, castration may be done at once. Radical operation should not be hurried into, however, for, after slough of all save the skin and the testis, the testis may remain viable and the skin-edges be brought gradually together over it by means of adhesive strips, and give finally—so great is the adaptability of the scrotal tissues—a good cosmetic result.

UNDESCENDED TESTIS

Unless the cord, when freed by dissection or elongated by dissecting away its veins and unfolding the kinks, is long enough to allow the testis to remain in the scrotum without being held under considerable tension, the operation will ultimately fail, the testis being actually drawn back into the canal or drawn up so tightly against the external ring as to cause constant and unbearable discomfort. Wherever the testis rests without undue tension within the scrotum, there are no special directions in the care of the wound, which resembles that after inguinal hernia. Special pads or other apparatus for holding the testis down are of no value. A testis which has long been retained is likely to have lost its power of functioning on account of pressure atrophy, so that this operation performed in an adult is not likely to have any effect on a preëxisting sterility.

CASTRATION

The wound after this operation calls for no special treatment. Wounds of the scrotum, on account of the folds in the skin, are liable to sepsis. The stump of the cord, unless the precaution is taken of sewing it into the abdominal ring, may retract and bleed. Hernia is likely to make its appearance after castration.

INTERNAL URETHROTOMY

As soon as the operation is completed, irrigate the bladder and urethra thoroughly with hot boric-acid solution (2 per cent.). Do not tie a catheter into the anterior urethra unless there is considerable hemorrhage. Put the patient to bed, and start on cream-of-tartar water and urotropin as soon as the stomach permits. He is not let up until the kidneys are actively secreting. Immediately after the first urination following operation irrigate the urethra through a Valentine nozzle or one of its modifications with warm silver nitrate solution (1:2000). Forty-eight hours after operation irrigate the urethra again with the same solution; pass sounds or the Kollmann dilator into the bladder to maintain the caliber to which the urethra has been cut, then irrigate again. Repeat the irrigation and sounds every other day until no bleeding follows. This indicates that the wound has healed, and its surface is covered with mucous membrane. Thereafter pass sounds twice a week, then once a week, gradually lengthening the interval, and omitting them entirely at the end of a year.

Frequently repeated irrigation as described above keeps the urethra clean, combats any tendency to infection, and does more to prevent reflex urethral chill than all other measures. When least expected, the passage of a sound will cause a chill, followed by a rise of temperature and considerable exhaustion, due to reflex causes. Why this should occur is not to be satisfactorily explained, but that it does occur is an established fact, most disquieting to the patient. (See Chap. XIV, p. 161.) A warm drink and heaters will encourage him to regard the chill as a small matter. Morphin usually acts well. A single chill is no cause for alarm, but repeated chills after the passage of sounds are likely to mean threatened infection. Keep such a patient in bed under regular constitutional treatment. Fortify the kidneys with diuretics and irrigate the urethra after each urination. Watch carefully for collections of pus round the penile urethra and in the perineum and open them promptly.

FIG. 188.—KOLLMANN DEEP URETHRAL DILATOR, WITH RUBBER COVERING.

Complications and Sequelæ.—This operation is rarely practised by American surgeons because of the dangers of hemorrhage, perineal abscess, extravasation of urine, and even septicemia. Hemorrhage after internal urethrotomy may be met by tying in a maximum sized soft catheter, with compression against the catheter from without. Since the other complications are to be met only by a perineal section, we then have the after-conditions of external urethrotomy. As a matter of practice also there is no time saved by an internal operation over the external one.

EXTERNAL URETHROTOMY

This is the operation of choice for deep strictures, and the only one for impassable strictures. Immediately after the operation irrigate the bladder and whole urethra with hot boric-acid solution (2 per cent.). All surgeons agree that after this operation a catheter must be tied into the bladder, but are about evenly divided as to whether it should be tied in through the perineum or through the urethra. In either case use a soft-rubber catheter (No. 30 French). Only as much of the catheter as contains the fenestrum should project into the bladder. As a precaution against plugging, an extra window may be cut in the catheter opposite and proximal to the other.

To hold a catheter in the perineum use a Watson perineal button of hard rubber (Fig. 189). With the catheter in place and the wound covered with sterile gauze, pass the large central hole of the button snugly over the catheter and against the perineum. Through each pair of lateral holes in the button pass a strip of tape. Pass two ends of the tapes backward and upward over the buttocks; the other two forward and upward over the pubes; tie all the ends together over the symphysis just above the root of the penis. The catheter must fit the button closely or it will not stay in place. Place a large dressing on the perineum perforated for the catheter and held in position by a T-bandage. A piece of rubber tubing, one half split into four tails, may be used instead of the button.

FIG. 189.—WATSON'S PERINEAL BUTTON OF HARD RUBBER FOR RETAINING SOFT-RUBBER CATHETER. The tapes are strung through holes in edge of button, which is then threaded on catheter. Buttons are made for each size catheter.

As soon as the patient is in bed, fasten to the open end of the catheter with a piece of glass tubing a long rubber tube which leads to a bottle beneath the bed (Fig. 201). A loop of the tube should be held by a safety-pin to the under sheet to allow slack for the patient to roll round in bed. If the bottle be tied to the side of the bed, there will be less danger of disarranging the apparatus should the bed be carelessly moved. As soon as the bladder fills the urine flows out into the tube, spontaneously establishing siphon drainage. At the end of forty-eight hours dress the perineal wound and remove the catheter. Apply a large absorbent dressing and change it as often as it becomes saturated with urine. For the first few days all the urine will escape through the perineum, perhaps involuntarily. Twenty-four hours after the catheter has been removed irrigate the bladder and urethra with hot silver nitrate solution (1 : 2000), pass sounds up to the size of the normal urethra, then irrigate again. Repeat the irrigations and sounds every other day until bleeding ceases; then twice a week, as described under Internal Urethrotomy.

If, as is preferable, the catheter is to be tied in through the urethra, it is held in place by any one of several ways. The best, from the point of view of cleanliness and efficiency, is as follows: Two pieces of ½-in. tape 8 in. long are fastened by their middle with a safety-pin through the tape and catheter exactly at the meatus. The ends of the tape are then passed down each side of the penis, and are held there by two

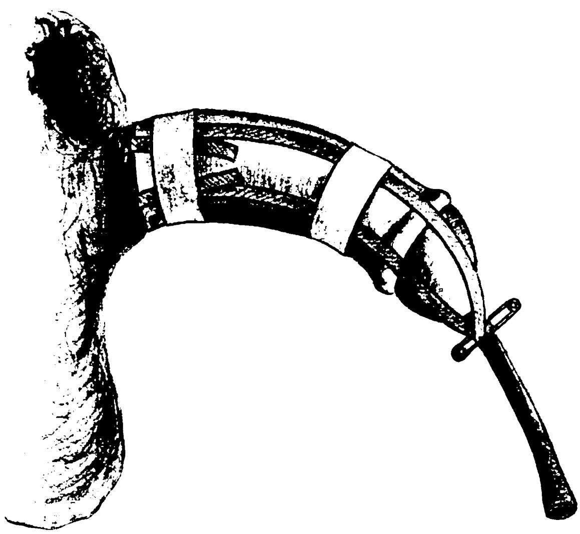

FIG. 190.—CATHETER HELD IN PENIS.

Two pieces of cotton tape are pinned at their middle by a safety-pin to the appropriate point on the catheter. The four ends are carried back to the root of the penis, and a narrow strip of adhesive plaster is bound loosely (to allow for future congestion) about penis and tapes. Over this strip the ends are turned back, and, to prevent slipping, bound down by a second circular turn of adhesive. A third collar of adhesive is applied just behind the corona. During the application the skin of the penis should be kept on a stretch, to prevent any play of the catheter in and out.

circular turns of zinc-oxid plaster about ½ in. wide. By this method the glans is free from any permanent application and remains, therefore, unirritated. This retaining apparatus can be readily changed, if need be, without disturbing the catheter (Fig. 190).

As soon as the patient is in bed establish siphon drainage, as described above. This method, if carefully applied and cared for, drains the bladder as well as the perineal catheter does, and, in addition, diverts the stream of urine from the wound. On the other hand, it is not as comfortable for the patient and is often troublesome to care for. Occasionally the catheter excites such spasmodic contractions of the urethra that the catheter is buckled completely out in spite of the fact that the retainer tapes hold firmly, and the attempt to keep it in place must be abandoned. Leave the catheter *in situ* if possible four to seven days. By that time, often before, a seropurulent discharge will be found

FIG. 191.—PASSING A SOUND.
Penis is manipulated as little as possible.

oozing from the urethra round the catheter. This secretion is the reaction of the urethra against the foreign body which it contains. If the discharge becomes profuse, remove the catheter promptly, but wait until the fifth day if possible. Twenty-four hours after removing the

FIG. 192.—PASSING A SOUND.
Beginning introduction.

catheter irrigate and sound the urethra as above. Rarely by the fifth day is the perineal wound found so far healed as to prevent the escape of some urine through it during the act of micturition.

After the removal of the catheter, irrespective of the way in which it had been worn, every attention must be given to healing the perineal wound and keeping the urethra open. At first it is not unusual to find that there is some loss of control of the sphincter, allowing the urine to dribble away involuntarily. This loss, as a rule, is regained a day or

FIG. 193.—PASSING A SOUND.
The handle is so gently elevated that the instrument finds its way into the urethra by its own weight.

two after the catheter is removed. About a week after the operation the patient begins to pass some urine through his penis. As the perineal wound heals, more and more urine comes through the penis, until, finally, it all comes that way. Occasionally after a day or so without perineal

FIG. 194.—PASSING A SOUND.
Demi-tour de maitre, carrying the tip to the pubic arch.

leakage small amounts of urine again escape from the perineum. This need offer no cause for alarm, provided the urethra is well dilated, for it soon ceases. The patient can materially help to send his urine through his penis if, during the act of micturition, he will stand perfectly upright and press his thighs closely together or stand cross-legged. As long as any urine escapes through the perineum the dressing should be changed after every urination. The patient can be taught to attend to this matter himself.

The secret of success lies in thorough and persistent use of sounds. The scarred urethra must be kept stretched up to normal caliber.[1] The slightest narrowing is enough to prevent the healing of the perineal wound and to perpetuate a urinary sinus. Any tendency toward contraction must be combated by more frequent sounding than that advised above. Leaving a sound in the urethra for five to ten minutes is often efficacious in overcoming a tendency to contraction. It is hard to convince patients of the necessity for the prolonged use of

FIG. 195.—PASSING A SOUND.
Demi-tour completed. Carrying the tip under the pubic arch.

sounds; failure to do so often means an unsuccessful operation and sometimes a urinary sinus in the perineum.

However dirty the bladder before operation, the short period of drainage and unobstructed outflow suffice to clean it up surprisingly well. If it is thought necessary, the bladder may be irrigated daily or oftener through the retained catheter; free diuresis and urinary antiseptics complete the cure.

Some cases of long-standing stricture are complicated by such conditions as extravasation of urine, peri-urethral abscess, or a watering-pot perineum full of scar tissue. In any case, no amount of good after-treatment will correct or make up for an inefficient operation. In short, the stricture must have been fully divided, the draining catheter must be extended well into the bladder, and the perineal wound, however small, must be a triangle, its base at the skin. That is to say,

[1] O. Horwitz, Ann. Surg., 1910, li, 557.

whatever drainage there is must be efficient. In uncomplicated and simple strictures the perineal wound may be made very small, may be drained with small strands of iodoform gauze, and, if the urethra has been sewed over the catheter, as is sometimes advisable, the wound may never leak urine. In cases with abscess or extravasation, however, the wound should be large, and packed lightly with enough iodoform gauze to maintain the wound as a single cavity for a time; the dressing should be changed once or twice in twenty-four hours, so as to keep it sweet.

For the frightfully septic cases, where multiple incisions of buttocks and scrotum have been necessary, dressings every three hours may help: remove all the packing, sponge out the depths of the wound with chlorinated soda (1:800), pack lightly with iodoform gauze, apply a large salt and citrate poultice, with a many-tailed bandage, and place outside

FIG. 196.—PASSING A SOUND.
Handle gently depressed in the median line as the instrument traverses the membranous portion and enters the bladder.

all this dressing a constantly refilled hot-water bottle, taking great care that no burn shall occur. When the wound (or wounds) is a single clean cavity wherein there seems to be no danger of side pockets forming, all packing or drainage should be left out; the wound, however, should be repeatedly cleaned mechanically and dressed with some stimulant, such as balsam of Peru.

Complications and Sequelæ.—*Plugging of catheter* with blood or pus may take place at any time. The danger of this is largely averted if, before insertion, as already described, an extra window is cut in the end of the catheter opposite the usual opening and about ½ in. higher. If the catheter becomes effectually plugged, either it may be forced out by the efforts of the bladder to empty itself or the bladder may fill up and the patient present all the signs and symptoms of distention.

When, in spite of the retaining apparatus, the catheter is forced out, it must, of course, be replaced at once. A soft catheter cannot usually be readily passed through a urethra which has recently been operated. The surest and easiest way to get a soft catheter back, with the least number of attempts and the least discomfort to the patient, is to make the catheter rigid in the usual curve by insertion into it of a small sound or probe to serve as a stilet. A catheter thus stiffened is to be thoroughly lubricated and inserted like a sound, remembering always that the roof of the urethra is supposed to be uninjured and is the part, therefore, to follow as a guide.

If the catheter be plugged, but remain in position, warm boric-acid solution should be forced through it from a fountain syringe or, better, in short sharp spurts from a hard-rubber hand syringe until the clot is dislodged and the drainage is well reëstablished. Sometimes suction will work where pressure will not. Blowing, on the other hand, is not to be encouraged. One of us once saw a case in consultation, after external urethrotomy, which presented the curious symptom-complex of marked distention, no passage of urine, bulging and *resonant* bladder. The case was cleared up by the explanation of the attending physician that he was accustomed to *blow* into the catheter to dislodge clots. Removal, cleaning, and reintroduction of the catheter saved the day. Where there is much bleeding it is always wise in prostate as well as stricture cases to have the catheter irrigated every half-hour for the first three hours after operation to forestall any such difficulty.

Hemorrhage at any time during the first three days after operation may take place from a considerable vessel in the bulb, or may persist from the very time of operation where the urethra and its surrounding tissues are congested from prolonged inflammation. If the hemorrhage is from the urethra itself, as in the case of internal urethrotomy (see p. 574), it is best controlled by the insertion of a catheter of maximum size. Such a catheter gives uniform pressure to the whole urethra and should stop the bleeding. If this is insufficient, the perineal wound may be tightly packed with iodoform gauze, which may, in addition, if one chooses, be soaked with adrenalin solution (1:1000). If the bleeding is arterial and not controlled by packing, it may be necessary to get the patient into the lithotomy position and explore the region of the wound, with or without anesthesia, to find and tie the bleeding vessel.

Sepsis.—Infection in the region of the wound should be met as sepsis everywhere—by the maintenance of perfectly free drainage and frequent dressing. Occasionally in parts of the urethra distal to the wound peri-urethral abscess may arise, particularly if the draining catheter is left in too long. This is characterized by pain and fever, the appearance of induration along part or all of the penile urethra, and, in due time, by the escape of pus from the meatus, on squeezing the indurated part or, possibly, even by the abscess pointing through the skin. This complication should be preventable or, at the worst, should be recognized at once, before it assumes any considerable importance. The draining catheter should be withdrawn, the abscess kept empty by repeated milking, done at least, for example, every two hours. The urethra, from the meatus to perineal wound, should be irrigated with a small-caliber soft-rubber catheter, first put in deeply and gradually withdrawn while irrigating, in order that the whole urethra shall be cleaned. This should be done every three or four hours.

Epididymitis may follow this operation by infection through the ducts in the prostatic urethra. This is more likely to appear also if the draining catheter is left in too long, and, like peri-urethral abscess, seems to depend upon the seropurulent discharge which we described above. The catheter should be removed, the bladder should be washed out twice a day, the testicle should be efficiently supported by a tin shelf across the thighs or by adhesive plaster, and either an ice-bag or flaxseed poultice applied, whichever is the more agreeable, though the former is more likely to abort a beginning process.

Persistent Perineal Fistula.—Urethral fistula after external urethrotomy may be said normally to persist for any period from a few days to a few weeks, and its time of closure must vary, as in all wounds, with the ability of the patient to heal, dependent on his resistance and general state of health and on the local conditions in the perineum. If, after several weeks (it cannot be stated more exactly), the amount of urine passed by the meatus does not continuously increase over that passed through the fistula, there is probably a mechanical reason. A valve-like flap may exist in the urethra just distal to the wound, or there may be a urethral stricture distal to the wound, either recurrent or not originally cut. In any case the cause, apart from any malignant disease, is probably mechanical, and the persistence of the fistula means that the urine chooses to take the easier channel of exit. The treatment is by the use of sounds through the whole length of the urethra. If, as is usual, a meatotomy has been done at operation, the ordinary steel sound is used, beginning with the largest size that can be passed, and increasing as rapidly as possible, with daily passings, until No. 30 or 31 French is reached. If meatotomy has not been done, the curved Kollmann dilator must be used.

RUPTURED URETHRA

Here perineal section will have been performed and a catheter passed the full length of the urethra and left in place for drainage. The urethra, when possible, will have been partly or even entirely sewed up at the torn place over the catheter. Some cases may heal by first intention, but more often they behave as after external urethrotomy. (See p. 575). The catheter is left in place five to seven days, unless there appears an excessive urethritis with toxic symptoms. Two days after the removal of the catheter a steel sound or Kollmann dilator must be passed, and thereafter as in the case of external urethrotomy.

On rupture of the fixed portion of the urethra where the ligamentous attachments of the prostate are torn, affording communication between the prevesical space and the perineum, the drainage-tubes should go well up into this space or even down through a small suprapubic wound.[1]

Complications and Sequelæ.—*Hemorrhage* and *shock* may be considerable; both are amply met by saline proctoclysis and by abundance of pure drinking-water.

Extravasation of urine may occur unless the perineal wound is large enough thoroughly to drain the region of the trauma. Not infrequently there has been a certain amount of extravasation of urine or blood before the case arrives in the surgeon's hand. When this occurs, every effort must be made to forestall or combat cellulitis.

PERINEAL PROSTATECTOMY

Since most patients on whom prostatectomy is done are somewhat advanced in years, it is as well in most of them to begin salt solution under the breasts at the moment of operation. After the completion of the operation the patient should not leave the table until all considerable hemorrhage has been obviously checked and free passage of fluid in and out of the bladder through the perineal catheter (with two fenestra) has been clearly demonstrated. Two small tubes or catheters fastened side by side may be used instead of one catheter. These serve for inlet and outlet respectively. One is fairly sure to remain unplugged. The drainage catheter is held in by the Watson button (Fig. 189) or by the split collar-tube, or in some other efficient manner, and the patient is put to bed, the drainage-tube being immediately connected with a bottle hanging at the side of the bed. The tubing should be led out under the thigh and the knees supported by

[1] O. C. Gaub, Jour. Am. Med. Assoc., 1910, lv, 2048.

a pillow. In this way the patient is free to turn in bed without danger of pulling out the catheter.

Instead of a perineal catheter, Watson's hard-rubber perineal drainage-tube may be used (Figs. 197 and 198).

The catheter should be removed at the end of twenty-four to forty-eight hours, but may need to be replaced. A stilet is used to stiffen it for the purpose of getting it back if necessary. Unless retention of urine appears, the patient should be set up in bed the day after operation and should be out of bed the second day if possible. Cases in which retention with fever persists cannot get up so soon. A sound must be passed on the third day and twice a week thereafter for two to six months, according to the individual tendency to form stricture of the urethra. (See also Cystotomy, p. 600.)

Out-of-door and general tonic treatment should be instituted.

Complications and Sequelæ.—*Hemorrhage.*—External hemorrhage is unlikely if the wound has been packed. The bladder may fill, however, and the patient show signs of internal concealed hemor-

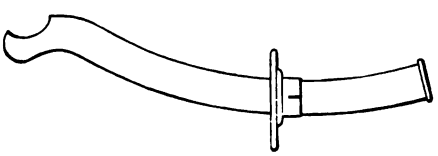

FIG. 197.—WATSON'S HARD-RUBBER PERINEAL DRAINAGE-TUBE.
Showing sliding collar to hold perineal straps.

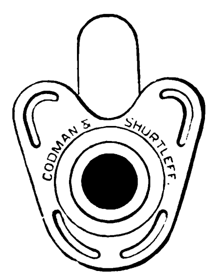

FIG. 198.—WATSON'S PERINEAL DRAINAGE-TUBE.
Front view of sliding collar.

rhage, or the bleeding may not be enough to give general symptoms, but enough, nevertheless, to plug the drainage catheter with blood-clot. The drainage, then, whether there be signs of hemorrhage or not, must be tested every hour or two for the first twelve hours at least. If it stops as if plugged, fluid may be forced from a relatively great height in the fountain syringe and so drive out the clot, or a hand syringe may force the clot out and the bladder should then be washed with a solution as hot as can be borne until the return is blood free. If the hemorrhage then continues to any considerable degree, the patient must be put in the lithotomy position, the packing removed, the bleeding point found, snapped, and tied, and the wound freshly packed.

Suppression of urine is combated by forcing fluids into the body by all means—namely, mouth, skin, and rectum; by exhibition of digitalis; by application of poultices or hot-water bags over the kidney regions; by hot pack or hot-air bath if the matter becomes serious. For drugs, a pill of $\frac{3}{4}$-grain of digitalis tol. every 4 hours, and caffein soda-benzoate, 1 grain subcutaneously every hour for several hours, will stimulate the kidneys.

Retention of Urine.—In the median perineal incision type of operation, such as that of Watson and others, the sphincter is either stretched to temporary paralysis or so torn that what urine appears in the bladder later usually drains without trouble. In the dissection operations of the Young type, the sphincter, as a rule, is not affected, and on removal of the catheter the cases with long dilated, fibrous, degenerated bladder walls will continue to fill up in an atonic manner, just as they did before operation. In these cases, therefore, constant drainage must be maintained, sometimes many weeks, with irrigations one, two, or three times daily with hot boric acid, salt solution, or potassium permanganate, until a certain amount of tone is recovered. Any type of operation should be followed by bladder washings until there is no evidence of atonicity or cystitis.

Infection.—The case may die almost immediately from surgical kidney; extensive infection of the wound may appear in cases of chronic foul bladder poorly prepared for operation; in patients much debilitated; after operations involving much mutilation. Free drainage and careful and frequent dressings constitute the treatment.

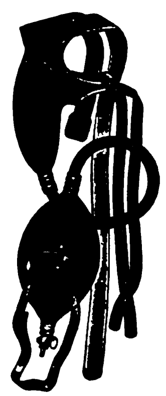

FIG. 199.—MALE URINAL. Soft-rubber, suspended by belt, worn in trouser-leg.

Persistent Perineal Fistula.—It is to be decided that this condition exists, not necessarily upon persistence for a number of weeks or months, but only if there is exhibited no tendency for the amount of perineal discharge to diminish, and at the same time if it be certain that the urethra is patent. Some effort to stimulate healing, in the way of balsam of Peru, nitrate of silver, Friar's balsam, etc., should be made. Sounds should maintain the urethra at No. 30 French. After six months a secondary operation to close the fistula should be done.

Persistence of incontinence, either through a perineal fistula or through the meatus, signifies a probable incurable injury to the sphincter. For this, however, the application of static electricity, with one electrode on the perineum and one over the lumbar spine, may be tried. An ambulatory urinal (Fig. 199) should be used when necessary. Excoriations should be prevented by applications to the skin.

SUPRAPUBIC PROSTATECTOMY

This operation, though relatively in disfavor in American practice at the present writing, seems to have the advantage that it affords inspection of the prostatic tumor and perhaps, therefore, more deliberate treatment with regard to the special formation that the enlargement presents; and that a suprapubic cystostomy may be done some time previous to the removal of the prostate, thus giving time for draining and cleaning up a distended foul bladder. It has the disadvantage that adequate drainage is difficult and that ascending infection of the kidneys seems liable to occur.

The patient is put to bed and drainage through the urethra and the suprapubic wound is immediately established. An ingenious and adequate method has been devised by Dr. Horace Packard,[1] of Boston (Fig. 200). Some operators prefer a single tube with a diameter of as much as 1 inch.[2] Without special apparatus, however, drainage can be efficient if the patient receives intelligent and conscientious attention day and night for the first three or four days. He should sit up in bed the day after operation and in a chair as soon as possible, returning to nearly normal conditions with as great rapidity as is allowed. Water is forced into the body by all methods from the very moment of operation. Urinary antiseptics are given constantly. For other details of

FIG. 200.—SUPRAPUBIC DRAINAGE.
Four small-caliber soft-rubber tubes fused together (Dr. Horace Packard).

[1] N. E. Med. Gaz., 1907, xvii, 13.
[2] P. W. Basham, Med. Assoc. of Southwest, Oct., 1910.

after-treatment see Suprapubic Cystotomy (p. 600) and General Considerations on Genito-urinary Cases (p. 566).

Complications and Sequelæ.—*Shock* complicated with hemorrhage is probably the commonest cause of death. Saline solution,

FIG. 201.—SUPRAPUBIC PROSTATECTOMY.
Constant drainage. Tube is pinned to the bed to allow sufficient slack for patient to turn about. Bottle is hung to side-iron of bed.

adrenalin, heaters, all the means already described (Chap. VII, p. 91), are to be at hand.

Hemorrhage.—The patient should not leave the table until all notable hemorrhage has been checked. If a considerable bleeding starts up in bed, the prostatic cavity must be packed through the suprapubic wound. The packing should be of iodoform gauze or plain gauze saturated with adrenalin if necessary. The packing should be removed in most cases at the end of twelve hours.

Sepsis.—Ascending infection may cause a double pyelitis, which may be rapidly fatal. Mere absorption of septic products from the prostatic wound cavity in cases inefficiently drained is enough to cause fatal issue. In the latter case treatment is obvious. In pyelitis large quantities of water, urinary antiseptics, poultices or heaters over the kidney regions, and general supportive treatment should give results. Suppression of urine is always to be feared. Prophylaxis by means of previous water saturation should be efficient against it, but if diminished secretion just after operation is apparent, besides salt solution under the skin, the patient should be given poultices over the kidney regions and diuretics by mouth. Sweating, using a hot-air bath when indicated, should be induced.

PROSTATOTOMY FOR PROSTATIC ABSCESS

Inasmuch as prostatic abscess can almost always be opened without entering the urethra, it is to be treated as any abscess: iodoform gauze tampon for first dressing, rubber tube subsequently if the skin-wound tends to close too rapidly.

Constant urethral drainage may be necessary in some cases because of spasmodic or inflammatory retention. Frequent hot sitz-baths aid drainage and give great relief. The coincident gonorrhea must be treated.

CHAPTER XLVIII

OPERATIONS ON THE KIDNEY, URETER, AND BLADDER

NEPHROTOMY

THE kidney may be subjected to a small incision, as for abscess, or it may be split open its entire length in order to get out a large stone or a number of stones in the pelvis or the calices. The loss of blood after either procedure is usually considerable. If necessary, the appropriate constitutional treatment for hemorrhage should be instituted. (See Chap. VI.) The shock following this operation is, most likely, due in great measure to the hemorrhage. If the kidney was found to contain stones and no appreciable amount of pus, the wound in the kidney is to be closed by interrupted mattress sutures of No. 1 or 2 chromic catgut. This should immediately control hemorrhage and should give a fair chance of primary healing of the kidney wound. A cigarette or spiral drainage leads down to the kidney.

If the pus in the kidney is enough in amount to make it merely a pus-cavity, or if the hydronephrosis is such that only a shell remains, and if also it has been determined before the operation that the patient has another kidney (by cutting down on it or by catheterizing the ureters), a nephrectomy will be done either primarily or after splitting the kidney. (See p. 597.)

If, however, for any reason the kidney itself is to be drained, a spiral drain with 2 in. of gauze protruding from one end may be packed into the purulent or bleeding cavity. A voluminous dressing is applied and the patient lies on his back with an additional small hard pad under the lumbar region to help prevent backache. Saline adrenalin solution—0.6 and 1 : 50,000, made by adding common salt (1 dram) and adrenalin solution, 1 : 1000 ($2\frac{1}{2}$ drams) to 1 pint of sterile water—should be started under the breasts as soon as the patient is on his back, and should be given to the limit of capacity of both breasts. Salt solution should also be started by the slow method per rectum and kept going twenty-four hours. Tincture of digitalis or strophanthus may be added to the enema if it seems best, and strychnin given subcutaneously ($\frac{1}{30}$ gr.) every one to six hours if indicated. The pads must be changed as often as they are wet. The patient must be kept warm to the extent of mild perspiration, and must be encouraged in every way to drink.

Occasionally bleeding occurs on removing the packing which has been placed in the kidney, because the blood-vessels in this organ have especially thin walls. On this account it is well to postpone withdrawing the tampon until it has been loosened by the suppurative process, and even then it should be removed a little at each dressing until it has all been loosened. In the mean time the urine drains round the gauze, through the wound, and the mucous membrane lining the ureter has an opportunity to become normal, because the flow of purulent urine through it has ceased. The urine usually becomes clear in a few days because the drainage is so free that there is no accumulation. The pelvis of the kidney contracts for the same reason.

For nourishment during the first week milk should be the main resource. Begin by adding an equal quantity of boiling water, together with a little lime-water. After that start soft solids and begin a rapid resumption of house diet. The amount of meat and eggs in the diet will depend somewhat upon the chemical composition of the stones removed and upon the reaction of the urine during convalescence. In a urine which tends to be strongly acid meat once a day is probably best. If the urine is alkaline, more may be given. If the urine continues to be alkaline, sodium benzoate (5 gr.), dissolved in a glassful of water, should be given three or four times a day. Whether the urine contains pus or not during the first two or three weeks, hexamethylamin should be given, 5 to 7½ gr., dissolved in much water, three or four times a day, with a view to rendering the urine sterile and bland.

The amount of urine, day and night, separately, should be carefully noted from the first, together with any gross appearance of blood therein. The blood should diminish and not be apparent to the naked eye after the third day in most cases.

Double nephrotomy offers some curious problems in after-treatment, as a personal communication from Dr. F. S. Watson will show.

" The features of the after-treatment of that case of double nephrotomy were:

"(1) The manner of arranging the drainage (Figs. 202, 203, 204).

"(2) The fact of the infection, and acute abscess of the second kidney, some nine years after the first one had been operated upon also for acute abscess.

"(3) The fact that the patient has been, except for some few weeks of which I will speak in a moment, comfortable, free from disagreeable odor, dry, and without disability, he having pursued an active, hard-working life during the whole time since the first operation, which was in 1894, with the above-noted exception.

"(4) The fact that the first kidney operated upon, which was so greatly injured as to have made it seem wise to have removed it at the outset, had the patient's condition at the time allowed it to be done, has ever since the original operation continued to supply urine having a specific gravity of from 1011 to 1017, and urea from 1.30 to 1.50, taking 2 as the normal quantity (the second kidney was much less seriously and less extensively damaged, although it had a large abscess in it), has secreted a urine of nearly normal quantities of the solid constituents, since it was operated upon. The drainage through the loins has been uninterrupted from the time of its being instituted in both kidneys—fifteen years in all.

"(5) The fact that the patient went on in perfectly good health for twelve years without any evidence of calculus-formation in either kidney.

"(6) That he then began to have calculi from both kidneys, which continued for several months, when I operated on the right and later on the left kidney, removing a lot of gravel and putty-like phosphatic concretions and calculous material in small masses from one kidney and a large single phosphatic calculus from the other.

"(7) The fact that he has had no symptoms of renal calculus since these operations, two years ago, and continues to be in excellent condition and hard at work.

"(8) That the urine has since then become much clearer than at any previous time and is free from blood.

" These are the most interesting features of the case subsequent to operation.

" The kidneys have been washed out night and morning ever since the operation with 1 : 4000 or 6000 solution of potassium permanganate, or sterile saline solution, or boric acid, 4 per cent. solution, through the Watson drainage-tubes. The tubes have been changed for clean ones each time this has been done. The fistulæ have never been allowed to contract, and the drainage-tubes have always been kept of large size, their calibers about ½ in. The best possible drainage has thus been maintained.

" Finally, hemorrhage took place from the kidney operated on first, twelve years after the operation. Nevertheless, daily irrigations went on as usual. Two weeks later he came to my office, and upon having the tube from the kidney replaced after it had been withdrawn to cleanse it, and without any trouble having occurred in getting it back again, a sharp hemorrhage suddenly occurred from that kidney, I succeeded in partially controlling it and got him to the hospital, where I laid open the whole of the tract of that fistula, found the hemorrhage to be proceeding from one point especially of the renal substance close to the inner orifice of the fistula, and after extracting a calculus from the kidney by forceps through the now much-enlarged canal of the fistula, I succeeded in wholly arresting the bleeding by tamponing the wound and bleeding surface af the kidney, after which we had no further trouble of any kind."

Complications and Sequelæ.—*Secondary hemorrhage* may take place at any time for from a few hours to weeks, months, or even years after operation if fistula persists. This may be due to inefficient hemostasis at the time of operation; it may be due to ulceration of a remaining stone into a renal vessel; it may be due to the presence of an unsuspected new-growth underlying the stones, or may be apparently a general venous ooze from the whole cut surface. Such bleeding must be met for the time being by packing the wound with gauze soaked with adrenalin, or at any time by secondary operation, even by nephrectomy, if packing does not control it.

Sepsis.—This may be superficial or deep, and may or may not cause general symptoms. If the kidney has been torn and the urine was foul, or if repeated packing has been necessary to stop bleeding, deep infection will probably appear. For this condition drainage must be free and efficient.

Suppression or *uremia* may take place at once, or at any time up to two weeks. It is seen more often in those beyond middle life and in those with stiff arteries and high-tension pulse, or in those in whom the other kidney is suffering with stone or other disease. Preventive treatment (p. 566) is, of course, the most important. Every means must be taken to produce sweating and diuresis.

Persistent urinary fistula after nephrotomy presents a difficult problem. Until the ureter has become normal, and especially in cases in which the disease has existed a long time, the wound in the kidney will not heal, and a fistula may persist, which is not only disagreeable, because of the odor and sensations of dressings constantly wet, but also because it results in distressing excoriations of the skin on account of the irritation of the urine. The problem of collecting the urine from such a fistula so as to allow the patient to lead an ambulatory life is well met by Dr. F. S. Watson's ingenious apparatus. The apparatus consists of the following parts:

(1) A cup-shaped hard-rubber shield perforated by two holes, one in the center of the shield and having the size of No. 28 of the French scale of measurement for urethral instruments; the other, which is somewhat smaller than the first, is placed just within and at the lowest point of the cup of the shield. A short hard-rubber tube is fitted into the last-named hole, and onto the farther end of this tube is attached another of soft rubber which passes to the smaller

of the two upright tubes of metal that are upon the upper surface of the receptacle (Fig. 203).

The leakage, which is so distressing a feature to the patient, and, because of the uriniferous odor, makes the condition so unpleasant to others, takes place around the outer sides of the tube which drains the kidney. It is this leakage which must be provided for by the apparatus, and it is done in a very simple manner by this contrivance, thus: As fast as the urine escapes upon the surface of the body it is necessarily caught within the cup of the shield and is withdrawn from it by the small tube which

FIG. 202.—WATSON'S APPARATUS FOR PERMANENT DRAINAGE OF THE KIDNEY THROUGH THE LOIN (WATSON AND CUNNINGHAM).

drains the latter as fast as the urine collects in it, and conveys it to the receptacle. The shield is provided with a soft-rubber rim, which fits into the raised edge of the rubber cup, and the shield is kept firmly pressed against the surface of the body by an elastic belt which is attached to each of its wings and which buckles in front (Fig. 202).

(2) A receptacle made of German silver which has a capacity of 9 ounces.

(3) A second belt, which is attached to the receptacle in the manner shown in Fig. 202, and which also passes around the body and buckles in front.

(4) Upon the lower part of the can is a metal cap, which can be detached from it. From the middle of this cap projects a short metal tube, over the end of which a soft-rubber tube is slipped; the further end of this tube is

FIG. 203.—WATSON'S APPARATUS (WATSON AND CUNNINGHAM).
Cup-shaped hard-rubber shield of Watson's apparatus for permanent renal drainage through the loin.

FIG. 204.—WATSON'S APPARATUS FOR PERMANENT DRAINAGE OF THE KIDNEY AS APPLIED (WATSON AND CUNNINGHAM).

furnished with a hard-rubber cap, by unscrewing which a hole is opened in its stem and allows the contents of the can to escape through it. Except at the time at which the can is being thus emptied, the end of the tube is worn beneath one of the elastic belts, which retains it at whatever point is most convenient to the wearer (Fig. 204).

(5) The only other feature of the apparatus which requires description is the arrangement by which the tubes connecting the shield with the receptacle are attached to the latter. This is done by passing the lower ends of the soft-rubber tubes into the two metal nozzles—or, if preferred, slipping them over them—which are placed upon the upper part of the receptacle. The manner in which the connection is made, as well as the relative positions of the shield and receptacle and other details of the apparatus, are shown in Figs. 202 and 203.

Fig. 204 shows the apparatus as it appears when properly placed on the patient's back.

The further points to be noted in connection with it are as follows:

The hole in the shield through which the tube which drains the kidney passes must be a little smaller than the tube, in order that the latter shall bind it in and thus be prevented from slipping to and fro. If in any case the tube should be too small to do this, its size can be increased by slipping over it a short bit of another and larger tube at the point at which it passes through the shield.

The receptacle can be worn inside the trousers, and is so small and flat that it attracts no attention and causes no discomfort.

Instead of a receptacle of this form the ordinary portable rubber urinal, which is attached to the leg, may be worn if preferred, the connecting tubes being united into one, near the shield, and lengthened, as may be required. The objection to this arrangement is the difficulty of keeping the rubber bag clean and odorless.

At night the metal receptacle is detached, the tubes of the shield are lengthened by attaching others to them, and these are carried to a bottle or other receiving vessel placed beside the bed. The patient should assume a semirecumbent position at night in order to secure the best drainage of the cup of the shield.

The connections of the belts with the shield and can respectively should be so arranged as to be detachable, in order that the other parts of the apparatus can be boiled, which should be done once daily. The tube draining the kidney should be changed for a fresh one each day, the one not in use being kept in an antiseptic fluid.

When the tube which drains the kidney has been properly adjusted in the organ, a mark should be made upon it at the point at which it emerges from the outer side of the shield, in order to avoid the necessity of having to readjust the tube each time that it is changed. The tube's inner end should rest within the renal pelvis in most cases, and should be so placed as to cause no pain to the patient.

NEPHRECTOMY

The dressing should not be so voluminous that it makes a mass uncomfortable to lie on. Temporary drainage is in the renal space. In bed the patient is surrounded by heaters, and symptoms of shock and hemorrhage attended to as they appear. Uncomplicated, the sutures should be out on the tenth day, the patient up when the remaining kidney seems to have assumed its doubled function.

If the nephrectomy has been for tuberculosis of the kidney, it is to be supposed that the ureter was followed down and removed. In the

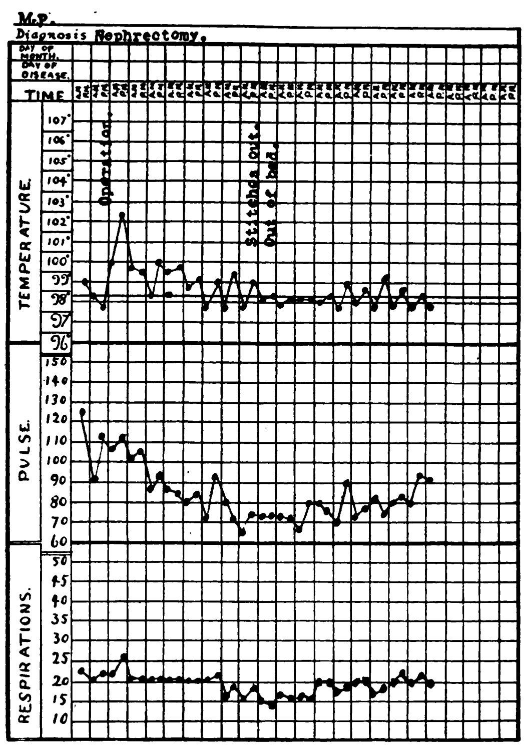

FIG. 205.—NEPHRECTOMY FOR SUPPURATING KIDNEY, DRAINED.

wound, therefore, if there is any question of tuberculosis remaining, it should be treated later by repeated applications of tincture of iodin, as in tuberculous wounds elsewhere.

Abdominal nephrectomy, a very rare operation, calls for no special consideration apart from nephrectomy in general.

Complications and Sequelæ.—*Suppression of Urine.*—After-care of nephrectomy, as in nephrotomy, should be at first directed toward encouraging the other kidney to rise to its increased labor. It has been contended by some that too high an arterial pressure might be induced by forcing the ingestion of fluids, but it seems to us doubtful if suppressive congestion of the other kidney is ever due alone to pressure from too great a volume of blood in the systemic circulation. It seems more probable that uremic suppression is due, on the contrary, to the concentration of blood containing too much matter to be excreted. The same consideration may be applied to meet the objection that one should seek to avoid the raising of blood-pressure until thrombosis is well established in the renal pedicle after nephrectomy.

In the matter of postoperative suppression there is one prophylactic possibility of which too little is ordinarily said. To quote F. Tilden Brown[1]: "A word about the prevailing method of posturing patients for nephrectomy. Of course, an extension of the iliocostal space greatly facilitates operation. This is ordinarily secured by bags of sand or air underlying the opposite anterolateral region of the abdomen. When, by such an arrangement, the spine is sufficiently flexed to extend the operative field, the pelvis is nearly lifted from the table, and the pyramidal support thus bears a considerable part of the total weight of the body. This pressure impinges upon a yielding surface immediately about the sound kidney, and that the organ may be heavily compressed against the spine, with deleterious consequences, appears to us quite possible. Experiments showed that 30 per cent. of the body weight was in this way superimposed on this region alone."

This evil is avoided by the use of an operating-table with the double-inclined plane arrangement (such as the Cunningham table), but it would seem as if there should be an actual gap between the planes to underlie that part of the trunk which ordinarily sustains all the lifting strain in the varieties of "nephrectomy" tables.[2] As Dr. Brown says: "We feel that every consideration should be accorded to the single healthy gland (kidney) during the removal of its mate."

Nitroglycerin and adrenalin, which cause a rapid rise in arterial tension, should be avoided if possible. The surgeon should rather trust to strychnin with digitalis or strophanthus to overcome the shock of operation. The observer may be easily led to mistake a condition of delayed surgical shock for auto-intoxication due to renal suppression. The former is probably the more likely, and should be ruled out before anuria is diagnosticated.

[1] Non-obstructive, Postoperative Anuria, Ann. Surg., 1981, xxxiii, 225, et seq.

[2] There has been much recently written on the matter of orthostatic albuminuria and the general relation of posture to kidney disease. See G. Pechowitsch, Deut. Med. Woch., 1910, xxxvi, 2020.

Hemorrhage.—At the time of operation the ligatures must be placed with all the care possible, using the so-called surgeon's knot, as small a mass being included in each tie as is feasible. The wound should be well retracted and well lighted, and every oozing point which appears after fairly vigorous sponging should be deliberately tied. If bleeding still persists, or cannot be reached by ligature, the hemostatic forceps or clamp should be left *in situ* for two days. If this is done, the greatest care must be taken to so build the dressing round the handle of the forceps and to so place the patient that the weight of the body in the recumbent posture shall not bear on the forceps. In some cases the dressing pad stains through with bright blood repeatedly to an extent which is disturbing. If this occurs, particularly with rising pulse, and it is known that every reasonable effort was made to control bleeding by direct ligation at the time of operation, the patient should be turned over on the well side, the wound opened and tightly packed with iodoform or some other chemically treated gauze. In packing a capacious cavity of this sort one should leave the end of each strip which has been introduced protruding from the wound, in order that later, when the packing is removed, nothing may be left.

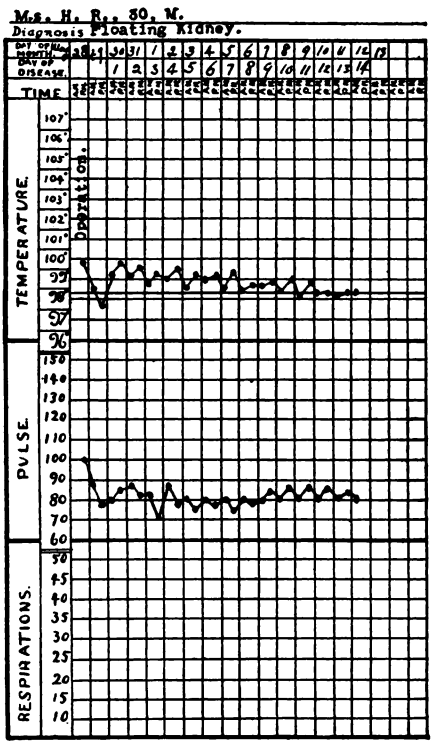

FIG. 206.—NEPHRORRHAPHY.
Uneventful recovery.

NEPHRORRHAPHY

This operation is rarely necessary. Whatever the type of operation used, the patient should be on the back about twenty-one days to allow thorough organization of the adhesions about the kidney in its new place. After this the patient may acquire strength as rapidly as possible, avoiding, however, great muscular strain, such as requires the fixing of the diaphragm and reaching upward or backward. Other than this there are practically no special directions for convalescence.

Complications and Sequelæ.—*Kink in the Ureter.*—It is possible that by the operation the kidney has been fastened in such a position as to kink the ureter or to interfere with the blood-supply. This is called strangulation or acute dislocation of the kidney, and an immediate secondary operation may be necessary.

The newly fixed kidney *may tear away*. Even so, if the patient be kept on his back, there should be enough raw surface in the region of the wound to enable the kidney to adhere. Certainly no second operation should be attempted for many months at least.

OPERATIONS UPON THE URETER

After operations upon the ureter, whether the operation has been for ureteral obstruction or for accidental or operative injury to the ureter, the wound must be drained down to the site of ureteral operation, but in such a way that there shall be no obstruction due to the drain. The drainage, if there is no leakage of urine, needs to be in place only twenty-four to thirty-six hours. Occasionally the abdominal wound has been closed primarily.[1] If urine escapes to a notable degree from the wound, means should be taken to protect the skin (p. 570) or to collect the urine, as in a persistent nephrotomy fistula (p. 593).

SUPRAPUBIC CYSTOTOMY

In these cases it is assumed that the bladder is closed by interrupted catgut sutures, but the wound down to the bladder is left open. This procedure may be followed unless one of the following conditions is present: (1) Cystitis, especially with foul-smelling urine; (2) when the stone was partially embedded in the bladder-wall or for any other reason the bladder was torn or bruised, as in the separation of a tumor; (3) hemorrhage, either present or reasonably to be expected. If the bladder is closed in this condition, it will fill with clot, cause violent tenesmus, and finally tear itself open through the line of sutures.

"The drainage of the bladder (after suprapubic cystotomy) by catheter in the urethra and siphonage is so difficult, the patients being so unsatisfactory for the first week or so, owing to the constant soakage in spite of voluminous dressings, that wherever it is possible the bladder opening should be closed by sutures. This is especially the case in elderly flabby patients with damaged kidneys and unsatisfactory vital power and will. Such tend to become apathetic, to lie helplessly on their backs, down in the bed, thus easily get stasis in their lung bases and bronchopneumonia, together with a low septic condition of the wound. The nursing in such cases is greatly helped by suturing of the wound, thus keeping the patients dry. One of the first to adopt this

[1] H. Cabot, Boston Med. and Surg. Jour., 1910, clxiii, 789.

plan successfully was Dr. L. S. Pilcher, of New York: a catheter was used until the ninth day; the patient, an adult, went out on the fourth, and on the fourteenth day was shown to the New York Medical Society, primary union having taken place throughout the whole extent of the wound, without unpleasant symptoms of any kind. Mr. Anderson (Lancet, 1890, i, 898) sutured the bladder in a boy aged ten. Acute pneumonia complicated the after-treatment, and on the night of the fourth day prolonged coughing tore open the wound. The case did well. During the first few days, if the urethral catheter becomes plugged, some urine, possibly septic, may be forced out between the sutures before the bladder wound is finally closed. If this extravasation takes place deep down in a wound like this, where the superficial parts have been closed, there is the gravest peril of a fatal issue from septic purulent infiltration of the connective tissue of the cavum Retzii, pelvis, and abdominal wall."[1]

Complications and Sequelæ.—*Shock* may appear immediately after operation. This is partly because patients, as a rule, are old; because persistent hemorrhage has been usually going on for a long time before, and because during operation there may have been considerable hemorrhage.

Hemorrhage.—Bleeding may continue unchecked from the time of operation or may start up secondarily two or three days after operation. Where the growth was in the lower segment of the bladder, near the exit, if bleeding is not stopped by simple packing, a small bougie may be passed by urethra into bladder, and a tampon may be made as follows:[2] A small shirt-button is placed in the center of 15 or 20 layers of gauze, 8 or 10 in. square. A long loop of silk is passed through the gauze, through the button, and back through the gauze, and the silk loop is then pulled by means of the bougie through the suprapubic wound and out through the urethra or the perineal wound, as one exists, dragging after it the conical tampon of gauze.

Sepsis.—This may follow partly from lowered resistance on account of the age of the patient or from a previous dirty condition of the bladder. In the latter case sepsis should have been anticipated by preliminary suprapubic drainage and irrigation. If sepsis occurs after operation, ample drainage must be established and repeated irrigations practised. Boric-acid solution (3 per cent.) or normal salt solution may be passed through the urethra or the perineal tube until it comes out suprapubically perfectly clear. This should be repeated as often as every two hours until acute signs or symptoms subside.

Peritonitis has followed where the operation has caused a perforation of the bladder-wall. This accident may easily happen when a polypoid tumor is pulled up from the fundus and snipped off.

[1] Jacobson, 1902, ii, 404.
[2] A. T. Cabot, Med. Rev., New York, Sept. 17, 1892.

Fistula.—In some cases it is found advisable to allow a suprapubic opening to persist, as, for instance, in the presence of malignant disease. The patient may be up and about, so far as his general condition will allow, with a drainage catheter passing through the fistula into the bladder. This may discharge into a large pad of gauze or its outer end may be carried into a rubber urinal strapped about the waist or thigh. Dr. Watson has designed a belt plate of hard rubber, curved to fit the body, through which a hole is bored obliquely, of the proper size to fit the catheter snugly. This is held in place against the fistula by a belt of broad strapping, and serves to prevent the drainage catheter from slipping in or out.

Walker[1] has devised another method to take care of this drainage, at the same time to prevent maceration of the skin and the general dis-

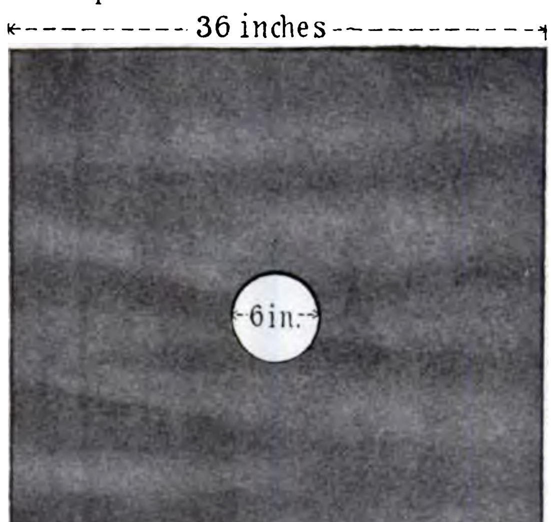

FIG. 207.—WALKER'S DEVICE TO AID IN KEEPING THE PATIENT DRY AFTER A SUPRAPUBIC CYSTOSTOMY.

comfort of a wet dressing. "The device consists of a pure gum rubber sheet, 1 yard square, with a round hole in the center 6 to 8 inches in diameter. The material is similar to that used by dentists.

"The sheet is laid on the patient immediately next to the skin so that the opening falls over the suprapubic wound. The usual amount of absorbent gauze is then laid on the wound, and the borders of the sheet are folded in, covering the gauze completely. The sheet with the enclosed gauze is held in place by an ordinary abdominal binder

[1] Johns Hopkins Hosp. Bull., 1911, xxii, 160.

or Scultetus bandage. By this arrangement whenever the gauze becomes saturated the fluid drains into the dependent portion of the sheet, where it collects and allows almost no leakage for several hours, during which time the patient's bed and clothing are kept dry. When properly adjusted the sheet is also of very material aid in protecting the clothing when the patient is in a wheel chair or walking about. A large opening in the rubber is necessary in order to supply a sufficient absorptive surface for the gauze. This arrangement has been found to work admirably with some patients, keeping them almost dry; for others, owing to the configuration of the abdomen, it will prove less satisfactory, but in all cases it undoubtedly adds to the general comfort."

LATERAL CYSTOTOMY

This operation for stone is practically never done in the United States now, the perineal or suprapubic routes or lithotrity having taken its place. The lateral wound gapes and is slow to heal.

MEDIAN PERINEAL LITHOTOMY

The advantages of median perineal lithotomy have been summed up thus by Dr. W. T. Briggs:[1]

"(1) It opens up the shortest and most direct route to the bladder; (2) it divides parts of the least importance; (3) it is an almost bloodless operation; (4) it affords a passage for any calculus which can be safely extracted through the perineum; (5) it affords the best passage for the fragmentation of unusual calculi; (6) it reduces the death-rate to a minimum." In his first 74 cases, none died. Nevertheless, this operation, except when stone is removed incidental to perineal prostatectomy, is rarely practised in America. For after-treatment see Perineal Prostatectomy, p. 584.

Complications and Sequelæ.—*Shock.*—As a rule, unless there has been much tearing in the operation, shock is not severe. Children stand it very well.

Hemorrhage, if it does not come from a vessel that can be reached by a forceps which is left for a time *in situ,* may be controlled by temporary packing of the bladder through the wound with gauze, which may be soaked in adrenalin.

Local sepsis is the most common cause of death, due to extravasation of foul urine into lacerated tissues of the pelvis. Free, almost ruthless, incisions must be made to relieve this condition. Extension of this process may show itself first or last as peritonitis.

[1] Trans. Amer. Surg. Assoc., v, 127.

Surgical Kidney.—This condition (p. 163) may be expected after any operation on bladder or urethra. The same is true of *urethritis, persistent fistula,* calling for later operation; *incontinence of urine,* where the prostatic urethra has been extensively injured during the removal of the stone through it; *sterility,* due to destruction of ejaculatory ducts in the prostatic urethra.

VAGINAL CYSTOSTOMY

This operation is of the greatest value in the treatment of obstinate chronic cystitis in women. It consists in the formation of an artificial vesicovaginal fistula for the purpose of establishing constant drainage of the bladder. It may be performed under cocain. Following this operation the tub-bath method of constant irrigation, as devised by G. L. Hunner,[1] is employed. An ordinary bath-tub is used. The patient is supported upon strips of canvas which are fastened to the edges of the tub by brass clips. A space is left beneath the vulva for the outflow from the bladder to escape. The patient may either lie down or sit up. In the latter case the strip at the head of the tub is drawn tightly across, and pillows placed on top to act as a support for the patient's back. A few slats are placed across the top of the tub and covered with bed-clothing.

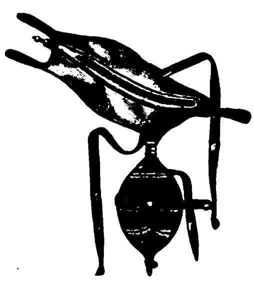

FIG. 208.—FEMALE URINAL FOR AMBULATORY USE.

Constant irrigation is maintained from a large irrigation jar at a height of 3 to 4 feet above the vulva, connecting with a self-retaining catheter which is inserted through the urethra. The overflow escapes through the cystostomy opening. Warm 4 per cent. boric-acid solution is used for the irrigation. The patient is kept in the tub during the day, but goes to bed at night, wearing a rubber urinal (Fig. 208). Hexamethylamin, 10 gr. three times a day, and the ingestion of large quantities of water, should be prescribed.

In case there is excoriation about the vulva or the bladder is very irritable, the tub should be filled with warm water to above the patient's hips, more being added when necessary.

The tub treatment is carried out until the exudate disappears from the bladder-wall, all vesical irritability has subsided, and the bladder is of approximately normal capacity. After this the patient may get up and be allowed to go about, wearing a rubber urinal. The cystostomy wound is left open for six months, the bladder being irrigated

[1] Jour. Amer. Med. Assoc., 1907, xlix, 2066.

daily. The operation for its closure does not differ from that for any vesicovaginal fistula (Chap. XLVI, p. 526). Neither does the after-treatment.

The diet should be largely liquid. Tea, coffee, alcohol, and condiments are forbidden.

The bowels are best attended to at night if the actual bath is used. They should move at least once in every twenty-four hours.

EXSTROPHY OF BLADDER

Plastic Operations.—These operations, all more or less variations of the type of Mr. Wood,[1] for the time being require the anterior surface of the body to be somewhat flexed to prevent pulling on the flaps. After the operation the patient should, therefore, be kept propped up in bed, the shoulders rounded over forward, and the knees flexed. A broad flannel strap or bandage, passed under the knees and over the shoulders, will surely prevent sudden extension of the body. Unless there is a definite contraindication, the patient should be kept quiet, even to stupidity, with morphin. The wounds should be dressed frequently and drainage of the newly formed bladder, with frequent washings, maintained for at least ten days.

Cystocolostomy (*Maydl's Operation*).—By this operation the trigone of the ectopic bladder, with its ureteral orifices, is transplanted into the wall of the sigmoid.

"A boy five years old was operated on in May, 1897. In March, 1898, his condition was reported by the operator as admirable. Quantity of urine, 1000–1200 cc. in twenty-four hours; specific gravity, 1.013; slight amount of albumin; no pus. The boy was able to hold urine five hours at a time, and then to eject it in a good stream from the rectum. In August, 1899 (a year and a half after the operation), the condition continued as satisfactory. The patient, now a rapidly growing and strengthening boy, enjoyed living, retaining his urine for six or seven hours during the daytime, but relieving himself often at night or running the risk of wetting the bed while in deep sleep."[2]

Complications and Sequelæ.—In 17 operations there were 2 deaths—one from shock and the other from infection. "The secondary accidents noted were—

"(1) *Fistula of the urinary passages*, with the accompanying localized peritonitis, all of which cases recovered.

"(2) *Pyelonephritis*, as the result of ascending invasion, resulted in the death of one case after a period of four months.

[1] Med. Chir. Transactions, London, lii, 85.

[2] Herczel, Centralbl. d. Harn- u. Sexorg., 1899, 563.

"(3) *Urinary incontinence* was present in only 2 cases. The other patients were able to hold their urine for at least three hours, sometimes six or seven hours, and in 1 case throughout the night. The urine was voided sometimes mixed with fecal matter, sometimes alone. The tolerance of the rectal membrane was perfect.

"In spite of the fact that this operation is undoubtedly far more severe than the plastic operation, the immediate results are extremely good and far better than those of the older methods.[1] Time alone can settle the question as to whether destruction of the kidneys from ascending inflammation will be a more common late result than after a plastic operation."[2]

[1] See Bransford Lewis, Ann. Surg., June, 1900, xxxi.
[2] Jacobson and Steward, ii, 448.

CHAPTER XLIX

OPERATIONS ON ANUS AND RECTUM

FISSURE IN ANO

THOROUGH dilatation of the sphincter under a general anesthetic cures this condition. The sphincter must not be stretched, however, till entirely relaxed under the anesthetic. By not taking this precaution an incontinence has been noted far more disagreeable than the condition for which the operation was done.[1] There may be enough infection in the fissure to spread into the deeper tissues after dilatation and cause a perineal or an ischiorectal abscess. The first movements after this operation should be assisted by oil enemas.

FISTULA IN ANO

In this disease, whether tuberculous or not, all attempts to sew up the wound, even after the most thorough treatment with antiseptics, so often fail that it will be assumed that the common operation of cutting through the fistulous tract and through the external sphincter muscle into the anal canal, with or without excision of the lining of the fistulous tract, has been performed. The wound should be painted with full-strength tincture of iodin, packed with iodoform gauze, and a fairly stiff soft-rubber tube, surrounded by gauze and rubber tissue (Fig. 87, p. 252), passed through the thoroughly dilated sphincter up into the rectum, as in the case of operation for hemorrhoids. Postoperative pain and spasm may be forestalled by inserting one or two morphin and belladonna suppositories into the anal canal before the patient leaves the table.

On the second day this rectal plug should be extracted, some aperient water given, and, after the movement, the wound thoroughly cleaned, again painted with tincture of iodin, and lightly packed with iodoform gauze. This procedure of bowel movement, followed by cleaning and dressing, is to be done daily, care being taken not to get the iodin on the surrounding skin.

After the second day the patient should be out-of-doors, but still reclining, all day if possible. These wounds, tuberculous or not, heal

[1] E. Melchoir, Münch. med. Woch., 1910, lviii, No. 33.

much better out-of-doors. The ideal conditions are to have the patient on the roof or in some other isolated place, where the region of the wound can be exposed to direct sunlight, just short of excessive sunburn, daily.

The patient should be up and about by the fifth day unless the wound is unusually large. If the fistula is not extensive, and if conditions are such that the patient must be gotten back to his work as soon as possible, the daily dressing with tincture of iodin may be omitted as soon as it is evident that the fistulous tract is granulating in well, and the patient given suppositories of iodoform and tannic acid, of each, 1 gr., to be inserted twice daily after cleansing the part. The bowels should be kept semifluid for some days. Control of the rectal contents should be satisfactory by the fifth day unless—(1) the external sphincter were cut in two places (a bad procedure, if at all avoidable); (2) the internal sphincter has been cut; (3) the cut has extended through the vaginal sphincter. Control does reappear in many cases even when the operation has made one of these procedures necessary, but complete control can never be promised, and operative repair of the sphincter is sometimes necessary.

Healing of these wounds seems, more than in many other kinds and situations, to depend to a great degree on the general condition of the patient. In tincture of iodin we have undoubtedly the best antiseptic and stimulant for the region.

PILONIDAL SINUS; CYST OF COCCYX

The treatment of these embryonic remains should be mentioned here only because of their regional relation to the subjects of this chapter.

They are usually not operated upon until septic, and the abscess-condition not infrequently leads the surgeon to forget that an epithelial-lined canal leads deep to the region of the coccyx and must be removed by dissection and curette. (See Branchial sinus, p. 443.) The wound is tightly packed at first, and is dressed about the third day, painted deep with tincture of iodin every second or third day, and is thus induced to heal from the bottom.

IMPERFORATE ANUS; IMPERFORATE RECTUM

Unless the operation attempting, first, to connect the rectum with the anal depression or, second, to connect the rectum with an artificial anus in the normal situation, succeeds at once and remains perforate, an inguinal colotomy must be made. In either case the problems involved in the treatment are the same as in colotomy, at first at least.

ISCHIORECTAL ABSCESS

The abscess-cavity is wiped out dry. Tincture of iodin is painted over the whole lining wall, including the incision through the sphincter, if one has been made. The wound is packed with 10 per cent. iodoform gauze to distend it and render it into one cavity without pockets. A suppository of morphin and belladonna, of each, ¼ gr., is placed in the rectum; a voluminous dry dressing is held on by a T-bandage.

The original packing need not be changed in most cases until the third or fourth day. It is then entirely removed, tincture of iodin again applied inside, and a smaller drainage wick of iodoform gauze inserted. The dressing is now done daily, but the iodin need only be used every third day. Direct sunlight on the wound, if practicable, greatly advances the healing. An emollient is kept round the anus and edges of the wound.

The patient is out of bed as soon as he can sit on an inflated rubber ring without too much discomfort. The bowels are moved daily from the beginning.

Complications and Sequelæ.—*Spread of Infection.*—Cases in which the incisions are to any degree inefficient in position or size may form new pockets; the infection may spread completely over the buttock or forward into scrotum or labium majus; from the rectum may appear a secondary infection with tetanus or the gas bacillus (bacillus aërogenes capsulatus), even resulting fatally.

Retention of urine may be bothersome for a few days, as after any rectal operation.

Loss of sphincter control will not appear if the muscle has been cut only once; if more than one incision through it has been made, a secondary operation may be necessary weeks or months later to restore its integrity.

Recurrences are not uncommon. In view of the theory that a certain percentage of cases are associated with tuberculosis, it is well to take measures to combat any tendency to this disease.

HEMORRHOIDS

Clamp and Cautery Operation.—It is understood that the sphincter has been absolutely paralyzed by thorough, slow dilatation. The hemorrhoid masses have been burned off along lines parallel to the axis of the anal canal, all immediate hemorrhage has been stopped, a gauze plug, containing a fairly stiff soft-rubber tube in its center for the passage of gas, and wrapped in rubber dam, has been placed in the rectum, protruding from it. A T-bandage holds the dressing firmly against the parts. Before the rectal plug has been inserted at the end of the operation a suppository containing $\frac{1}{4}$ to $\frac{1}{3}$ gr. morphin sulphate and $\frac{1}{4}$ gr. extract of belladonna has been inserted.

Uncomplicated, there is inevitably considerable pain, which should be controlled by the administration of morphin. There should be no bleeding. Surgeons are at variance on the question as to whether or not one should use the rectal plug. Personally, we cannot see any notable difference in the convalescence either way, particularly if the original dilatation of the sphincter has been complete.

Similarly, if the piles have been burned from a dilated anus, there can be no ground, on the plea of insufficient healing, to prevent a movement of the bowels for from five to seven days. Best results, indeed, seem to follow early movement of the bowels; the packing of the lower bowel with fecal matter retained for several days tends to produce congestion in the recently operated area. Two Seidlitz powders or a dose of castor oil is given on the third day, and when the desire for a movement comes, 6 or 8 ounces of warm sweet oil are injected through a tube passed 4 or 5 inches up, in order to soften the presenting fecal mass. The first movement should then be easy, though pain is sometimes so severe that the patient faints, and for this possibility the nurse should watch. After each movement and morning and night for a week a suppository containing—

Iodoform,	1 gr.
Tannic acid	1 gr.
Cocoa-butter	q. s.

should be inserted within the rectum. After a week one such suppository should be used after each movement.

The patient should stay in bed a full week, first, because recumbency is the most comfortable position, and, second, because of possible complications.

Unguentum gallæ cum opio (B. P.) is an excellent ointment, applied at night and after each movement to the whole anal region, to help shrink away redundant tissue.

Complications and Sequelæ.—*Hemorrhage.*—Bleeding may occur because the clamp has bitten too deeply into the submucous tissue, or too much has been included in the clamp and the wound separates shortly afterward. Bleeding is likely also if the cautery has been too hot, cutting the piles off too cleanly, leaving no eschar. If the hemorrhage is considerable, an attempt may be made to control it by packing. If it is arterial, this will probably fail and the patient must be put in the lithotomy position, the bleeding point found, clamped, and tied.

Embolism.—Fatal embolism has been reported at any time up to the eighth day after this operation, though it is more likely after ligature. Treatment is, of course, of no avail, but the possibility of this occurrence should be always in mind when giving a prognosis of this relatively unimportant disease and in allowing the patient to get out of bed too early.

Sepsis.—Dilatation of the sphincter may cause numerous fissures, any one of which may become infected, and even lead to a large ischio-rectal abscess. Sepsis may, in persons in reduced condition, take the form of a prolonged ulceration of the several stumps. This should yield, however, to good hygiene and the suppositories as above.

Stricture of the Rectum.—This after-effect is practically unknown after a careful operation, but may occur where the clamp has not protected underlying tissues from the cautery. It can be met and controlled by repeated use and slow passage of a rectal bougie.

Retention of Urine.—In operations about the anterior quadrants of the rectum one should always bear in mind the possibility of injuries to the urethra, and also the fact that much manipulation and traumatism of these parts may result in an acute irritation of the peri-urethral tissues, which will cause a temporary edema and constriction of the urethral canal. In such cases it will sometimes be found impossible to pass an ordinary soft-rubber or flexible catheter into the bladder, and one should always be provided with a silver catheter in order to be able to draw the urine. As soon as the distention subsides, these suggestions of stricture rapidly disappear. It is advisable to induce the patient to urinate before attempting to catheterize him if possible, even if he has to stand on his feet to do so. It is well to wait for from four to fourteen hours before resorting to the catheter, only varying this rule in such cases as suffer from distention of the bladder. A certain amount of cystitis and atony of the bladder may be developed by too long delay, but it much more frequently occurs as a result of too frequent and too early catheterization, even under the most particular aseptic precautions.[1] The catheter may be perfectly sterilized and the operator as clean as antiseptics can make him, and yet, as the walls of the anterior and deep urethra cannot be sterilized, slight traumatism, such as may be produced by the softest instrument, will sometimes set up an attack of urethritis and cystitis which will take months to clear up.

Firm packing of the rectum may cause retention of urine, and sometimes even render the passage of the catheter impossible. When this occurs, the dressings should be removed, and frequently after this is done

[1] S. Hadda, Berlin. Klin. Woch., 1910, xlvii, No. 34.

the patient can pass urine voluntarily. In all cases before the catheter is passed the anterior urethra should be flushed with boric-acid solution.

Treatment by Ligature.—This operation is used relatively little in America, and in the after-care arise, as a rule, only two complications: (1) *Hemorrhage.* If the ligature, insecurely placed or tied around too wide a base, slip sufficiently, hemorrhage may take place and require the application of a hemostatic forceps, to be left in position. (2) *Pain* after this operation may call for considerable amounts of morphin.

Whitehead's Operation.[1]—In this operation, after dilatation, the whole pile-bearing area is cut away in a cuff or cylinder and the edge of mucous membrane is sewed down to the skin with interrupted chromic catgut sutures. If the continuous suture is used, one suture should not go more than a third of the way round the circle, lest the whole act as a purse-string. Catharsis should be regulated as after the cautery operation, and the same directions hold with regard to antiseptics, iodoform being the best dressing.

The possibility of *stricture* after this operation is always to be mentioned. If the operation is done properly, namely, excising only mucosa, not removing too wide a cuff, and stitching with great care, stricture will not occur.

Hemorrhage, which is sometimes supposed to be a common complication of this operation, should not occur if ordinary precautions are taken to tie off bleeding points before completing the operation by sewing down the amputated mucosa to the anal margin. Pain may be severe in a certain number of cases; it seems to be dependent, in some measure at least, on tightly drawn sutures. It will be less if the sphincter has been sufficiently stretched as to become paretic, and if a morphin and belladonna suppository has been inserted. It yields rapidly to hot boric fomentations applied locally. Bishop[2] recommends the early administration of gentle laxatives, such as cascara and licorice powder, after operation, so as to forestall the formation of hard masses, such as might in their passage cause damage by tearing and splitting the partly healed tissues.

PROLAPSE OF RECTUM

The after-treatment of this condition differs in no way from that of Whitehead's operation for hemorrhoids (see above).

[1] Brit. Med. Jour., Feb. 26, 1887.
[2] Ibid., Oct. 30, 1909.

KRASKE'S OPERATION FOR CANCER OF THE RECTUM

Access to the rectum by resection of the sacrum was first described by Kraske in 1885 before the Deutsche Gesellschaft für Chirurgie. Since the publication[1] of his original article his method has been modified by a large number of operators. As these operations differ from Kraske's only in minor ways, the after-treatment of all is essentially the same, therefore it will be understood that what is said here concerning the Kraske operation applies equally to all other methods of excision of the rectum by the sacral route.

The operation should be preceded by a few days of careful preliminary treatment, diminishing as far as possible the intestinal contents by enemas, catharsis, and a diet consisting of liquids without milk. As in all rectal operations, the sphincter ani must be thoroughly stretched before the operation is begun. The method of choice in dealing with the bowel after resection of the portion containing the growth is end-to-end anastomosis of the proximal and distal portions. When this can be satisfactorily accomplished, the rectum is packed through the anus with gauze surrounding a rubber tube which is passed up beyond the point of suture. The rubber tube allows the passage of gas and the gauze pack protects the line of suture. If the peritoneal cavity has been opened, the peritoneum is united to the serous coat of the bowel except for a small opening through which is passed a gauze wick. A second gauze drain is so passed into the wound as to surround the line of anastomosis, and the remainder of the incision closed with silkworm-gut sutures. A large sterile gauze dressing is placed over the wound and held in position by adhesive straps, outside of which a swathe and T-bandage are worn.

The patient is put to bed lying on his side and $\frac{1}{4}$ gr. of morphin is given hypodermically before he comes out of ether. The diet during the first ten days should consist of liquids without milk. On the fourth day the dressing is done, the wicks removed, and replaced by smaller ones. The gauze and tube are removed from the rectum and the bowels opened by an oil enema[2] retained one-half hour and followed by a copious irrigation of plain water. The stools are now kept liquid by the daily administration of salines, oil enemas being given whenever there is the slightest tendency for the feces to become hard. The gauze pads on the wound should be changed after each movement. The wicks

[1] Archiv f. klin. Chir., 1886, xxxiii, 563.

[2] Care must be exercised in introducing the rectal tube. A case has come to our notice where fatal peritonitis resulted from the nurse forcing the tube through the line of sutures into the peritoneal cavity.

may usually be omitted on the fifth day. If there is much discharge from the sinus, it should be irrigated daily with chlorinated soda solution (1:80). The stitches are taken out on the tenth day.

If the patient is old or in poor physical condition, he should be got out of bed into a chair at the end of forty-eight hours. Otherwise he will be more comfortable in bed for ten days. After the tenth day soft solids may be added to the diet. Full diet is begun at the end of two weeks. After the first ten days the bowels are kept moderately free by catharsis. Oil enemas are no longer necessary.

The rectum must be examined at frequent intervals after this operation to detect recurrence of stricture from contraction of the scar. This inspection should be made at least twice every month for six months, then once each month for the remainder of the first year, and at least once in three months until five years have elapsed from the time of operation.

Where, as often happens, it is impossible to unite the bowel ends after resection, the proximal end is sutured to the skin of the sacral incision, making a sacral anus. A wick is passed into the peritoneal cavity, which is always opened under these circumstances, above this anus, and a second into the postrectal tissues below it. The remainder of the incision is closed with silkworm-gut. The wicks are removed and omitted on the fourth day. The stitches are taken out on the tenth day. The artificial anus is treated the same as one in the anterior abdominal wall.

Complications and Sequelæ.—*Infection.*—This is the most common complication, and often leads to sloughing of the line of suture in the bowel, resulting in a fecal fistula.

Fecal Fistula.—When a fistula develops in the sacral wound, the gauze must be removed from the rectum and the wicks taken out of the wound. The sinuses and fistula should be irrigated twice daily with a 1:80 solution of chlorinated soda. The skin about the fistula is smeared with 10 per cent. stearate of zinc ointment and a large absorbent pad, frequently changed, is used to catch the discharge from the wound. The fistula usually closes spontaneously, but if it does not after waiting for three months, it must be closed by operative means.

Injury to Adjacent Organs.—The bladder, urethra, prostate, or seminal vesicles may be injured, and if not repaired, may result in a fistula between the rectum and the genito-urinary tract, which is likely to carry infection to the bladder and kidneys. Injury to the vagina may result in a rectovaginal fistula which, however, as a rule, will close spontaneously unless recurrence takes place in its walls.

Disturbances of the Urinary Tract.—These may be slight and transitory as a result of pressure of the dressings, or reflex irritation from the trauma of the operation, or they may be so severe as to result in uremia.

Hemorrhage.—This is rare. If not controlled by packing in the wound and rectum, the incision must be reopened and the bleeding point found and ligated.

Stricture of the Rectum.—This is to be anticipated by frequent inspection of the rectum and the passage of rubber bougies whenever any tendency toward narrowing of the lumen appears.

Incontinence of Feces.—This is to be avoided whenever possible by preserving the external sphincter at operation. When it is necessary to sacrifice the sphincter, incontinence may be avoided, or at least diminished, by Gersuny's method, which consists in twisting the bowel 180 to 275 degrees on its long axis before suturing it to the skin, or by the method of Willem, in which the rectum is brought out through the fibers of the gluteus maximus, which serves as a new sphincter.

Recurrence.—When there seems to be a chance of entirely removing it, the attempt should be made to excise the recurrent growth. If this fails or appears impossible, palliative treatment directed to the patient's comfort should be instituted.

WEIR'S COMBINED OPERATION FOR CANCER OF THE RECTUM

This operation, described by Weir in 1900,[1] consists in the abdominal resection of the rectum completed by suture of the cut ends, which are both drawn down through the anus, outside of the body. The bowel is then returned inside the pelvis, the peritoneum over the pelvis and the abdominal wound in the mean while having been closed without drainage. An incision is made through the skin between the tip of the coccyx and the anus, and a rubber drainage-tube passed through this into the postrectal space as high as the peritoneum. A rubber tube surrounded by gauze is then passed up inside the rectum until its upper end lies above the line of suture. The anus and postrectal wound are covered with a large sterile pad, held in position by a T-bandage. Both tubes are removed on the fourth day, the rectal tube omitted, and the postrectal shortened. The postrectal tube is shortened daily and usually may be omitted on the ninth day The abdominal wound is simply dressed with sterile gauze and left undisturbed until the tenth day, when the stitches are removed.

The patient is kept on a diet of liquids without milk throughout the

[1] Jour. Amer. Med. Assoc., 1901, xxxvii, 801.

convalescence.. In the absence of distention the bowels are not moved until the ninth day. Calomel is given the evening before the eighth, and on the morning of the ninth a high oil enema, retained one-half hour, followed by a high suds enema. After this the bowels are kept open by daily catharsis. The patient is allowed to sit up in bed on the eighth, and get up on the tenth, day. The subsequent care of the patient is the same as described for Kraske's operation.

Complications and Sequelæ.—*Peritonitis, shock, secondary hemorrhage,* and other complications common to all celiotomies, may occur and should be treated by appropriate measures.

Distention.—Every effort should be made to control distention by hot applications and the careful passage of a small rectal tube or large catheter up through the rubber tube in the rectum into the sigmoid. If these fail, catharsis should be resorted to, and the use of enemas as a last resort.

Infection in the perirectal tissues may result in a fecal fistula discharging through the postanal wound, but this, if simply kept clean by irrigations with chlorinated soda solution, will usually close spontaneously.

Injury to adjacent organs should be less common than after Kraske's operation, since in this procedure the dissection is, for the most part, carried out under the eye.

Of disturbances of the urinary tract, stricture of the rectum, recurrence and incontinence of feces, that which has already been said under Kraske's operation applies here.

The after-treatment of the other methods of combined operations, including the elaborate technique lately described by W. C. Lusk,[1] is identical with that described for Weir's operation.

VAGINAL PROCTECTOMY

This is the method of choice for the removal of cancer of the rectum in the female. The vaginal wound is closed with heavy catgut or with silkworm gut except at its upper portion, where a small drain is inserted if the peritoneal cavity has been opened. A rubber tube surrounded with gauze is passed into the rectum through the anus and carried above the line of suture. This and the vaginal wick are removed on the fourth day and entirely omitted. The stitches are removed on the tenth day. Other details of treatment are exactly similar to those described for Kraske's operation.

[1] Surg., Gyn. and Obstetrics, 1908, vii, 113, also ibid., 1909, ix, 491.

CHAPTER L

OPERATIONS ON THE EXTREMITIES

AMPUTATIONS

In general, where the wounds are sewed tight, they present no distinctions from other simple incised wounds. If, on account of oozing from muscles, rubber dam, tube, or gauze temporary drainage has been put in, this may be withdrawn at the end of twenty-four hours and the provisional suture tied. The sutures should be left in a full ten days, and after their removal the wound should be reinforced by two, three, or more zinc-oxid plaster strips, so narrow that they will not cover the whole wound, but long enough to distribute the strain of the end of the stump along the length of the limb. A splint is applied to the stump, protruding to protect the end. A cradle holds the bed-clothes up.

The stay in bed is from ten days to a number of weeks, according to the nature and healing of the wound.

Complications and Sequelæ.—*Sepsis* may be met by drainage through the wound opening, as little of it, however, as will insure efficient outlet. A persisting sinus means either a deep-lying infected ligature or necrotic bone. The latter may be only unremoved splinters of bone or may be the cut end. Thirteen to sixteen weeks should be given, however, before any secondary operation is undertaken, unless special indications arise. During this period splinters and small chips of bone will ordinarily separate and come out.

Thrombosis and Embolism.—In patients with arteriosclerosis or other cardiovascular disease, including myocarditis, in patients suffering profoundly from shock, in cases of infected wounds, and in other conditions, thrombosis is always a possibility. When this occurs, with its cyanosis, edema, or threatened gangrene, the treatment is largely expectant. The limb must be kept warm, slightly elevated, and all sudden movements must be especially prevented, lest embolism occur.

Painful Stump.—This diagnosis must not be made too quickly. Every newly healing bone or scar is somewhat sensitive, and the degree of sensibility varies with the character of the individual. A scar badly placed, in such a way that it bears against the clothes, bandage, or apparatus, causes a kind of painful stump. The expression, however, is properly applied to a stump in which a severed nerve or nerves are caught in the scar, and to cases where the flaps are too short and are adherent to the bone in such a manner that pressure or pull causes pain. For all degrees of sensitiveness not due to the last two causes, massage with cold cream, wintergreen oil, zinc-oxid ointment, or some other such emollient preparation, together with hot and cold sprays and exposure to the sun, will quickly harden the stump. Fairly tight application of a Shaker flannel bandage, or a so-called "horse" bandage, will help to cause atrophy of the stump, help it to assume the ultimate form for the artificial limb socket, and prevent edema. Under such bandaging, also, sensitiveness not due to an organic cause will rapidly diminish. If these all fail to relieve the condition, further operation must be done—either removal of an inch or more of bone or the dissection out of the nerve-ends and their removal.

Amputations of the Shoulder and Shoulder-girdle.—The dressing after either of these operations is held in place by adhesive straps and a bandage or swathe passing about the chest and over the shoulder.

After amputation of the shoulder-girdle pneumonia appears to be a relatively frequent complication. All possibility of hypostatic congestion should, therefore, be guarded against by raising the patient high in the bed, and frequent turning from side to side.

The Arm.—A relatively small dressing is held on by adhesive straps and bandage. A large pad is placed between the stump and the chest and a swathe band holds the arm against the chest for the first five or six days. The stitches are removed on the tenth day, the wound then being supported by adhesive strips.

Forearm.—The arm is immobilized for ten days by an internal angular splint applied with the forearm intermediate between pronation and supination. The splint should project beyond the stump for 1 or 2 inches, thus furnishing a certain amount of protection for it.

Fingers.—The hand is supported by an anterior splint extending from the bend of the elbow to just beyond the finger-tips, and carried in a sling. The splint is taken off at the end of ten days.

Hip.—This is the most severe of all amputations,[1] and measures to combat shock form a very important part of the after-treatment. Pressure on the stump is avoided by a small firm pillow beneath the ischial tuberosity on the amputated side and a cradle over the pelvis. The dressing must be large because there is usually free drainage of serum from the wound. It is held in place by plaster straps, outside

[1] Chavasse, Lancet, 1900, ii, 154.

of which a figure-of-8 bandage is applied about the pelvis. The dressing should not be disturbed for at least four days, if possible, because of the additional shock. The bowels are not opened for this length of time in order not to run the risk of soiling the dressing. The greatest of care must be observed to prevent bed-sores.

Thigh.—A copious dressing is used because here, too, the discharge of serum is considerable. A well-padded posterior splint is applied, extending a little beyond the end of the stump, held on by strips of adhesive plaster and a spica bandage. The distal extremity of the splint should be elevated on a pillow in order to relax the quadriceps extensor. The splint is worn for ten days.

Leg.--After the dressing is applied the knee is immobilized and the stump supported by a long ham splint, which is held on by plaster straps and a bandage. It is important that the splint extend beyond the end of the stump, so as to furnish protection for it. This splint may be removed at the end of ten days.

Toes.—After amputation of the toes rapid union of the wound is promoted if a long plantar splint is worn for ten days, but this is not absolutely necessary if the patient will faithfully use crutches and keep the foot off the ground for this length of time.

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LIGATION OF THE INNOMINATE ARTERY

Aneurysm of the innominate artery was first successfully treated by ligation by Burrell.[1] Access to the artery is gained by resection of the right sternoclavicular articulation and a small portion of both the sternum and clavicle. The method was described first by Cooper in 1859,[2] but was not used again until Burrell, at the time unaware of Cooper's work, performed the same operation.

The muscles overlying the artery and the skin are sutured without drainage, and a dry sterile dressing, held in place by plaster strips, is applied. This is left undisturbed until the tenth day, when the stitches are removed. The right arm is wrapped in cotton or sheet-wadding and bandaged to keep up its heat. In Burrell's case the pulsation in the right radial artery returned on the sixth day. To insure rest for the

[1] Boston Med. and Surg. Jour., 1895, cxxxiii, 125.

[2] Amer. Jour. Med. Sci., 1859, xxxviii, 395.

vascular system the patient is kept in bed, on a light diet, and given morphin, $\frac{1}{8}$ gr., every four hours. The latter is a very important part of the after-treatment. The bowels are moved on the fourth day and kept free. The patient is allowed out of bed at the end of eight weeks. There is some swelling and more or less loss of strength in the arm for a time after the operation.

LIGATION OF THE CAROTID ARTERY

Complications and Sequelæ.—*Cerebral Symptoms.*—These are said to occur in as many as 25 per cent. of cases, and may appear at once or not until some days after operation. All such symptoms are due to the diminished cerebral blood-supply, and vary from faintness, giddiness, impaired vision, up to complete hemiplegia in those cases where the circle of Willis is congenitally incomplete.[1] The after-treatment involves no special detail beyond perfect quiet until the new conditions are well established.

Sepsis is always possible, and where this occurs and silk ligatures have been used, the sinus will probably persist at least three weeks, until the silk comes away. Wherever notable sepsis takes place, the danger of secondary hemorrhage is considerable.

Recurrent pulsation frequently appears, but nevertheless the cerebral pressure is undoubtedly diminished and the object of the operation thus accomplished.

Lung complications are said to be not uncommon, due to the diminished freedom of respiratory movements secondary to the disturbed circulation in the brain and medulla.

LIGATION OF THE SUBCLAVIAN ARTERY

Complications and Sequelæ.—The mortality in this operation is high (out of 48 cases, 25 die).

Sepsis is the greatest danger. If it occurs outside the aneurysmal sac, the dangers are, of course, principally from secondary hemorrhage. If sepsis occurs within the sac, the liability to infection seems to be increased from the fact that the ligature is so close to the sac that the clot is poorly formed and loose, and embolism is liable to occur. In such cases the swelling, which has first diminished, now, in the second or third week, begins to increase in size, with pain and tenderness, but without pulsation. This must be emptied by incision, and in this event secondary hemorrhage is liable to take place and can be met only by

[1] Walter C. Howe (Boston City Hospital Reports, 1903, xiv, 162) reports such a case and gives complete bibliography of the subject.

attempts at packing. Hemorrhage at any time after operation may be looked for, even though asepsis is perfect, because of the diseased condition of the artery walls which lay behind the original lesion.

Faulty circulation in the arm causes the limb to become numb, cold, stiff, and weak. After the wound is thoroughly healed, this is to be met by the application of warmth, massage, and electricity.

A cord of the brachial plexus may be included in the ligature. Such a mistake causes an agonizing pain at the site of operation and throughout the length of the arm. It must be immediately relieved by further operation, removing the ligature and placing a new one properly.

The *pleura may be injured* when the needle is passed during the operation, but, except for infection, this accident is of little importance.

The *phrenic nerve* or the *subclavian vein* may rarely be injured at the time of operation, but these are rather operative details.

LIGATION OF THE EXTERNAL ILIAC OR FEMORAL ARTERY

Complications and Sequelæ.—*Sepsis* and *secondary hemorrhage* from sepsis or slipping ligature are always possibilities, and call for no new directions for treatment.

Gangrene of the limb should be uncommon if the limb is well protected by horizontal position, wrapping in cotton, and careful use of heaters.

Pain at site of operation may be persistent as the result of the tying-in of some nerve-filament.

Swelling of the limb is to be met by wearing a flannel or elastic bandage for the first few weeks.

ARTERIAL SUTURE

The first suture of an artery was performed by Hallowell,[1] an English surgeon, in 1759. The method which he employed was to pass a pin through the lips of a wound in the brachial artery and then wind a thread about it. The operation was successful. Eck[2] was the first to successfully perform lateral anastomosis. Von Horoch[3] attempted end-to-end arterial suture, but this was first successfully performed by Abbe[4] by means of a glass bobbin. Since then arterial suture has been developed by Murphy, Jaboulay, and Briau. Within the last few years the brilliant experimental work of Jaboulay's pupil, Carrel,[5]

[1] Lambert, Medical Observations and Inquiries, London, 1762.
[2] Militär-Med. Jour., cxxxi, 1876.
[3] Allgem. Wiener med. Zeit., 1888, xxxiii, 263, 279.
[4] N. Y. Med. Jour., 1894, lix, 33.
[5] Jour. Amer. Med. Assoc., 1905, xlv, 1645; Ann. Surg., 1906, xliii, 303; Surg., Gyn., and Obst., 1906, ii, 266; Bull. Johns Hopkins Hosp., 1907, xviii, 18.

Guthrie, and others has aroused renewed interest in this operation. Lund,[1] Sherman,[2] Ehrenfried and Boothby,[3] and others have reported successful cases of arterial suture. The number of cases is still limited, but from the study of the available literature the following rules for after-treatment may be set forth as conservative and satisfactory, to be later modified as experience with this operation increases.

The superficial structures are united with catgut, and the skin with silkworm-gut or horsehair, leaving a small opening into the tissues about the vessel through which is inserted a rubber-tissue drain. The wound is dressed with sterile gauze and the limb immobilized by a splint. The drain is removed after twenty-four hours. The stitches are taken out on the tenth day. Immobilization is continued up to three weeks. In the upper extremity the patient may go about carefully after ten days, but in the lower, he should be kept in bed three weeks.

The résumé of a case may be of interest:

T. G. was brought to the Relief Station of the Boston City Hospital at 4.30 P. M., April 23, 1911, by a police ambulance, with the story that he had been stabbed in the left groin. He was conscious, restless, and pale, pulse 80, of small volume and low tension. Just below Poupart's ligament on the left was a narrow, somewhat pouting, clean-cut slit in the skin about $\frac{3}{4}$ inch long, running nearly transversely. There was considerable blood on the thigh and the clothes covering the thigh. About the wound was some swelling. No pulsation in the femoral artery or its branches below this point was made out.

The thigh was cleaned and shaved. On the passing of a director into the wound, to ascertain where to introduce a wick, active arterial hemorrhage ensued. The wound was packed and a sterile dressing was applied with pressure. Heaters and blankets were ordered, and salt solution administered by rectum. Patient was cold, restless, and weak for two or three hours, but then became more quiet, stronger, and warmer. There was no return of pulsation in the branches of the femoral artery. Operation was advised and accepted.

Operation, Drs. Crandon and Ehrenfried: Under ether an incision was made above and parallel to Poupart's ligament. The external iliac artery was found and a Crile clamp applied. An incision 5 inches long was made over and parallel to the femoral artery, the region of the punctured wound was laid open, and the dissection carried down to the femoral artery. This was found completely severed, though the ends were held together beneath by some strands of uncut adventitia. The surrounding tissues were infiltrated with blood-clot. The vein and nerve were intact.

[1] Ann. Surg., 1909, xlix, 394.
[2] California State Medical Journal, 1908, vi, 56.
[3] Ann. Surg., 1911, liv, 485.

Crile clamps were applied to the artery, the adventitia trimmed away, and the ends sewed together by the technique described by Ehrenfried and Boothby (*op. cit.*). The clamps were taken off, and then the clamp on the iliac artery was removed. There was some oozing of blood from the anastomosis, which ceased in two minutes under light pressure. Pulsation was readily felt beyond the suture.

The abdominal wound was sewed up in layers, the thigh wound, by mass sutures. Sterile dressing was applied. Stimulation, heaters, and blankets.

The recovery was rapid and uneventful, despite the weakness of the patient from loss of blood. When seen the next day the left foot was warm, and on the day following pulsation of the dorsalis pedis could be made out, and heaters and blankets were discontinued. The temperature and pulse were normal on the fourth day, and remained so. On May 3d the stitches were removed and on May 7th the patient went home well, except for a small granulating area at the site of the original wound.

Complications and Sequelæ.—The chief complication to be feared is thrombosis, which may result in obstruction of the circulation and occasionally gangrene.

Arteriovenous Anastomosis.—This operation, employed with some success by Hubbard,[1] for gangrene of the leg, is as yet on the surgical frontier. The after-treatment is that for ligation of a large artery.

MATAS' OPERATION FOR ANEURYSM

In the Matas [2] operation, either with or without obliteration of the lumen of the artery, the aneurysmal sac is occluded by a deep stitch of silkworm gut or catgut on either side of the wound, passing through the skin and both walls of the sac, and tied over a roll of gauze to maintain sufficient tension without cutting into the skin. The skin is then sutured to the middle of the bottom of the sac with silkworm gut or catgut, the same stitches uniting the skin-edges. The furrow thus formed is filled with sterile gauze. The entire limb is then wound with cotton, reinforced over the line of the artery. Outside of this several strips of cardboard are placed, covered, in turn, by more cotton or sheet-wadding, and a firm gauze bandage applied from below upward.

When the seat of the aneurysm is the brachial artery, the arm is held in a sling and a circular bandage or swathe applied. Where the femoral or popliteal artery is involved, the limb is immobilized by a posterior

[1] Ann. Surg., 1906, xliv, 559; 1908, xlviii, 897.

[2] Trans. Amer. Surg. Assoc., 1902, xx, 396. See also F. G. Balch and F. T. Murphy, Boston Med. and Surg. Jour., 1909, clix, 860; G. P. Hamner, Jour. Amer. Med. Assoc., 1910, liv, 1942.

splint. The fingers or toes, as the case may be, should be left exposed in order that the state of the circulation may be determined. If the extremity remains warm and the color good, the bandages are changed only when they begin to loosen, usually in about forty-eight hours, but, in the absence of the elevation of temperature, the gauze over the wound is left undisturbed until the tenth day, when the stitches are removed and all dressings and splints omitted. In the case of aneurysms of the lower extremity the patient should not begin to use the limb for three weeks, and in those of the upper extremity vigorous movements should be avoided for some time, but gentle ones may be attempted after the tenth day.

Complications and Sequelæ.—*Gangrene* may result from the imperfect establishment of collateral circulation, which is unavoidable; or as the result of the formation of a clot at the site of distal compression, which becomes an embolus and lodges in a vessel beyond the aneurysm. This must be regarded as an accidental failure of technique. From either cause gangrene is rare and requires amputation.

Secondary hemorrhage can occur only as a result of imperfect technique and demands ligation of the arterial trunk.

Suppuration is the most frequent complication and probably depends in some measure on failure perfectly to obliterate the aneurysmal cavity. It is manifested by elevation of temperature and severe pain at the site of the incision. The treatment is the same as for any wound infection.

VARICOSE VEINS OF LOWER EXTREMITY

After the commonly employed type of operation, that of Mayo,[1] using his vein enucleator and making three to five or more incisions, there remain several small wounds which are sutured and covered with a thin layer of sterile gauze held in position so as not to slip by adhesive strapping. Collodion is not so good. If the older technique of dissecting out the venous trunk is performed, there will be, instead, one or more long wounds, which have to be carefully sutured and which are hard to keep from becoming septic. After the dry sterile dressing is applied, the extremity is bandaged from toes to groin with a 3-inch "Ideal" bandage.

The patient is kept in bed with the leg elevated on a pillow for twelve days, the bandage being reapplied daily, but the wounds left undisturbed until the twelfth day, when the stitches are removed and the dressing omitted. The patient is then allowed to get up, but continues to wear the bandage for three months.

[1] C. H. Mayo, Surg., Gyn. and Obst., 1906, ii. 385.

When a varicose ulcer has been excised and grafted, a roll of gauze is placed about the leg above and below the area. A sheet of wire gauze is passed about this portion of the leg, and held with adhesive plaster in such a manner that it is supported by the two rolls of gauze above referred to and does not come in contact with the grafted area. The bandage is then applied over this. Thus the progress of the graft may be watched without disturbing it, and at the end of twelve days this dressing is removed for the first time, and a simple protective dressing only is worn over the grafted area from this time.

Where there is an extensive eczema of the extremity complicating varicose veins which cannot be cleared up by a careful preliminary treatment before operation, this area should be sealed over with compound tincture of benzoin until the operative wound is sufficiently well healed (two or three days) to prevent the entrance of infection.

Complications and Sequelæ.—Infection and pulmonary embolism occur in rare instances.

SUBACROMIAL BURSITIS

The operation devised by E. A. Codman[1] for this condition includes the removal of that part of the subdeltoid sac which protrudes beyond the tip of the acromion, and the possible scraping out of any area of degeneration in the insertion of the infraspinatus beneath the floor of the bursa.

The wound is sewed tight and the hand and forearm are put in a sling. No great effort should be made at fixation or even rest. At the end of four days passive movements should be begun, and at the end of one week all motions within usual limits should be freely made. Recovery with all functions should be complete within a month.

OLECRANON BURSITIS

Excision in the aseptic cases and crucial incision in the septic cases should both be followed by fixation of the elbow with an internal angular splint. The open infected wound is packed with gauze and kept so, renewed daily, until granulations fill it.

SUTURE OF TENDON AND MUSCLE

Wounds of tendons are most common at the wrist. Instances of ruptures of the long head of the biceps, the quadriceps extensor, and other muscles and tendons have been reported. If an important tendon

[1] Boston Med. and Surg. Jour., 1908, clix, 533.

is divided, in part or completely, the wound is thoroughly cleaned, the tendons sutured with fine silk or Pagenstecher, and the wound closed with silk or silkworm gut. If the wound is much lacerated or there is particular reason to fear infection, a very small rubber tissue or catgut drain may be inserted just under the skin, to be taken out after forty-eight hours.

The dressing should be voluminous enough to absorb all the oozing. A splint must be so designed and applied that the part is so flexed or hyperextended, as the case may require, that no tension is allowed to fall on the uniting tendons. A splint, anterior or posterior, is applied to the opposite aspect of the limb from that of the wound, long enough to fixate all the joints between the points of origin and insertion of the muscles involved. If made of wire, it can readily be bent to the proper angle, otherwise it is built up or padded at the distal end in order that the flexion or hyperextension may be efficiently maintained. The forearm and splint are then bandaged and the arm carried in a sling.

The wound is inspected without removing the splint if possible, at the end of forty-eight hours, and again on the fourth day. On the seventh day the stitches are removed.

The time for removing the splint and beginning motion cannot be arbitrarily stated. The purpose of after-treatment is to prevent too firm adhesions of the united tendon in its sheath, and, at the same time, to avoid undue strain on the new union. The arm is kept on the splint for four weeks, but after the second week the splint should be removed twice a week and careful passive motion of the fingers carried out, great pains being taken not to flex or extend them to an extent to strain the sutured place.

At the end of four weeks the splint is omitted and careful use of the forearm begun. Massage and passive motion should be carried out until the stiffness disappears. Wounds of the tendons at the wrist are frequently complicated by injury to the median nerve, which should be repaired at the same time, and treated by electricity after removal of the splint.

After wounds of the larger tendons, such as the biceps or quadriceps extensor, have been sutured, the limbs are best immobilized by plaster-of-Paris. In wounds of the biceps tendon the arm should be maintained in acute flexion for six weeks, after which careful use may be begun. After suture of the quadriceps extensor the limb should be immobilized in extension by a plaster spica extending from the crests of the ilia to the ankle. This is worn for eight weeks, after which passive motion is begun, but no active use of the leg is allowable for three months.

TENDON TRANSPLANTATION

The general after-care for tendon transplantation,[1] whether the healthy tendon be sewed into the paralytic tendon or directly into the periosteum, involves no principle different from that of tendon suture. Bearing in mind the poor blood-supply of the tendons, the same conservatism is exhibited before subjecting the sutured region to great strain. A split plaster cast should be worn for six or eight weeks, and then, on a leg, a properly constructed brace should be applied. Massage and passive motion should be carried out assiduously by an expert.

NERVE SUTURE

The nerves most commonly injured and treated by suture are the musculospiral in fractures of the humerus, the median at the wrist, the ulnar near the internal condyle, and the facial nerve. The skin incision is closed without drainage unless the injury was accompanied by considerable trauma to the soft parts, and covered with a small, dry, sterile dressing, and the arm immobilized in such a position that the nerve will be under no tension. In suture of the musculospiral and of the ulnar this is secured by a straight internal splint extending from the axilla to the finger-tips, maintaining the arm in the position of complete extension. After suture of the median nerve, which is nearly always accompanied by suture of one or more of the tendons at the wrist, unless the tendon suture has been done previously and the nerve injury overlooked, a posterior splint is applied reaching from the elbow to beyond the finger-tips and bent up or padded at the distal extremity to maintain flexion at the carpus.

In the absence of tendon injury immobilization is maintained for two weeks, after which massage and electricity are commenced and the patient gradually allowed to resume the use of his arm. Electricity should be given daily for fifteen minutes, beginning with the galvanic current applied to the muscles supplied by the sutured nerve. As soon as the muscles begin to react to stimulation of the nerve above the point of suture the electrode should be applied to the nerve itself. As soon as regeneration is sufficiently advanced to produce reaction to the faradic current, this may be employed. Massage three times a week will aid in maintaining the nutrition of the paralyzed muscles. The maximum improvement after nerve suture may not be reached for one year, hence treatment must be faithfully continued for this length of time.

[1] E. H. Bradford and R. Soutter, Boston Med. and Surg. Jour., 1907, clvi, 655.

SUTURE OF THE BRACHIAL PLEXUS

The wound is closed except for a small drain at its dependent portion, if necessary, and a plaster bandage is applied in such a way as to elevate the shoulder, rotate the chin, and incline the head toward the affected side. The wound may be dressed through a window cut in the plaster over it, the wick being removed on the second day and omitted. A dry sterile dressing is applied until the wound is united. The stitches are removed on the seventh day. Immobilization is maintained for three weeks, after which the plaster is removed and electricity, massage, and passive motion of the arm carried out daily after the same principles which apply to the after-treatment of suture of smaller nerve-trunks. Improvement is slow and may progress during several years.

NERVE ANASTOMOSIS

The first successful nerve anastomosis in man was reported by Sick and Sänger in 1897.[1] The distal stump of a paralyzed musculospiral nerve was grafted into the median, and the patient regained perfect control of the muscles supplied by both nerves. Anastomosis of the spinal accessory and facial was performed in 1895 by Ballance,[2] and by Faure[3] in 1898. Both operations were failures. The first successful anastomosis of these two nerves was done by Kennedy in 1899.[4] In Kennedy's case the operation was performed for facial tic, and anastomosis followed immediately the interruption of function of the facial nerve. Anastomosis of the hypoglossal with the facial was likewise first performed by Ballance (*loc. cit.*) in 1903. Since the work of these pioneers the operations of facial anastomosis have been performed by a considerable number of surgeons, particularly for nerve injury during mastoid exenteration. The results have been, on the whole, promising. Mintz[5] found in 22 published cases only 7 which were absolute failures. In infantile paralysis nerve anastomosis was first performed by Peckham,[6] who grafted certain branches of the internal popliteal into the paralyzed external popliteal nerve.

Facial paralysis is only treated by operation when careful electric nerve examination shows the degeneration to be complete and the history is of such traumatism as to make a diagnosis of complete destruction of the nerves practically positive. The most satisfactory

[1] Arch. f. klin. Chir., 1897, liv, 271.
[2] Brit. Med. Jour., 1903, i, 1009.
[3] Gaz. des Hôp., 1898, 71[e] année, 259.
[4] Phil. Trans. Roy. Soc., 1900, cxciv, 127.
[5] Cent. f. Chir., 1904, xxxi, 684.
[6] Providence Med. Jour., 1900, i, 1.

operation in our experience is that of W. W. Grant, of Denver.[1] He divides the spinal accessory just before it enters the sternomastoid, and carries the end up to the distal end of the paralyzed end of the facial nerve, which is divided at the styloid foramen. He then divides the descendens hypoglossi $\frac{3}{4}$ inch down its course and sews it to the peripheral stump of the spinal accessory.

The after-treatment of nerve anastomosis does not differ from that of simple nerve suture as regards electricity, massage, immobilization, etc. After operations upon the facial nerve the skin incision is closed with an intracuticular suture of silkworm-gut and covered with a sterile cocoon, which is removed at the end of ten days and the stitch taken out. The head and neck should be so bandaged as to hold it fixed for the first week in order to minimize scar formation. The patient may get out of bed at the end of a week. Electricity is begun at the end of ten days. Almost at once the patient may show better control of food in the paralyzed cheek, and improvement in appearance of the face in repose, but the first facial motion, always associated with the shoulder motion when the spinal accessory is used, will not appear until about four months, and the maximum improvement may not be observed short of a year.

After anastomosis of the internal with the external popliteal the incision is closed without drainage and the limb immobilized for two weeks in plaster. At the end of this time the plaster is taken off, the stitches removed, and massage and electricity commenced.

Complications and Sequelæ.—The complications of facial anastomosis are *paralysis* of the muscles supplied by the sound nerve, resulting in paralysis and hemiatrophy of the tongue when the hypoglossal is used, or paralysis of the sternomastoid and trapezius if the spinal accessory is selected, accompanied by a tendency to contraction on the part of corresponding muscles on the opposite side; and *associated movements* of the groups of muscles supplied by both nerves. The second of these results in more or less severe spasm of the muscles of the face with attempts to move the shoulder or tongue, as the case may be.

Atrophy and paralysis may be, to a considerable extent, obviated by not completely dividing the sound nerve, but merely taking part of it to form the anastomosis. Even under such circumstances more or less atrophy and paralysis will result, but this will entirely clear up within two or three months. Electricity should be applied to the mus-

[1] Traumatic Facial Paralysis, Jour. Amer. Med. Assoc., 1910, lv, 1438.

cles normally supplied by the sound as well as those by the paralyzed nerve.

Associated movements of the facial muscles with the trapezius muscle or the tongue, depending on whether the spinal accessory or the hypoglossal nerve is employed, are usually present, but may be greatly diminished by reëducation and exercises.

PSOAS ABSCESS

Whether a psoas abscess ruptures and, therefore, makes its own vent, or is opened by primary operation, the after-treatment is the same.

If the site of the original disease is in the spine proper, it is assumed that the back has been fixed with relative lordosis in a plaster jacket.[1] If the disease is in the sacro-iliac joint, for fixation of the pelvis a tight-fitting girdle may be employed if it gives subjective relief. Proper care of the sinus and its discharge consists only in cleanliness. The skin about the mouth of the sinus is cleaned once, twice, or oftener daily, according to the amount of discharge; it is then gone over with 70 per cent. alcohol; some emollient skin protective, such as zinc ointment, is spread about, and a probe wrapped in cotton saturated with tincture of iodin is run deep into the sinus once daily. If practicable, the region is exposed to direct sunlight.

Everything possible for general hygiene should be done, twenty-four hours a day out-of-doors being one of the most important requisites.

Complications and Sequelæ.—*Obstruction to the Drainage.*—The reappearance of local pain and tenderness, with fever, particularly if the amount of discharge is at the same time markedly diminished, should suggest that the sinus no longer efficiently drains the cavity. A flexible uterine sound may be inserted gently and manipulated until a thorough opening is assured.

Distant or General Tuberculosis.—It should always be in mind that the disease may be manifest at the same time in lungs or kidneys or other parts, depending much upon one's particular resistance to this infection. The wise use of tuberculin should be considered.

Neuralgia.—Rarely, in a healing sinus which points in the groin the contraction of scar tissue may involve the anterior crural or other nerves with paresis of the quadriceps extensor and much neuralgic pain. Time and galvanism may give relief, otherwise it will become necessary to free the nerve of pressure by operation.

[1] E. G. Brackett and L. R. G. Crandon, Boston Med. and Surg. Jour., 1905, cliii, 515.

INGUINAL BUBO (ABSCESS OF THE GROIN)

The vertical incision is by far the best, in that it drains most efficiently and heals without the edges dimpling in, as they do in the parallel to groin incision. Iodoform gauze or paste packing for the first twenty-four hours is used for ambulatory cases. If the patient can remain recumbent, the salt and citrate poultice most favors drainage. As healing proceeds the oleoresin of copaiba or balsam of Peru may be used. To stimulate indolent granulation tincture of iodin in the depths of the wound is the best application. Superabundant granulations should be cut down with scissors curved on the flat.

The origin of the enlarged lymph-node should be sought on genitals or lower extremity and treated.

PARONYCHIA AND PERIONYCHIA

If the septic process involves the sulcus from which the nail arises, it tends to become chronic, with deformity of the nail unless early in the disease the nail is removed. Mere incision, as a rule, is not sufficient. If the nail is removed, no incision is necessary. After removal a rubber finger-cot with a few drops of glycerin in the distal end of it is slipped over the finger, and under these conditions it is allowed to macerate, with an occasional cleaning, for two or three days. At the end of this time all dressing is removed except a bit of balsam of Peru or scarlet red ointment until the epithelium is formed over the bed of the nail. The new nail will grow in from four to six months.

INGROWING TOE-NAIL

Whatever the type of operation, one expects a mildly septic wound. Salt and citrate soaks and poultices are to be used until the active inflammation has subsided. Emollient dressings are used during the healing.

Proper shoeing should be prescribed. (See p. 352.)

PALMAR GANGLION; TUBERCULOUS TENOSYNOVITIS

If primary union takes place after the excision of the melon-seed sac, the most important part of after-treatment consists in continuous efforts to prevent the matting together of the denuded tendons. This calls for active and passive motion of the fingers to their limits. Should a wound not heal by primary union, it should be treated as any open tuberculous wound; namely, by daily application of tincture of iodin and exposure to sunlight.

DUPUYTREN'S CONTRACTION

Practically the only operative procedure now carried out in these cases of contraction of the palmar fascia is the so-called open method, by which the fascia is dissected out. This is to be preferred over the older methods of subcutaneous fasciotomy and the V incision of Busch, through skin and fascia, sewed up as a Y, because of—(1) the lessened liability to recurrence; (2) the lessened danger of injuring nerves and vessels; and (3) the short after-treatment, without the necessity of wearing expensive and irksome mechanical appliances. The dissection can be carried out through a longitudinal incision over each contraction band (Kocher), or, better still, in case two or more fingers are affected, a U-shaped flap can be turned back on the wrist (Keen), uncovering the entire palm.

The importance of complete asepsis is to be emphasized. The hand should be thoroughly cleaned before the operation (Chap. XXXIX, p. 383), and it should be protected with care until entirely healed. Sepsis in the wound frequently means permanent loss of function through interference with the tendons. Ligatures should be avoided so far as possible.

Sometimes not only the palmar fascia and its prolongations into the fingers must be excised, but the resulting contraction of the flexor tendons in old cases must also be corrected by splitting and hemisection. The hand should be made to straighten freely. It should be held straight and a few sutures of horsehair put in to approximate the skin edges. A sterile dressing should be applied and the hand and finger bandaged to a wooden palmar splint or to a malleable iron strap, which should extend from the wrist to the tips of the affected fingers. This should be left on six days, by which time the skin will be fairly well healed. Gentle passive movements should now be given the fingers and the wound redressed. Stitches should be out on the eighth or tenth day, and if at the time of operation the hand was put up slightly flexed, it should be fully extended by this time. After the stitches are out the collodion dressing should be applied, to be kept on until the healing is absolute and massage and passive movements regularly instituted. On returning to work the patient should wear a leather protector in the palm.

If the contraction has been severe, the fingers had better not be put up straight immediately after the operation on account of the pain from stretching the digital nerves, which have been structurally shortened. In extensive dissections, also, a slight degree of flexion is usually recommended until circulation is adjusted.[1]

[1] A. H. Tubby, Trans. Amer. Orthop. Assoc., 1900, xiii, 149, and Lancet, 1901, i, 90.

Calot[1] is more radical, and holds the hand in complete extension or even hyperextension, then inserts the sutures and puts on a plaster-of-Paris mitt, the end of which is trimmed off so as to uncover the pulps of the finger-tips and allow the circulation and innervation of the fingers to be closely observed. The day after operation this is bivalved in order to relieve internal tension. It is kept on three weeks, and then removed and the fingers manipulated.

SKIN-GRAFTS[2]

Thiersch Grafts.—A convenient and efficient form of dressing is sterilized silver-foil, after the manner first advised in America by Halsted at the Johns Hopkins Hospital. Virgin silver-foil comes in books, each leaf separated from the next by a sheet of tissue. One or more books are put between two blocks of wood and the whole sterilized by baking. The silver book, having the folded edge cut off, now becomes a pile of alternate foil and paper tissue. After the grafts are placed they are fairly well dried by very gentle sponging. A layer of tissue with foil on top is now reversed over the grafted area and the paper withdrawn, leaving a layer of silver which shortly breaks up into granulated particles. One method is to cut the original sheet into strips and apply, leaving the paper well wet, in clap-board layers, next the silver. Better, in our experience, is it to remove the paper. When the whole area is well covered with silver, loosely packed sterile gauze of considerable thickness, so as to absorb the ooze, is placed over it and a dressing which will not confine the discharges applied. If the part grafted is a limb, it should be fixed in a splint. As a rule, no further dressing need be done for seven days. At that time the gauze next the silver should be teased off, wetting at the same time with sterile saline solution, taking time and care to remove it. Dry dressings for a few more days should result in complete healing. Uncovered areas will need regrafting later.

Thiersch grafts may be dressed from the first by clap-board layers of sterile cotton cloth in ½-inch strips containing holes here and there for the escape of serum. A dry dressing is applied outside of these strips.[3]

Judd, of the Mayo clinic,[4] dresses the grafted surface with forty to

[1] L'Orthopédie Indispensable, 1909, 705.

[2] For a recent consideration of this subject see Ehrenfried and Cotton, "Reverdin and Other Methods of Skin-graft," Boston Med. and Surg. Jour., 1909, clxi, 911.

[3] Brockway, Johns Hopkins Hosp. Bull., 1889, i, 36.

[4] Coll. Papers, 1910, 538.

fifty layers of dry gauze, all applied at once. The gauze pad is a little larger than the grafted area, and is held in position during the placing of many pieces of adhesive plaster so that it cannot move. This dressing is covered with one of cotton and bandage, and is left in place eight to ten days.

Reverdin Grafts.—These grafts are removed from a clean area of skin with a needle and a knife. The process does not hurt enough usually to make cocain necessary. Such points of skin are then laid here and there all over the clean granulating area to be grafted. Silver foil, or sterile fenestrated compress cloth, or gauze waterproofed in celloidin may be placed next the grafts, and a dressing applied as for the Thiersch method.

Wolfe Grafts.—These grafts include the whole thickness of the skin into the subcutaneous tissue, and will take very well on face and neck; less well elsewhere. Dry dressing should be used, the greatest care being taken that there is enough pressure to hold the graft against the area upon which it is planted, but not enough pressure to discourage circulation into it.

Flap Grafts.—A voluminous dressing of dry sterile gauze, with absolute fixation of the parts by adhesive strapping or plaster-of-Paris is advisable. Forty-eight hours after operation a window should be lifted in the dressing and the wound secretions noted. If sepsis is evident, the opening should be enlarged and a moist dressing of boric acid or weak chlorinated soda solution applied, to be changed every twenty-four hours or oftener. If there is no secretion, maintain absolute asepsis. Frequently the tip of the flap will necrose, as well as corners or angles. These slough away under dry dressings, and the space left uncovered fills in by granulation.

The pedicle should be severed as soon as it is reasonably certain that the flap has grown to the base on which it rests, and shows the pink color of good circulation. This varies from the sixth to the fourteenth day. In doubtful cases the pedicle can be severed or tied off gradually, from day to day.

CHAPTER LI

OPERATIONS ON BONES AND JOINTS

EXCISION OF ELBOW

PASSIVE motions of the fingers and wrist should begin on the second or third day. The new flail-joint at the elbow should be moved passively as early as the eighth or tenth day. This may be done by putting the joint up after the operation on an internal angular splint, provided at its angle with a turn-buckle. Twisting this turn-buckle will give a gradually regulated and safe movement. If the operation has been for tuberculosis, persistent remains of the disease or sinuses may modify the treatment, but if the excision has been for traumatic ankylosis, constantly increasing passive motion should be practised after the tenth day and active motion tried in three weeks.

Ability to use the new joint depends much on the character of the patient, his courage, and previously acquired mechanical dexterity. The patient should be given a weight to carry, such as a pail each day containing more water. In the case of a child, the sound arm may be bound up so that the excised joint must be used.

The operation is, indeed, but a small part of the treatment. Rotation of the forearm will be lost, and mere rotation of the whole limb at the shoulder substituted unless early care is taken to preserve forearm rotation. At first the upper end of the forearm should be firmly held by one hand and the patient's hand rotated passively with the nurse's other hand. At the end of four months motion in the new joint should be free and fairly efficient, but the final perfection of the joint may not be attained short of a year.

Excision of the joint for tuberculosis is now rarely practised, treatment for this condition having reduced itself to hygienic regulation and the use of fixation, with or without passive congestion or vaccines. Occasionally operation will have to be done for drainage. When the tuberculosis has subsided and has been quiet three or four years, then excision may be practised, if advisable, as if the condition were merely traumatic, and the after-treatment is, of course, the same.

EXCISION OF SHOULDER-JOINT

In general, the same comments should be made concerning the after-care in this operation as in the case of the elbow. Passive movement should not be begun until the deep parts of the wound are sufficiently healed; that is to say, ten to fourteen days. Then passive motion is followed by increasing, graded, active motion. A large enough pad must be maintained in the axilla to prevent the new head of the bone being pulled in against the coracoid process, and to hold it instead in the glenoid cavity. The normal motions of the humerus, in relation to the scapula, should be recalled and resumed, in order that none should be lost. The motions, such as sweeping, rotating the crank of a clothes-wringer, bringing a gun into proper position at the shoulder, may all be practised.

EXCISION OF WRIST

Passive motion of the fingers should be begun on the second day, the wrist or seat of operation, however, being thoroughly supported and fixed by splint and dressing. If motion of the fingers is not begun early, the tendons become adherent and the hand is useless. As the parts get stronger the splint is made shorter, though some support should be worn until there is no tendency for the new joint to collapse in any direction—in short, until it is strong. Some kind of leather support, molded to fit the limb from the middle of the forearm to the knuckles, should be devised.

EXCISION OF HIP

The wound is closed except for a space at the lower angle, where a provisional stitch is inserted and a cigarette drain passed. At the end of forty-eight hours the drain is removed and the stitch tied. Goldthwait, Painter, and Osgood [1] insist upon the importance of this early closure of the wound. The patient is kept in bed six weeks, with extension to the limb. At the end of this time a plaster spica is applied with the thigh in abduction and slight outward rotation, and the patient is got up on a high sole and crutches. Weight bearing should not be attempted for ten to twelve months, although the spica need not be worn more than three or four months unless there is great instability of the remaining joint.

EXCISION OF KNEE

The result of this operation is a stiff knee. No sutures are necessary in the bones. The wound is closed with a small drain which is removed at the end of forty-eight hours, and a previously inserted provisional stitch tied. The limb is immobilized in a plaster reaching from the perineum to the toes. The leg should be put up in about

[1] Diseases of the Bones and Joints, Boston, 1909, 242.

5 degrees of flexion at the knee-joint rather than in complete extension, as this will give a less awkward limb. At the end of three weeks the patient is gotten out of bed, and in two weeks more locomotion with the aid of crutches and a high sole on the shoe of the opposite foot is begun. At the end of eight weeks the plaster is taken off and the union tested. If firm, weight bearing may be begun at ten weeks. The plaster should be reapplied and worn until the end of twelve weeks.

OPEN (OR "COMPOUND") FRACTURES

After the operation the limb should be put up in permanent apparatus adapted to the site and nature of the fracture, except where the trauma was attended by much mangling of the tissues, with the consequent increased possibility of direct infection. In this case the apparatus should be designed to facilitate the necessary change of dressing, while yet maintaining the fragments with sufficient firmness to avoid pain or excessive deformity. During the first week attention should be focused on the wound rather than the fracture.

Ordinarily, under our present-day conservative treatment, unnecessary manipulation of the wound is severely avoided. The skin and such torn tissue as presents through the wound is cleaned scrupulously, as little trimming as possible is done, and then the parts are restored as nearly as may be to their normal relations, without further devitalizing the bruised tissues by handling or strong antiseptic irrigation. If the skin wound is not large, it is left open for drainage of exudate, which is sure to follow. It may be enlarged. If the fracture is deep, a drainage tract may be maintained by a coiled piece of rubber dam or a small soft tube. Unnecessary sutures are a distinct evil and deep sutures are rarely indicated. If catgut is used for the skin, the stitches may be left to take care of themselves, if no infection follows and there is no drainage to remove, until such time as the dressing or plaster-of-Paris is removed for the purpose of inspecting position.

There is a large series of open fractures which, after operation, should receive as good fixation as though there was no external wound; for instance, an open fracture in the middle of the leg or forearm is preferably put up in plaster-of-Paris. Care should be taken that a smooth, voluminous dressing of gauze is first applied to absorb the abundant serosanguinous exudate, and that the plaster bandage is loose enough to allow for some postoperative swelling. This exudate increases the pressure within the bandage, and great care should be taken to watch the toes or the fingers, that if they become at all cold, blue, or edematous, the plaster may be split down one side and the edges wedged apart, or, if necessary, along both sides ("bivalved"); straps of webbing should then be buckled around to keep the two halves in place.

If there is no evidence of pressure, the general pain in the limb may and should be controlled by morphin during the first thirty-six hours. If the pain continues more than thirty-six hours, something is wrong. *Use no more morphin,* but split the plaster and, if necessary, remove it to find the source of discomfort. Often a little adjusting of the padding is all that will be necessary. The circulation may be interfered with so seriously, either from pressure of the apparatus or injury of vessels from trauma or subsequent manipulation, that gangrene ensues and amputation is necessary. We have seen this happen in

FIG. 209.—CRADLE TO KEEP WEIGHT OF BEDCLOTHES OFF INJURED LIMB.

fracture of the lower end of the femur from injury to the popliteal vessels.

If there are no signs of infection, the dressing in an undrained case should not be removed until the wound has healed, that is, ten days or two weeks. Then the apparatus should be removed, the wound inspected, stitches taken out, and, if advisable, an *x*-ray taken to show whether or not readjustment is necessary. New apparatus should now be applied, after any indicated manipulation is performed, to allow for the removal of the wound dressing, the reduction of the post-operative swelling, and the atrophy of disuse. After this the treatment is that for closed fractures of the same type.

In case drainage has been left, as is frequently the case, provision should be made for dressing the wound after forty-eight hours. If the fracture has been put up in plaster, a window should have been cut or the plaster split before it has hardened, and the lid held in place by means of webbing straps or adhesive plaster until the proper time arrives, when the sheet-wadding is cut away with scissors and the dressing exposed. Forty-eight hours is long enough to allow primary infection to become apparent in drained cases. If the dressing shows nothing but clean serum, it is aseptically removed, a new dressing applied, the window-lid put in place and fixed by a plaster-of-Paris roller, and the limb is not again disturbed until the ten days or two weeks are up. Careless technique at this first dressing is, without doubt, frequently responsible for secondary infection of open fractures in hospital cases.

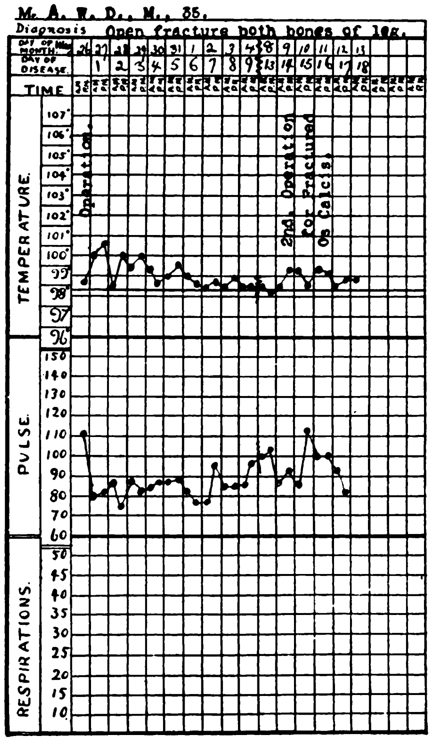

FIG. 210.—OPEN FRACTURE OPERATIONS.
Aseptic reaction continued over several days, as is usual in these cases.

A patient receiving an open fracture, unless he is suffering from some concurrent disease, does not exhibit any elevation of temperature if seen immediately. The temperature after the operation may be expected in the first twenty-four hours to rise to 99.6° F. If on the second day it continues to rise over 100° F. (see Chart, Fig. 21, p. 62) and is associated with pain, the presence of an infection should be assumed and the wound examined. If sepsis is apparent in a reddening about the wound, localized superficial tenderness, or a seropurulent ooze from the wound or the suture tracts, or if, on the first dressing in drained cases, seropus appears on the dressing, or follows after the drain when it is removed, the case should at once be submitted to an aggressive routine treatment. The apparatus should be adapted to allow easy and generous access to the wound. Sutures should be removed to promote unrestrained exit for tissue ooze, and the wound may have to be enlarged for the same purpose. Counteropenings should be made for more efficient drainage, and fenestrated rubber tubes inserted wherever they will be of service. If the infection is especially virulent in its manifestations, through-and-through rubber-tube drainage should be instituted at once. Hot antiseptic (and aseptic) absorbent compresses should be applied and renewed every two or four hours, as the urgency of the case demands, day and night. Later on, as the pus tracts have become more or less walled off, through-and-through irrigation may be instituted, having a care that the pressure shall not distribute infected matter to places as yet uninfected. In badly septic cases continuous warm irrigation or continuous hot soaks should be practised when feasible.

In cases of frank sepsis the fracture should be judiciously neglected for the time being, and nicety of apposition should be forgotten. To fixate the part in something approximating normal position, and at the same time to allow ample access to the wound, will require an apparatus which may tax the ingenuity and the mechanical skill of the surgeon. Plaster-of-Paris is adaptable to this sort of dressing. If there is but one sinus, a generously sized window may be cut out, and if the plaster is weakened thereby, it can be reinforced by ridges of plaster up and down the sides, or by bridges of strap iron, with their extremi-

FIG. 211.—CABOT POSTERIOR WIRE SPLINT.
Covered with bandage, ready for application.

ties incorporated in the plaster above and below the opening. In cases of multiple sinuses or through-and-through openings a separate plaster can be put on above and below the wound and these united by iron bridges.

The disadvantage of the fenestrated plaster lies in the uncleanliness at the edges of the window. The moisture from the poultices soaks up into the sheet-wadding, organisms enter and thrive on the débris of exfoliated skin, and sometimes such air-borne bacteria as the bacillus of green pus (Bacillus pyocyaneus) find their habitat here and form a disagreeable complication. Various methods have been devised to form a water-tight line of juncture between skin and dressing at the edge of the plaster, such as lining the plaster with oiled silk or rubber dam. The best scheme of which we know is that described by Crouse.[1] He dissolves dental rubber (No. 2) in commercial chloroform, and

[1] Virginia Med. Semi-Monthly, 1903, viii, 122.

stirs into this paste shredded absorbent wool. After drying the skin carefully he caulks the opening between plaster and skin with this mixture, which dries into an impervious water-tight coating. He then applies a coat of shellac over the entire plaster.

FIG. 212.—CABOT SPLINT.
Pads of folded pillow-slips placed to fit contours of leg. One side splint is in position. Straps are in place.

If there is much discharge or if pus issues from two or more sinuses, then it is frequently advisable to use some other form of apparatus, such as a Cabot posterior wire splint (Fig. 211). This should be well and comfortably padded and, on a leg, there should also be well-padded sideboards. The two side pieces and posterior wire splint, properly padded, form a three-sided box which, strapped together,

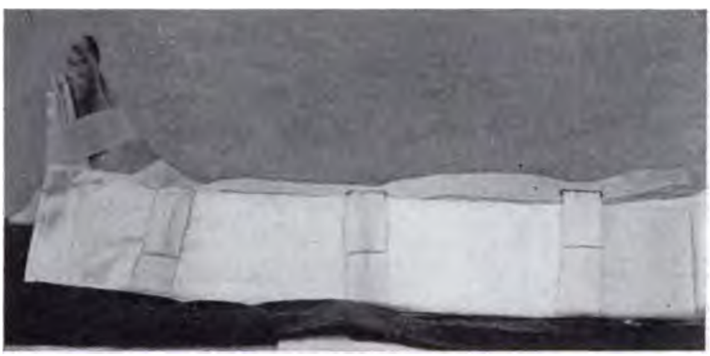

FIG. 213.—CABOT SPLINT.
The completed application: two side splints, webbing straps, and buckles.

holds the leg firmly. The wire splint with its foot-piece keeps the foot at right angles and prevents rotation of the lower fragment, and even when taken down to do the dressing, maintains the position of the foot with assurance (Fig. 212). If the condition necessitates the employment of the hot soak, and the location of the fracture adapts itself to this procedure, the wire can be passed through rubber tubing before it is bent. It is then fixed to the limb by adhesive plaster (which will have to be reënforced frequently) and splint and the extremity can be immersed in the bath.

FIG. 214.—PILLOW AND SIDE SPLINTS BEING APPLIED.

The leg is laid upon a feather pillow, one end of which goes just above the knee. Under, and at each side of, the leg is placed a strip of splint wood, long enough to reach from above the knee to 1 in. below the heel, each board being encased in a pillow-slip. Loops of muslin bandage are passed under leg and splints, and, while the assistant is exerting pressure to approximate the side boards, these are drawn tight and tied, the middle one first. Note the pad of sheet-wadding to protect the skin from the tight bandage.

The old-established pillow-and-side splint (Fig. 214) is an excellent temporary apparatus for a septic open leg fracture, but it has the disadvantage of needing the constant attention of the surgeon. The

FIG. 215.—PILLOW AND SIDE SPLINTS.

The loops being tied, the pillow is smoothed out and the overlapping edges pinned together snugly in front. The end of the pillow projecting below the foot is pinned together in the median line so as to maintain the foot at right angles. If inversion of the foot is desired, it can be gained by inserting a wide roll of bandage between the lower end of the outer splint and the pillow, and another, if desired for counterpressure, between splint and pillow on the inner side, just above the malleolus.

dressing cannot here be done by the nurse, or even by the surgeon alone, as each time it is performed the foot must be held carefully in the correct position by a second person, otherwise there are apt to be pain and rotation of the lower fragment. If the wound is on the under side of the leg or thigh, nothing is better than the Smith anterior splint apparatus (Fig. 216), which keeps the leg constantly suspended horizontally in such a way that the sinus can be dressed without disturbing the patient or the relation of the fragments (Fig. 217). Unless carefully applied it is, however, apt to be irksome.

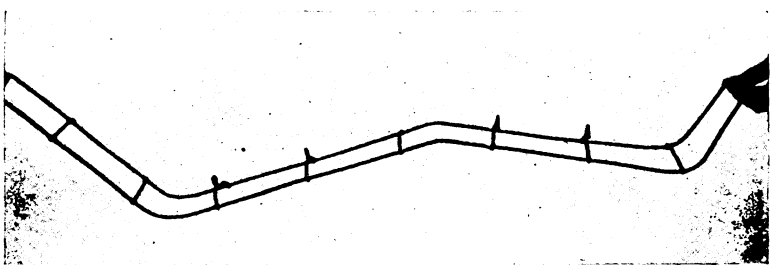

FIG. 216.—NATHAN R. SMITH ANTERIOR SPLINT.

Open fractures of the femur and of the humerus can best be treated by extension. For *open fracture of the femur* the classic Buck's extension is applied, two long strips of adhesive plaster extending on each side of the leg from 2 inches above the malleolus up as far above the knee as the nature of the wound allows. They are held firmly to the leg by further strips of adhesive plaster applied spirally. The leg should lie naturally on a posterior splint, extending from the beginning of the tendo Achillis to the buttock, padded to fit the contour of the leg. Round the thigh the dressing should be maintained by loosely

FIG. 217.—SMITH ANTERIOR SPLINT APPLIED.

applied coaptation splints, held in place by straps with buckles, allowing frequent easy removal, if necessary, to get at a wound or sinus. About 20 to 35 pounds weight should be applied, connected by a pulley over the end of the bed to the adhesive straps through the agency of a "spreader" acting like a whiffle-tree, 2 inches below the foot. A T-splint should be placed along the outer edge of the leg, extending from 4 inches below the foot to within 6 inches of the axilla, where it is held in place by a pocket swathe; the purpose of this is to prevent undue motion of the body, not of the leg. The straps and splints should not exert pressure against any bony points, especially the malleoli, tip of the heel, the outer border of the tibia, and the patella. The patient should lie upon a Bradford frame.

The complicated modifications of Buck's apparatus, which entirely conceal the leg, especially the application of starch bandages, though giving a more finished appearance, are undesirable. We have seen a beautiful apparatus, in which the leg was encased from toes to groin in neatly applied starch bandages, on removal reveal the leg alive with maggots, such as are not infrequent in neglected septic wounds. They cause no temperature and often remarkably little itching; they possess a characteristic odor which is not readily forgotten. Maggots may be present for weeks under a bandage or in a plaster bandage without being suspected.

When a Hoffa table (Fig. 53, p. 221) or other suitable apparatus is at hand, and there is good reason to suppose the wound will remain aseptic, a plaster spica bandage may be applied in open fractured femurs. A plaster spica is distinctly contraindicated in those cases in which temporary drainage has been instituted or sepsis is expected, or where there are no provisions for proper application of the apparatus.

In the treatment of *open fracture of the humerus* the use of the extension principle with patient in bed is to be recommended. Treatment by ambulatory apparatus should not be considered until all danger of infection in the wound is passed. If at first an ambulatory apparatus has been used and the wound becomes infected, the seriousness of the condition should be explained to the patient; he should be put to bed and an extension apparatus applied. Under this form of treatment the wound can be readily and painlessly dressed, and at the same time the fragments are maintained in the best possible apposition.

For extension of the arm apply a strip of adhesive plaster on each side from just above the styloid process to as high up the arm as the location of the wound will permit. Reinforce these with spirally applied strips of adhesive. To the lower end of each of the extension strips a strap of webbing is stitched, which passes down beside the forearm and hand to a spreader, from which a rope goes over a pulley at the foot of the bed. About 10 to 20 pounds of weight are applied. The arm should lie naturally on a well-padded splint extending from the tips of the fingers to the axilla. A T-splint should be applied between the arm and the body, on the same side as the injured arm, extending to the axilla. It is held in place by a pocket swathe around the body, as in the femur apparatus. The dressing is maintained by coaptation splints lightly held in place by straps with buckles allowing easy removal.

Complications and Sequelæ.—In open fractures there exists an increased liability to complications, such as osteomyelitis, fat embolism, thrombosis and pulmonary embolism, and non-union.[1] These must be borne in mind. The occurrence of virulent sepsis and septicopyemia, gas-bacillus infection, or gangrene will frequently indicate immediate amputation of the limb.

On account of the seriousness of infection in open fractures, from the moment the operation is completed until the wound is firmly united all aseptic precautions should be scrupulously employed; dressings should be done only when necessary and with the most minute care to prevent possibility of infection.

As moist dressings are frequently used in open fractures that have become more or less infected, a word of caution is necessary in regard to their preparation. In many hospitals it is the custom to use a basin kept on the ward car for holding the solution; this basin is rarely or never boiled; it may have just been used to receive catheterized urine or infected dressings; it is often returned to the ward car with simple rinsing in cold water. For the preparation of a moist dressing, a boiled basin should be insisted upon; if no large boiling tank is in the ward, it is a simple matter to put the basin on the gas stove partially filled with water and allow it to boil for about five minutes. This effectually sterilizes it. Nurse and ward attendants should be made to realize that mild antiseptic solutions, weak corrosive, boric acid, alcohol, etc., as ordinarily employed, will not sterilize basins.

Occasionally it becomes advisable to give the infected wound a hot soak, especially in open fractures of the small bones of the hand that are infected; here again the soak-basin is often used from patient to patient without boiling, a thing that ought never to occur. It should be sterilized beyond all possibility of question before being used in these cases. Through the neglect of boiling dressings and soak-basins we have seen an infection travel along the entire surgical ward; one of these cases died.

[1] F. W. Murray, Treatment of Delayed Union by Thyroid Extract, Ann. Surg., 1900, xxxi, 695; L. Morel, Parathyroid Treatment of Fractures, Arch. Gén. de Chir., 1910, iv, 245.

Open fractures are very apt to show a low-grade infection, characterized by the discharge of 3 or 4 drams of seropurulent matter daily for several weeks. This discharge is usually maintained by small free-lying bits of dead bone, or irritation from the ends of the fragments which, denuded of periosteum, become ebonized and act as foreign bodies. If it persists unduly, the fragments should be found and removed, or even the tip of the bone may have to be removed with rongeurs.

In cases which have been discharging for a long time and the discharge suddenly ceases, pocketing of pus should be suspected, and this may even occur with little or no rise of temperature. The pocket usually is in the fatty connective tissue between the skin and muscle fascia. Often it is advisable to make the incision through the skin, not in the center of the fluctuating area, but at a more dependent point, to allow more efficient drainage.

In lower leg fractures, after the wound is practically healed and the patient is allowed up and about on crutches, blisters are apt to develop from the exudation of serum as a result of the unaccustomed dependency of the limb and the resumption of function. These sometimes become infected and cause repeated breaking down of the wound. To forestall this occurrence the plaster should be split and the leg frequently inspected. Blisters, as soon as formed, should have the skin entirely removed and a dressing of some aseptic emollient applied.

OPERATIVE FIXATION OF FRACTURES

(Wiring, Suturing, Parkhill Clamp, Wire Nail, Bone Peg, Bone Plates)

Operative methods of fixation of the fragments after fracture have been in use for nearly sixty years. The earliest method employed was wiring. In later years wire has become largely replaced by absorbable sutures, because its presence, acting as a foreign body, has frequently led to conditions necessitating its removal. Other devices also for retention of the fragments in apposition have been devised, such as the Parkhill clamp, the wire nail, and the bone peg.

In principle the mechanical measures are the same as for any corresponding fracture which has not been wired or sutured. The treatment of the wound is that of any aseptic closed wound. Where wire has been used and there is persistent suppuration, the wire must be cut down upon and removed.

The Parkhill Clamp.—This was first presented by Parkhill in 1897.[1] Briefly described, it consists of four screws, two of which are

[1] Trans. Amer. Surg. Assoc., 1897, xv, 251.

inserted into each fragment, and the four held together by a clamp outside the wound. The incision is closed except for the passage of the four screws, and covered with sterilized gauze, which is passed beneath and round the clamp, and the limb inclosed in plaster. At the end of ten days the wound is dressed through a window in the plaster and the stitches removed. The plaster is omitted at the end of from four to six weeks in the smaller bones, or eight weeks in the case of the femur, and the clamp is then removed and the screws easily taken out of the bone. The screw-holes are covered with sterile gauze for a few days until they are closed in. In all bones except the femur the union by this time is sufficient to allow use. The femur should be again put up in plaster for three weeks, and weight bearing is not allowed until the end of the twelfth week.

The Wire Nail.—This finds its chief use in fractures of the neck of the femur. Silver nails, screws, and ivory pegs have also been used in the same manner. According to Sir William McCormack,[1] the first operation of this character was done by v. Langenbeck. The first in America was done by Willy Meyer.[2] The largest number of cases reported by any one man was reported by Nicolaysen,[3] who had performed 21.

Nicolaysen's technique differs from that employed by most of the other operators in that the nail is simply driven in through the skin without making an incision. The nail is wound about with sterile gauze and a plaster spica is applied reaching from the iliac crests to the toes. At the end of four weeks a window is cut over the trochanter, and the nail, which is always loose, is removed. At the end of eight to ten weeks the plaster is removed and the patient gotten up on crutches. At the end of three months weight-bearing is begun. The after-treatment of cases in which an incision has been employed is substantially the same. The incision is closed without drainage and a sterile dressing applied. On the tenth day a window is cut in the plaster and the stitches removed. Some surgeons cut down upon the nail under cocain and remove it at the end of six weeks. Others leave it *in situ* indefinitely.

This operation seems to be remarkably free from complications. In 36 cases collected by H. Augustus Wilson[4] the only complication was suppuration in the wound, which occurred in one case.

[1] Antiseptic Surgery. London, 1880, 200.
[2] Ann. Surg., 1803, xviii, 30.
[3] Nord. Med. Ark., Stockholm, 1897, viii, 1; also ibid., 1899, x, 1.
[4] Amer. Jour. Orthopedic Surg., 1907–08, v, 339.

Bone pegs and **ferrules** were introduced by Senn.[1] They have the advantage of being absorbable. The after-treatment is the same as for the suturing of a fracture with any absorbable material.

Lane's Bone Plates.—These ingenious mechanical devices are rapidly coming into more extensive use. They are made of metal and celluloid in various shapes: the best known in this country are the rigid steel plates described by Lane[2] (Fig. 218). The wound should be closed with intracuticular catgut in order that no subsequent dressings need be necessary. The bone plates are intended only to hold the ends in apposition, and the whole limb, therefore, must be held in

FIG. 218.—LANE'S PLATES AND THE INSTRUMENTS USED IN THEIR APPLICATION.

fixation by plaster-of-Paris bandage with as much care and with as thorough immobilization of the joints as in a simple fracture, and as if no plate had been used. Thus, for the leg the plaster extends from base of toes to groin; for fractured femur it extends from foot to ribs; for forearm, from fingers to shoulder.[3] The wounds should in all simple fractures and most open fractures, if treated at once, heal by first intention. In the tibia the plate must be necessarily so superficial that it here acts most often as a foreign body. M. S. Hender-

[1] Ann. Surg., 1893, xviii, 125.
[2] Lancet, 1907, i, 1283; Ann. Surg., 1909, l, 1106.
[3] E. Martin, Jour. Amer. Med. Assoc., 1911, lvii, 1353.

son, of the Mayo clinic, reports[1] the use of the metal bone splint in 27 cases, in only 2 of which has it been necessary to remove the splint. This report is better, however, than the average. F. B. Lund,[2] in 11 recent cases of non-union and mal-union, has reported 1 case of infection and 4 in which removal of the plate was necessary. Another series of 19 cases included 7 in which the plates had to be removed. The plate may be the nidus of actual infection or may be acting only as a foreign body, and when removed may have already accomplished its purpose of fixation. Unless the suppuration, therefore, is active the plate is to be left in position from two to six weeks.

Operation for Fractured Patella.—Operative treatment of this condition has shown a constant tendency to simplification. Elaborate methods of application of silver wire have fallen into disuse. It is now fairly well established that the lateral tears in the capsule are of importance, and that careful approximation of torn edges of the capsular ligaments is of more value than strong suture material approximating bone. The liability of the synovia to infection is generally considered greater than that of the peritoneum. The knee should be opened with as much respect as the cranial cavity.

After the dressing, either a plaster-of-Paris bandage should be applied from above ankle to groin, or a long, well-fitting ham splint may be used. In either case, enough padding should be put in the popliteal space to avoid hyperextension, which is unnecessary and uncomfortable.

The skin sutures should be removed at the end of ten days; the wound is then reinforced with plaster straps and the splint continued.

Four weeks from operation, passive motion, slight and gentle at first, is begun, and two weeks later use of the leg may be begun with only a flannel bandage over the knee. From that time on further motion of the joint should be encouraged, and at the end of the eighth week may be forced to a degree short of painful. The flannel bandage, if necessary, from ankle up, should be worn until the tendency to edema of the leg disappears—possibly three months.

Complications and Sequelæ.—*Sepsis.*—Infection of the skin should be suspected if slight temperature persists or if there is superficial tenderness through the dressing. Prompt detection and attention to such infection often precludes the disaster of deep infection. Infection of the knee-joint is one of the most serious calamities of surgery, and can be met only by prompt opening of the wound, washing

[1] Coll. Papers, 1910, 531.
[2] Boston Med. and Surg. Jour., 1911, clxv, 827.

out with saline, and efficient drainage. The joint is, of course, necessarily sacrificed, and more than that, the infection is so serious that life is often held in the balance.[1]

Persistent Adhesions.—This condition is met as after operations for dislocated cartilage, but force must be applied with good judgment, lest separation of the newly healed patella take place.

Suture of the Olecranon.—The wound is closed without drainage, and the arm, in extension, put up in a plaster reaching from the axilla to the ends of the metacarpal bones. The wound is dressed and the stitches removed through a window in the plaster at the end of ten days. The plaster is taken off at the end of four weeks and passive motion begun.

OPERATIONS ON THE KNEE: DISLOCATED CARTILAGE, SYNOVIAL FRINGE

The after-care is made most simple if the joint has been opened by a lateral curved incision, convex forward in the skin, and a transverse incision of the capsule itself, the latter part going backward beyond the middle of the tuberosity. If this method of entering the joint is used, the skin heals freely movable over the deep scar, and there is not presented a single healing plane from skin to knee-joint, with the dangers of direct infection. With this method of incision, then, or a direct vertical incision, the joint need only be splinted after the application of the dressing by four rolls of cotton wadding, each 2 inches in diameter and 2 feet long, placed equidistant about the joint, parallel with the leg. Such a method of splinting will allow the knee to rest in a comfortable position—that is to say, slightly flexed—and will allow slight movement from the start. Troublesome adhesions are much less liable to form. The skin stitches are removed in ten days. All splints are then removed, a flannel bandage is applied, and passive motion is begun. Four days later active motion should be tried and the patient should be encouraged to get about, using crutches or two sticks at first. When the leg is first hung down, edema of the foot and leg may appear. A flannel bandage from foot to above knee-joint will control this within a week in a vigorous person.

Complications and Sequelæ.—*Sepsis.*—Infection of the skin around the wound may be easily met and overcome. Any persistent temperature, tenderness, or pain should lead to immediate investiga-

[1] David D. Scannell (Boston Med. and Surg. Jour., 1906, clv, 568) reports an exceedingly dirty open fracture of the patella, which, conscientiously cleaned, healed by first intention.

tion of the wound, even as early as the second day. Skin infection may thus be checked where it is, before it penetrates the capsule. Infection of the knee-joint is a disaster covered under Suture of Patella (p. 649).

Adhesions.—The knee after this operation is always limited in motion at first. After the twenty-first day passive motion should force flexion. The thigh should be put over the knee of the surgeon or over the arm of a chair, and the leg gently but firmly flexed, gaining a little each day. For active motion, the patient should stand and slowly stoop, thus forcing flexion with his body weight. To these procedures may be added intelligent massage and, at times, baking may be helpful. For obstinate cases flexion may be brought about by special apparatus, such as that of Zander.

OPERATION FOR RECURRENT DISLOCATION OF THE SHOULDER

Up to 1894 excision of the head of the humerus was the method of treatment in vogue for recurrent dislocation of the shoulder, although Gerster[1] makes casual reference to a case operated upon by him in 1883, in which he excised a portion of the capsule of the joint. In 1894 Ricard[2] reported 2 cases successfully treated by taking a reef in the capsule.

To Burrell[3] is due the credit of originating and perfecting the technique of shortening the capsule by partial excision and suture, which he described in 1897, with the report of two successful cases. The advantage of Burrell's method over Ricard's is obvious, since the former allows exploration of the interior of the shoulder-joint and the removal of loose bodies which are occasionally found.

The after-treatment of both Burrell's and Ricard's operations is identical. The capsule is sutured with catgut, the muscles brought together, and the skin wound closed with silkworm-gut. A dry sterile dressing fixed with collodion or plaster straps is applied and the arm put up in a Velpeau, with the elbow elevated and carried inward toward the median line. The arm is not disturbed until the tenth day, when the first dressing is done and the stitches removed. The Velpeau is replaced and continued until four weeks from the date of operation, when massage and passive motion are begun, and the patient is allowed to return to work at the end of eight weeks.[5]

[1] C. F. Painter and A. P. Cornwall, The Technique of Arthrotomy, Boston Med. and Surg. Jour., 1910, clxiii, 601.

[2] Rules of Aseptic and Antiseptic Surgery, New York, 1888, 8.

[3] Bull. de l'acad. de med., 1894, N. S., xxxi, 330.

[4] Amer. Jour. Med. Sci., 1897, N. S., cxiv, 166.

[5] T. T. Thomas, Jour. Amer. Med. Assoc., 1910, liv, 834.

OPERATION FOR PURULENT ARTHRITIS

It will be assumed that no joint is incised for drainage unless the presence of infected fluid has been determined by needle puncture. The knee will be drained by an incision each side of the patella. The ankle will be drained by an incision just in front of each malleolus. The wrist will be drained by an incision over each styloid process. For these three joints through-and-through drainage will be established by a single piece of rubber dam. The elbow, shoulder, and sterno-clavicular joint are drained by a single incision, the rubber dam being held in by a single stitch through it and the skin.

The best dressing for drainage undoubtedly is the salt and citrate poultice. The rubber dam is withdrawn in from forty-eight to ninety-six hours. The poultices are maintained one or two days longer if the temperature has not reached normal. Passive motion should be begun by the fifth day, unless the process is still very active and painful, and continued in increasing duration daily. If permanent ankylosis supervenes, operation and the use of Baer's membrane should be considered.[1]

OSTEOMYELITIS

For our earliest conception of the regeneration of bone from periosteum after subperiosteal resection of the diaphysis we are indebted to Ollier.[2] His technique was carried out with successful issue in 2 cases of suppurative periostitis by Cheever in 1868.[3] The operation was performed in France and England by Duplay, MacDougall, and Holmes, but it was not accepted in Germany until Jottkowitz[4] reported a successful regeneration of the femur after excision of the shaft. The pathology of the method of treatment of osteomyelitis by early resection of the necrotic bone, allowing regeneration from the periosteum, was studied by E. H. Nichols in 1898,[5] and his suggestions were carried out by Hayward W. Cushing.[6] For an exhaustive description of the pathology of osteomyelitis and the technique of operation, the reader is referred to the masterly article read by Nichols[7] at the meeting of the American Medical Association in 1903.

[1] R. B. Osgood, Boston Med. and Surg. Jour., 1911, clxv, 86.

[2] Traité Experimentale et Clinique de la Régénération des Os, et de la production artificielle du Tissue Osseux, Paris, 1867.

[3] Reproduction of the Tibia, Med. and Surg. Reports of the Boston City Hospital, 1870, i, 362.

[4] Deut. Zeit. f. Chir., 1899, lii, 213.

[5] Communication Mass. Med. Soc., 1898, xvii, 875.

[6] Ann. Surg., 1899, xxx, 468.

[7] Jour. Amer. Med. Assoc., 1904, xlii, 439.

The consideration of the after-treatment may be divided into that—(1) Of the acute stage; (2) of the subacute; and (3) of the chronic.

Acute Stage.—In the acute stage there is more or less extensive suppuration in the marrow The pus is evacuated by incision of the soft parts and removal of a portion of the cortex of the bone. The wound is packed with iodoform gauze and a few stitches taken at the extremities. A moist citrate salt dressing is applied and the limb immobilized by a splint. The dressing is done at the end of forty-eight hours and daily thereafter. At each dressing the cavity is irrigated with chlorinated soda solution (1:80) and repacked. In exceptional cases the bone regenerates completely and the wound heals spontaneously. Usually, however, a sequestrum forms, which must be removed by a secondary operation.

Subacute Stage.—This secondary operation in the case of bones having an accessory bone to serve as a splint, as the tibia, should be performed while the periosteum is still plastic, but has begun to ossify in its deeper layers—ordinarily about eight weeks after drainage of the acute suppuration. In the case of bones like the humerus, which have no such accessory support, it is necessary to wait until the regenerating periosteum has obtained sufficient stiffness to prevent distortion by muscular pull, but not long enough to allow the periosteum to have lost its power of central growth. The proper time for operation may be estimated by the thickness of the involucrum, the rule given by Nichols (*loc. cit.*) being to operate when the total diameter of the involucrum is about equal to one-half the diameter of the normal shaft. This is usually about twelve weeks after the drainage of the abscess-cavity.

The after-treatment of operations on both types of bone is identical, the later operation requiring as much time for regeneration as the earlier. The wound is closed with or without drainage, according to the amount of discharge from the cavity before operation, a moist antiseptic dressing is applied, and the limb immobilized in plaster. The patient is kept in bed about two weeks when a bone of the upper extremity is involved, but the plaster is continued for about six months, after which regeneration should be complete enough to begin use. In bones of the lower extremity the patient is allowed up on crutches and a high sole at the end of six to eight weeks, but the plaster is continued until from six to eight months, after which it is removed and weight-bearing gradually begun. Small sinuses may form during the convalescence from one of these operations and require curetting, but usually they will eventually heal without further difficulty.

Chronic Stage.—In the chronic cases the sequestrum becomes surrounded by a wall of dense bone which has no power of central growth, and its removal, therefore, is not followed by closure of the cavity. Various procedures have been devised for this purpose. Hamilton [1] tried to graft in pieces of sponge in the hope that they would serve as a framework for the formation of the new bone, but this method has proved an utter failure.

Schede [2] disinfected the cavity as thoroughly as possible, allowed it to fill up with blood, and then sutured the skin over the top, allowing the blood-clot to organize and the cavity in this way to become filled in with fibrous tissue. In spite of the obvious difficulties in the way of rendering the cavity sterile, this method has sometimes proved successful. The best method is that of Neuber,[3] who cleans out the cavity, draws in the adjacent skin and soft parts, and nails or sutures them to the bottom of the cavity, thus lining it with skin.

The Mosetig-Moorhof method [4] consists in rendering the cavity as nearly aseptic as possible, drying it, and filling it with a mixture of—

Iodoform..	60 parts
Spermaceti..	40 parts
Oil of sesame..	40 parts

which is poured in warm and then hardens and hermetically seals the cavity. The soft tissues are then sutured over it. The originators reported 120 cases successfully treated by this method. Nichols,[5] however, has not seen such satisfactory results.

OPERATIONS FOR BOW-LEGS, KNOCK-KNEES, AND COXA VARA

These will be considered together for the sake of convenience. Two forms of operation are in use—osteoclasis and osteotomy. The former is employed in the ordinary outward bowing of the femur. The latter is the method of choice when the deformity is in close relationship with a joint, as in knock-knees or coxa vara, or where both anteroposterior and lateral bowing are present. Osteotomy is done at various levels, being called Gant's operation when done below the trochanters; Macewen's, above the condyles; and Trendelenburg's, when both the tibia and fibula are sawn through just above the malleoli.

[1] Edinburgh Med. Jour., 1881, xxvii, 385.
[2] Deut. med. Woch., 1886, xii, 389.
[3] Arch. f. klin. Chir., 1879, xxv, 316.
[4] Centralbl. f. Chir., 1903, xxx, 433.
[5] Keen's Surgery, Phila., 1909, ii, 43.

The after-treatment is the same for both osteoclasis and osteotomy, except after Gant's operation. Plaster bandages extending from the groins to the toes are applied, maintaining the limb in the corrected position, and are worn for four weeks, and then cut along each side so that they may be taken off at night. At the end of six weeks they may be removed entirely and weight-bearing begun if the union is firm. After subtrochanteric osteotomy a double plaster spica extending to the ankles, applied with the limbs in abduction, is worn for six weeks, then omitted at night for two weeks more, and finally left off altogether at the end of the eighth week, at which time weight-bearing may be commenced.

Complications and Sequelæ.—These operations are seldom accompanied by special complications. Delay in union sometimes occurs after osteotomy and requires a longer period of fixation in plaster, together with efforts to influence nutrition. In children, the frequently coexisting rachitis must be treated. Recurrence of the deformity sometimes takes place and necessitates a repetition of the operation.

Convulsions occasionally occur after or during the progress of orthopedic operations. A. Schanz[1] believes these to be due to fat embolism. On the other hand, Codivilla[2] explains them as the result of traction on nerve-filaments, especially of the sciatic. Working under his direction, V. Neri[3] produced experimentally a similar symptom-complex by traction on the sciatic nerve in animals. Accordingly, Codivilla advises as a prophylactic measure the use of extreme care and gentleness in the stretching of soft parts at operation; and when convulsions do occur, to place the limb in a position to relieve the tension on the nerve, and to loosen the extension if any is being used.

CLUB-FOOT (CONGENITAL EQUINOVARUS)

The operation may consist in—(1) manual correction; (2) subcutaneous tenotomies; (3) open division of the resistant structures (Phelps); (4) forcible correction with instruments, and (5) bone operations. In any case, the foot should be held overcorrected in plaster-of-Paris for four to twelve weeks, depending on the age of the patient and the degree of deformity. The patient should then be fitted with a Bradford or Taylor club-foot shoe; in an infant the plaster should be continued, removing it at intervals to allow of manipulation, until he is old enough to walk, when a brace should be applied. After the

[1] Cent. f. Chir., 1911, xxxvii, 43.
[2] Deut. med. Woch., 1910, xxxvi, 2134.
[3] Zeitschr. f. orthopäd Chir., 1909, xxiv, 87.

brace is discontinued, it may be well to have the child wear a shoe having a lift of $\frac{3}{8}$ to $\frac{5}{8}$ inch along the outer border of the sole.

The following technique of plaster application, recently described by Ehrenfried,[4] is particularly adaptable to the postoperative treatment of infants and young children:

"The plaster is applied from thigh to tips of toes, with the knee flexed, so as to prevent the cast from twisting on the leg, and allowing a return of the varus deformity. The skin should be clean and dry and well powdered, and the foot and leg should be evenly and snugly padded with narrow sheet-wadding. The bony prominences should be generously covered, but if too much wadding is used it is likely to pack together, so that the foot and leg become loose in the cast.

"If the plaster is applied to the best advantage, three 2-inch rolls are ample in a young infant, and four 3-inch bandages will suffice for an older

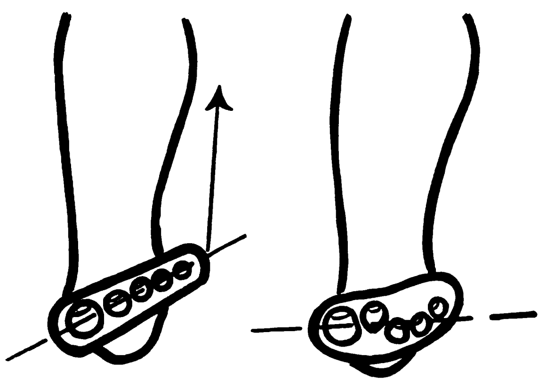

FIG. 219.—DIAGRAM SHOWING ADVANTAGE IN APPLYING A COLLAR AND ALLOWING IT TO SET BEFORE ATTEMPTING TO MAINTAIN POSITION OVER OLD METHOD OF ATTEMPTING TO OVERCORRECT WITH PLASTER STILL WET (EHRENFRIED).

child. Of the first roll, half is used in making a collar about the forefoot. This is so applied—the foot hanging relaxed—with circulars and reverses, as to lie snugly against the foot. It should extend to the tips of the toes, but should not cramp them or hide their extremities. It should fit closely against the inner border of the great toe, to its very tip, so as to give efficient leverage in abduction. The remainder of the roll is applied in circular turns about the thigh, carried as high up as possible.

"No further plaster is applied until the collar has set. When this has become solid, one can efficiently manipulate the forefoot as a unit and apply a considerable amount of force without cramping or dislocating the toes, or causing pressure sloughs, for the pressure is not concentrated, but is distributed evenly through the collar (Fig. 219).

[4] Boston Med. and Surg. Jour., 1909, clxi, 741.

"The second roll is applied, after six or eight minutes, in the form of circular turns over the thigh and under the ball of the foot. These turns are drawn as tightly as possible, with the object in view of flexing the knee and dorsiflexing the foot at acute angles. If the bandage goes high up on the thigh and far out on the foot, there will be a considerable leverage at the command of the operator (Fig. 220). This roller should always be applied in such direction that the turns, when drawn tight, will naturally assist in elevating the outer border of the foot and maintaining eversion, thus: on the right leg the plaster should be applied, as ordinarily, in the direction of the hands of a clock; on the left, in the

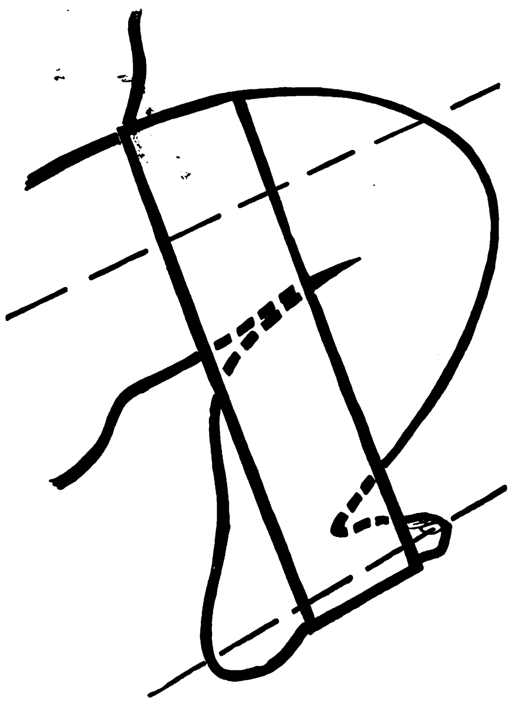

FIG. 220.—DIAGRAM SHOWING THE ADVANTAGE OF CIRCULAR TURNS OVER THE THIGH AND UNDER THE FOOT IN GAINING AND MAINTAINING THE GREATEST POSSIBLE AMOUNT OF DORSIFLEXION (EHRENFRIED).

reverse. The last inches of this roller should be used in making a tight circular or two about the calf to draw the plaster which has just been applied close in to the leg.

"The third roller is put on immediately and is used to cover in the knee and heel, which have not yet been touched. The plaster here need not be thick, as it is not essential in maintaining the position; and for the sake of lightness it had best be applied in recurrent turns (Figs. 221 and 222).

"A plaster applied in this way will hold all the correction which can be gained by manipulation, with the exception of abduction. To obtain this, the foot should be held abducted while the plaster is drying. In holding the

FIG. 221.—PLASTER APPLIED, SIDE VIEW (EHRENFRIED).

FIG. 222.—PLASTER APPLIED, FRONT VIEW.

The extreme degree of overcorrection—the foot being directed outward and upward, and the outer border elevated—is apparent (Ehrenfried).

position care should be taken not to indent the plaster with the fingers, or a slough may result. After it has dried sufficiently to maintain its own position, any trimming which may be necessary about the toes is performed, and it is a good rule also to split the plaster part way down the outer side, so as to allow of its being removed more readily in case of emergency or when the proper time arrives.

"The child is not allowed to depart until it is certain, from the color of the toes, that there is no interference with circulation; and the mother is instructed to bring the baby immediately or remove the plaster herself if the toes become white or blue. In a resistant foot, where considerable pressure may have to be exerted, there is always some danger, but with this form of plaster it is at a minimum because there is no pressure from plaster under the popliteal space or in the bend of the ankle."

Complications and Sequelæ.—*Slough* and interference with circulation from pressure of the plaster.

Rigid foot, depending sometimes on maintaining the foot too long in plaster without manipulation, and sometimes resulting necessarily from the operation.

Recurrence of the Deformity.—This latter complication is practically bound to occur unless the postoperative care is followed out with the utmost patience and assiduity. The foot must be retained in overcorrection by plaster or apparatus, in marked cases, for two years in children and one year in adults; if by plaster, the bandage must be changed every two weeks to allow of manipulation. The patient should be kept under observation for a year or two longer. The tendency to toe-in must be opposed.

HALLUX VALGUS

The operation of Weir, whereby the exostosis is removed and the severed dorsal tendon is sewed into the side of the phalanx, and W. J. Mayo's operation, whereby the exostosis is removed and the bursa is turned in to make a new joint surface, are the two best operations. For either, the curved incision, convex downward, has the best blood supply, and, therefore, heals best. The objection that the shoe will press against the scar so placed is theoretic only. A wad of cotton is placed between the great and next toe. No splint need be applied; the bed-clothes should be so held up that their weight shall not come on the toes. The patient may get out of bed on the second day, but the leg should be kept horizontal for a week. At the end of ten days the stitches should be taken out and walking should be attempted. The pledget of cotton should be kept between the toes for four weeks at least. Right and left stockings should be used, if obtainable, and flexible anatomic shoes should be prescribed. (See Chap. XXXVI, p. 352.)

OPERATION FOR SPINA BIFIDA

After operations for spina bifida the one great essential to success is the prevention of infective material entering the wound. When the defect is at the lower end of the spine, in close proximity to the rectum, and the skin over the sac is already macerated and septic, this is far from easy, and requires the utmost care and watchfulness on the part of the nurse. The wound is closed tightly with continuous cat-gut, reinforced by a few silkworm-gut sutures. A dry dressing is applied and held in place by a tight band. Outside of this a second dressing is placed, which can be changed as often as soiled. The inner dressing must be changed about every other day because of the condition of the skin and the danger of the gauze becoming soiled. The silkworm-gut stitches are taken out at the end of a week. The nursing or feeding of the infant must, of course, go on as before the operation. A temperature during the first day or two of the convalescence, even of 105° F., does not necessarily indicate any serious complication. The same is true of rise in the pulse-rate. Of much more importance is the way the child takes nourishment. A refusal to nurse or take the bottle is often the forerunner of a serious complication.

Complications and Sequelæ.—Lovett[1] has reported 24 personal cases with a mortality of 37½ per cent., 11 of which were in private practice, with only 2 deaths. He collected 88 cases from the literature, with 30 deaths.

(1) *Meningitis.*—This is an extremely serious complication, and results from infection, whether at the time of operation or entering the wound afterward. Twitching of the face, eyelids, or hands should be treated by the injection of chloral (1 gr. for an infant of one month) or potassium bromid (5 gr. at one month) by rectum, repeated, if necessary, every hour for three doses. Tapping of the ventricles is useless.

(2) *Leakage of Cerebrospinal Fluid.*—If this cannot be controlled by pressure, an additional suture must be inserted in the wound, for unless this leakage can be stopped, death is almost inevitable. The child is kept lying on its back with the pelvis elevated to prevent too rapid drainage.[2]

(3) *Superficial Infection of the Wound.*—Lovett (*loc. cit.*) stated that he had met with a few cases of superficial infection, in none of which had the wound broken down or any other serious complication occurred.

(4) *Later Complications.*—An operation for spina bifida cannot be

[1] Amer. Jour. Orth. Surg., 1907–08, v, 208.
[2] B. Heile, Berlin. klin. Woch., 1910, xlvii, 2301.

considered as successful until after the elapse of at least three years, since within this time many of the children die from hydrocephalus, convulsions, or intestinal complications. Sachtleben[1] gives this secondary mortality as 29 per cent.

LAMINECTOMY

The dura is closed without drainage, but a gauze or cigarette drain is placed down to the dura, and the aponeurosis, muscle, and skin are closed except at this point. The skin sutures are of silkworm-gut. A sterile gauze dressing, held with adhesive plaster, is applied, and outside of this a swathe, if in the dorsal, or a bandage, if in the cervical, region.

The first dressing is done at the end of forty-eight hours and the wick omitted. After this the wound is inspected and the dressing changed at from two- to four-day intervals, depending upon the amount of discharge from the sinus. The stitches are removed on the fourteenth day.

Where the operation is done for a tumor or some similar condition not associated with injury, no especial support for the spine is necessary. The patient is placed on an air-cushion and may be turned from side to side without great difficulty. At the end of three weeks the patient may get up and begin to move about.

On the other hand, when the operation has been performed after a *fracture of the spine*, the convalescence is fraught with complications and difficulties. When the fracture is in the dorsal or lumbar region, the spine is immobilized by sand-bags placed under the back and the patient is placed on a Bradford frame (a gas-pipe rectangle supporting a canvas hammock). When the cervical region is involved, extension is employed by means of an extension apparatus like that used for cervical caries. If the patient survives this, immobilization and extension must be employed for at least six to eight weeks and the patient is then put in a plaster or leather jacket, which is worn for months or years.

These patients are always, at least at the outset, partly or completely paralyzed below the level of the lesion. This necessitates the most careful nursing to prevent bed-sores. The skin must be rubbed twice a day with 50 per cent. alcohol and powdered with talcum or starch and zinc dusting-powder, especially in the folds. The subcutaneous bony processes must be protected from pressure by inflated rubber rings. If there is incontinence of sphincters, a large oakum pad must be placed beneath the buttocks, frequently changed, and the skin in the region

[1] Inaug. Diss., Breslau, 1903; Cent. f. Chir., 1904, xxi, 341.

carefully dried and powdered. In spite of the necessity for immobilization the patient must be turned from side to side, still supporting the spine with sand-bags, however, to avoid continuous pressure on any one spot and hypostatic congestion of the lungs. If the skin becomes broken, the spot must be protected by an inflated ring and the alcohol and powdering process repeated with increased frequency.

Retention of urine is the rule, but the patient should be catheterized. Catheterization almost inevitably results in cystitis, but it is delayed in proportion to the cleanliness exercised in the use of the catheter.

Massage and electricity to the paralyzed extremities will aid in restoration of function if there is to be any, and later a brace may be devised, if necessary, to allow the patient to walk. The diet should be chiefly liquid for the first few days, and if the patient survives and gains in strength, a fairly extensive diet may be allowed later, even small amounts of meat and vegetables being given after the first week. The bowels are moved by enemas if necessary.

Complications and Sequelæ.—(1) *Leakage of cerebrospinal fluid* after operation is controlled by a tight pressure bandage on the wound.

(2) *Meningitis* is one of the most common complications and is almost necessarily fatal.

(3) *Bed-sores* should be treated by relief of pressure, using an inflated ring, and the daily application of a 10 per cent. iodoform in lanolin ointment. Bed-sores may be the result of trophic disturbances as well as pressure, and under such circumstances result fatally with great rapidity. (See Chap. XXXII.)

(4) *General infection, pneumonia, bladder infection extending to kidneys*, and *shock* are common causes of death after fractures of the spine.

(5) *Cystitis*, when it occurs, must be treated by constant drainage and daily bladder irrigations with 4 per cent. boric acid or 1:5000 silver nitrate solution. Urinary antiseptics are given by mouth.

CHAPTER LII

THERAPEUTIC IMMUNIZATION AND VACCINE THERAPY

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Principles of Immunization

Spontaneous recovery from bacterial disease and future lessened susceptibility to a similar infection is evidence that a self-immunizing power exists; that there is a cellular mechanism of considerable efficiency capable of reacting against bacteria in a destructive manner. Considering the wide distribution of bacteria in the body, and the constant exposure to infection of various kinds, we must look upon a condition of health as a result of the efficient working of this cellular mechanism; upon actual infection, as indicating its failure; upon localized infection, as success in protecting the body from the spread of disease, but failure in being unable to extinguish the infection locally.

The arrest of pulmonary tuberculosis due to careful hygiene, the antitoxin treatment of diphtheria, of tetanus, cerebrospinal meningitis, the success of surgery in the treatment of local infections, may be taken as clinical evidence that the immunizing mechanism may be favorably influenced by treatment. The success of small-pox vaccination and the antityphoid inoculation of Wright, of the antirabic inoculation of Pasteur, are clinical evidence that the immunizing mechanism is capable of reacting to artificial stimulus in the establishment of a condition of immunity.

Laboratory research throws considerable light on the means through which this immunity is brought about. The basis for the power of self-immunization is that inherent in the animal organism to adapt itself to overcome changing conditions and noxious influences. Botany furnishes an example of this adaptation by an experiment of growing a plant in a poisonous atmosphere. By starting with a small, gradually increasing percentage of noxious gas, the plant is found to develop the ability to exist in a concentration such as would have killed it had the eventual concentration been used at first. Spontaneous recovery from infectious disease, protection by inoculation or vaccination, are examples of this truth of adaptation.

The purpose of this chapter is to consider the means of increasing the efficiency of the immunizing mechanism. The following measures will be considered: Extirpation, drainage, antiseptics, determination of blood fluids to the affected part by (1) active hyperemia, (2) passive hyperemia, (3) massage, or (4) suction, antitoxins, vaccines, exercise, rest, hygiene, bacteriotropic chemicals.

When spontaneous recovery from infectious diseases takes place the blood is found to possess the ability to destroy the particular infecting organism or to neutralize its specific toxin, which it did not possess before. Ehrlich injected ricin into animals in gradually increasing amount, and found that finally they were able to survive a dose which if given at first would have caused them to succumb. This adaptation of the animal to withstand toxic doses of ricin depended upon the ability of the mechanism of adaptation to elaborate a substance with selective neutralizing action upon the toxin; in other words, specific antitoxin. Horses treated by injection of increasing doses of diphtheria toxin became immune to excessive doses, quite as Ehrlich's animals had become immune to ricin. The blood-serum of the treated horse had the ability of neutralizing the toxin when mixed in proper proportions, a quality which the normal serum did not possess. When in human beings recovery from diphtheria takes place without the injection of antitoxin we know that the mechanism of immunity has produced sufficient antitoxin to neutralize the poison entering the blood-stream. Immunity thus produced is active. Active immunity, then, is that which results from actual infection.

When, in a case of diphtheria, symptoms of toxemia are marked we conclude that the immunizing mechanism is producing antitoxin in insufficient quantities to neutralize the toxin as it enters the body. In such cases we must conceive that the cells concerned in the production of antibodies are subject to toxic overstimulation and their functioning temporarily paralyzed. Injection of antitoxin at once relieves the cells of the stress of excessive toxemia. This neutralization of toxin in the body by injection of antitoxin is entirely independent of the patient's immunizing mechanism, and will take place if the circulation is sufficiently good for the antitoxin to be taken into the blood-stream. Immunity of this type is termed passive, in that the immunizing mechanism of the patient has little to do with the result produced.

IMMUNIZATION AGAINST THE BACTERIAL CELL

The power of the animal body to produce substances which shall protect it is not limited to poisons or toxins. It is found also that in response to infection with living or to the inoculation of killed pathogenic bacteria there is a response which may not only direct itself to the neutralization of the poisons which they contain, excrete, or secrete, but also which may direct itself to the actual destruction of the invading bacteria. These antibacterial substances, to be found in the blood subsequent to infection or to inoculation with certain killed bacteria, are, for the most part, directed only against those bacteria and their poisons which constitute the actual stimulus to the formation of these antibacterial substances.

ANTITROPINS: AGGLUTININS, BACTERICIDINS, AND BACTERIOLYSINS

So far it has been impossible to isolate these newly formed protective *antitropins*, as they are termed, and they are only differentiated by the different manner in which they severally exert their power against the bacteria in response to infection with which they have been produced, and by their behavior when subjected to certain laboratory tests. In response to actual infection with certain organisms, such as typhoid, cholera, and some others, or to inoculation with killed cultures of the same organisms, the blood-serum is found to have acquired the power of agglutinating, killing, and dissolving these organisms when brought into contact with them *in vitro*, and these substances are named, respectively, *agglutinins*, *bactericidins*, and *bacteriolysins*. They are not to be demonstrated in an effective amount with serum of normal individuals. In the common infectious processes due to the staphylococcus, streptococcus, pneumococcus, and some others, the blood-serum itself has no such inherent destructive action so far as is now known, and hence these substances do not seriously enter into consideration as means of protection against these organisms. In the bodily reaction against typhoid, colon, cholera, and some other infections the rôle of these antibacterial substances appears to be an important one.

OPSONIN AND PHAGOCYTOSIS

There is, however, beyond these distinctly antibacterial substances a fourth factor, the *opsonin*, which, working in conjunction with the leukocytes and other phagocytic cells, accomplishes the destruction of bacteria. The opsonin so affects the bacteria by combination with their cell protoplasm that the phagocytic cells are enabled to ingest those microörganisms with which they come into contact. Whereas the first three antitropins are produced by the body only in response to a limited number of infections, the opsonin and the phagocytes in conjunction exert their destructive effect against all pathogenic bacteria. As is well known, Metchnikoff, as far back as 1883, attributed recovery from infectious diseases, decreased susceptibility to any infectious disease from which an individual has recently recovered, and in certain cases natural immunity, to the ability of the leukocytes to ingest and kill bacteria. He did not, however, recognize that the serum had an effect upon bacteria to prepare them for phagocytosis, but supposed that if the serum had any effect it was exerted in the way of stimulating the leukocytes to greater phagocytic activity. In 1895, when Denys and LeClef produced immunity to the streptococcus by injecting rabbits with increasing numbers of these organisms, they considered that the reason for this immunity was the increased ability of the rabbits' leukocytes to ingest bacteria, but they also attributed this increase in phagocytic power to the effect of some newly acquired characteristic of the serum resulting from inoculation, which had the effect of stimulating the leukocytes themselves more actively to attack and ingest the bacteria.

Actual Rôle of Opsonin.—The demonstration of the actual rôle of opsonin is the result of the researches of Wright and Douglas. They showed that the leukocytes owe their ability to ingest bacteria to the presence in the serum of a substance whose function it is to combine with the bacterial cell and render it palatable to the leukocytes; that this opsonin does not exert a stimulating action upon the leukocytes themselves in the process of ingesting bacteria; that, in the absence of serum, bacteria are not ingested by leukocytes excepting in a negligible degree; that opsonin is a constituent of normal serum, and is much larger and more effective in amount in the serum of animals that are made immune to some microörganism by protective inoculation; that, in the human being, upon recovery from certain infectious diseases, increased opsonic power is demonstrable; that opsonin in normal blood is active in preparing nearly all varieties of bacteria for phagocytosis; and that, where there is effective response to any particular infection leading toward recovery, the increase in the phagocytic power is directed only against the infecting organism, the efficiency of phagocytosis against other organisms being approximately as found in uninfected individuals.

Importance of Phagocytosis to Opsonin.—When pathogenic bacteria penetrate the skin or mucous membrane they find opposed to them in the blood-serum neither the agglutinin, bactericidin, or bacteriolysin of specific nature, or in amount sufficient to exert destructive action. This is because, although normal blood may be lytic, agglutinative, or bactericidal to a very slight degree against some organisms, it is inconceivable that such normal action can have any great degree of efficiency. These substances are only called into being some time after infection has taken place, when their presence may be demonstrated in the blood-serum. In other words, they develop as a result of the stimulus afforded by the bacterial poison in the tissue. They are specific, in that they are directed only against the particular germ at the stimulus of which they have been developed. They constitute the *secondary specific defence* which the cellular mechanism automatically offers after infection has taken place. These specific means of defence are developed in response to infection by only a few types of organism, such as colon, typhoid, cholera, and some others. In the blood-serum, after infection by the staphylococcus, streptococcus, pneumococcus, none of these substances is in effective amount. In favor of this is the finding of Nuttall, and later of Wright, that the blood exerts no bactericidal action on the staphylococcus; of Denys, that the serum of rabbits immunized to the streptococcus had no bactericidal action.

We must, therefore, at present assume that we have in phagocytosis and the opsonin which renders it possible the predominating factors *as first defence against infection.* The opsonic power, or the power of rendering bacteria fit for phagocytosis, is, in general, equal in uninfected individuals. It is directed with apparently equal efficiency against any and all pathogenic organisms. We must look upon the phenomenon of inflammation in its initial stages as the effort of immunizing mechanism to bring to the point of infection through hyperemia a continually replenished supply of phagocytic cells and of opsonin.

In the case of streptococcus, pneumococcus, and staphylococcus actual infection signifies the failure of the initial phagocytic resistance. As secondary defence, we find specific increase in opsonic power and usually no other specific antibacterial element in efficient amount.

Theories as to the Origin of Opsonin and Other Antitropins.—Opsonin and other bacteriotropins probably originate from the connective-tissue cells as a result of their stimulation by the specific poisons, inducing them to react in the formation of these protective substances. It is reasonable to look upon these protective substances as free receptors which are able to act in their destructive manner upon the bacterial cells. In favor of local production of opsonins, that is, at the point of inoculation of killed bacteria, there is considerable evidence. Theoretic conception of the formation and the manner of action of opsonins and other antibacterial substances, developed as a result of inoculation of killed cultures of vaccine, is well shown in Fig. 223. It will be seen that the bacterial vaccine injected locally is sup-

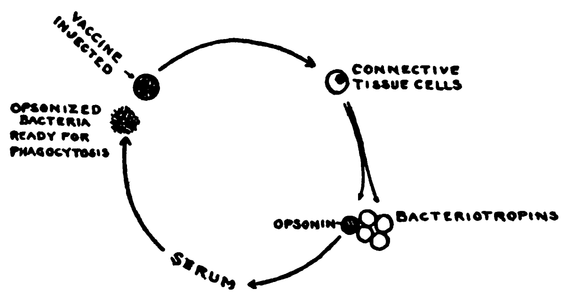

FIG. 223.—CHART ILLUSTRATING THE PROBABLE MODE OF ACTION OF VACCINE WHEN INJECTED.

posed to disintegrate in the subcutaneous tissue, setting free its specific poisons, which act upon the body cells and stimulate them to produce corresponding antisubstances or antitropins, according to the character of the microörganism injected. These new substances, opsonins, bactericidins, agglutinins, etc., as the case may be, are sent forth into the blood-stream, and conveyed to all parts of the body to the

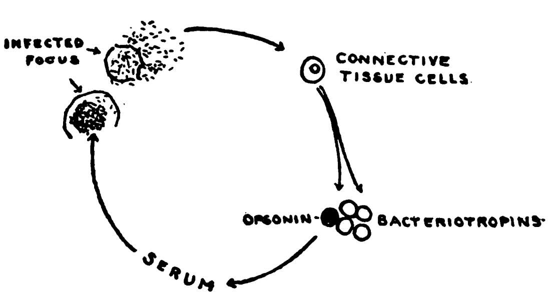

FIG. 224.—CHART ILLUSTRATING THE EFFECT OF MANIPULATING AN INFECTED FOCUS, IN DISSEMINATING BACTERIA, AND THE PROBABLE MODE OF ACTION OF THIS LIVING VACCINE.

foci of infection and combine with the bacteria in a destructive manner. In the case of opsonin, a combination is effected with the bacterial cell which renders it subject to phagocytosis.

Wright not only demonstrated the rôle of opsonin as a factor of predominating importance in the protective mechanism of the body, but also developed the method of Leishman, so that it could be used to measure, more or less accurately, the effective opsonic power of the blood in many infectious processes. The effective opsonic power of the blood is to be taken as meaning the relative efficiency of phagocytosis at the instance of the patient's serum, compared to that induced by the serum of normal individuals, against the same microörganism. The result of this comparison, that is, the ratio of the two, he termed the *opsonic index*.

Determination of the Opsonic Index.—Wright's method for this determination is briefly as follows: Into a capillary pipet, as shown (Fig. 225), with a rubber teat affixed, are drawn equal volumes of the blood-serum of a normal individual, of blood-corpuscles which have been

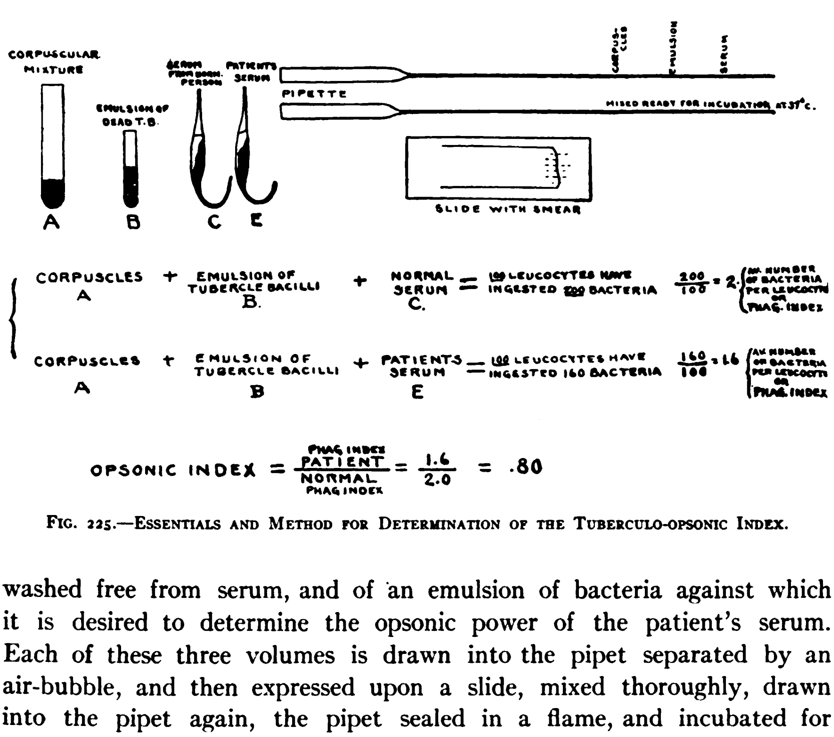

Fig. 225.—Essentials and Method for Determination of the Tuberculo-opsonic Index.

washed free from serum, and of an emulsion of bacteria against which it is desired to determine the opsonic power of the patient's serum. Each of these three volumes is drawn into the pipet separated by an air-bubble, and then expressed upon a slide, mixed thoroughly, drawn into the pipet again, the pipet sealed in a flame, and incubated for fifteen minutes at 37.5° C. A similar procedure is carried out, using the same corpuscle and the same emulsion of bacteria, but the patient's serum instead of the normal, and incubation is carried out for the same length of time. These pipets are removed at the end of the incuba-tion period, the small end broken off, and the contents expressed upon a clean slide, mixed thoroughly, and a small drop of this mixture placed upon a clean slide, and a smear made. Each of the mixtures is treated in this way. If the smears are then stained and the leukocytes scrutinized it will be found that they have ingested numbers of bacteria in each of the specimens. All the bacteria contained in 100 leukocytes in the case of each slide are counted, and the average number ingested by each leukocyte is calculated. This number is termed the phagocytic index. The opsonic index is determined by dividing the average number of bacteria per leukocyte which have been ingested in the experiment with the patient's serum by the average number ingested in the experiment when the normal blood-serum is used. The resulting figure represents the ratio between the phagocytic power of the patient's and the normal serum, the normal serum being considered as unity. An opsonic index, therefore, of 1.5 indicates that the effective phagocytic power or opsonic power of the patient's blood is one and a half times that of the normal individual. If the result of the division is 0.5, it shows that the effective phagocytic or opsonic power of the patient's serum is just half that of the normal individual. In order to obtain an average normal serum it is the custom to mix the blood-serum of several individuals who are known not to be infected with the particular organism in question.

Significance of Measurements of the Opsonic Power of the Blood.—Inasmuch as, in response to infections by all pathogenic bacteria, opsonin is a factor in the immune reaction, we expect the measurement of the opsonic power of the blood to give some indication as to the character of the response. In infections due to staphylococci, streptococci, and pneumococci, and others in which phagocytosis appears to be the predominating factor, we expect the opsonic index to furnish a more definite clue to the success of the response to bacterial stimulus than in infections such as colon and typhoid, in which, in addition to opsonin, we find agglutinin, bactericidin, and bacteriolysin as factors in the immune reaction. We can only say that the opsonic power elevated above the normal is indicative of a favorable response of the immunizing mechanism. It is possible also to measure roughly the agglutinin and bactericidin. Attempts at measurement of these factors are more important as a basis for certain fundamental truths as to the functionating of the mechanism for adaptation than as representing any definite valuation of the efficiency of the immunizing mechanism in any given case.

To summarize briefly, the animal body has the ability to adapt itself to noxious influences in a varied manner, depending on their chemical character. The seat of this mechanism of adaptation lies in some particular cells or groups of cells. These cells have the power, in response to noxious stimuli, to form substances which are applied by means of the blood to neutralize such stimuli or destroy them if they be bacterial in type. A condition of health presupposes constant activity and efficiency of this mechanism directed against bacteria endeavoring to invade the tissues. Actual infection indicates its failure. Recovery from infection indicates its complete success. Chronic local disease indicates a partial success in protecting the rest of the body, but failure in being unable to extinguish the infection locally.

The finer workings of this immunizing mechanism appear to be manifested largely in the production of specific chemical substances which circulate in the blood, as antitoxins, to neutralize the poison: agglutinins, bactericidins, bacteriolysins, and opsonins, which have specific chemical effect upon the bacteria leading to their destruction. The prevention of infection seems largely due to efficient phagocytosis, this depending upon the normal antibacterial constituent of the blood, opsonin. The other chemical means of defence are only called into being *after disease* has found its foothold.

Acquired Immunity.—Recovery from an infectious disease, and subsequent non-susceptibility to infection by the causal microörganism, presupposes that adaptation has taken place, and in some infections, such as typhoid, we may find expression of this phenomenon in the acquired ability of the blood fluid to agglutinate, kill, and dissolve the typhoid bacillus. We anticipate a definite degree of immunity from this disease as long as we find evidence of specific antityphoid power in the blood. Even after they disappear the usual freedom from subsequent attacks of the same disease suggest that the immunizing mechanism still retains latent power for renewed attack, if it becomes necessary.

We must attribute recovery from measles, scarlet fever, and smallpox to a similarly fashioned process, though neither the microörganisms nor specific antibacterial substances in the blood after recovery have been demonstrated. Immunity thus acquired is usually permanent.

Recurrences of pneumonia, erysipelas, and furunculosis are common. The reason appears to be that the persistence of specific opsonin, which apparently is the most important factor in immunity, is of brief duration after recovery from the attack.

Artificially Produced Immunity.—If it be desired to produce immunity to a specific infectious disease, it is obvious that means must be used which will insure the presence of specific antitropins in the blood. This result may be produced by inoculations with living attenuated microörganisms, producing a non-fatal disease, or by injection of killed microörganisms known to produce the particular disease.

We have an example of *immunity through production of non-fatal disease* in the protection against small-pox. The universal success of vaccination in connection with other successful attempts at immunization of animals by using attenuated bacteria, as in the case of anthrax, furnishes a basis for the belief that the immunity is due to a similar production of antitropins and has the same basis of cell stimulation and adaptation.

Immunity Through Injection of Killed Bacteria.—The immunizing mechanism shows a remarkable versatility in its varied methods of adaptation against different bacteria. This must depend on differences in the chemical composition of the bacteria or of the toxin they produce. In diphtheria the disease is chiefly produced through diffusible toxin. Immunity appears to depend chiefly upon the defence fashioned particularly to neutralize the toxin. In the case of typhoid no diffusible toxin comparable to that of diphtheria has been demonstrated. In this instance the antibacterial attack is distinctly against the bacterial cell. It is quite the same in pneumococcus, streptococcus, and staphylococcus infections.

The stimulus to the formation of these distinctly antibacterial substances must derive itself from the chemical qualities of the protein composing the bacterial cell. It is inconceivable that the intact bacterial cell can serve as such a stimulus, and it is probable that the antigenic activity reaches its fullest efficiency only *upon disintegration of the bacteria in the tissues.*

Definition of the Term Vaccine.—The immunizing response of the body in the production of bacteriotropic or antitoxic substances depends upon the stimulus afforded by pathogenic microörganisms or their toxins. This response takes place, first, in the natural course of the disease process; second, as the result of protective inoculation with attenuated microörganisms; third, of killed microörganisms; fourth, of bacterial poisons, secreted or excreted, or produced through disintegration of bacteria in their growth upon culture-media.

To such inocula Wright has given the term vaccines. The bacterial cell exerts its most efficient stimulus only when disintegrated, so that its chemical constituents are set free; consequently we should define vaccine as any chemical substance which, when it is introduced into the body, induces the elaboration of protective substances, bacteriotropic or antitoxic elements.

Bacterial Vaccine.—A bacterial vaccine is a suspension of killed bacteria in suitable solution, with sufficient added preservative, as carbolic acid, to insure constant sterility. Such a vaccine is standardized as to the number of separate bacteria contained per cubic centimeter, or weight of bacterial substance per cubic centimeter.

We have in the case of typhoid, plague, and cholera examples of bacterial vaccines in protective inoculation. In protective inoculation against small-pox the vaccinating stimulus is living, producing a mild disease and resulting in development of specific protective elements. Antirabic vaccine is composed likewise of living attenuated microorganisms given in successively increasing doses.

Production of immunity after infection has taken place by means of vaccine was first accomplished by Pasteur in antirabic inoculation. The purpose was to produce by artificial means a more rapid development of specific protective substances than would occur in the natural course of the disease. It is assumed that antirabic vaccine, though attenuated, has the chemical properties of the virulent virus, but is incapable of producing disease. It is assumed that there is insufficient formation of antibodies normally because the cells in and about the focus of disease are subject to toxic overstimulation and do not functionate efficiently. Injection of a harmless vaccine in unpoisoned cellular tissue exploits the immunizing function of the normal cells in the interests of cellular tissue already poisoned and unable to functionate.

Demonstration of Production of Antitropins by the Use of Killed Cultures and Their Application for Production of Immunity in Human Beings.—Pfeiffer found that specific agglutinating power developed in the blood of individuals inoculated by killed typhoid culture. Based on this finding, Sir A. E. Wright pursued further studies, and found that after a single inoculation the bactericidal power of the blood could be increased sometimes a thousandfold. Later he demonstrated that a high opsonic power could also be produced. These findings suggested the use of killed cultures to immunize by artificially inducing elaboration of specific typhotrophic substances. Wright tested the efficiency of this method during the Boer War in South Africa. The results more than fulfilled expectations. Mortality and incidence of the disease among those inoculated were each cut down one-half, compared with the same in an uninoculated group.

As a result of his study of the production of bactericidins in the blood of individuals subsequent to protective typhoid inoculation, Wright was struck by the fact that there was a definite sequence of events in the production of bactericidins in every case, and that the same sequence of events is to be observed in the production of other antibacterial substances, particularly the agglutinins and the opsonins. The features of the bodily reaction Wright gives as follows:

In every case following inoculation of vaccine there is a *negative phase*, characterized by an impoverishment of the blood in antitropic substances. (Associated with this negative phase is a condition of increased susceptibility to bacterial infection or to the toxic effect of the toxin used. This negative phase coincides with the period which may be associated clinically with greater or less constitutional distress.)

Succeeding the negative phase is a so-called *positive phase*, characterized by flooding the circulating blood with newly formed antitropic substances. (It is presumed that this phase is associated with a maximum resistance to bacterial invasion and minimum sensibility to the poisonous action of the vaccine.) There next comes a fall in the bacteriotropic content, resulting in a slightly lower bacterial resistance, but, compared to the period before inoculation, the blood shows an increase in its antitropic elements. (The body at this period, however, and subsequently seems to possess a greater power of response to the same vaccinating stimulus.) Wright sees in the negative phase a period of stimulation of the body-cells by the vaccine; in the positive phase, a period in which active protective response is heralded by marked increase in the antitropic substances, and after the remission of the stimulus and a slight fall in the antibacterial power, a more or less continued period of increased resistance.

The importance of this sequence of events, which he has shown to be the case in the production of bactericidins, Wright believed to be fundamental, as a delineation of the character of protective response in general. If this is so, measurements of other protective substances, such as antitoxins, agglutinins, and opsonins, should follow a like course in their development. Ehrlich and Brieger, in 1893, showed that a corresponding curve was obtained from measurement of the antitoxic content of the blood subsequent to inoculation. Jorgensen and Madsen found that the law of positive and negative phase applied likewise to the elaboration of agglutinins after inoculation in typhoid and cholera. Later, by measuring the variation in the phagocytic power subsequent to staphylococcic inoculation, Wright showed that the same sequence of negative and positive phase was to be observed.

THERAPEUTIC INOCULATION

Therapeutic inoculation, as developed by Wright, is an offshoot of protective inoculation. His study of the immunizing response following protective inoculation led him to suspect that a similar response might be produced in the case of actual chronic infectious disease; that the antibacterial power of the blood could be increased by inoculation of killed bacteria. In 1900 he made use of a staphylococcic vaccine in a case of chronic skin infection. About a year later he published his results of therapeutic inoculation in staphylococcic infections. He found that, in connection with the clinical success of the experiment, the phagocytic power of the blood was increased following the inoculation; that there occurred the same sequence of negative and positive phase in the variation of the phagocytic power of the blood that he had observed following protective typhoid inoculation in the variation of the agglutinins and bactericidins. This definite sequence of variation in the antibacterial power of the blood following inoculation by vaccine, the negative phase followed by the positive phase, shown by Ehrlich and Brieger to take place in antitoxin production; by Jorgensen and Madsen in the case of agglutinins after typhoid and cholera inoculation; by Wright in the case of agglutinins and bactericidins following typhoid inoculation; and, lastly, in the phagocytic power of the blood following staphylococcic and other vaccines, may be termed the law of negative and positive phase, and is of absolutely fundamental importance for several reasons, particularly as indicating the character of the response to be sought in the endeavor to increase the antibacterial power of the blood.

Thus it remained for Wright to show that the *antibacterial power of the blood could be increased* by appropriate inoculation *after infection had taken place and had become chronic;* that, correlated with this evidence of heightened immunity, clinical improvement took place.

The Relation of Protective Inoculation to Therapeutic Inoculation.—The success of protective inoculation in general cannot be questioned. As against typhoid, it induces the formation of antibacterial substances in the blood that could not be demonstrated before. It cannot be said, however, that in the case of normal individuals a total lack of immunity to any infection exists. Protective inoculation materially raises the specific antibacterial power of the blood, in which, in all probability, some degree of immunity already existed.

In protecting against streptococcus, pneumococcus, staphylococcus, and the like, we must usually assume previous or present infection by these common organisms. It may have been of such minute proportion that we have not been aware of it. That such has occurred and has remained local, presupposes that there has been a specific reaction. On the whole, therefore, it is justifiable to conclude that protective inoculation merely raises to a higher level immunity already, in some degree, possessed.

In therapeutic inoculation we start with the knowledge of infection that already exists. As Theobald Smith[1] puts it, when we induce immunity we simply stimulate the body to a higher resistance rather than put into it something that was not there before. Protective inoculation and therapeutic inoculation do not differ, therefore, in principle.

The problem of therapeutic inoculation, in raising the immunity when definite local infection exists, is obviously much greater and more complicated than that of protective inoculation. It is easy to see wherein the preparedness against invasion by specific microorganisms, afforded by protective inoculation, may destroy invading bacteria before disease can be produced. That therapeutic inoculation in the actual presence of infection is efficient in raising the immunity to the extent of curing the disease, or even of benefiting the patient, is not so easy to see at first, and certainly requires both laboratory and clinical evidence to support it. Interpretation of Pasteur's success in antirabic inoculation after infection is perhaps the first clinical evidence of the efficiency of therapeutic inoculation after disease organisms have entered the body. From the researches of Prof. Sir A. E. Wright we find not only laboratory evidence of increased bacterial resistance following therapeutic inoculation, but also clinical evidence of the effect of this increased antibacterial power upon bacterial lesions, as leading to their control and oftentimes their cure when more or less localized in their type.

The Study of the Immune Response to Infection as Indicated by Opsonic Index Determinations.—The opsonic index is no measure of the total degree of immunity of the patient. Its variations, under varying conditions of health, disease, and after therapeutic inoculation, are merely to be taken as indication of whether or not the antibody forming mechanism is giving evidence of response in the production of specific antibacterial substances. Indication may be obtained through opsonic index determinations, in conjunction with clinical observation, as to whether there is too great or too little bacterial stimulus, and what the conditions are which govern the acquisition of this bacterial stimulus.

Opsonic Power in Health.—The opsonic power of healthy

[1] Medical Communications, Mass. Med. Soc., vol. xxi, No. 3, 1910, p. 766.

individuals conforms to a certain mean, the variation being slight in the same individual from day to day or in different individuals compared to each other, as against any microörganism with which none of them is infected.

Fleming[1] has reported observations made in Wright's laboratory on the opsonic power in individuals whose blood has been used as normals in the routine opsonic technique in Wright's laboratory. Between 600 and 700 indices were determined upon these normal individuals, and it was found that in 97.5 per cent. of the cases the extreme variation was between 0.90 and 1.10, but that in only 2.5 per cent. of the determinations the indices were either above 1.10

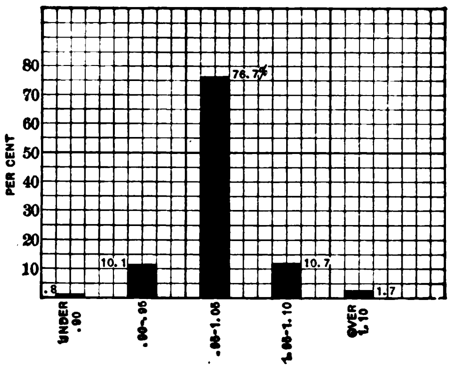

FIG. 226.—VARIATION OF THE OPSONIC INDEX IN NORMAL INDIVIDUALS. BASED ON 635 DETERMINATIONS.

This chart shows graphically the results of 635 tuberculo-opsonic index determinations on the blood of a number of individuals clinically uninfected by tubercle. These individuals were, for the most part, laboratory workers whose sera were constantly being used as "normals" in opsonic index determination. These observations were collected by Fleming and reported in the "Practitioner," London, May, 1908, all from the records of Sir A. E. Wright's laboratory. It will be seen that 76.7 per cent. of the indices fell within 0.95 to 1.05; 10.1 per cent. between 0.90 and 0.95; 10.7 per cent. between 1.05 and 1.10; and 2.5 per cent. below 0.90 or above 1.10. Hence it may be concluded that the variation of the tuberculo-opsonic indices in normal individuals is within comparatively small limits, 94.5 per cent. being between 0.90 and 1.10.

or below 0.90. In three-fourths of the cases there was a variation between 0.95 and 1.05; that is, a range of variation of 0.10.

Bulloch[2] showed that the opsonic indices of 34 medical students compared to his own serum, which was considered normal against the tubercle bacillus, showed extreme variation from 0.8 to 1.2. But three of these cases showed indices above 1.10 or below 0.90, or about 12 per cent. The remaining cases—31—or 87.5 per cent.—were between 0.90 and 1. The average normal opsonic index was 0.965. The index obtained in the same way from 32 healthy hospital nurses

[1] Practitioner, London, May, 1908.

[2] Trans. Path. Soc., London, 1905, vol. lvi, part 3.

showed a variation between 0.80 and 1.10. Again, he found that about 87.5 per cent. fell between 0.90 and 1.10, with the average normal opsonic index as 0.969.

Urwick, in 20 cases, found about 80 per cent. between 0.90 and 1.10.[1]

It appears, then, that the opsonic indices of normal individuals practically all fall within a certain definite range of variation. This holds true against other pathogenic bacteria as it does against the tubercle bacillus. The reason for this variation is probably partly due to unavoidable error in opsonic technique. We see that the extreme limit of variation is 0.20 in from 87 to 97 per cent. of the cases. This furnishes us a reasonable basis for the conclusion that, if the opsonic technique is skilfully carried out, as these observations would suggest, there is no reason why the experimental error should be any greater in the determination of the opsonic indices of the serum of infected individuals than it is in that of the normal.

The *significance of these observations* is that healthy individuals may be considered as having equal ability invested in their phagocytic mechanism of ingesting bacteria as they enter the body. In the absence of any definite knowledge of other means of ready attack, it is certainly suggestive that the opsonin, in conjunction with the leukocytes, constitutes the early and active defense against any and all invading bacteria.

Opsonic Power as Influenced by Presence of an Infectious Process.—After infection has taken place variations in the opsonic index against the infecting microörganism are found, depending on the character of the infection, as to whether it is localized, fulminating, or general. The variation may be above or below normal and the excursion wide, from day to day or from hour to hour, in infections of the acute fulminating type. The important point to be noted is that, whatever the variations in the opsonic power, they are specific against the microörganism producing the infection. If the blood be tested against some microörganisms with which the patient is not infected no striking variations in the opsonic power will be found.

The fact of these variations after infection suggests a possible difference between the normal opsonin and that which is developed specifically after infection. There are certain differences between immune opsonin (that developed subsequent to specific infection) and the normal opsonin found in the blood of healthy individuals. So far as the present discussion is concerned, however, whether this

[1] Studies on Immunization, Wright, p. 145.

difference be in amount or in character is unimportant. The effect in making phagocytosis possible is the same.

Localized Infections.—Localized tuberculosis may be taken as a type of strictly local infection, though, of course, in no case can one say that bacilli are not entering the blood-stream. However, from the condition of apparent health, the absence of temperature associated, we conclude that the process is essentially local. In this group of infections we include local tuberculous lesions, acne, furunculosis, carbuncle, and traumatic infections that have passed the acute stage and have become indolent.

In these local pyogenic and tubercular infections the opsonic power of the blood is found to be characteristically below normal. The more chronic and localized the disease, the more constant the finding of low opsonic power of the blood-stream.

Systemic Infections.—Passing on to the condition of the opsonic power of the blood in acute infections or infections associated with systemic disturbance and temperature, we are struck at once by the marked variations. Wright[1] reports opsonic indices upon the blood of a child suffering from tuberculous caries of the fibula, associated with constitutional disturbance. There were seven indices determined at from one- to nine-day intervals. The extreme limits of variation were from 0.98 to 1.73. It should be noted that on the two days following a scraping operation the index, which two days before the operation was 0.98, was increased to 1.73. As a note, in explanation of this elevated index, Wright states:[2] "A rise in the opsonic power similar to this here registered has been repeatedly observed by us in connection with the stirring up, by surgical interference, of tuberculous foci." A case of tuberculous caries of spine with constitutional disturbance gave five indices, determined at from one- to two-day intervals, ranging from 0.65 to 1.4. A case of the same kind gave three indices ranging from 0.6 to 2.4, taken at one- and two-day intervals. Other observers have confirmed these wide fluctuations in the opsonic power in pulmonary tuberculosis and tuberculosis of the non-localized type.

In acute fulminating infections and the so-called septicemias due to pyogenic organisms, wide variations in the opsonic power of the blood have been observed, and are to be considered characteristic.

Associated with various diseases which undermine the patient's health we sometimes find a condition of furunculosis. During

[1] Proceedings of the Royal Society, 1906, vol. xxvii.

[2] Studies in Immunization, p. 153.

systemic infections like typhoid it is common. In cases of diabetes patients are conspicuously subject to staphylococcic infections. A series of 16 cases of diabetes mellitus were studied with reference to the condition of the opsonic index, suspecting that a condition of lowered opsonic power accounted for the susceptibility to staphylococcic infection. This study, made by DaCosta, and reported in the American Journal of Medical Sciences, July, 1907, p. 57, showed that the average opsonic index was 0.62 and the range from 0.34 to 0.72.

A reason for the low opsonic power of the blood-stream in the presence of localized infection is suggested by the laboratory experiment of adding large numbers of bacteria to a highly immune serum taken from an animal immunized by injection with corresponding bacteria. If sufficient bacteria are added the serum will be found to be almost totally depleted of its specific antibacterial power. It is easy to show that this loss is due to combination with the bacterial cell. Blood fluids lose their antibacterial power by combination of their immune substances with bacteria, at the stimulus of which these substances were developed. It seems reasonable, therefore, in the case of localized infections that the antibacterial power of the blood-stream should be subnormal, and that this should be due to gradual abstraction by combination with bacteria and bacterial substances in and about a focus of infection.

The usual walled-off condition of localized infection produces a more or less restricted blood-supply. This is to be taken as a reason for the inability of the blood-stream to receive bacterial substance which should constitute stimulus to the formation of antibacterial substances. Hence, segregation of a focus of infection is an important factor in producing a low antibacterial power of the blood-stream.

The significance of wide fluctuations in opsonic power in non-localized or systemic infections is that the blood-stream must be receiving bacteria from the focus of infection, and possibly may be the seat of actual growth. Otherwise there would be no such evidence of immunizing response.

The Antibacterial Power of the Blood-stream Compared with that of the Tissues in a Condition of Health.—Bacteria entering the blood-stream have arrayed against them practically all the defensive forces of the body in the antibacterial elements of the serum and its phagocytic cells. They stand but little chance against this formidable first defence. Bacteria entering the tissues, however, meet with a defense which is much weaker, in that at the point of entrance there can be only limited numbers of phagocytic cells, and such opsonin as the fluids in the immediate vicinity contain. This defence is infinitesimal compared to that which the blood-stream, with its whole force of leukocytes, entire concentration of opsonin, and possibly other protective substances, presents.

Should bacteria enter directly into the blood-stream, therefore, the chances of their resisting the phagocytic attack are obviously much less than in the case of their entrance into cellular tissue. The rarity of septicemia compared with the frequency of local infection bears this out clinically. The tendency of local infection to remain local is also clinical evidence of the high antibacterial efficiency of the blood-stream, as compared with that of the tissues and their fluids in which the bacteria have been able to gain a foothold.

When bacteria penetrate the protective barrier of the skin or mucous membrane they meet with the first active defence in the opsonin and phagocytic cells of the immediate vicinity. The fact that infectious disease is comparatively rare, while minute infection is suggestively a daily occurrence, leads to the conclusion that the body is capable of furnishing a defence that is efficient beyond the degree that would be expected of the few phagocytic cells and opsonin in the tissue at the point of infection.

The body's means of strengthening the local antibacterial attack is through the early reaction of inflammation, active hyperemia. Through this phenomenon the protective mechanism is enabled to bring into contact with the infected focus a continuously fresh supply of antibacterial substances and fresh replacement of leukocytes. To this automatic response we must ascribe, to a large degree, freedom from infectious disease.

Failure in this initial defence is signalized by the development of actual infectious disease. That bacteria have been able to overcome the normal defence may be due to extreme virulence, to their numbers, to their entrance where blood circulation is deficient, or, finally, to a blood-stream deficient in protective substances.

Virulence.—It has been shown by Rosenow[1] that, when virulent pneumococci are added to a normal serum, *in vitro*, and then brought into contact with living active phagocytes, they are not ingested. This indicates that these virulent pneumococci are not acted upon by the opsonin in normal serum in a manner effective enough to render them phagocytable. They may contain some substance having an

[1] Illinois Med. Jour., 1908, xiii.

antiopsonic effect. The same phenomenon occurs in the case of virulent streptococci. In the case of the pneumococcus, Rosenow found that this resistance to phagocytosis was due to a quality which they possess when virulent, but lose after growth on culture-media. He was able to extract from virulent pneumococci a substance which, when brought into contact with non-virulent pneumococci for a number of hours, rendered them insusceptible, relatively, to phagocytosis.

In the above, we have laboratory proof of resistance of bacteria to phagocytosis, probably due to resistance to opsonification, in the case of the streptococcus and pneumococcus. It is readily conceivable that in actual infection by these organisms, and possibly others, no matter how effective the opsonin or the phagocytic cells may be under ordinary conditions, they may, in the manner suggested in Rosenow's experiment, render the phagocytic attack almost powerless through extreme virulence.

Entrance of Excessive Numbers of Bacteria.—It is easy to conceive how excessive numbers of bacteria entering at one point may cause immediate abstraction of local antibacterial substances and thus many may escape the phagocytic attack. Such will be apt to find conditions suitable for growth in fluids of low antibacterial power. Beyond the production of local conditions suitable for growth through abstraction of antibodies, if considerable numbers of bacteria enter the blood-stream there will also occur a lowering of the antibacterial power through combination with the bacterial cells, and this depletion may be accentuated conceivably if the numbers of bacteria that enter the blood-stream are sufficient to so overstimulate the antibody forming cells that protective response temporarily fails. The condition of lowered antibacterial power of the blood-stream thus brought about not only makes possible the spread of the disease locally, but also the development of secondary foci of infection.

Infection at Points of Deficient Circulation.—Theoretically, parts of the body which are poorly vascularized should be favorable points for bacteria to lodge and grow. The skin is mechanically a good protection. Its vascularity is a most excellent secondary defense. Bacteria getting beyond the limits of a superficial infection run a very good chance of being destroyed in the blood-stream if normal in its antibacterial efficiency. If, for reasons above stated or others, as will be suggested later, the opsonic power of the blood is below normal or defective, bacteria may exist long enough in the blood to reach points of more or less sluggish circulation, such as the tendinous insertion of muscle about the joints, the joint capsules, and bone. The sluggish capillary circulation may conceivably result in a few bacteria lodging in the tissues and causing depletion of the lymph in the immediate vicinity in its antibodies. The possibilities of this focus receiving sufficient quantum of antibodies to replace those depleted by growth of bacteria is limited by the fundamental deficiency of the blood-supply. The bacteria find suitable conditions for growth.

The *development of tuberculous and other bone diseases following trauma* which does not produce any abrasion of the skin indicates infection from within; that the trauma has produced a condition of local susceptibility to infection. It is reasonable to ascribe this local susceptibility to the disturbance of circulation by rupture of capillaries and exudation of blood fluid, a resulting stagnant condition of lymph, and difficulty in the replacement of this lymph by fluid of higher antibacterial power. Thus are afforded to microörganisms that chance to reach such a focus comparatively unrestrained opportunities for growth.

Entrance of Bacteria Into the Blood-stream Deficient in Its Protective Power.—In diabetes clinical experience indicates an increased susceptibility. DaCosta has shown the reason in the low opsonic power of the blood-stream. Further clinical experience has shown that patients suffering from generalized infections may be unusually susceptible to infections of other types. In wasting diseases, such as typhoid, it is not uncommon to have furunculosis as a complicating infection.

In endeavoring to account for infectious disease other than accidental traumatic infection, we must bear in mind that human beings are, most of them, subject to minute infections by the common pyogenic microörganisms, such as streptococcus, pneumococcus, staphylococcus, and possibly colon bacillus, almost constantly. The difference between infection and infectious disease is merely one of proportion. In the first case the infection may not be noticeable; in the second, it produces signs and symptoms. That these infections continue to be minute means a well-grounded immunity of the blood-stream. If anything happens, however, to disturb this favorable balance of immunity the bacteria are there to take advantage. The conditions which affect the normal immunity of the blood-stream, rendering it less efficient, are known only in a general way. Lack of food, physical exhaustion, and lowering of the body temperature may be mentioned as possible factors.

The retention in the body, through inefficient excretion of toxic substances from faulty metabolism, may conceivably limit antibody production, or neutralize antibodies after they are produced, or, finally, paralyze the phagocytic cells. Thus, the normal antibacterial efficiency of the blood-stream conceivably may be seriously depleted by *conditions concerning which we have no knowledge and for which we have no remedy.*

It is inconceivable that the use of bacterial vaccine should have anything but temporary efficiency in the case of localized infections developing as a result of generally lowered antibacterial power of the blood-stream from such obscure causes. It may be that the opsonic power of the blood may be temporarily increased by exhibition of vaccine, but the fundamental process at the basis will maintain itself in spite of bacterial stimulation.

It is reaosnable to make use of bacterial vaccines when it is found that the opsonic power of the blood-stream is low, or in the case of infections comparatively localized in type in which we know it to be low, but, with the above considerations in mind, it is folly to assume that bacterial vaccine should fulfil the indications in all cases.

The Significance of a Localized Infection.—The development of a focus of infection signalizes the failure of the immunizing mechanism, through the early phenomenon of hyperemia, to focus at the point of infection blood fluids of sufficiently high bacteriotropic power and, possibly, phagocytes in sufficient numbers to destroy the bacteria before an actual disease focus is produced. When the focus of infection becomes localized we see in this success of the secondary defence, which consists essentially of an efficient walling off of the infected area, a blood-stream of specifically elevated antibacterial power as against the infecting bacteria, and probably an increased circulation in the tissues adjacent to the disease focus.

The Conditions in the Focus of Infection.—When toxins have been produced in sufficient amount, the circulation sufficiently cut off by exudation and swelling, and there has been a pouring out of leukocytes and liquefaction of tissues, there is thus produced an abscess-cavity surrounded by a wall of tissue infiltrated, swollen, and full of bacteria. The interchange of blood and lymph through this wall must necessarily be deficient and the fluids in it more or less stagnant. The antibacterial content of the lymph becomes depleted by combination of antibodies with the bacteria present, and offers considerably less obstruction to bacterial growth than the normal fluids of the blood-stream. The actual pus may be almost entirely deprived of its opsonic power, as shown by Wright.[1]

A tryptic ferment derived from broken-down leukocytes is a content of pus in the case of pyogenic infections. When pus is under pressure its effect is to dissolve connective tissue and probably to afford new channels for bacterial extension.

The *antibacterial content of fluids in a focus of infection* has been shown conclusively to be subnormal. This is due to abstraction of protective substances of stagnant lymph by combination with bacteria, and Wright has shown that apparently healthy leukocytes derived from pus, even when in contact with healthy serum, have lost their power of phagocytosis.

The conditions, therefore, in the focus of infection, stagnant lymph of low antibacterial power, impossibility of sufficient interchange of fluid from the focus of infection with the highly protective fluid of the circulating blood (this dependent upon the obstruction to circulation through swelling and the walling off process), are such as to supply conditions suitable for bacterial growth, and favor a persistence of infection locally.

Brawny infiltration, such as carbuncle, is an example of the condition in which bacteria cultivate themselves, to a considerable degree safeguarded from the circulating blood through swelling, exudation, and walling off about the focus of disease.

The Effect of the Existence of a Localized Infection on the Antibacterial Power of the Blood-stream.—While the opsonic power of the blood-stream has always been found to be much higher than the fluid in the focus of infection in a given case, it is generally found, in the case of chronic localized infection, such as local tuberculosis, lupus, and acne, that the opsonic power of the blood-stream is depleted much below the normal. This is due, on the one hand, to the lack of bacterial stimulus to be obtained from the focus of infection on account of its comparatively segregated condition; second, because of gradual loss of opsonin which it should normally possess through continuous contact with bacteria and toxin in the outskirts of the focus of infection.

Physiology of the Protective Response.—In the *normal individual* the blood-stream is to be considered the reservoir of antibacterial power. Its fluids contain opsonin and phagocytic cells, together of sufficient antibacterial power to destroy microörganisms that enter. The blood is capable of being directed in abnormally

[1] Proc. Roy. Soc., 1904, vol. lxxiv.

large amount, through the reaction of inflammation, to any part of the tissue that becomes a point of bacterial invasion.

The reaction of inflammation is, from beginning to end, essentially a protective process. One of its earliest phenomena, active hyperemia, indicates the endeavor of the immunizing mechanism to render the bacteriotropic pressure at the point of bacterial invasion as nearly as possible equivalent to that of the circulating blood.

The wide distribution of pathogenic bacteria on the skin and mucous surfaces of the body suggests that the condition of health is the outcome of constant strife between the bacteria endeavoring to enter the tissues and the repelling forces of the opsonins and phagocytes reinforced constantly from the blood-stream.

The fact of infectious disease registers not only the failure of the phagocytic attack, but also of the reinforcement derived from the blood-stream through the early reaction of inflammation, hyperemia. Numbers of bacteria, having avoided the initial phagocytic attack, deplete fluids locally of their opsonin, multiply, and may fairly soon give evidence of entrance into the blood-stream by the production of temperature. The clinical evidence locally is that of a spreading infection. Opsonic measurements of the blood-stream at this acute stage show evidence of depletion in antibacterial power.

Bacteria when entering the blood-stream in this depleted condition find a less active phagocytic attack, and may conceivably exist long enough to be carried to some other part of the body and possibly produce secondary foci of disease. The extension of the disease locally is evidence of and seems to be the result of this depletion in the antibacterial power of the blood-stream.

This stage is also one of stimulation of the antibody-forming mechanism through the bacteria which leave the focus of infection and enter the blood-stream or lymphatics. Sooner or later, as a result of this bacterial stimulus, examination of the blood may reveal the presence of new protective substances and increased power of the normally present opsonin.

This entrance of bacteria into the blood-stream, constituting as it does the stimulus to the protective mechanism, and followed, as it is, by evidence of protective response, presence of newly developed specific antibodies, is termed *auto-inoculation*. As a result of it the blood-stream becomes more highly protective. This constitutes the *secondary defence*, the fortification of the blood-stream through the acquisition of new means of bacterial attack, specific antibacterial substances, such as increased opsonic power, and, depending on the kind of infecting organism, specific agglutinating, bactericidal, and bacteriolytic power.

If the secondary defence is successful the result should be destruction of the bacteria present in the blood-stream and a more vigorous attack upon those on the outskirts of the spreading infection. Evidence of final success is localization of the infection, subsidence of temperature, and abatement of symptoms of general toxemia.

Failure in the Development of Secondary Defence.—It is not difficult to imagine the effect of continuous entrance of excessive numbers of bacteria into the blood-stream as auto-inoculating stimuli. We should expect that the antibody-forming mechanism might not only be *so overstimulated* that it would fail to respond in sufficient production of antibodies, but also that such antibodies as were produced would soon be *absorbed by the auto-inoculating bacteria.* It is probable that both of these factors are active in rendering the blood-stream low in its antibacterial efficiency *when auto-inoculation is excessive.* Associated with this failure in the secondary defence we should expect, clinically, spreading of the infection locally, lymphangitis, involvement of glands, high temperature, and presence of bacteria in the blood-stream. These are exactly the conditions met with in acute fulminating infections.

Spontaneous cure of such an infection must obviously derive itself in part from some event which shall eliminate excessive auto-inoculation if it is taking place. In liquefaction of the tissues in the focus of infection, discharge of the infected pus and bacteria, the elimination of the tryptic burrowing effect of the pus and more efficient cellular walling off, we have phenomena of the normal immunizing mechanism which lead to the elimination of excessive auto-inoculation. The result is that the antibody-forming cells are relieved of the toxic stimulus, finally recover from toxic overstimulation, and the blood-stream is in a condition to receive new antibodies and retain them, since it contains no longer excess of bacterial toxins to neutralize them.

The *liquefaction and discharge of pus* is an important factor in the immune reaction not only because it accomplishes the elimination of auto-inoculation, but also because it makes way for the entrance into what was the pus-cavity of lymph of higher bacterial power than the pus, and, what is perhaps quite as important, lymph which has the power of neutralizing the tryptic or dissolving action of pus. It, therefore, contributes to cure of the disease locally, in that it makes possible improvement in the local antibacterial attack.

Septicemia.—If excessive auto-inoculation is not normally or artificially checked, conditions for unrestricted growth in the blood-stream and in the tissues may be afforded.

We may conceive that the antibody-forming cells become subject to excessive stimulus and functionating is interfered with. The blood-stream fails, therefore, to receive a sufficient quantum of antibodies and its proper antibacterial efficiency is depleted through absorption by excessive amount of bacterial substance. In the blood-stream thus depleted it is conceivable that bacteria may exist long enough to be deposited at points of low resistance locally and to produce new foci. Each new focus will have its effect in depleting the blood-stream further of its antibacterial power, so that, finally, actual multiplication may be possible in the blood-stream itself and true septicemia develop.

The Walling-off Process.—The development of the secondary defence—in other words, of specific antibacterial substances in the blood—obviously cannot take place excepting through the presence of specific bacterial stimulus derived from the focus of infection. Excessive stimulus during the fulminating stages of an infection may fail in producing an efficient protective response through overstimulation of the antibody-forming cells. Elimination of this excessive auto-inoculation is the first requisite, both from the standpoint of freeing the blood from toxins which deplete it of its antibodies and freeing the cells of the toxic stress which renders them temporarily deficient in their ability to produce antibodies or to functionate properly otherwise. The closing up of avenues by which bacteria may leave the focus of infection through swelling, exudation, and, finally, by cellular proliferation, is one of nature's methods of automatically eliminating excessive auto-inoculation.

It is easy to see how this normal protective process may go to the extreme of such complete segregation that, finally, almost no auto-inoculating stimuli will emanate from the focus. And, for quite the same reason, it is clear that the antibacterial substances which the blood possesses cannot come into contact with the bacteria in the focus. Under these conditions we do not expect to find in the blood-stream any evidence of protective response, and, in fact, as has been shown, we do not find it. We also have to consider gradual abstraction of the normally possessed antibodies through continuous slight contact with the outskirts of one or more chronic bacterial foci.

Interpretation of the above considerations leads to the conclusion that the persistence of localized infection registers the success of the immunizing mechanism, in protecting the body by the segregation of the infection, that the more complete the segregation the better the body is safeguarded. In like measure, the more complete the segregation of the bacteria in the focus of infection, the better protected are they from the action of the blood fluids, and, to the same degree, are the antibody-forming cells denied the stimulus to the formation of specific antibodies. With these considerations in mind, we are justified in assuming that in the case of chronic localized infection the immunizing mechanism may, in some cases, have overreached itself, as it were, and have brought about conditions conducive to the persistence of the infection locally.

Determination of Antibodies to the Focus of Infection.—When bacteria and bacterial substances are entering the blood-stream we may find evidence that such is taking place by detecting the presence of new specific antibacterial substances in the blood-stream, which we know are to be found only subsequent to the entrance of auto-inoculating bacterial stimuli. Detection of the increase in one antibody is sufficient evidence that auto-inoculation has taken place in sufficient amount to stimulate the antibody-forming mechanism and to result in immunizing response. A succession of positive and negative phases, as indicated by fluctuations in the opsonic power, are indicative of response to a succession of auto-inoculating stimuli. Supposing that this series of auto-inoculations is not so excessive as to maintain the blood-stream in a condition of low antibacterial power, that the final result is rather to increase its antibacterial efficiency than to lower it, there is still another requirement of the greatest importance, that these newly produced antibodies may, in addition to their effect in sterilizing the blood-stream, also be enabled to direct themselves against the bacteria in the local focus of disease.

The application of new antibodies locally depends obviously upon conditions in the focus of infection, which will allow free circulation of blood and lymph. If the free interchange of antibodies to and from the focus is interfered with, the protective elements which the blood possesses cannot be efficiently applied. This is commonly the condition met within chronic localized infections, and is obviously one of the reasons for their chronicity.

As previously suggested, conditions may spontaneously develop as a part of the normal immune reaction which provide for a more free circulation through liquefaction and discharge. Thus, stagnant lymph in the walls of the cavity which has been thus produced may flow outward and allow for fresh inflow of the fluid from the blood-stream of higher antibacterial power.

As long as discharge into the abscess-cavity and outward maintains itself, so long will a continuously fresh supply of antibodies and phagocytic cells from the blood-stream exert as nearly as possible the maximum immunizing effect that the blood-stream has to offer. This is nature's method of finally extinguishing infection by bringing about this evening up of the bacteriotropic pressure.

It should be clear that if anything takes place to block the discharge from such an abscess-cavity, the fluids in the walls will again stagnate and gradually be depleted of their specific antibodies by combination with the bacteria present. Conditions suitable for further multiplication of bacteria in the walls of the abscess-cavity are thus brought about. In the normal course of events, unless provision is made to obviate it, coagulation of lymph takes place, and pretty soon closes fairly effectually the channels for outflow of lymph into the abscess-cavity. That conditions suitable for the persistence of bacterial growth may in this way be produced there is sufficient clinical evidence to be found in the frequency of exacerbations in local foci, in which there has developed a crust, or in which, through the coagulation of discharge and the drying of a gauze wick, the exit for the discharge is sealed.

Coagulation of lymph, then, is one of the natural phenomena which leads to chronicity and spread of the disease, in that it prevents the efficient application of antibacterial substance locally.

Induced Auto-inoculation.—Without dispersion of sufficient numbers of bacteria from an infected focus, so that unpoisoned cellular tissue may derive stimulus for specific antibody formation, the immunizing mechanism cannot reach its highest efficiency as against the infecting microörganisms. Sufficient spontaneous inoculation, in other words, is essential to the development of the body's secondary defence, the array of specific antibacterial substances in the blood-stream. We have considered conditions occurring in the natural course of infectious disease to render auto-inoculation possible and effective; which prevent or limit auto-inoculation, and the effect of the consequent denial to the antibody-forming cells of specific bacterial stimulus; which allow excessive auto-inoculation, and its effect in the depletion of the antibacterial power of the blood-stream; and, finally, conditions which, under the natural conditions, tend to eliminate excessive or toxic auto-inoculation. As evidence of auto-inoculation, we find response in the production of specific antibacterial substances. We take an elevation in the opsonic power as indicating that efficient auto-inoculation has taken place; a series of fluctuations in opsonic power as indicating a series of protective responses to a like series of auto-inoculating stimuli; consistently low,

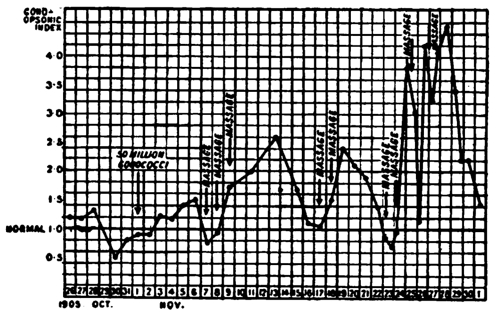

FIG. 227.—INDUCED AUTO-INOCULATION.

The effect of massage of a gonorrheal joint upon the opsonic content of the blood (Wright, Lancet, November 2, 1907, 1227).

non-fluctuating opsonic power, as indicating absence of bacterial stimulus. Without this conception of the mechanism of auto-inoculation, and its effect upon the protective response, a proper conception of the mechanism of the immune reaction is not to be ob-

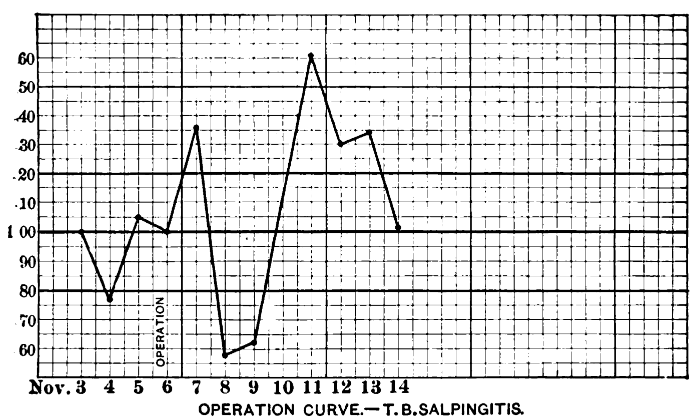

FIG. 228.—AUTO-INOCULATION AS REGISTERED BY THE OPSONIC INDEX FOLLOWING OPERATIVE PROCEDURE IN A CASE OF TUBERCULOUS SALPINGITIS.

tained, nor will it be possible in the treatment to so select and correlate measures that they may have the effect of rendering normal physiologic immunizing process efficient at points where its failure is obvious.

Massage of a gland or joint, passive or active motion of a joint, surgical operation, increase in the active blood-supply to an affected part, by heat or other means, Bier's passive hyperemia, walking and deep breathing in pulmonary tuberculosis, shouting in laryngeal tuberculosis, all were shown to be followed by an immunizing response registered by elevation of the opsonic power of the blood.

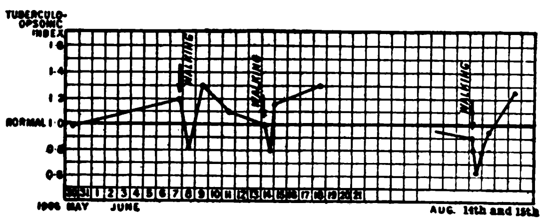

FIG. 229.—INDUCED AUTO-INOCULATION.
Tuberculous bone disease—ankle. The effect of walking (Wright, Lancet, November 2, 1907, 1229).

The charts shown (Figs. 227, 228, 229, 230, 231,) are very important, as indicating the nature of auto-inoculation and its effect upon the antibacterial power of the blood-stream.

Having studied the features of the immune reaction against infection, and having seen that the whole is physiologic in its nature,

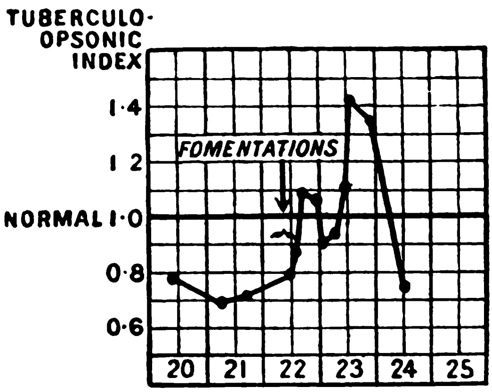

FIG. 230.—INDUCED AUTO-INOCULATION.
The effect of fomentations as shown by variation in the opsonic index (Wright, Lancet, November 2, 1907, 1232).

it should be clear that the largest factor in recovery from any infection is the body's own self-immunizing power. It should be clear that the measures we use in treatment must first be directed to secure the efficient functionating of all the body cells through proper feeding and hygiene; to avoid the use of any measure which will interfere with the normal immunizing process in any of its phases; to render any phase of this process more efficient where possible; when failure is evidenced by persistence of disease, to endeavor to make this failure good by some artificial measure. The endeavor should be to allow the immunizing process to take place so far as is possible by nature's own methods. This entails the use of a number of methods, and, more important still, a proper correlation of these methods.

Early Stages of Local Infection.—Clinical observation has indicated that the application of heat in the form of soaks and poultices is valuable at this stage. When properly applied, their effect is to increase the local hyperemia, and thus to enhance the efficiency of the normal process by which the antibacterial forces, the phagocytes and

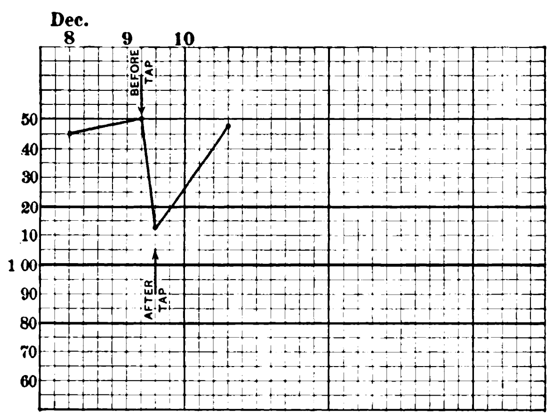

FIG. 231.—INDUCED AUTO-INOCULATION.
Here is registered by a fall in the gono-opsonic power an auto-inoculation due to the tapping of a gonorrheal joint.

serum, are focused against the invading bacteria. The apparent attempt of the immunizing mechanism to even up the bacteriotropic pressure in the focus of infection with that of the blood-stream is furthered through the increasing rapidity of the interchange of fluids from one to the other. Lymph depleted of its opsonin and phagocytic cells filled to repletion with bacteria in the focus are replaced by fluid of higher opsonic power and fresh phagocytic cells.

Bier's passive hyperemia has been applied to all sorts of infections at all stages where the physical conditions were such as to allow of it The objection to passive hyperemia in the early stages of an infection is quite the same as against the Gamgee dressing, namely, the induction of stasis of lymph flow in the focus of infection at a period *when the introduction and replacement of fresh lymph should* *be as rapidly carried out as possible.* Upon general principles, then, this measure is contraindicated, because it obstructs the development of a normally efficient means of antibacterial attack. Apart from this contraindication, as interfering with the normal immunizing process, it may have the particular effect, in case the infection is extensive, of inducing excessive auto-inoculation, consequent lowering the opsonic power of the blood-stream, and making it possible not only for bacteria to exist therein long enough to lodge in other parts of the body and possibly to produce new foci of disease, but also making the resistance to the local spread of the infection less active. The actual effect of Bier's bandage in inducing auto-inoculation is well shown in one of the charts. The mechanism of such auto-inoculation is that blood fluid is forced from the vessels into the tissues, and there probably takes up bacteria and bacterial poison which, when the bandage is released, enters the blood-current. The application of Bier's bandage never can be without its danger where the infectious process is extensive and there is no local exit for discharge.

Exception to the rule against Bier's passive hyperemia for use in acute closed infections is in the case of slight, limited infectious processes, the fingers, for instance. Here alternation of active and passive hyperemia may be more efficient than the active hyperemia that is normal or artificially induced. For instance, Bier's bandage is applied for ten minutes, the finger then immersed in a hot soak for half an hour, and the same repeated a number of times. The mechanism is something as follows: The fluid is forced from the vessels into the focus, *producing swelling.* It reinforces that which is present by its opsonin and phagocytes. Early release of pressure does not allow it to remain there long enough to lose its opsonin and become a culture-media. The focus being small, when the bandage is removed and the fluid returned to the blood-stream, auto-inoculation should not be excessive. On the contrary, it might be expected to be an efficient stimulus for immunizing response without excessive reduction in the bacteriotropic power of the blood. In the induction of more intense hyperemia by heat we derive at once a more increased active circulation in channels that have been dilated as a result of the passive hyperemia. These procedures, if used judiciously, not only should not interfere with the natural hyperemic reaction, but should render it more efficient.

Indications in Fulminating or Spreading Infection.—In the later stages of infection, when involvement of tissue locally is extensive and spread of the infection is unchecked, we see in this condition failure in the initial hyperemic attack of the immunizing mechanism. Temperature and constitutional symptoms indicate that auto-inoculation is taking place in toxic amount. This is clinical evidence of the depleted antibacterial power of the blood-stream. The indication, obviously, *is artificially to eliminate this toxic auto-inoculation.* This is the rationale of surgical measures. Opening up the focus of infection accomplishes this in the following manner: Discharge of fluid greatly deficient in opsonic power and tryptic in its action upon connective tissue, dissolving it and opening up channels for extension of bacterial growth; of leukocytes incapable of ingesting bacteria even in the presence of opsonin; finally, elimination of the pressure within the focus, which renders spread more easy. Thus the blood-stream is freed from toxic auto-inoculation and the antibody-forming mechanism from overstimulation.

The effect of surgery upon the focus of infection is to allow discharge of the stagnant fluid, its replacement by fluid of higher antibacterial power, and unpoisoned leukocytes. The blood-stream is relieved of auto-inoculating numbers of bacteria, depleting it of its antibodies. The antibody-forming cells are relieved of overstimulation and, in favorable cases, finally react in the formation of new antibacterial substances. The blood-stream thus reinforced at once offers not only a barrier to the spread of the focus, but also, if the discharge continues, furnishes decided reinforcement to the antibacterial attack within the walls of the focus of disease, through constant circulation into the focus and outward as discharge.

The surgical operation then owes its efficiency to the elimination of auto-inoculation, and to the production of conditions allowing of the application of fresh blood fluids of high protective power against the bacteria existing in the focus of infection, in stagnant fluid of very little protective power. The rationale of the surgical measure, therefore, lies in the fact that, by rendering the secondary defence efficient, it at least leads to localization of the infected area.

Antiseptics.—There is nothing more natural than to attempt, by frequent irrigation and by wet antiseptic dressings, to destroy the bacteria remaining in the operative cavity by means of antiseptic solutions. Clinical experience has shown that strong antiseptics are not efficient; in fact, retard rather than accelerate the immunizing process locally. Consequently, practice is gravitated toward the use of irrigations merely for mechanical cleansing, either of normal salt solution or some clean solution, such as boric acid. Strong antiseptics are inefficient because they are not only parasitropic, but histotropic. When sufficiently strong to kill bacteria they also destroy tissue cells. The antiseptic cannot come into contact with all bacteria in the focus. Those which continue to exist may conceivably find a more or less suitable medium for growth in the tissue devitalized by the antiseptic. The effect of devitalized tissue in the walls of such a cavity may conceivably be to seal the natural avenues of exit for the lymph, and result finally in stagnation of fluid in the walls and the redevelopment of conditions in the focus of infection which the operation temporarily removed. Further, it is difficult to imagine that serum and phagocytic cells have an efficient antibacterial power when in contact with strong antiseptics. We know that strong antiseptics interfere with the normal immunizing process. The reason is probably somewhat as suggested.

Drainage is commonly understood to mean the evacuation of pus and the maintenance of free openings, so that any pus may continue to find exit. The mechanical process of removing pus is responsible for efficient localization and its probable mechanism has been indicated. In order, however, to destroy the bacteria remaining in the walls of the focus it is obviously necessary that the blood fluids should not be allowed to stagnate, should be replaced by fluid from the bloodstream continuously. This is only possible on condition that a continuously free discharge from the walls of the cavity and outward is taking place. As has previously been shown, the tendency to the formation of crust through lymph coagulation in the walls of the cavity is evident within a few hours after operation. The effect is to seal channels for exit of lymph; in fact, to cause stagnation and inefficient replacement of lymph in the walls. It is certain that measures should be sought to make possible this interchange of fluid.

Wicks.—Dry gauze wicks are efficient until they become thoroughly soaked. They are apt soon to become dry or, if not, coagulation soon renders them more as plugs than drains. An illustrative case, among a number seen by the writer, had cellulitis of the neck in which there had been two operative wounds which had, on the previous day, been connected by continuous gauze wick. The condition had shown no tendency to improve during more than a week. The wick was dry and stiff, and upon removal several drams of pus were evacuated. This case progressed rapidly to resolution in a few days after the use of the wick was abolished, and the lesions covered by a pad kept continuously wet with a solution of *sodium citrate* (1 *per cent.*) and *sodium chlorid* (4 *per cent.*).

Sodium Citrate and Sodium Chlorid Solution.—To render the immunizing mechanism more efficient when it fails through inefficient local application of antibodies, Wright devised this solution, which is calculated to prevent coagulation of lymph, crust formation, and consequent cessation of discharge. The effect of the sodium citrate is to produce precipitation of calcium salts and thus to prevent coagulation. If constantly applied to the wound-cavity, exit for lymph discharge is rendered continuously open. The sodium chlorid content renders the solution hypertonic, and tends by osmosis to draw lymph through the walls of the cavity. This solution, then, forestalls plugging of the capillaries and lymph spaces, and by chemical means induces a continuously free discharge. Thus, there is brought about a continuous circulation of lymph of antibacterial power, as nearly as possible equal to that of the blood-stream through the infected walls of the cavity. The writer has found proof of the efficacy of this measure through its use for the last five years. If the opening does not mechanically close itself, neither wicks nor drains are necessary. If, through contraction of muscle, the opening mechanically closes itself, rubber dam or rubber tubing should be used.

Bier's Suction.—One can forcibly drain the walls of a focus of infection of their fluids by applying Bier's cup. When used in connection with sodium citrate and chlorid solution, its occasional use will produce more rapid drainage, and, hence, more rapid replenishment with fluid of a higher antibacterial power from the blood-stream. Bier's cup should not be used unless the sodium citrate and chlorid solution has been applied for several hours, and then with extreme care. Several cases have come to the writer's notice of local exacerbation developing after too frequent or too forcible Bier suction. Suction is a rational measure because it may aid in the application of immune substances locally, but, if a sodium citrate and chlorid solution is used, it is generally unnecessary.

Tuberculous Abscess.—*Indications.*—In the case of an abscess-cavity due to the breaking down of a tuberculous focus, such as a lymph-node, conditions are not quite the same as in an abscess due to pyogenic organisms. This is due to the fact that the pus, in its low content of polymorphonuclear leukocytes, from the breaking down of which tryptic ferment is obtained, would not be expected to exert and, in fact, does not exert much of a dissolving action upon the connective tissue. There is to be observed no tendency to spread, as is found in the case of tryptic pus of pyogenic organisms. Further, the walling off of the limiting membrane of the node is active in preventing extension. It is possible, therefore, if desirable, to postpone the evacuation of such a cavity without danger to the patient, and, as will be seen later, in the treatment of tuberculosis, it may be of advantage to postpone evacuation for certain reasons.

The danger of secondary infection in tuberculous processes makes it desirable to evacuate the pus through as small an opening as possible. Where wide incision is used, the chance of secondary infection is much greater than if pus be aspirated or drained through a minute incision. The absence of tryptic action renders it possible to abstract the pus by means of an aspirating needle and syringe when necessary. Such aspiration may have to be repeated frequently, but the final result will commonly be quite as good as that obtained where incision is made, so far as efficient drainage goes; there will be no sizable scar and the chance of secondary infection will be minimized.

Where bacteria are growing in a serous cavity, clinical improvement is known to follow evacuation of the contents of such a cavity. We have seen that the opsonic power of the blood, in contact with bacteria growing in this manner, is much lower than that of the circulating blood. The excellent results which sometimes occur in the case of tuberculous peritonitis, which have been attributed to opening up of the abdomen and allowing air to enter, are readily explained by the fact that the abstraction of fluid of low antibacterial power has been followed by an inflow of lymph from the blood-stream with considerably higher antibacterial power. Thus we have rationale for tapping when more extensive operation is contraindicated.

Chronic Discharging Sinus.—Persistence of a discharging sinus depends primarily on the presence of a focus of disease at its base. When this is removed, however, so far as possible, the discharge is still apt to continue on account of infection of the sinus walls by pyogenic organisms. The persistence of bacterial growth is due to the difficulty of blood fluid and leukocytes penetrating the connective-tissue walls of the sinus and coming into contact with the bacteria in effective amount to destroy them. Coagulation of lymph at the exit of the sinus tends further to obstruct free interchange of fluid in the infected sinus.

Fundamental to the cure of these conditions, therefore, is the use of measures which will induce a stream of lymph through the walls of the sinus into contact with the bacteria. The use of sodium citrate and salt solution as an irrigation, in association with cupping, may produce the desired effect. The use of wicks to keep such sinuses open is inefficient, for the reason stated previously. Frequent probing does more harm than good, in that by trauma to the tissue it is apt to produce hemorrhage, and through clotting the sinus is obstructed; abstraction of the protective substances in the effused blood rapidly takes place, the result being that an excellent culture-medium is produced for the further growth of the bacteria. Where the situation admits of it, the laying open of a sinus by operative procedure, the application of iodin, etc., proves in practice, particularly in the fistulous sinuses about the rectum, to be the most rapidly efficient procedure, in that the whole length of the sinus is opened up and it granulates from the bottom.

Indications for Treatment in Chronic Localized Infections.—Bacterial Vaccine.—When surgery has, in the manner suggested, reduced a spreading pyogenic infection to a localized process, and when, by the methods suggested, as full a lymph-stream as possible is caused to flow through the walls of the focus; in other words, when efficient drainage is maintained, we may still at times meet with a process which, in spite of these favorable conditions, becomes indolent and chronic. The measures already used have been directed toward safeguarding the rest of the body and toward producing efficient application of the antibacterial substances which the blood-stream contains against the bacteria locally. We must here recognize that this localization may be a reason for chronicity, in that through the elimination of auto-inoculation the stimulus to the formation of specific antibodies is denied to the cells involved in their production. This, in connection with abstraction of antibacterial substances by constant slight contact with the focus of infection, renders the blood-stream low in its total antibacterial power, as has been previously shown.

The blood-stream has been shown to be higher in antibacterial power than any other body fluid and is many times higher than fluid in an infected focus. It is obvious that a blood-stream low in its antibacterial content cannot be as efficient locally as a destructive agent as if its protective power were greater. We have seen that in chronic localized infections the opsonic power of the blood is consistently subnormal, and in many cases not more than two- or three-tenths of the normal. Bulloch[1] showed that in cases of lupus, where opsonic power of the blood was subnormal, the determination of blood to the focus produced by exposure to x-ray and Finsen ray was not as efficient as in cases where the opsonic power was normal or above.

[1] Trans. Path. Soc. of London, 1905, lvi, part 3.

On similar consideration, Wright based the *fundamental principle that in cases where the antibacterial power of the blood is below the standard necessary for the most efficient response to infection, measures to increase the antibacterial power of the blood should be used.*

We have seen that it is possible by the injection of bacterial vaccine corresponding to the bacterial character of the infection to bring about an immunizing response in the achievement of a heightened bacteriotropic power of the circulating blood, and if the dosage of vaccine be of proper size and given at proper intervals, the high bacteriotropic power may be more or less constantly maintained. The result of such inoculation will be, as Wright puts it, that the citadel of the circulating blood will be more secure against septicemic invasion. Bacteria entering the blood will be more apt to be killed instead of being carried from point to point unharmed and in a condition to establish new foci. The blood will have at its disposal a reservoir of antibacterial fluid of satisfactory potency and available for flushing any bacterial nidus in the tissue, wherever it may be.

Induced Auto-inoculation Instead of Bacterial Vaccine in Localized Infections.—The surgeon's work, therefore, is not always completed when he has secured free drainage and conditions necessary for application of antibodies locally. It may be that the infection will persist through low antibacterial power of the blood-stream. It is rational, therefore, in cases that do not show tendency to improve consistently to make use of bacterial vaccines to secure a blood-stream of higher specific protective power.

Vaccine in Generalized Infections.—It is easy to see the rationale of vaccine in localized infections in which the low antibacterial power is known to be due to inefficient bacterial stimulus to the antibody mechanism. It is more difficult, however, to see wherein it can be of value in cases where there is no lack of bacterial stimulus. In generalized infections there is no absence of auto-inoculation, in fact, it is continuous. The struggle is taking place in the blood-stream, the immunizing mechanism is receiving all the stimulus necessary, and such antibodies as are produced are applied against the bacteria in an unobstructed manner. The immunizing mechanism is rendered inefficient through toxic overstimulation, and such antibodies as are produced are rapidly absorbed by excessive bacterial poison in the blood. The obvious indication is to eliminate auto-inoculation. Absolute rest is the only measure we have to favor this. *The only basis for giving vaccines is a supposition that* *the bacterial stimulus is not efficiently applied.* That vaccine applied in concentrated form in connection with comparatively uninjured cellular tissue may cause the local elaboration of protective substances when the stimulus applied through the blood-stream, being not so concentrated, is less efficient. To the objection that vaccine might aggravate intoxication, Wright suggests that there is reason to believe that vaccine injected is held back in the tissues for a certain length of time before being taken into the blood-stream. However, the fact remains that in septicemic cases judicious injection of vaccine may produce an immunizing response, registered by the opsonic index.[1]

Clinical evidence comes from Thompson[2] in his report of 7 cases of septicemia treated by vaccine derived from organisms obtained from the blood-stream: 3 cases recovered and 4 died. In 2 of the fatal cases the effect of the vaccine was strikingly but temporarily beneficial; in 2 others the benefit was slight, but demonstrable; in the others immediate and continued improvement followed the use of the vaccine.

Vaccine When Auto-inoculation Cannot be Checked.—Sometimes, in persisting local infections, we have evidence that auto-inoculation is taking place, in irregular temperature, symptoms of toxemia, and fluctuations in the opsonic index as so consistent. Very often a careful search will reveal in pocketing of pus a redevelopment of the condition of acute abscess formation, though possibly of small proportions. Drainage in such a case is usually efficient. Occasionally, however, drainage is found to be good, but in spite of it auto-inoculation takes place, temperature and clinical symptoms persist. In such a case, the auto-inoculation may be either too excessive or too frequent, or the blood-stream inefficient in offering sufficient reinforcement to the antibacterial power of the fluids in the focus of infection. At any rate, the auto-inoculations are not followed by response that is effective. Exhibition of a proper vaccine is indicated in these cases not because auto-inoculation is lacking, but because of the possibility that it is inefficient.

It would at once suggest itself that we should find in Bier's passive hyperemia, as applied to certain infections, as tuberculous joints, ulcerations, etc., where such can be applied, a measure which would not only increase the antibacterial power of the blood, but at the same time cause a determination of lymph to the focus of disease. Such

[1] Lancet, Nov. 2, 1907, Charts 14, 15, etc.
[2] Amer. Jour. of Med. Sci., Aug., 1908.

treatment is advantageous, perhaps, in certain ways, in that we are always using the correct vaccine; in that we are not confronted with the difficulty of isolating organisms and preparing vaccine; that there is no delay in its application; that stagnant lymph may be replaced by lymph of higher bacteriotropic power and which will exert a beneficial action. The disadvantages are, however, that auto-inoculations consist of living bacteria, as well as their products, carried into the blood-stream; that auto-inoculations constitute *unmeasured doses* of bacteria; that the dose may at any time be excessive in the case of an infected focus of considerable size; that in the case of a small focus the auto-inoculation may be too small to be beneficial, and where bacterial growth is gradually lessened by immunizing response to previous auto-inoculation, the size of the auto-inoculations will be considerably lessened; in cases where there is actually required a gradual increase in the amount of auto-inoculation in order to produce adequate immunizing response; that auto-inoculations cannot be made use of in infections where the location is unsuitable. The use of bacterial vaccines, on the other hand, are more advantageous in most cases, because the dose can be accurately measured and can be increased at will; it is not so time-consuming in its application for both the patient and the practitioner as the procedure of auto-inoculation. It is infinitely safer, because it does not depend for its usefulness upon the entrance into the blood-stream of living organisms.

Summary of Indications for Vaccine.—The exhibition of vaccine we have, therefore, found to be indicated, *first*, in localized infections; *second*, in infections which, by various procedures, have been rendered local in character; *third*, in infections subject to intermittent auto-inoculation which cannot be checked; *fourth*, we have considered the question of their indication in generalized infections; in other words, where the blood-stream is subject to continuous auto-inoculation.

Guidance to Correct Dosage.—Vaccine is a poison, and we must in our use of it consider it to be such first and last. It has absolutely no resemblance in its constitution or its mode of action within the body to antitoxins, such as diphtheria antitoxin. In consideration of its being a poison or a toxin, we have at once a decided reason for careful consideration of the dosage that we should use in treatment. That it is, when properly used, a powerful factor in control of some diseases is beginning to be generally recognized. That it is also equally powerful in doing harm is realized by the few who, by inordinate dosage, have produced unfortunate results, and by those within whose observations these cases have come. That killed bacteria can, when injected into the *normal* individual, produce nausea, malaise, rigors, vomiting, etc., and localized inflammatory condition at the point of inoculation, the extensive experience of Wright in protective typhoid inoculation has clearly shown. In other words, the injection of bacterial poison may produce the same train of symptoms as living bacteria of the same sort.

A dose of vaccine containing 100,000,000 killed staphylococcus pyogenes aureus, when injected into a patient suffering from furunculosis, is commonly followed by improvement in the local conditions during the next twenty-four hours. A dosage of 500,000,000 of the same organism in a similar case is also commonly followed by local exacerbations in the furuncles already present, and very probably will be followed by the development of new lesions. Temperature and generalized symptoms may or may not be produced. It is further well known that if, in a patient suffering from pulmonary tuberculosis, a dose of $\frac{1}{10}$ c.mm. O. T. is given subcutaneously, it is apt to be followed by a febrile reaction in the subsequent few hours, associated with signs of increased activity in the focus of disease. The injection of this dosage of tuberculin in an uninfected individual is without constitutional effect. The same may be said about the injection of killed staphylococci in case the patient is not infected.

From these facts it would appear that *the effect produced by these agents is not primarily due to the amount of toxin they contain*, otherwise we should have produced the same symptoms in normal individuals. Rather, it would appear to be that the exacerbations of the infected individuals are due, not to the inherent toxic power of the dose employed, but to some effect which it exerts only when the organism is infected.

The knowledge that it is possible to secure an adequate immunizing response on the part of the body from the inoculation of bacterial vaccine, without the previous induction of symptoms of toxemia, and that, by consistently increasing the dosage of vaccine, likewise guarding ourselves against such toxic symptoms, we may maintain the protective mechanism at a high level of efficiency correlated with improvement and final cure of the disease process, is derived absolutely and entirely from the study which Wright has made of the body reaction against infection, and subsequent to inoculation, by means of the opsonic index.

In Fig. 232 is shown a curve representing daily variations in the phagocytic power of the blood, as registered by opsonic index determinations, in a case of tuberculosis after an inoculation of $\frac{1}{2000}$ mg. of tuberculin R. This curve, while not typical, illustrates a certain sequence of events in the production of opsonins which will follow the inoculation of any vaccine if given in sufficient dosage.

At the start we have two opsonic indices, which represent a low normal phagocytic power, consistent with that to be found in chronic localized tuberculosis. Immediately following inoculation there is recorded a slight rise in the phagocytic power, which, though in any case possibly due to error in estimation, occurs so frequently that it may have some significance. It is possible that it represents an immediate response to the stimulus furnished by the absorption of a minute amount of the inoculum. A very important feature is the marked decrease in phagocytic power which continues low until the third day. This per-

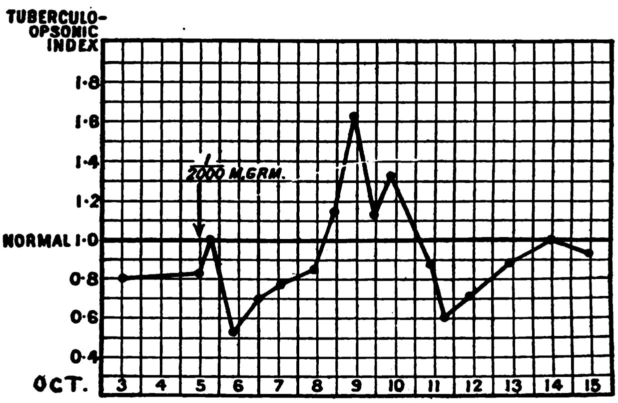

FIG. 232.—OPSONIC CURVE ILLUSTRATING THE VARIATIONS IN THE OPSONIC INDEX OF THE BLOOD FOLLOWING INOCULATION (A. E. Wright, Lancet, 1907, 1218).

iod of diminished phagocytic power constitutes the negative phase, and represents a period in which the phagocytic defense to the tubercle bacillus is obviously weakened. Following this negative phase comes a wave-like increase in the phagocytic power, registered by a considerably and continuously elevated opsonic index. During this period, termed by Wright the positive phase, the offense which the phagocytes are able to offer should be at its best. The next feature to be noted is the gradual sinking away of the opsonic power, followed subsequently by a gradual rise to a condition somewhat slightly more elevated than at the start.

In describing the features of this curve, Wright terms the negative phase the ebb, the positive phase the flow, the subsequent decline as the back flow, and the final condition, in which the curve is slightly more elevated than at the start, he terms the sustained high tide of immunity. The form of the curve produced, and consequently the sequence of events in the immunizing response, depends on the dosage of vaccine injected. If the dose be small, that is, insufficient perhaps to produce clinical improvement, there may be an immediate rise in the opsonic index without any preceding fall or negative phase. The positive phase or increased phagocytic power under these conditions, however, will be of short duration, a few hours perhaps, and the height of the rise may not be very great. If a larger dose be given, that is, a dose which produces a satisfactory immunizing response, as would be consistent with improvement in the condition of the patient, a sequence of events similar to Fig. 232 may be obtained; that is, there will be a fall for a longer or shorter time, followed by a rise of the phagocytic power above normal, and then a gradual fall again. The effect of an excessive dose of vaccine, that is, a dose of sufficient size to produce toxic symptoms, would be to induce an immediate fall in the phagocytic power and a more or less continued depression, depending on the size of the dose. The continuation of this phase of depression may be for a number of days. If no further inoculation is given, there may occur a spontaneous recovery of opsonic power.

Wright states[1] that, where an excessive dose of vaccine has been given, a reinoculation, as soon as constitutional symptoms have disappeared, of a minimum dose of vaccine would practically always result in a desirable rise in the phagocytic power. The changes in the phagocytic power of the blood-stream induced by inoculation, as above sketched, will apply to chronic localized infectious disease, as well as to generalized infections, but the use of sufficient dose to induce a persistence of negative phase is, in this latter, as we shall see later, a dangerous procedure.

It is obviously desirable in treatment to maintain, for as long a period as possible, a high level of phagocytic resistance. The proper time for repeating inoculations would naturally be at the time when the phagocytic power is falling, marking the end of the positive phase. A negative phase of short duration is commonly followed by a positive phase of correspondingly short duration and slight elevation. An accentuated negative phase of moderate duration, say, thirty-six hours, may be followed by a positive phase, lasting several days. An excessive dose may be followed by merely a prolonged negative phase; hence the dose is an extremely important factor.

[1] Lancet, August 24, 1907, p. 493.

A repetition of the condition repeated in Fig. 232 is desirable. To produce this, inoculations must be given at the end of the positive phase. If the inoculations are given too frequently, the effect is to produce a partial failure in response and an elision of a portion of the positive phase. It is impossible, by frequent inoculation of tuberculin, superimposing one dose upon another, to produce a continuous increase in the opsonic power.[1] Each inoculation must be treated as an independent event, and should be followed by another inoculation as soon as its effect is wearing off.

Correlation of These Variations with Clinical Symptoms.—It does not matter, for practical purposes, whether the opsonic index is or is not a measure of the protective response to inoculation, if it can be shown that it corresponds in its rise and in its fall to conditions of improvement and aggravation in the clinical symptoms of the patient and in the activity or non-activity of the focus of disease. The correlation between the clinical symptoms and the condition of the opsonic power of the blood has been definitely shown as follows: First, in cases of chronic localized staphylococcic and tuberculous infections we have seen that the opsonic power as against the infecting organism is invariably low. Secondly, as a result of thousands of opsonic observations, Wright states that he has satisfied himself that in all infections a low opsonic index is correlated with an unsatisfactory clinical condition, while a high opsonic index is correlated with a clinical condition which shows improvement for the time being. Exception to this is found to be occasional, and is accounted for by the supposition that the lack of improvement is due to a walled-off condition of the focus of disease, and to the impossibility of the circulating blood coming thoroughly in contact with the infecting organisms.

Hektoen states[2] that in the early stages of pneumonia, diphtheria, and erysipelas, when the symptoms are most pronounced, we have a condition of negative phase or lowered opsonic power, and that when the symptoms begin to subside, such subsidence is associated with a rising opsonic power. This variation also applies to the streptococcus in scarlet fever. In fatal cases of pneumonia the opsonic curve may not recover from its primary depression, but sinks lower and lower. He refers to the clear and close association *between recovery and the wave-like rise of opsonin, and to the similar correlation of improvement in*

[1] Wright, Studies in Immunization, p. 273.
[2] Cleveland Med. Jour., May, 1909.

symptoms and conditions associated with a rise in opsonic power following immunization by vaccine.

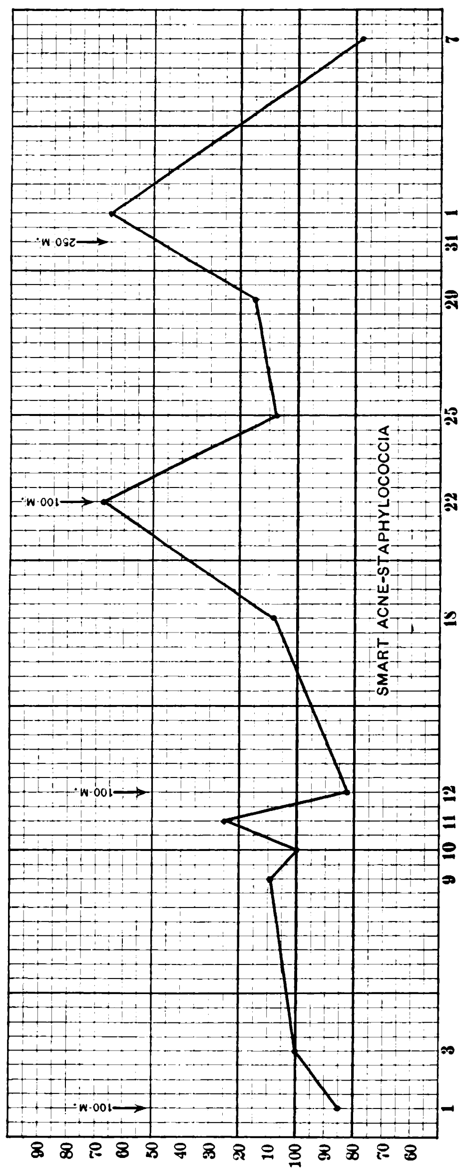

FIG. 233.—CHART SHOWS THE EFFECT OF FOUR INOCULATIONS DURING A PERIOD OF ONE MONTH IN A CASE OF GENERALIZED STAPHYLOCOCCIC INFECTION OF THE SKIN.

Note that the opsonic indices are all well above normal during the latter part of the month; that definitely correlated with this registered increase in the opsonic power, the clinical condition improved, and recovery was complete.

Recognizing in the negative phase following inoculation a phase of lowered resistance, and in the positive phase a period of increased resistance, it is the endeavor, by means of vaccines, to secure, associated with as brief a period as possible of lowered phagocytic power, as prolonged a period as possible of elevated phagocytic power.

Finally, we are led to the conclusion that the negative phase, as measured by the opsonic index, in that it is associated with aggravation of the disease or at least a condition of stasis, is a thing to be avoided, and that any therapeutic measure which may induce such a condition might be dangerous to the life of the patient in some cases or inimical to progress toward recovery. We see in furunculosis, following the inoculation of a large dose of vaccine, indications of this aggravation during the period in which the opsonic index is subnormal, in the fact of increased tenderness, discharge, and the development of fresh furuncles. In the case of gonorrheal joints, associated with the negative phase after inoculation, we find commonly increased pain, tenderness, and possibly swelling in the joint, and in some it stood before inoculation, in the absence of constitutional disturbance on the part of the patient, he considers that a larger dose could have been administered. The ideal dosage is one which will induce a slight initial fall after inoculation, and after from seven to ten days will be found to be higher than it was at the outset. The duration of the initial fall depends, of course, on the dosage, and should not be longer than from twenty-four to forty-eight hours. The question of increasing the dosage is decided entirely upon the manner of the immunizing response obtained. Wright's rule is never to increase to a larger dose until one fails to obtain a satisfactory elevation in the opsonic index with the dose used. The question of superimposing one dose upon another before the opsonic index has begun to show signs of falling is an important one. It would appear at first glance to be best to derive the full effect from the past dose before injecting the next, and this seems to be actually the case. Wright has shown that, in a case of tuberculosis, it is impossible to cause a cumulation in the direction of a positive phase; that is, one cannot, by injecting tuberculin frequently, produce a gradually increasing opsonic power.[1] He, therefore, considers each inoculation independently, and does not attempt to produce a gradually increasing elevation in the opsonic power.

The difficulty of obtaining accurately estimated opsonic indices, and the large amount of time necessary for their correct determination, has rendered it desirable to find some more simple method of giving vaccine than that based on the determination of the opsonic index as a guide in every case. In consideration of the fact that the opsonic index has a definite correlation with the clinical symptoms, it is possible, in those cases in which signs and symptoms may be easily observable, to make use of them as guides to dosage of vaccine. In the case of furunculosis the development of new furuncles and their continued aggravation for several days would be evidence of lowered phagocytic power; in other words, of a pronounced and continued negative phase. It may be taken as evidence that the dosage of vaccine was too large. If, on the following day after inoculation, in such cases, there is a slight exacerbation in the furuncles already present, but on the subsequent day a marked improvement and a continued improvement over the several following days, the dosage may be taken as correct. In the case of a sinus or abscess, a marked increase in the discharge may indicate the induction of a marked negative phase from too large dosage. In the case of an ulcer, the increase in discharge and extension may mean the

[1] See Trans. Med. Chir. Soc., vol. lxxxix, 1906, Chart 5.

same thing. In the case of a gonorrheal joint, local exacerbations may continue for several days, and in such a case the dosage has been too large. In the case of bladder infections, we may take pain, frequency of micturition, the condition of the urine, and possibly temperature, as indications.

In glandular tuberculosis a single excessive dose may or may not produce increased swelling and pain. Such walled-off infections are not as immediately susceptible to lowered resistance, because of their walled-off condition, and because the conditions in the focus are of much less antibacterial efficiency than that of the circulating blood in an untreated case. Where a series of excessive doses, however, are given, we may, after a long time, find a lack of progress, or in extension of the process to other glands, that, instead of increasing the patient's resistance, we have, by our injections, induced a condition of predominating negative phase. It is in these conditions particularly that occasional opsonic index determinations may be necessary to determine whether or not our dosage is successful in producing satisfactory phagocytic response. In fact, in this type of case the opsonic index is the only ready method for determining whether the tuberculin used is of satisfactory potency. In localized infections, therefore, where it is possible to observe the symptoms and conditions following vaccine, we are able at once to say whether or not our dosage is efficient or harmful. In the treatment of generalized infections, such as the septicemias, and in erysipelas, cellulitis, uterine sepsis, etc., infections characterized by temperature and generalized symptoms, much more care is necessary in using vaccine than in the localized infections, and much smaller doses must be used, with the idea of producing an immediate positive phase. In spite of the fact that the opsonic power may be low, and that the amount of vaccine introduced would seem infinitesimal compared to that already in the body, it is impossible to conceive that large doses could do anything but maintain a lowered state of resistance. We know that a minute dose of streptococcus, for instance, of 5,000,000, may produce in septicemia an immediate elevation in opsonic power. We further know that such an elevation will persist for but a few hours only, hence such dosage must be repeated more frequently than if larger doses were given. Hence in septicemia the dose should be repeated every day or more often. We cannot afford in these cases to diminish the phagocytic power or other factors in resistance even for a few hours, because during that time the bacteria will find conditions more suitable for unbridled growth. In infectious processes with temperature, a drop during the few hours following inoculation would indicate that the dosage used was not harmful, while a rise might or might not indicate that the effect was toxic. Temperature and subjective symptoms appear to be the best clinical guide.

A good rule to follow in the use of vaccine is, *the sicker the patient, the smaller the dose that should be given.*

When it is impossible to obtain guidance from clinical symptoms, as in tuberculous glands, as to the dosage necessary, one must fall back on experience in giving tuberculin to these cases under guidance of the opsonic index. The initial dosage should be so small that symptoms are out of question, and every increase should be likewise minute enough to entirely avoid them.

There is no rule as to the period that is to elapse between doses. The vaccinating qualities of the vaccine, and the ability of the patient to respond to its action, are variable factors. Hence no interval has been laid down as the proper one. A minute dose which may produce a rise in the opsonic power almost at once will be followed by a brief positive phase, and hence reinoculation is soon necessary. A dosage might be arrived at which could be repeated every four hours, every day, or less often. There can be no fixed rule. In septicemia and like conditions small doses must be used and hence they must be given daily or more often.

In starting inoculation after operative procedures, the fact that the operation *has induced an autoinoculation* should be borne in mind, and no vaccine given until the full effect of it has worn off. In carbuncle two or three days may elapse, in tubercle a week perhaps, depending on the amount of autoinoculation which the extent of the surgical procedures would lead one to suspect.

Dangers in Overdosage.—It is obviously most desirable in the exhibition of vaccine to avoid producing anything in the way of severe subjective symptoms. The future of vaccine therapy will be much more secure if satisfactory results can be achieved without production of unpleasant symptoms immediately following inoculation. We may take, of course, production of subjective symptoms as danger-signals, that the dosage is producing a negative phase and may well be smaller. If inoculation be given, using signs of intolerance of vaccine as a guide, there must be reached in almost every case treated a point when intolerance will be manifested. The so-called clinical method of giving vaccine gradually increases the dosage, with the idea of securing eventually tolerance to large doses of vaccine. In contrast, the method that

Wright has developed, using the opsonic index as a guide, does not increase the dose until there is evidence that the last dose has not been efficient in raising the opsonic power of the blood. Increase, therefore, has been gradual. During five months' service in Wright's clinic, at St. Mary's Hospital, the writer remembers but one or two instances where severe subjective symptoms, focal or general, were produced by inoculations. In cases treated by the writer in the past four years, opsonic index determinations have not been used as a guide to treatment. The initial dose has always been sufficiently small to make it certain that no serious negative phase will be induced. The doses have been increased gradually, in accordance with the experience gained in treating cases with the opsonic index as a guide, and in infections other than localized staphylococcic there has been but rare instance in which tolerance has been noted. The final dosage of tuberculin, after a year's treatment, has invariably been smaller than that reached after a like period by those using the clinical method. The results have been satisfactory, and the patients in all cases have continued to accept treatment without any fear of being made ill. In the case of furunculosis, however, it has been the custom to give somewhat larger doses than those calculated *not to produce* subjective symptoms, as it appears that more rapid improvement will take place following a dosage, such as may produce temporary exacerbation without doing the patient harm.

Glandular tuberculosis is noteworthy, in that, even though prolonged negative phase may follow a tuberculin injection, there may be no evidence in the condition of the patient or in the focus of disease that such is the case. A series of excessive doses may be thus given over a long period, and the sum total of the effect may be in the direction of reducing the patient's resistance instead of increasing it. In some cases, where no improvement is shown from month to month, it is impossible to determine whether or not the scheme of dosage has been such as to produce a heightened opsonic power consistent with improvement. In these cases the opsonic index, occasionally determined, will indicate as to whether the tuberculin as given is efficient.

It has been shown by Wright and others that excessive doses or too frequent dosage induces a more or less continuous condition of negative phase and lack of resistance. While such a condition might not be of serious import to the life of the patient, in glandular tuberculosis, in furunculosis, or in strictly localized infections, it is certainly not the case where bacteria are multiplying in or gaining entrance into the blood through autoinoculation. It is perfectly evident that if, in such cases, the ability of the blood-stream to destroy bacteria is lessened, there will be offered a much better opportunity for living bacteria to exist in the blood-stream for a sufficient length of time to be transferred to other parts of the body, and possibly to produce new foci of disease. In addition to this, the size of the autoinoculation, that is, the number of bacteria introduced into the blood, may be definitely increased on account of the increased activity in the focus, which is known to accompany the negative phase immediately following excessive autoinoculations. This stirring up of the focus after excessive inoculation, and its effect in inducing autoinoculation, is perfectly well illustrated in pulmonary tuberculosis following diagnostic dosage of tuberculin. Here, the focal signs and the temperature induced can mean nothing else than that bacteria are being taken in excessive numbers into the blood-stream. In pulmonary tuberculosis, the harm which an excessive dose of tuberculin may produce is evidenced by the unfortunate results which occurred following the first use of tuberculin after its discovery by Koch, and since that time, by the induction of generalized tuberculous infections and the production of other foci of disease following its excessive use.

A case of extensive furunculosis of the neck of several months' duration is illustrative of the harmful effect of injudicious dosage of vaccine in localized infections. The case was referred to the writer for decision of the question as to why the vaccine as injected had not been followed by a cure. Patient had been receiving 400,000,000 staphylococcus aureus vaccine daily for about a week, and, previous to this, the same dosage had been given every two or three days for a month. The condition showed no improvement. Following the writer's suggestion, no vaccine was injected for five days. Then the same dosage was given and repeated four days later. At the end of two weeks the patient was entirely well, and, so far as is known, has since remained so. This would appear to be clinical evidence of a more or less continuous negative phase produced by too large and too frequent dosage, and of its result in leading to chronicity rather than to recovery. Such cases are not serious in their outcome, but their frequent occurrence cannot be of any advantage to the welfare of vaccine therapy.

The really serious results of overdosage of vaccine would appear to be in the generalized infections and in those subject to autoinoculation. Here the maintenance of a lowered antibacterial power in the blood-stream may most certainly be conducive to unbridled growth of bacteria in the blood, and to the induction, in acute cases of severe toxemia. In septicemias, such lowering of the antibacterial power obviously should not be produced even for a few hours. In cases subject to intermittent autoinoculation, excessive dosage of vaccine, occasionally given, might conceivably do no harm, but if given sufficiently often to cause a persistent lowering of the antibacterial power of the blood, *although conceivable that the patient may recover in spite of it, he cannot recover on account of it.* A case in point, indicating probably disastrous results from over dosage of vaccine, is one which came to the writer's attention after it had been treated for over a month with injections of colon vaccine. Following appendectomy a discharging sinus persisted. That autoinoculation was taking place irregular temperature indicated. For some time colon vaccine had been injected every few days, and for the week before the patient was seen by the writer, inoculations of 200,000,000 organisms had been given approximately *every four hours.* It was stated that the idea in giving such frequent and excessive dosage was based on the supposition that opsonins are produced locally; that a localized inflammatory reaction at the point of inoculation is indicative that the vaccine is effective in production of antibodies; that hence, the more local reactions that are produced, the greater the production of antibacterial substances.

Without discussing the fallacy of this reasoning it may be stated that the patient gradually lost ground, became emaciated, and finally reached an extremely critical condition. Physical examination suggested that the condition might be due to an abscess in the vicinity of the diaphragm. Operation revealed that there was no such condition. Smears on agar were made from the blood at the time of operation, and on being incubated showed a solid growth of colon over the whole surface of the culture-medium. The patient died several days later. In the absence of any evidence of local condition which might have produced death, it is to be assumed that it was due to colon septicemia.

In treating septicemic cases, a scheme of dosage that will induce repeated slight elevations of the opsonic power, without previous negative phase, must be used. Elision of negative phase is possible if we hold to minute dosage. The rise in opsonic power obtained is of short duration. Hence reinoculation is necessary at short intervals. The same rule holds in all cases subject to autoinoculation.

The size and frequency of dosage depend on the character of the autoinoculation: small, if it be continuous and excessive, as indicated by temperature and toxemia; larger, if intermittent and less in amount.

The rule that "the sicker the patient the smaller the dose of vaccine" cannot be repeated too often or too strongly emphasized.

Site for Inoculation.—That commonly used, because most convenient to get at, is the upper posterior portion of the arm. The back or abdomen is quite as satisfactory, but cannot be reached so easily.

The probability that antibacterial substances are produced at the point of inoculation would suggest that advantage might be gained by placing the inoculation at such a point, in relation to the lesion, that the lymph-stream may at once carry the newly formed protective substances into contact with the bacteria therein, before they become diluted by the whole blood-stream. Wright states that by thus inoculating "up stream," as it were, better results have been obtained in certain cases than by the usual method.

Local Reaction.—Inoculation of vaccine, using dosage of serviceable proportions, commonly produces at the point of injection an inflammatory reaction. This is dependent partly upon the size of the dose, partly on the condition of sensitization of the patient to the poison of the infecting bacterium. Ordinary therapeutic doses do not produce a reaction in the case of individuals uninfected by the corresponding organism. In infected individuals the reaction varies somewhat according to the size of the dose. As the patient recovers from the infection, the reaction becomes less marked and finally may not appear after very large doses. The reaction consists of redness, swelling, tenderness over an area of varying size. It may involve the skin of the whole posterior portion of the upper arm. Its onset is commonly within a few hours after inoculation, and it reaches a maximum within thirty-six hours. If the inoculation be given deeply, the reaction is less apparent. Associated with a marked local reaction may also occur a focal reaction, manifested by increased signs of activity in the lesion. Experience has shown that, in general, those cases which develop the more active local reactions react best to the vaccine in their protective response, and are most apt to do well.

These local reactions are specific. They do not appear unless the vaccine used is derived from the organism that is the infecting agent. In localized infections the absence of reactions after a moderate dose indicates that the vaccine is probably not the proper one; in other words, the diagnosis of the actual infecting agent is in error. Exception to this rule is found in some individuals who have apparently not the power to react. In some grave septicemias local reactions may be absent. A properly small dose in septicemia may produce only the slightest local reaction, or none at all if injected deeply.

Untoward local effects are rarely seen. It is conceivable that a reaction might be so acute that the tissues might break down. This actually occurred in one of the writer's cases. Culture from the pus proved sterile. The vaccine, which had been used in treating many patients with good results, also proved sterile.

In tuberculous conditions therapeutic doses of vaccine, if injected deeply, commonly produce no demonstrable local reaction. A small, hard nodule may, however, develop. If injected into the skin, or just below it, a reaction similar to that of von Pirquet may be produced. Local reactions have not been prominent in cases treated by the writer.

Skin reactions, in that they appear to be specific, are valuable as indicating whether or not the proper vaccine is being used, and their intensity indicates to some degree the power of protective response of the individual. The gradual loss of ability to react locally to increasing doses may mean increasing immunity to the organism in question.

Focal Reaction.—This is best seen in the treatment of furunculosis. If the dose of vaccine be of sufficient size, associated with the local reaction and the negative phase, increased tenderness, possibly swelling, increased discharge, and possibly a new lesion, may appear at the seat of infection. In pulmonary tuberculosis focal reaction consists in increased râles, both in number and extent, and possibly increased expectoration.

In gonorrheal joints a dose of 10,000,000 bacteria may be followed by increase in pain, swelling, and tenderness in any or all joints affected. If a larger dose is used, the symptoms become more pronounced. These focal reactions give evidence of increased activity of the bacteria in the focus of infection. The period in which they develop corresponds to that of the local reaction, and to the phase of diminished resistances, as indicated by the opsonic index.

Focal reactions are made use of in diagnosis of pulmonary tuberculosis, and Irons [1] has made use of the focal reaction in diagnosis of gonorrheal joints. In some cases of localized tuberculosis focal reaction may follow a dosage of $\frac{1}{500}$ mg. or less of tuberculin, and thus localizing diagnoses may sometimes be made.

PREPARATION OF BACTERIAL VACCINE

The successful application of bacterial vaccine in the treatment of infectious processes depends fundamentally upon a properly prepared and constituted vaccine. There is required for the production of such a vaccine a well-equipped laboratory, separate and apart from routine

[1] Arch. of Int. Med., 1908, i, p. 432.

pathologic work, kept clean and as free as possible from dust, and devoted exclusively to the purpose. Test-tubes and other glass receptacles which may be used as containers at any stage in the preparation of vaccine should be used exclusively for these purposes. Animals used in inoculation experiments should be kept apart from those used in routine pathologic work. Certain special apparatus will be convenient, and will later be described. Of importance equal to that of a laboratory is the use of a carefully elaborated technique, which shall offer every possible safeguard to the end of securing vaccines that shall be accurately standardized, sterile, and free from any contaminating growth.

The constitution of the bacterial vaccine is suggested by the commonly accepted definition, which is as follows: *The bacterial vaccine is a suspension of killed bacteria, which, when introduced into the animal body in sufficient dosage, induces an elaboration of antibacterial or protective substances, specific in their action against the variety of bacteria injected.* A properly constituted vaccine for any particular case is, therefore, one that is made up of the specific bacteria that are the causal agents in the condition to be treated. There may be a number of bacteria of different kinds found coexistent in a given lesion. In mixed infections of this sort it will be necessary to determine which variety is the disease producer. In case the responsibility cannot be fixed, it will be necessary to use coincidentally two or three differently constituted vaccines to properly meet a mixed infection. If investigation shows infection to be due to a staphylococcus, pneumococcus, gonococcus, or to the tubercle bacillus, it is commonly satisfactory to make use of corresponding stock vaccine. In most of the other infections the infecting organism should be derived from the lesion and grown in pure culture, and from this culture the vaccine prepared.

LABORATORY TECHNIQUE

The technique to be followed in the preparation of vaccine varies somewhat according to the nature of the organism dealt with. The preparation of a *staphylococcus vaccine* will be described as a type, and modifications necessary in dealing with other species will be later noted.

The water of condensation in three or four tubes of nutrient agar is inoculated from a pure culture, the surfaces thickly inseminated, and incubated for a period of from twenty-four to forty-eight hours. The contents of a test-tube containing 10 cc. of 0.85 sterile salt solution, made up in distilled water, is poured into one of these tubes, and the growth rubbed off by means of a sterile platinum wire (Fig. 235). The opalescent emulsion thus produced is poured into the second, then into the third, and finally into the sterile tube which originally contained the salt solution. In pouring the emulsion from one tube to another great care must be taken thoroughly to burn off and heat the open ends of the tubes. They must be held slanted, at as small an angle as possible from the horizontal, at all times while being manipulated, in order to prevent air contamination. If, during the course of the preparation an open tube is temporarily set aside, it should be slanted in the same manner and for the same purpose. The final tube containing the emulsion is then heated in the blow-pipe flame, drawn out and closed, and shaken vigorously for from

FIG. 234.—POURING STERILE SALT SOLUTION INTO AGAR CULTURE.

FIG. 235.—WASHING OFF GROWTH.

FIG. 236.—STERILE TUBE CONTAINING EMULSION.

five to ten minutes, in order to produce a homogeneous emulsion. The sealing of a test-tube containing fluid requires some skill, the result of practice. The tube, held at an angle of 45 degrees or less, in the left hand, the open end is cautiously heated in the yellow flame until it is dry, both inside and out, up to two or three inches from its open end. Air is then turned on, and with the blue flame the extreme end of the tube is melted and a short piece of glass tubing is made to adhere to it, which shall serve as a handle when the tube is drawn out (Fig. 237). The tube is then rotated continuously in the flame, which impinges

FIG. 237.—TUBE CONTAINING BACTERIAL EMULSION, WITH HANDLE ATTACHED AS AN AID IN SEALING.

FIG. 238.—TUBE PARTIALLY DRAWN WITH WALLS THICKENED.

FIG. 239.—TUBE COMPLETELY DRAWN OUT.

as near the end as possible. When the wall of the tube is molten, the glass walls of the tube are allowed to run together, in order to thicken the wall of the portion that is to be drawn out. If this process of thickening is not accomplished, the wall of the portion drawn out may be too thin to be serviceable (Fig. 238). When properly thickened, the tube is drawn out while still in the flame until the diameter of the molten part is two-thirds that of the cool portion. It is then removed from the flame, and immediately drawn out until the tapered portion is ⅛ in. or so in diameter and 3 or 4 in. long (Fig. 239). The tube is then allowed to cool, heated subsequently in a small flame, sealed, and allowed to stand upright until cool (Fig. 240).

FIG. 240.—TUBE SEALED, READY FOR SHAKING.

Standardization.—After thorough shaking (fifteen minutes is sufficient), the tapered end is deeply scratched with a file or glass-cutting knife, ½ in. from the end (Fig. 241), broken off, sterilized in the Bunsen flame, cooled, a few drops expressed into a clean watch-glass or other receptacle (Fig. 242), and the open end of the tube resealed. It will commonly be found that the shaking has not broken up the clumps of bacteria, and that, therefore, further manipulation is necessary, that the portion of the emulsion to be standardized may contain as few and as small clumps of bacteria as possible. For this purpose, a small

FIG. 241.—SCRATCHING TUBE WITH GLASS CUTTING KNIFE, IN ORDER TO BREAK.

pipet is drawn out with a capillary portion about 1 mm. in diameter, and cut off squarely about 1 in. from the stub. A rubber teat is affixed to this pipet, the emulsion is drawn in and out forcibly, the pipet being held at right angles to the table against the bottom of the watch-glass (Fig. 243). By this means, further breaking up is effected. The emulsion should then contain bacteria singly, in pairs, or in very small groups.

A capillary pipet, drawn from ¼-in. glass tubing, exactly the same as the pipet used for opsonic index determination, the capillary end being about 5 in. long, cut squarely, is marked with a glass marking-pencil $\frac{3}{4}$ in. from the tip. A ligature is bound round the thumb of the left hand, the dorsum is pricked near the nail with a blunt glass needle (Fig.

FIG. 242.—EXPRESSING A FEW DROPS OF EMULSION FOR STANDARDIZATION; HEAT OF HAND EXPANDS THE AIR IN THE TUBE, AND FORCES OUT THE FLUID.

FIG. 243.—BREAKING UP A BACTERIAL EMULSION FOR STANDARDIZATION, OR FOR OPSONIC INDEX DETERMINATION BY PIPETING.

FIG. 244.—PRICKING THUMB WITH GLASS NEEDLE.

244). A rubber teat having been fitted to the pipet, three or four volumes of 0.85 salt solution are drawn in, then one volume of blood, one of bacterial emulsion, and again three or four volumes of salt solution (Fig. 245). The volumes of blood and emulsion must be separated from each other and from the salt solution in the pipet by air-bubbles; that is, as each volume is aspirated, it is allowed to run upward in the pipet, so that a space is left before the next volume is aspirated. The "volume" referred to is the amount of fluid between the end of the pipet and the pencil-mark. The amount of salt solution used does not alter the final results and need not be accurately measured. The contents

FIG. 245.—TAKING UP ONE VOLUME OF BLOOD INTO PIPET FOR STANDARDIZATION.

of the capillary are then thoroughly mixed on a glass slide by alternately pressing and releasing the rubber teat (Fig. 246), in order that in the mixture there shall be an even distribution of bacteria and red corpuscles. A small drop is then expressed on each of two or three clean glass slides (Fig. 247), and with the end of a fresh slide a smear is made (Fig. 248) and allowed to dry. These smeared slides are then immersed in a saturated solution of mercuric chlorid for three minutes, and stained with carbolthionin blue

FIG. 246.—MIXING BLOOD AND EMULSION.
Each one volume and several volumes of normal salt solution on slide.

for about one minute cold (thionin pure, Grübler, ¼ per cent., carbolic acid, 1 per cent.). If stained properly, the red corpuscles will have a light green and the bacteria a deep purple tint.

The actual standardization consists in counting the number of red corpuscles and bacteria contained in a series of fields of equal size in one of these slides, until 500 red corpuscles and the number of bacteria met with have been enumerated. In order to make counting easier, a more restricted field than that allowed by the eye-piece is of advantage, and to this end four hairs are made to adhere to the diaphragm inside the eye-piece, in such position that a small square field will be marked off and projected on the slide for a counting area. The number of cells and bacteria in each field are noted, added, and when 500 cells have been counted, the following proportion is worked out. Supposing that in counting 500 cells 600 bacteria have been encountered, the proportion is as follows: 500 (red cells) : 600 (bacteria) as 5,000,000,000 (the number of red cells in 1 cc. of normal blood) is to x. x — 6,000,000,000 of bacteria to the cubic centimeter.

FIG. 247.—A SMALL DROP OF MIXED BLOOD AND EMULSION ON EACH OF TWO SLIDES, READY FOR SMEARS.

The requirements for accuracy in this method of standardization are that the individual whose corpuscles are used shall have an approximately normal red count; that the bacterial emulsion shall be free from clumps; that where fields containing suggestions of hemolyzed red cells are met with, they should be excluded; fields should be counted in widely separated portions of the slide to insure fair average. At its best, this numerical test of the vaccine is but an approximation, but it is quite accurate enough for use. Quite as important as the number of the bacteria is their virulence, which cannot be measured except

FIG. 248.—MAKING SMEAR.

by the method of trial and error upon the patient. To avoid error we use minute doses of the vaccine to start in the case of any vaccine that has never been tried. The actual numerical standardization of a vaccine, then, by these methods, has been satisfactorily arrived at.

A more accurate count is possible, and much easier accomplished, if on the slide to be counted the number of red cells about equal that of the bacteria. Hence, if before mixing the blood and emulsion for standardization the vaccine appears to be extremely thick, sterile salt solution should be added in sufficient quantity properly to dilute; if the emulsion appears to be thin, as in the case of streptococcus and pneumococcus vaccine, two to six volumes of emulsion should be used to one of the blood. Experience teaches one to judge the probable content of a bacterial emulsion per cc. from its opacity, so that the proper adjustment can be made from inspection.

Sterilization.—As soon as the few drops of emulsion are expressed from the tube for standardization, the tube is sealed and at once immersed in a water-bath at 60° C., in which

FIG. 249.—WATER-BATH FOR STERILIZING VACCINES.

A, Metal thermoregulator; *B*, wire basket; *D*, Spindle attached to bottom of basket; *C*, Diaphragm with set-screw, for holding tubes of vaccine beneath the surface of water. This slides on spindle *D*.

it is allowed to remain for one hour. The shorter the exposure to heat, the less the vaccinating quality of the vaccine should suffer. After the period of sterilization, care having been taken that the temperature of the bath has remained constant, and that the tube has been completely immersed, it is removed from the bath, the end broken off, and, with sterile precautions, one or two drops of emulsion is expressed upon the surface of an agar

FIG. 250.—EXPRESSING DROP OF VACCINE ON SURFACE OF AGAR SLANT, FOR TEST OF STERILITY.

slant (Figs. 250, 251). This, incubated twelve hours, will show whether or not the vaccine has been successfully sterilized. After sterilization, a label is affixed to the tube container stating the kind of vaccine, its derivation, number of bacteria per cubic centimeter, the length of time sterilized, and the date. The vaccine should not be used for inoculation until the test culture has been incubated at least twelve hours and is proved to be sterile.

Keeping qualities of vaccine may be insured by storing the stocks in a cool place. It is probable that there is some deterioration month by month. A toxin, such as old tuberculin, appears not to retain its vaccinating power for more than a few weeks *if diluted*. Tuberculin R, and the so-called bacillen emulsion, apparently lose none of their efficiency in the various dilutions, even after several months. The writer has used a

FIG. 251.—EXPRESSING DROP OF EMULSION ON STERILE PLATINUM LOOP, FOR TEST OF STERILITY OF VACCINE.

staphylococcic vaccine which he prepared in Wright's laboratory for over a year, and has noted very little diminution in its vaccinating qualities, even though it has been kept at room temperature. It is not necessary to keep vaccines upon ice if they are to be used within two or three months.

FIG. 252.—ESSENTIALS FOR BLOOD CULTURES.

A, "Collin" syringe, sterilized with oil at 140° C., inserted into a sterile 8" by 1" test-tube; the needle in cotton plug; a heavy rubber test-tube cap holds syringe in tube; B, bouillon in 8" by 1" tube sealed; C, bile in 8" by 1" tube sealed; D, lysol; E, alcohol lamp; F, glass-cutting knife.

If one desires to prepare large amounts of vaccine, methods used by commercial houses may be employed. In dealing with a large inoculation clinic, the writer has found that the preparation of considerable quantities at one time is desirable. For this purpose mass cultures, grown on the surface of agar in Roux flasks, or large flat eight or sixteen-ounce bottles with wide necks, furnish the necessary growth. To inoculate such bottles a twelve-hour growth of the organism in bouillon is poured over the surface of the receptacle and stood upright in the incubator. The sterile salt solution used in the preparation may amount to 50 cc. or more, and it is, therefore, convenient to use as containers 8 by 1 inch extra heavy test-tubes, which will be the final containers for the stock vaccine. Care must be used in burning off the neck of a bottle or flask, both inside and out, before making any transfers of fluid by pouring. There is less danger of air contamination if the transfer of emulsions is made by means of pipets. The method of sealing the large tubes is similar to that where a smaller one is used. The other steps in the preparation of stock are

FIG. 253.—READY FOR ADDING LYSOL TO BOTTLE OF STERILE 85 PER CENT. SALT SOLUTION. COTTON PLUG REMOVED.

as stated. It is well to have the bacterial contents of stocks, in case of staphylococcus, from 5,000,000,000 to 15,000,000,000 per cc.

Bottling the Vaccine.—The next step is to dilute a portion of the vaccine prepared, in such strength and in such containers as will make it convenient for actual use in the treatment of patients. In the case of our staphylococcus vaccines, three strengths are desirable: one bottle containing 200,000,000 organisms per cc., another 500,000,000, and

FIG. 254.—ADDING LYSOL, ½ OF 1 PER CENT., TO VACCINE BOTTLE CONTAINING STERILE 85 PER CENT. SALT SOLUTION. COTTON PLUG IS THEN REPLACED.

a third 1,000,000,000. A convenient-sized bottle for staphylococcic vaccine contains 50 cc., but where a small number of cases are being treated, bottles of 15 cc. capacity are more satisfactory.

The mode of preparation of these vaccine bottles is as follows: A number of large-mouthed ½-ounce "French square" bottles are washed with weak hydrochloric acid solution, rinsed with water, and dried out thoroughly by inverting over a heater. They are then plugged lightly with cotton and placed in a dry sterilizer for one hour, in order to set the cotton plugs. With a large pipet there is added to each bottle 15 cc. of 0.85 per cent. salt solution, made up with distilled water, and the cotton plugs replaced. These bottles are then autoclaved for one-half hour at fifteen pounds pressure. To each bottle is then added 35 c.mm. of pure lysol, and the cotton plug replaced (Fig. 254). The method of adding this lysol is as follows: By means of a standard millimeter pipet, 35 c.mm. of

FIG. 255.—AFTER STERILE RUBBER CAP IS ASEPTICALLY APPLIED TO "BLANK" VACCINE BOTTLE, THE LATTER IS DIPPED INTO MELTED PARAFFIN (AT 140° C.) TO SEAL.

mercury are measured out and drawn into a pipet similar to that used for standardization purposes. This pipet is marked off, so that the above quantity of lysol can be measured. The pipet is then sterilized in the flame and used for the above purpose. Each bottle will then contain 85 per cent. sterile salt solution, with ¼ of 1 per cent. (approximately) of lysol as a preservative.

FIG. 256.—APPLYING CAP TO VACCINE BOTTLE.

These bottles are then to be covered with sterile rubber caps, such as those used in Wright's laboratory. The rubber should be thick and of pure gum, and of such consistency that it will heal after each puncture of the hypodermic needle.

This cap should be rinsed in water and boiled ten to fifteen minutes in a 10 per cent. lysol solution. The bottles should be taken one at a time, held at an angle of 45 degrees or less, the neck burned off in a Bunsen flame, with sterile forceps the cap removed from the lysol solution, and stretched over the neck of the bottle aseptically. As each bottle is capped, with the thumb pressed tightly against its top (Fig. 256), it is at once shaken in order thoroughly to distribute the lysol, otherwise it is apt to be stringy and break up into small flocculi later. After all the bottles are thus capped and shaken they are inverted, and the cap dipped into melted paraffin in order thoroughly to seal (Fig. 255). These bottles may be termed "blanks," and are to be used as containers for vaccine for use on the individual patient.

The method of transferring the vaccine from the stock tube which we have just prepared is as follows: if we desire the vaccine to contain 1,000,000,000 per cc., we find that

FIG. 257.—ABSTRACTING STANDARDIZED AND STERILIZED VACCINE FROM STOCK TUBE.

we need in our 15 cc. bottle a total of 15,000,000,000 organisms. There being 6,000,000,000 organisms (in this case) in each cc. of our stock, simple calculation will show that it is necessary to add 2½ cc. of the stock to the solution in the bottle. Before adding the vaccine, however, we must abstract an equal amount of fluid from the bottle. These transfers are made, using a 2 cc. syringe graduated to $\frac{1}{10}$ cc. A drop of pure lysol is placed upon the rubber cap of the "blank" bottle, the sterile needle is inserted through this lysol, the

FIG. 258.—INJECTING PROPER AMOUNT OF VACCINE INTO BOTTLE OF STERILE LYSOLIZED SALT SOLUTION, FOR ACTUAL USE, IN TREATMENT.

bottle inverted, and the amount withdrawn. The tube containing the stock vaccine is vigorously shaken for a minute or two, the end of the tapered portion is broken off, flamed, and the tube held in the left hand inverted. If the fluid does not enter the tapered portion far enough for the needle to reach it, the heat of the hand, plus a little shaking, will often suffice to effect this. If not, the but end of the tube may be held near a Bunsen flame. The proper amount of emulsion, in this case 2½ cc., is to be withdrawn and injected through the rubber cap into the bottle (Fig. 258). The bottle will now contain 15 cc., each cubic centimeter which will hold 1,000,000,000 of organisms. This bottle, after being labeled properly and shaken, is ready for use.

If the vaccine stock be a large one, or apt to be opened frequently, it is best to add, as a preservative before closing, ¼ per cent. lysol. If the amount of emulsion to be added to each bottle is more than 10 per cent. of its total bulk, the stock should always previously receive ¼ per cent. lysol, in order that the completed vaccine may still have the full ¼ per cent. of lysol. To estimate roughly the amount of vaccine in a tube, in order to determine the proper amount of lysol to add, the tube is immersed, up to the level of the vaccine, in a graduated beaker with some water in it and the rise in the water noted. Allowance of the thickness of the vaccine container must be made and subtracted.

Carbolic acid, ¼ per cent. to ½ per cent. or more, may be used as a preservative instead of lysol. The advantage of the former is that the vaccine is less opalescent and does not

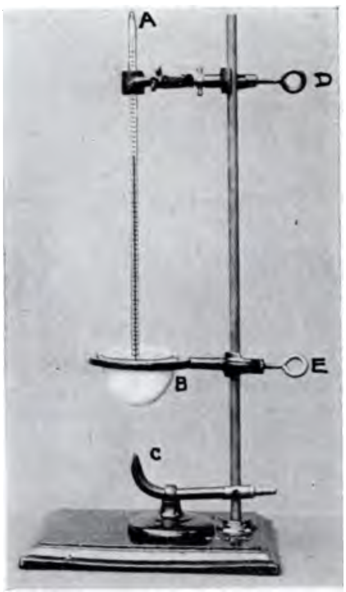

FIG. 259.—SIMPLE APPARATUS FOR OIL STERILIZATION, CONSISTING OF RING STAND.

A, Thermometer; B, porcelain dish for oil; C, burner (Bunsen); D, clamp for thermometer; E, ring for dish.

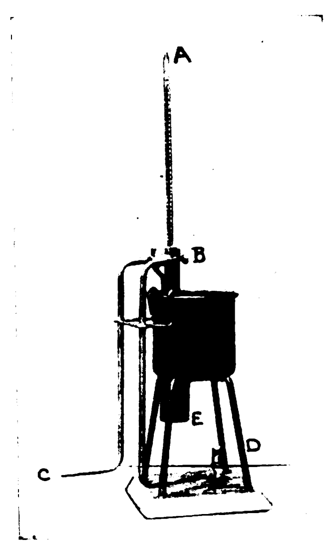

FIG. 260.—OIL BATH FOR STERILIZATION OF SYRINGES USED IN INOCULATION, PREPARATION OF VACCINES, AND TAKING BLOOD CULTURES, ETC.

A, Thermometer; B, bimetallic thermo-regulator; C, gas inlet and pipe leading through regulator; D, 2-foot "Bray" burner; E, prolongation of oil receptacle to accommodate thermometer and regulator.

develop a flocculent precipitate, which occasionally forms when lysol is used. It appears to the writer that lysolized vaccines are more efficient than those preserved by carbolic acid.

Method of Sterilizing Syringes.—The syringe is so continuously in use in making vaccines and in inoculating patients, that some more ready and effectual method for instantaneous sterilization than boiling affords is of great advantage. Sterilization by boiling is slow, inefficient, and causes the syringe to deteriorate. The method introduced by Wright for sterilizing syringes, by filling and refilling several times with cotton-seed oil, kept at a temperature of 130° to 150° C., meets every requirement. These temperatures at once kill bacteria or spores; that is, they give us an instantaneous autoclaving effect. Besides, the oil keeps the syringe always in easy working order. Syringes of the Roux-

Collin or the Ermold type will stand these temperatures with rare breakage. The writer has used a single Ermold syringe for four months without replacement of any part save the needle. A simple and satisfactory oil bath is here illustrated (Fig. 241). A more satisfactory oil bath, however, is one having a device for regulating the temperature constantly at the desired point (Fig. 260).

The preparation of a *streptococcus vaccine* requires the cultures to be grown for from one to three days, and that once or twice during this time a sterile platinum wire be carried over the surface in order to cause thick insemination. One or two bouillon cultures planted at the same time should be used to wash off the agar growth instead of salt solution, in order to fortify the emulsion. The breaking up of the chains of streptococcus for standardization purposes is difficult, and a more prolonged shaking and pipeting than in the case of staphylococcus and some other bacteria will always be required. A streptococcus emulsion may contain from 200,000,000 to 1,000,000,000 per cubic centimeter, and, consequently, in standardizing one must take from three to six times as much emulsion as blood, according to one's estimate as to the probable content of the emulsion from gross appearances. Streptococcus vaccines should be bottled for actual use in strengths of from 50,000,000 to 200,000,000 of bacteria per cc.

Pneumococcus and *gonococcus* vaccines differ from the staphylococcic vaccine in the mode of preparation only in their difficulty in growth, and in their requirement that special culture-media should be used; 1 cc. of hydrocele fluid or human serum for each tube. For the pneumococcus sheep serum may be used. For this purpose 50 cc. of clear sheep serum is added to 100 cc. of distilled water, and sterilized for fifteen minutes at 10 pounds pressure in an autoclave. The resulting fluid will be quite opalescent, but they will contain no flocculi. One or 2 cc. of this added to each tube of nutrient agar makes a fair medium. Emulsification of pneumococcus is somewhat more difficult than of staphylococcus. Fifteen minutes' shaking, plus five minutes' pipeting, will be necessary.

Colon and *typhoid* vaccines may be sterilized in forty-five minutes, and at a temperature of 58° C., or for seventy minutes at 53° C. Emulsification is very easy and very little pipeting is required. In standardization of typhoid vaccine a blood should be used which does not agglutinate typhoid bacilli. For curative inoculation, typhoid vaccine should be bottled in strengths of 100,000,000 to 200,000,000 per cc.

THE TUBERCULINS

Tuberculin R and tuberculin O are the results of a process of grinding the bodies of virulent tubercle bacilli into a fine powder. The bacilli are finely comminuted, suspended in water, and centrifugalized. The deposit is called tuberculin R, the supernatant cloudy fluid tuberculin O. The former is, then, bacillary substance with some soluble portions of the bacilli removed; the latter is an opalescent solution of the substances soluble in water.

Bacillary emulsion, or B. E., is a suspension of the comminuted bodies of tubercle bacilli. It, therefore, contains all the immunizing substances of the bacilli, whereas tuberculin R is minus certain soluble constituents. Although there are many other tuberculin preparations, the three mentioned are the most commonly used in the treatment of the types of tuberculosis with which this article deals.

The preparation of these tuberculins for actual use on the patient consists in making proper dilutions of the concentrated preparations obtained from manufacturers. Tuberculin R is commonly sold in vials containing 1 cc. of fluid in which there are 2 mg. of vaccinating substance (Miester, Lucius, and Bruning). Bacillary emulsion may be obtained in 5 cc. vials, each cubic centimeter containing 5 mg. of bacillary substance.

It is convenient to prepare for actual use three strengths of tuberculin R and of bacillary emulsion, one to contain $\frac{1}{500}$ mg. per cc., another $\frac{1}{1000}$ mg. per cc., and a third $\frac{1}{5000}$ mg. per cc., in order that the dosage may be accurately administered. Before making dilutions of the German product it has been found best to sterilize the original preparation for one hour at 60° C. If sterilization is to be done, it will be necessary to make two of Wright's so-called "curly pipets." For this purpose a piece of $\frac{5}{16}$ or $\frac{3}{8}$-inch tubing, 6 in. long, is heated in its middle and drawn out into a $\frac{1}{8}$-inch capillary, and cut off so that the tapered end of each tube will be 4 or 5 in. long. The undrawn end is then heated at a point such that will allow at least 1 cc. of fluid to be drawn into the tube. After the glass is thoroughly molten at this point, it is drawn out so that there will be a constricted portion a little over an inch long, and while still pliable, the end of the tube is rotated in its long diameter or twisted so that the drawn-out portion is given a complete recurve (Fig. 261). This tube is sterilized in the flame. A second is prepared in the same way, and likewise sterilized. The vial containing tuberculin is unstoppered, the mouth flamed, and the contents drawn up into the curly pipet and the end sealed; 1 cc. of sterile salt solution is poured into the vial to completely wash out the tuberculin which may have been adherent to the interior of the vial. This is drawn up into the second pipet, which is likewise sealed. These two pipets are then suspended for one hour in a water-bath at 60° C. We then have 2 cc. of tuberculin R, in which there is a total of 2 mg. of solid substance. To an

FIG. 261.—WRIGHT'S "CURLY PIPET" USED AS A CONTAINER FOR TUBERCULIN DURING STERILIZATION.

8 by 1 test-tube, containing exactly 48 cc. of sterile 85 per cent. salt solution, the contents of these two pipets are added, and the tube drawn out in the flame and sealed as previously described. We then have a solution of tuberculin R which contains $\frac{1}{25}$ mg. per cc. The bacillary emulsion should be sterilized and prepared in the same manner. In this case, however, but 1 cc. of the fluid is withdrawn from the original vial under sterile precautions, the stopper replaced, and the remainder saved for future use. Certain American preparations of tuberculin do not require sterilization, according to the statement of the manufacturers. The technique of diluting these preparations may be as follows: To an 8 by 1 tube, containing 48 cc. of sterile salt solution, 1 cc. of tuberculin R is added, using a sterile syringe. The vial is then washed out with 1 cc. of sterile salt solution and this added. We then have a solution containing $\frac{1}{25}$ mg. per cc. The tube is sealed and labeled. The dilutions made in this manner are kept as stocks, and from them further dilutions are made for actual use—125 c.mm. of lysol should be added to each 50 cc. stock solution. To prepare a solution to contain $\frac{1}{100}$ mg. per cc., we find that, using a 15 cc. bottle of lysolized salt solution, we require a total of $\frac{15}{1000}$ mg. of bacillary substance. There being $\frac{1}{25}$ mg. in every cubic centimeter of the stock, we find that we require 0.37 cc. of the stock. This amount having been extracted from a blank lysol salt vaccine bottle with a sterile syringe, the same amount of the stock is injected through the rubber cap and the bottle well shaken. To prepare a bottle to contain $\frac{1}{500}$ mg. per cc. twice this amount of the stock must be added. To prepare a bottle to contain $\frac{1}{5000}$ mg. per cc. we must transfer 3 cc. from the bottle containing $\frac{1}{1000}$ mg. per cc. Before these additions are made, equal quanta of the contents of the blank vaccine bottles must be abstracted.

Tuberculin O is used for the von Pirquet tuberculocutaneous test. It is convenient for use to have old tuberculin in sealed capillary tubes, each one containing sufficient undiluted tuberculin for a single test. Three-eighth inch glass tubing is drawn out into a fine capillary, the long tube thus made is cut into 2-inch lengths, one end of each sterilized, and inserted into the tuberculin container. The fluid readily runs into these tubes by capillary traction. Both ends are then sealed in the flame.

THE STERILIZATION OF VACCINES

At the present time the only method that can be recommended for every-day use in killing bacteria for vaccines is the use of heat. The temperature of 60° C. for one hour can be depended on to kill any species of bacteria which are at present used in the preparation of vaccine. It is the temperature most commonly used.

There is sufficient evidence that this amount of heating injures the vaccinating qualities of certain bacteria. It is, therefore, desirable to subject the vaccine to as short an exposure as possible to this degree of temperature. In the case of staphylococcus albus, citreus, colon, and Friedländer's bacillus, exposing in a water-bath at 60° C. for fifteen minutes, and immediately following the addition of $\frac{1}{4}$ of 1 per cent. (of the total bulk) of lysol, has been found sufficient to destroy these bacteria. In the case of staphylococcus aureus, however, from twenty to twenty-five minutes will commonly be required. In the case of gonococcus the addition of $\frac{1}{4}$ of 1 per cent. lysol to the bacterial emulsion, thorough shaking, and exposure to a temperature of $37\frac{1}{2}$° C. in an ordinary incubator for a period of twelve hours have been found to kill the organisms. In the case of typhoid the present method of sterilization used in Wright's laboratory, London, is exposure to a temperature of 53° C. for seventy minutes. In the case of streptococcus and pneumococcus heating for thirty minutes is ordinarily sufficient. In all cases it is wise to add lysol immediately after sterilization. In every case the vaccine should be tested culturally to prove its sterility. Other methods of destroying bacteria in the preparation of vaccine to the end of rendering it a more efficient immunizing agent will be discussed later.

NEW METHODS OF KILLING BACTERIA FOR VACCINES

There is considerable evidence that vaccines composed of bacteria killed by heat are not so efficient, so far as their vaccinating qualities are concerned, as those killed by some other methods. It appears that heat in some manner modifies the particular toxic substances contained in the bacterial cell in such a manner as to render them less efficient in inducing the formation of corresponding specific protective substances. It would be desirable, if possible, to make use of bacterial protoplasm as vaccine without subjecting it to the modification of heat.

We have good evidence, in the work of Weaver and Tunnclifie,[1] that a streptococcic vaccine, composed of organisms killed by a solution of galactose, has superior vaccinating qualities to the same killed by heat. By inoculating animals they compared the immunizing effect of vaccines prepared by these two methods. Their experience in using streptococcic vaccine, prepared in the ordinary manner by heating, is consistent with that obtained by many workers, in that they found that the results were not so good as had been obtained in the use of vaccines of other types of organisms.

Their technique was as follows: They washed off in a sterile 25 per cent. galactose solution a twenty-four-hour growth of streptococcus on blood-agar, 2 cc. of the solution being employed for each agar slant. This suspension of bacteria in galactose solution was incubated for from forty-eight to seventy-two hours, and during this period was shaken several times. The emulsion obtained from each agar tube was centrifugalized, the supernatant fluid pipeted off, and the residue desiccated in vacuum over calcium chlorid at room temperature and sealed. Usually the bacteria were found to have been

[1] Jour. Infec. Dis., Dec. 18, 1908.

killed in twenty-four hours. One strain of streptococcus was not killed in forty-eight hours, but was sterile after seventy-two hours. The killed organisms were then suspended in 2 or 3 cc. of sterile normal salt solution. The vaccines which they used for comparison were prepared in the usual manner, and killed by thirty minutes' exposure to a temperature of 60° C. They found that galactose-killed streptococci induced in rabbits more or less immunity to the living streptococcus. It required five to seven days after the inoculation for this immunity to appear. Protection afforded by two doses was greater than that of a single dose. They found that the opsonic index was elevated after injections and followed a more or less regular course. The negative phase was more marked after the first dose than after the second. The index was usually highest on the second or the third, fourth, and fifth days after injection. The larger the dose, the higher the indices. Two guinea-pigs were protected, each by the injection of 500,000,000 galactose-killed streptococci, and six days later each was inoculated with a living streptococcus culture intraperitoneally. Both were well a month after inoculation. The control, unprotected animal died in eighteen hours. As a part of the same experiment, guinea-pigs were inoculated by the same doses of heat-killed bacteria, and after the same period were inoculated with a living broth culture intraperitoneally. All these animals died.

Again, one rabbit was inoculated with 500,000,000 galactose-killed streptococci, four days later the same dose was repeated, and after ten days 3 cc. of a twenty-four-hour living broth culture of streptococcus was injected intraperitoneally. The rabbit did not become sick and was well a month later. A second rabbit, inoculated in the same manner, but with heat-killed streptococci, and later injected with the same amount of a living streptococcus culture intraperitoneally, died twelve hours after inoculation.

The advantage of the galactose-killed vaccine over that killed by heat appears to be perfectly definite. In one of the rabbits treated by galactose-killed vaccine the opsonic index six days after inoculation was 6. In the rabbit of the same group, treated by heat-killed vaccine, the opsonic index remained approximately 1.[1]

They conclude that subcutaneous injections of galactose-killed streptococci all produce definite phenomena, in the fact of a very great rise in the opsonin, as indicated by the increased phagocytic power; that hand in hand with this rise in opsonic power the animals developed a considerable degree of immunity to living virulent streptococci, of sufficient degree to protect the animal against doses of living culture that killed normal animals. The protection may be complete, or it may delay and modify the infection.

In marked contrast are the effects of the injection of heat-killed streptococci, in that they did not produce any pronounced increase in opsonin; the animals thus treated, when injected with living cultures, later appear to have had even less resistance than normal

[1] The clinical results in the use of heat-killed streptococci would more or less confirm this view. Certainly the use of streptococcus vaccine is not commonly followed by the consistently good effects seen in the case of vaccines prepared from other organisms. A reasonable explanation is that particular endotoxins of the streptococcus are much more easily altered by heat than those of some other bacteria commonly and successfully used. In general accord with these observations, as to the comparative inefficiency of streptococcus vaccine when killed by exposure to a temperature of 60° C. for one hour, is the experience of Leary (Boston Med. and Surg. Jour., 1909, clxi, 716). He states that "clinical results from the use of such vaccine were unsatisfactory." Consequently, he shortened the time of sterilization to fifteen minutes at 60° C. and obtained better results. "Positive cultures of the streptococcus may be obtained from the suspension" at the end of exposure. He adds ¼ per cent. carbolic acid after heating. He states that "this small amount of carbolic acid . . . results in killing or further attenuation of the organism, so that infection is not possible. We have now used such vaccine on several hundred cases without any infections and with results markedly superior to those obtained when Wright's rule was followed."

animals. They report excellent results in the treatment of patients. First, a case of suppurative otitis media and mastoiditis, the second, of chronic erysipelas. They conclude that, in view of the results in attempts in protecting rabbits against virulent streptococci by heat-killed vaccine, it is doubtful if one gains any advantage in the therapeutic use of streptococci killed by heat.

Clinical Practice

ACUTE FULMINATING INFECTIONS

A constant protection against the invasion of pathogenic organisms is the unbroken skin in health. The hair-follicles and the openings of the sebaceous and sweat-glands, however, become avenues of entrance for bacteria at times and localized infections may result. Excessive activity in the secretion of sebaceous material renders the skin oily and more apt to harbor bacteria on its surface. The tendency of these glands to become occluded, resulting in the formation of sebaceous cysts and comedones, offers opportunities for the surface bacteria to grow in a medium which is more or less out of contact with the circulating blood. Thus we have conditions which predispose to acne and furunculosis. A perfectly healthy skin is more or less proof against such infections, unless the organisms be inadvertently rubbed into these minute openings, or some injury impairs the blood-supply.

Infections taking place through the normal openings of the skin are commonly localized. We have, as a result, acne and furunculosis. This, however, depends largely on the virulence and character of the infecting organisms. When lymphangitis and temperature develop, the infection may be termed acute and fulminating in type, because in these cases the bacteria are unquestionably being taken into the blood-stream. The most serious of these fulminating infections are obviously those which originate from the entrance of bacteria through some traumatic break in the skin. The most common and least serious under ordinary conditions are those due to the staphylococcus. The graver infections result from the entrance of streptococcus, pneumococcus, and occasionally to some other bacteria. The gravity of the infection depends upon the number of organisms that gain entrance, the depth to which they penetrate, and the character of the tissues in which they find their initial seat. It is obvious, if large numbers of virulent bacteria suddenly find their entrance into the subcutaneous tissue, they will find opposed to them only few leukocytes and only a certain quantum of lymph. Although certain of the bacteria may be destroyed at once, an excess of organisms will immediately absorb the antibacterial substances that are at the locus of entrance. Trauma to the tissues at this point and a lymph of lowered antibacterial power would furnish a good medium on which bacteria which are not killed, will find more or less unbridled opportunity for growth.

If the locus of infection be superficial, tissue necrosis may take place in such a manner that the pus may point, and either evacuate itself or be readily evacuated by surgical procedure; further applications of heat will be efficient in inducing a more free blood-supply. The deep infection may be beyond the scope of ordinary therapeusis. Any collection of fluid which later will develop will necessarily be under greater tension; excessive autoinoculation will be apt to take place, because of this tension and of the impossibility of the pus to discharge itself. We have considered previously the characteristics of the pus of pyogenic bacteria, and have noted that it has a distinct tendency to dissolve connective tissue on account of the tryptic ferment it contains. In a deep infection this solution of tissues will take place in all directions under excessive tension.

If infection enters a tendon-sheath, there is nothing to prevent a severe infectious process, as the conditions are such in these sheaths as to prevent any rapid replacement of lymph, exhausted of its antibacterial power, by fresh lymph from the blood and leukocytes. The same may be said of serous cavities, such as the joints. There are but two types of localized infection which can be treated successfully by specific antitoxins. They are diphtheria and tetanus. Success in the treatment of the former depends on the addition of antitoxin during the early period of the disease, before it has appeared in the normal course of events in the blood. The success in the treatment of tetanus by antitoxin is nowhere near so great. In order to be efficient it must be administered immediately after infection has taken place, in large doses, at least every eight up to twelve hours.

In the treatment of superficial fulminating infections, in their very early stages, clinical practice appears to be overwhelmingly in favor of the application of heat by poultices and hot soaks where they can be applied. The application of these measures is unquestionably the first indication, for the reason that it tends to further the efficiency of the process which the body first makes use of in its struggle against infection, in that it increases the supply of blood to the part and thus aids in rendering conditions in the focus of infection, so far as opsonin and leukocytes are concerned, as nearly like that to be found in the circulating blood as possible. It is a rational procedure, because it tends to render more effective the initial protective reaction of the immunizing mechanism. Any therapeutic measure which might inhibit in any way the initial hyperemic reaction must be considered, on the grounds stated, an improper procedure. Bier's passive hyperemia and Gamgee dressings are instances of therapeutic measures misapplied if used at this early stage of the infection. They induce a condition of stasis of circulation in the infected focus, whereas the clear indication is a rapid interchange of lymph into and out of, the focus, and a continuous supply of fresh leukocytes, such as active hyperemia brings about. (See Principles of Immunization.)

Although any measure to obstruct free hyperemia is thoroughly irrational in general, superficial infections, in which the blood-supply appears to be deficient, particularly when the infection is of very slight dimension, may be sometimes excepted. In some of these cases intermittent passive hyperemia, as described on p. 265, would appear more advantageous than an endeavor to increase hyperemia by heat. This is seen in slight infections of the fingers.

Where the infected area is large, as in phlegmon, *passive hyperemia may be decidedly dangerous*, because the blood-stream may receive excessive autoinoculation from the lymph which has been forced throughout the infected area, and has been taken into the blood again bearing excessive numbers of bacilli.

The use of vaccines at this stage, even supposing that accurate bacteriologic diagnosis can be readily made, is generally contraindicated, because the failure of the body to immunize itself is not due to any deficiency in bacterial stimulus.

The breaking down of the tissues, the formation of a pus-pocket, attest the failure of the initial attempt to destroy the bacteria. We have seen that pus under pressure not only furnishes conditions favorable to local growth of bacteria, but also, by its tryptic ferment, leads to the spread of the infection by solution of the connective tissue.

At this point, surgical measures have always found their rational application, and removing the pus, relieving the pressure, nullifying the tendency of the infection to spread, and allowing fresh lymph from the blood to take the place of lymph which has lost its antibacterial power by its long contact with bacteria. The fresh lymph not only exerts its effect against the bacteria, but neutralizes the tryptic ferment of the pus and prevents further solution of the tissue.

One of the most important and efficient therapeutic measures that have been offered in the treatment of localized infections Wright has given us in the sodium citrate and chlorid solution which he advises. This solution is composed of 4 per cent. sodium chlorid and 1 per cent.

sodium citrate in water. It is used as an irrigation and as a constant dressing in the case of abscesses and infected wounds. Its action, as has been previously stated, by means of its sodium citrate content, is to decalcify the lymph and prevent its clotting in the walls of the cavity, to prevent the formation of crusts in the same manner; and of the salt content, in that it furnishes a hypertonic solution, to induce a flow of lymph from the tissues into the abscess cavity. Thus, by the constant application of this solution after operative procedure, free circulation of fresh lymph is secured and maintained in the focus. When this solution is used, wicks become totally unnecessary; an exception may be found in the case of wounds which mechanically close themselves and obstruct the exit of fluid. In this case rubber dam should be used for its mechanical effect in keeping the wound open.

Contraindication to sodium citrate and salt solution is to be found in cases where there is a tendency to hemorrhage.

The salt content of this solution is very irritating to the skin, and may, if necessary, be diminished to a 2 per cent. solution. The skin should always be protected by means of boric ointment, in order to prevent pustulation, which may result from irritation of the salt.

Having secured by surgical measures the evacuation of pus and consequent elimination of excessive autoinoculation, by means of the citrate and salt solution the maintenance of free drainage, and consequent furtherance of conditions necessary for destruction of the bacteria, we have next to consider the condition of the blood-stream as to its antibacterial efficiency. Following the elimination of autoinoculation, the opsonic power of the blood rises sooner or later to above normal. If the opsonic power maintains itself above normal, such may be taken as evidence of a proper immunizing response to bacterial stimulus. Clinical evidence of such a favorable response is to be seen in the subsidence of local and general symptoms and improvement in local conditions. Vaccine may be reasonably withheld so long as the conditions suggest that the immunizing response is sufficient. In the majority of cases incision, coupled with maintenance of free drainage by the use of citrate and salt solution, is followed by resolution. In those cases that do not readily clear up, opsonic determinations generally indicate a low antibacterial power of the blood-stream. Consideration shows that the surgical measures have changed what bade fair to become a generalized infection into a localized process. Autoinoculation has been entirely eliminated, and the blood receives no impulse leading to the production of specific antibodies. Hence we should furnish the stimulus by injection of corresponding vaccine. The failure of these processes to resolve is sufficient reason for the exhibition of vaccine without resorting to opsonic determinations.

In every localized infection a culture should be obtained at the time of operation, not only for record as to the nature of the infection, but also to enable one to furnish a vaccine if later needed.

Vaccine is indicated when these processes give evidence of becoming indolent, to take the place of autoinoculation, which is found to be lacking in such conditions. Vaccine should be withheld until it is evident that the beneficial effects of previous autoinoculation, either natural or induced by the operative procedure, have worn off. Indolence of the lesion may be taken to indicate this state of affairs.

Where temperature persists, it usually means that there is some pocket that has not been drained. If, in spite of apparent good drainage, temperature persists irregularly, whatever autoinoculation that may be responsible for the temperature is probably not efficient in the production of antibodies. In such cases vaccine should be given regularly, with the hope of producing a continuous elevation in the opsonic power.

The **dosage** must be small, eliminating, so far as possible, the period of negative phase—therefore, frequent. In the case of streptococcus and pneumococcus initial dosage of from 2,000,000 to 5,000,000; colon, 10,000,000; staphylococcus, 25,000,000, should be injected daily and gradually increased by from 2,000,000 to 10,000,000, always avoiding any increase in temperature or subjective symptoms. As the dosage is increased, a greater period must elapse before the next is given.

Satisfactory response is indicated by a drop in temperature. If temperature does not fall within the next twelve hours, and if the patient shows no signs of increased toxemia, the dose may be guardedly increased.

Where the infection produces no temperature, but is indolent in resolution, larger doses may be given from the first, as the lesion now has the characteristics of a localized infection. The initial dosage of pneumococcus and streptococcus may be 10,000,000, increased by the same amount two days later, and gradually increased further up to 100,000,000 or more every three or four days. The other local measures, as suggested, to cause determination of the blood to the focus, must be used. Initial dose of staphylococcus may be from 50,000,000 to 100,000,000; of colon, 10,000,000 to 20,000,000. The smaller doses in these cases may be repeated every two days, the larger, every three or four days. Every dose should be allowed to exert its full effect before the next is given. Opsonic index determinations furnish evidence as to the time when the effect of a dose of vaccine is wearing off.

The suggestions here offered as to dosage are based on study of requirements by means of the opsonic index; generalized reaction, associated with fever following vaccine, in the localized infections, may take place if too large dosage be given. This indicates that living bacteria are in the blood-stream, and that *conditions favoring spread of the infection* have been produced. This condition should be entirely avoided, and can be if the dosage be increased very gradually.

In the absence of generalized reaction following vaccine we have local evidence in an increased discharge, swelling, tenderness, etc., that the dosage is too large. The writer has made it a point, in the exhibition of vaccine, to seek to avoid any local or general reaction. In that excellent therapeutic effect may be produced, with total absence of toxic symptoms or local exacerbation, except in rare cases, the writer's experience entirely corroborates that of Wright.

Treatment of *deep punctured wounds* should be surgical, and should not be delayed, particularly if tendon-sheath involvement is suspected. The development of pus should not be awaited. The other measures referred to should then be applied as indicated to induce determination of blood to the lesion.

In all cases an infected member should be held in an elevated or horizontal position, in order that there may be no obstruction to the free return of venous blood, to the end of securing free interchange of blood fluids.

In the writer's experience, the use of vaccine when the acute infections have become indolent has fulfilled a distinct indication, and has been followed by excellent results in the majority of cases treated. There has been, apparently, no advantage gained when vaccines have been used during the acute febrile period. Vaccine has seemed to be less efficient in streptococcic infections than in others. The results have improved since the adoption of better methods for sterilizing the vaccine.

Vaccine should be prepared from cultures obtained from the patient if possible. Until such can be prepared, corresponding stock vaccines should be used.

Some most striking results have been obtained in treatment of infected laparotomy wounds, when the colon bacillus has been the causal agent. A type of this case, treated by the writer, is a girl of ten years, who for two months after appendectomy had a septic temperature, associated with a fistulous opening discharging pus and feces. Reoperated twice, in search for some undischarged pocket of pus, but none was found. When seen, the patient was much emaciated, was unable to retain food by mouth, was running an elevated temperature, discharging feces and much pus from the operative wound. A bad prognosis had been given. The colon bacillus was isolated from the pus and vaccine injected as follows: First day, 10,000,000; second, 20,000,000; fourth, 40,000,000; fifth, 80,000,000. The temperature had begun to drop after the second dose, and at the end of a week became normal and remained so. Discharge of pus ceased; the child was able to take food by mouth. Some weeks later, after the fecal fistula had closed, patient was discharged well.

GENERALIZED INFECTIONS

The Septicemias.—Septicemias may be divided into two classes: first, those which derive their bacteria from some active focus of infection, such as uterine sepsis; and, second, those in which the bacteria appear to be cultivating themselves in the blood-stream, or cultivating themselves in some part of the endarterial system, as in malignant endocarditis. In the first, there is a condition of more or less continuous autoinoculation, and possibly also growth of bacteria in the blood itself; in the second, the preponderance of growth of bacteria appears to be in the blood.

In the first class we must include acute fulminating infections when associated with temperature, and likewise carbuncle, phlegmon, erysipelas, uterine sepsis, and other infections which start locally, but which are characterized by continuous or intermittent autoinoculation; in the second class would naturally be included those septicemias in which the atrium of infection is not demonstrable or in which the locus of infection cannot be extirpated or drained.

At once the difference in prognosis between these two classes of cases is apparent, when we consider that in the former it is possible commonly, by means of operative measures, to eliminate autoinoculation in varying degree, and thus diminish the numbers of bacteria that are being sent into the blood-stream, while in the latter, the true septicemias, we have no control over autoinoculation, because it appears the bacteria find in the blood-stream a suitable medium for growth, or continually find entrance from some focus that cannot be eradicated, as, for instance, vegetations in the endocardium.

In septicemia dependent on local infections the fact of the immediate amelioration in symptoms, drop in temperature, and disappearance of bacteria in the blood-stream, after operation, indicates that the blood-stream has the inherent power of destroying the bacteria present, provided that constantly new invasions of bacteria from the focus of infection be inhibited. It suggests that the presence of bacteria in the blood-stream is largely due to autoinoculation, and that if growth does occur in the blood-stream itself, it may be accounted for by diminished antibacterial power, produced by a combination of antibacterial substances as soon as they enter the blood-stream with the bacteria already present.

We have obviously no control over the bacterial content of the blood in the true septicemias, save by making use of measures to increase the power of the blood-stream itself to destroy the bacteria.

Uterine Sepsis and Similar Conditions.—Treatment should be directed first to the elimination of autoinoculation by absolute rest and such local measures as may cause free drainage. By such methods, abstraction of antibacterial substances from the blood-stream, by continued fresh invasion of bacteria, will be lessened. Fresh increments of antibodies in the blood-stream, instead of being immediately absorbed by the bacteria, will be applied in the circulating blood against the bacteria in the focus and lead to its final localization.

Where temperature persists after these procedures, opsonic index determinations have shown that autoinoculation has not been thoroughly eliminated. The continuance of symptoms and temperature shows that the autoinoculation is not effective in the production of sufficient antibodies to destroy the bacteria that enter the blood, that the focus has not become localized. If it is impossible to secure better drainage, the next indication is to endeavor to fortify the blood-stream by means of bacterial vaccines.

In treating septicemias we cannot afford, even for a few hours, to break down, in the smallest degree, or maintain in a condition of depression, any barrier offered against the growth of bacteria. We, therefore, have immediate reason for the use of sufficiently small dosage to cause complete elimination of the negative phase or phase of diminished resistance. In the giving of vaccines in febrile cases it is the desire to produce, by subcutaneous inoculation, a reaction followed by raised immunity and no preceding negative phase. This is particularly the case in septicemias. The best way to prevent the taking of large amounts of vaccine into the circulation is by reducing the dosage. The opsonic index has provided a method for testing the effect of inoculation, and by its use it was found possible to produce an immediate reaction in the production of antibacterial substances without any previous diminution. Wright has shown it possible in tuberculosis to produce a rise in opsonic power within one hour after inoculation. Haffkine, referred to by Wright,[1] was the first to obtain a condition of immunity twenty-four hours after inoculation of plague vaccine. Wright later showed the same was possible, using a typhoid vaccine.

[1] Lancet, August 24, 1907.

Based on the supposition that, in spite of the fact that the blood-stream contains toxic numbers of bacteria and toxic substances in large amount, these do not furnish a sufficiently concentrated stimulus, because they are diluted by the whole blood-stream, to the cells responsible for the formation of antibacterial substances, we are justified in expecting that a concentrated dose of vaccine, incorporated in the subcutaneous tissue, might be efficient at this point.

That it is possible in septicemia to induce a rise in the opsonic power of the blood without any previous induction of negative phase we have a sufficiency of laboratory evidence. This rise, however, is necessarily fleeting, and the stimulus in the way of vaccine must be repeatedly and frequently given.

We not only have the laboratory evidence of the efficiency of vaccine in producing a rise in the opsonic power in septicemia, but also evidence of associated clinical improvement, which renders this rise more significant. Purely clinical evidence as to the efficacy of vaccine in septicemias has been furnished by several writers, among them Thompson.[1]

He reports 7 cases of streptococcic endocarditis in which, following the use of homologous vaccine, 3 recovered; in 2 of the fatal cases the effect of vaccine was strikingly but temporarily beneficial, and in 2 other cases the benefit was slight but demonstrable. He reports 1 case of advanced pyemia as cured. In all cases striking effect was noted in the decline in temperature following vaccine, and there was associated clinical improvement.

Hartwell, Streeter, and Green[2] report 9 septicemias treated, 4 due to the staphylococcus aureus, 5 to streptococcus, of which 4 died. Their opinion was that in those that recovered successful outcome was no more due to the vaccine than to the surgical treatment. In 18 cases of puerperal sepsis, 15 of which were due to the streptococcus, they state that the effect of the vaccine on the temperature was at times striking.

Thompson's method of treatment consisted of fairly large and infrequent dosage. In one case 50,000,000, 100,000,000, and 200,000,000, twice, of killed streptococci, were given at six-day intervals. In another 10 inoculations were given, varying from 100,000,000 to 300,000,000, at intervals of four or five days. In another, 13,000,000 to 20,000,000 were given on account of the feebleness of the patient—24 inoculations in all—at first every other day and later every day.

[1] Amer. Jour. Med. Sci., August, 1909.
[2] Surg., Gyn., and Obst., September, 1909.

The writer has treated one case of staphylococcus septicemia for a period of three weeks, giving from 25,000,000 to 100,000,000 every day at first, and later every other day. The patient recovered several months after inoculations were stopped. One case of malignant endocarditis due to the streptococcus: This patient was in a critical condition when seen; history and the condition of the heart indicated an endocarditis of long standing. Vaccine was given in dosage of from 10,000,000 to 25,000,000 every other day. There were absolutely no untoward results, and there was a distinct average lowering of temperature. The patient died of cardiac failure after about two weeks. One case of pyemia due to staphylococcus was apparently temporarily benefited by vaccine, but finally succumbed. Six cases of septicemia, following localized infections, some of them of joints, were treated after surgical measures had been exhausted and bad prognosis had been given, with ultimate recovery of 4.

These citations suggest that vaccine may fulfil a distinct indication in generalized infections. That its use is productive of a rise in the opsonic power of the blood, if properly given, is certain; that, associated with this, amelioration in symptoms is produced, seems apparent. It is entirely too much to expect of the exhibition of vaccine that it should be a cure-all for these serious cases. There are unquestionably many factors to be considered which make for life or death of the patient, and over which vaccine can have no control. For instance, it has been clearly shown by Rosenow and others that bacteria have the power of immunizing themselves against the blood fluid. Further, it has been shown by Rosenow that virulent pneumococci resist phagocytosis. Even though the antibacterial power of the blood were raised to a very high degree, it might not be able to cope with such conditions. We have further to consider the effect of the poison upon the functions of certain organs which may be injured beyond repair, and which, in spite of the efficient response of the immunizing mechanism to vaccine, would, nevertheless, lead to an ultimately fatal outcome.

Diagnosis.—It is not within the scope of this chapter to enter into details of bacteriologic diagnosis. As in the case of every infection of importance, accurate bacteriologic diagnosis should be made for record, this being of particular importance when specific treatment by vaccine may be required.

When possible to obtain a discharge, diagnosis may be readily made, otherwise blood-culture will be necessary. The observation of Rosenow (*loc. cit.*) that the use of agar as a medium for blood-cultures yielded positive growth repeatedly where cultures in broth remained sterile, indicates that the accepted idea that fluid media are always preferable to solid media for blood-cultures is erroneous. The use of both solid and liquid media will not only tend to secure greater average success, but also will give a fair idea of the relative numbers of bacteria in the blood.

Dosage.—While it is desirable, if possible, to guide the dosage by means of the opsonic index, it is possible to treat this type of case depending upon clinical symptoms alone. It should be borne in mind that we must avoid the lowering of the patient's resistance by using excessive dosage. While the opsonic power may be continuously low, and apparently it would seem that even large doses of vaccine could not further lower it, theoretically we should expect large dosage to do nothing else than to *increase the condition of overexcitation under which the protective mechanism is struggling.* Clinically, we find that sometimes even small dosage will be followed by alarming symptoms and evidence of increased toxemia. This would not appear to be due to the amount of toxin administered, but to the effect it has upon the protective mechanism. It does not seem that this toxic effect is always registered by the lowering of the opsonic power, because it is already much reduced perhaps, but, nevertheless, clinical experience would indicate that we have in some manner broken down the barriers of resistance which the patient normally possesses. We should not, even after a few hours, allow this to take place. We can, by the exhibition of minute doses at short intervals, achieve a slight and repeated rise in the opsonic power, and, associated with this, we can see improvement without any injurious effect upon the patient. Until it can be definitely shown that large doses can be given without harm, *we must in practice hold to such amounts of vaccine as will be effective and without danger.*

In the case of streptococcus, from 1,000,000 to 5,000,000 may be an initial dose. Two millions is practically always safe. This should be repeated in from twelve to twenty-four hours, and, if there are no untoward effects, may be increased on the following day. Inasmuch as the dosage depends upon the virulence of the vaccine and the condition of the patient, no absolute rule can be given. It may be possible to repeat these minute doses every six or eight hours with nothing but benefit. A maximum dosage might be said to be 25,000,000 daily, though this will not always apply. Where the blood infection emanates from a local focus, the increase in dosage may be rapid and the amount given finally larger. As the dosage is increased and the patient improves, one- or two-day intervals between the doses may be desirable. In the case of pneumococcus the dosage is practically the same. In the case of staphylococcus it is sometimes found that the organism is of low virulence, and it may be found that even from 100,000,000 to 200,000,000 may be given every two or three days. Much care must be taken in giving initial doses of colon vaccine, the dosage being from 5,000,000. *The virulence of all vaccine varies, and is not to be measured by the number of bacteria in the dose given.* In one instance an inoculum of 5,000,000 streptococci of one strain might conceivably have the virulence of five times or more that dose in the case of another strain. The dosage should always be increased in such a manner that no exacerbation will be produced. *The sicker the patient, the smaller the dose that should be given.*

A sudden rise in temperature and increase in toxic symptoms suggest that the dosage may have been too large. These signs may, however, have been produced in the normal course of events and have no relation to the vaccine. If the dose that has been followed by such signs is minute, there is no contraindication to repetition on the next day. If the dose was of larger proportions, it would be well to reduce its size next day.

While in the case of pneumococcus, streptococcus, and staphylococcus, the most common causes of the septicemias, immunity appears to be largely due to the opsonin and the phagocytes, in the case of colon and typhoid we see in the agglutinins, bactericidins, etc., additional factors of equal or greater importance. The development of these substances is by no means parallel to that of opsonin, but in the case of a given dose of vaccine, these substances make their appearance usually later than the increase in opsonins. Hence, we may have an elevated opsonic index, and at the same time a low agglutinating power in these infections. A dose of sufficient size to cause a decided increase in opsonin may be inefficient in producing agglutinins in large amount. It is desirable, of course, to induce formation of these substances, and hence in colon infections a more rapid increase in dosage is advisable. At the very start, however, dosage *must be small, in order not temporarily to lower the opsonic resistance.* Later, it would appear that, at least clinically, within certain limits, these other antibodies more than balance temporary lowering of the opsonic index after good-sized dosage. In the case of a child with colon septicemia following appendectomy the writer gave as an initial dose 10,000,000, on the following day 20,000,000, two days later 40,000,000, and again, two days after, 80,000,000, with immediate fall in temperature and recovery.

INFECTIOUS ARTHRITIS

Suppurative conditions are most frequently due to the streptococcus, staphylococcus, or pneumococcus, but in the case of traumatic infections following punctured wounds, other organisms may be found. After thorough drainage by surgical measures, the most important indication is to render drainage permanently effective. The inefficiency of gauze wicks to allow of good drainage has been considered. Their action is commonly more effective in preventing efficient discharge than in promoting it. Where mechanical conditions are such that the operative wound naturally closes itself, the insertion of a rubber dam is effective in preventing this closure. The uselessness of antiseptics as irrigations of joints, and, in fact, their positive harm, needs little comment.

The prime indication in these infections, as well as in all others, is to produce a free and continuous streaming of lymph from the blood into the infected focus, in order that, as nearly as possible, the sum total of its antibacterial power can be exerted against the bacteria as they cultivate themselves in the tissues. In order that this shall take place, evacuation of the pus and elimination of pressure is the first necessity; the second is to perpetuate a free and clear external opening.

The usefulness of the sodium citrate and chlorid solution in meeting these requirements has been sufficiently considered. In practice it is possible, by use of this solution, to prevent any tendency to crust formation, to produce a discharge as long as is desirable, and to maintain an unobstructed opening for as long a period as desired, subject, of course, to the gradual closure that will take place through the process of healing. It appears, in general, that operative wounds heal less rapidly if this solution is kept constantly applied.

When, in spite of these measures, the infection becomes indolent, either with or without temperature, the use of appropriate vaccine is indicated. Where there is a temperature, the dose, of course, should be small, and under all conditions considerably smaller than in most other localized infections.

Vaccine, always in association with the other measures indicated, has, in the writer's hands, appeared to be efficient in a number of cases of suppurative joint infection. Two cases should be cited in which, following operation, a septicemic condition developed, streptococci were isolated from the blood, and vaccine given, with ultimate recovery and good functionating joint.

It has been usually the case, where temperature has again developed after once having reached normal, that some pocket of pus has developed. Vaccine cannot, of course, be expected to cope with such a complication, and is contraindicated until it is clear that foci of pus are satisfactorily evacuated.

Gonorrheal Arthritis.—These infections in their acute stage present a condition of more or less continuous autoinoculation, as evidenced by the temperature. The ordinary treatment by fixation of the part affected commonly is sufficient to satisfy the primary indication in all infections associated with autoinoculation and temperature, namely, the elimination of such autoinoculation and thus the production of a strictly localized infection.

Inasmuch as in the ordinary course of events elimination of autoinoculation is secured after a few days of treatment, it does not appear necessary to use vaccines during this acute stage.

When temperature subsides and autoinoculation consequently ceases, we usually find a condition of lowered opsonic power for reasons previously discussed. The indication is, therefore, to furnish a stimulus, by means of vaccine, that shall set in motion the protective mechanism and result in the elaboration of protective substances in increased amount.

Although certain cases of gonorrheal arthritis gradually progress toward complete recovery, the frequency with which they become chronic and resist all the ordinary measures of treatment attests the failure of the immunizing mechanism in these cases.

We see in the low antibacterial content of the blood-stream, and the obstruction to circulation produced by the local swelling, factors which render this chronicity possible.

The consensus of opinion among those who have treated a considerable number of cases of this type by injections of gonococcic vaccine appears to be that vaccine is a valuable therapeutic measure.

Hartwell[1] reports the treatment of 31 cases of gonorrheal arthritis. These cases were first treated at periods varying from one month to one year after the acute attack. In 27 of these cases the end-results were completely functionating joints without disability. Those which did not entirely clear up, so far as function is concerned, had already, when treatment was started, become ankylosed. Dosage, in Hartwell's chronic cases, reached as high as 500,000,000 to 600,000,000. Interval between dosage was from five days to a week. Subjective symptoms, such as malaise, nausea, and vomiting, were occasionally produced, but no untoward event occurred which was ultimately serious. He prepared his vaccine by two methods—the first exposure to 60° C., and in the second he exposed his vaccine in an ice-box over night, added $\frac{1}{4}$ of 1 per cent. of lysol, and allowed it to stand twelve hours before using. There appeared to be no differences in the vaccinating qualities of these differently prepared vaccines. He used autogenous vaccine in 21 cases, with what he considers better results than where stock vaccine was used. His method was gradually to increase the dosage, with the idea of overcoming tolerance already produced by previous dosage.

[1] Ann. Surg., November, 1909, p. 939.

In 20 acute cases treated he thought the vaccine diminished pain and hastened resolution. Nine of these cases recovered with free motion of the joint affected. He found that in the acute cases other joints became infected after the first few inoculations. He thinks these were due to the ordinary course of the disease, and not to the effect of the vaccine. His dosage in acute cases was from 25,000,000 to 100,000,000, and the interval two to four days.

Hartwell concludes that gonococcal vaccine is a valuable therapeutic agent in gonorrheal arthritis in all stages except where ankylosis has occurred. It does not prevent extension to other joints, nor does it produce lasting immunity sufficient to prevent recurrence after a new attack of acute urethritis.

Thirty-one cases of gonococcal arthritis were treated by means of vaccine by Irons.[1] His conclusions are conservative when he states that in certain cases of gonococcal arthritis recovery can be hastened by injection of dead gonococci, and that the chronic ambulatory cases showed better response to inoculation than the more acute cases. Improvement, however, in the acute cases often seems more rapid after inoculation than by other treatment. In 15 cases he found that the opsonic index was low at first. His guidance in the use of vaccine was by clinical symptoms, and the vaccine used was of various kinds, varying from one to a number of combined strains.

The dosage employed by him at first was 20,000,000 to 50,000,000, and later, and in other cases, the dosage was increased to 100,000,000 and rarely to 1,000,000,000, with an interval of three to seven days. No harm was done by using these large doses, beyond production of clinical symptoms during the next twenty-four hours, associated with the negative phase, such as joint pain, tenderness, fever, and malaise when large doses were given.

Cole and Meakins[2] report the treatment of 15 cases. They used the opsonic index as a guide for treatment and found that in each case inoculations were followed by a rise in the opsonic index during the first week; that by the tenth day the index fell again; their dosage was large, varying from 200,000,000 to 1,000,000,000. They state that constitutional disturbance was met with rarely and was severe in but one case. They repeated their inoculations every seven to ten days. They conclude that the chronic cases show better results than the acute. Cases that have progressed slowly under other treatment show almost immediate improvement soon after vaccine is given.

Considerable numbers of cases have been reported by other observers, with approximately the same conclusions. The writer has had, or has at present under treatment, 20 cases of chronic gonorrheal arthritis.

[1] Arch. Int. Med., i, No. 4, 433.

[2] Bull. Johns Hopkins Hospital, June, July, 1907, p. 223.

In 16 treatment was begun at from one month to two years after the acute attack. All these cases had resisted other forms of treatment. Twelve of these cases recovered completely after from one to four months' treatment, with complete functionating joints. In all cases stock vaccine was used. The initial dosage was always small—from 5,000,000 to 10,000,000, injected at intervals of three to five days.

The attempt was made, as in the treatment of all other infections, to so gradually increase the dose that the general symptoms should be entirely avoided and focal symptoms so far as possible. In no case were generalized symptoms produced. In chronic cases the dosage has rarely exceeded 50,000,000. In 4 acute cases treated the dosage has been from 5,000,000 to 25,000,000. The longest period of treatment in acute cases was two months. There was no fresh joint involvement after the treatment had begun. In these cases the inoculations appeared to have some control over the pain.

One case, which is particularly striking, is that of a man twenty-five years old, who had several joints affected for over two years. The condition remained more or less active in the ankles, and there was considerable tenderness and swelling in the plantar surfaces of the feet. Walking was extremely painful, and the patient had been unable to go about his work for a long time. An inoculation of 5,000,000 was given, and five days later 10,000,000. Two days after the first dose the patient stated that he could walk with less pain, and after the second dose he walked into the clinic without any perceptible limp. In this case there was complete recovery after eight inoculations.

So far as is known there has been no recurrence. Treatment has been started on a number of cases with such immediately beneficial results that the patients have ceased attending the clinic, and, therefore, the outcome is unknown.

Other Types of Infectious Arthritis.—There are certain non-suppurative inflammatory processes occurring in and about the joints the characteristics of which are decidedly in favor of their being of bacterial origin. Until recently many acute and subacute inflammatory conditions of the joints and periarticular tissues have been grouped under the general heading of rheumatism. Based on the character of the disease, the typical so-called *articular rheumatism* has been for some time placed in the group of bacterial infections, although no definite organism has as yet been proved conclusively to be the cause of this disease. There are, however, beyond the typical rheumatic fever, non-suppurative inflammatory conditions of the joints which are associated with similar constitutional and local symptoms and signs, characteristics which are quite as much in favor of their being considered infectious processes as the same are in favor of the infectious nature of acute articular rheumatism. These arthritic conditions very commonly follow apparently localized infections, such as tonsillitis, pharyngitis, and rhinitis. They are rather common sequelæ of scarlet fever. The fact that these conditions often follow acute local infections suggests that the infective material has been transferred to the blood-stream and the bacteria have lodged and grown in and about the joint.

It would appear, as has been previously suggested, that local infections associated with temperature are not really local, but are more or less continuously sending bacteria into the blood-stream. Decidedly in favor of this is the fact of wide fluctuation in the opsonic power of the blood, which can be due to nothing else than the taking up of bacteria and their products by the blood-stream.

Sequence of events in scarlet fever often furnishes evidence that bacteria exist in the circulating blood, derived originally from the throat infection as an atrium. In severe cases streptococci can commonly be obtained by blood culture. In postscarlatinal nephritis they are to be found in large numbers in the kidney. In the writer's observation of scarlet-fever cases at the Boston City Hospital, South Department, during a period of over two years, scarlatinal arthritis was frequently seen. It was of all degrees, varying from slight periarticular inflammation, associated with a little temperature, to a condition of suppuration in one or more joints. In every case (6) of this kind that came to operation the streptococcus was demonstrated in pure culture in the pus. It would seem reasonable, therefore, to attribute these arthritic conditions in scarlet fever to streptococcus infection, varying in intensity according to the protective reaction which they induce in the patient. It is quite as reasonable to attribute the acute arthritic conditions following tonsillitis to entrance of bacteria into the blood-stream and localization in and about the joint, in tissues which are normally poor in vessels, where the supply of protective substances, therefore, must be correspondingly less than in better vascularized tissue.

The bacteria, having been transferred into the blood-stream and lodged in such poorly vascularized tissues as those about the joints, soon render the local conditions more suitable for their growth. They accomplish this by abstraction of antibacterial substances from the lymph in the immediate vicinity of the locus, and through swelling and exudation which ensue it becomes more and more difficult for an interchange between the fluid in the locus and fresh lymph from the blood-stream to take place. The bacteria, then, have most excellent conditions for growth in a more or less stagnant fluid of continuously low antibacterial power. The blood-stream has been able to ward off infection of a generalized type, but the fact that infection has taken place clearly indicates that it has not been able to exert its full power against the bacteria in the tissues.

As a result of the development of localized infection, the blood-stream itself suffers in a decided manner a loss of a considerable portion of its antibacterial power. The opsonic index in these localized infections is consistently subnormal. A reasonable explanation of this fact would appear to be, first, that the blood is unable to derive sufficient autoinoculation to induce formation of protective substances, because the localized condition shuts it off from anything like a free circulation, and it consequently takes up but few bacteria; secondly, the blood suffers a gradual loss of opsonin and other antibodies which it would otherwise have by continuous slight contact with the outskirts of the bacterial focus.

We can justifiably ascribe the chronicity of some of these infections to the same conditions that apply to all chronic infections; namely, a low opsonic power of the blood-stream, and the difficulty of its coming into contact intimately with the bacteria in the focus in sufficient amount to cause their destruction. We need no better confirmation of this than the sequence of events which follows the forced entrance of fresh lymph into the focus, by means of *Bier's bandage,* and the subsequent drainage of this lymph into the circulation. Clinically, such procedure is commonly followed by marked amelioration in local signs and symptoms, not only in the joint to which the bandage was applied, but to other infected joints if there be any. By means of opsonic determinations we find variations quite similar to those produced by an inoculation of a vaccine derived from a corresponding organism. First there may be a negative phase and subsequently a positive phase. This can mean nothing else than that these variations register an immunizing response, and indicate that the increased supply of blood-fluid has abstracted from the focus sufficient bacteria and toxin to constitute an autoinoculating ictus, thus leading to the increased formation of antibacterial substances. We can also see, as a reason for the improvement in the local focus, the replacement of the stagnant lymph in the focus of infection by fresh lymph from the blood of higher antibacterial power. In these considerations we can derive indications for treatment.

The question of using Bier's bandage as a therapeutic measure has been discussed. Its advantage lies in the fact that no diagnosis is necessary; its disadvantage, in the fact that the dosage of living vaccine that is sent into the body cannot be measured, and always there is the possible danger of the development of new foci in other parts of the body. Unquestionably the response to a living vaccine of exactly the infecting organism is of more efficiency than that following the use of a killed corresponding vaccine. It is a very much safer procedure to make use of vaccine.

The question of *bacteriologic diagnosis* is the most important and the most difficult one to settle. The difficulty of obtaining a positive blood-culture, even in some cases of septicemia, indicates that in these cases positive results from blood-culture are not to be expected, except possibly in cases where there is temperature.

Bearing in mind the possibility that the condition may have started from a localized infection, a history of tonsillitis, laryngitis, or pharyngitis should be sought, and cultures taken from the tonsils or nasopharynx or nasal cavity, as may be suggested by the history or by the local conditions. It would appear to be justifiable in the case of pure culture of pneumococcus, for instance, obtained from the tonsils, to prepare an autogenous vaccine and make use of it as a therapeutic test. In febrile cases dosage should run from 5,000,000 to 25,000,000; in afebrile cases from 10,000,000 to 100,000,000 or more. Where the dose is small, the interval should be short. As the dose is increased in the chronic cases, three days to a week may elapse between the doses. The initial dose is always the minimal.

Before vaccine is given, the first indication is the elimination of auto-inoculation by fixation of the joint, or, in case several are affected, absolute rest will be advisable to accomplish this end.

There have been reported but a few cases of treatment by vaccines of these non-suppurative joint conditions. Two interesting cases of this type have been seen by the writer, and one of them was successfully treated.

Case I.—The patient, a woman of forty-five years, suffered with so-called rheumatism for a period of ten years. She was referred to the writer to settle the question of diagnosis and treatment. During this time different joints became successively involved, and each attack was associated with some fever, malaise, pain, tenderness, and swelling about the infected joint. After two or three weeks the condition would begin to quiet down, leaving stiffness, slight swelling, and some disability. Rarely were two joints affected at the same time. The knees, the ankles, the elbows, and shoulders have been successively involved. The general condition of the patient was very good, and there has been no special loss of weight. She had been subject to attacks of tonsillitis, although the throat showed nothing but moderately enlarged tonsils. The question of the tonsils being the atrium of infection was, of course, immediately considered, and cultures were planted on acetic agar. A pure growth of pneumococcus was obtained.

It was impossible at the time to prove by opsonic indices whether this pneumococcus was the actual cause of the arthritis, but it was thought wise to prepare an autogenous vaccine and to give it for therapeutic test. After a few inoculations of from 5,000,000 to 25,000,000, given at three- to five-day intervals, the most marked changes took place. In the recently involved joint the process quieted down almost immediately, and in the joints that had been affected for some time there was immediate and progressive improvement. The patient has since gone on to practically complete recovery, with very little disability, and in eight months has had no recurrence.

There is, theoretically, no class of cases that offer any clearer indication for specific treatment by bacterial vaccine than infectious, non-suppurative arthritis or periarthritic infections if accurate bacteriologic diagnosis can be made.

There is no danger in the use of bacterial vaccine if dosage is so carefully graded that no symptoms are produced.

There is always a positive danger of over-autoinoculation and the possible development of other foci if Bier's bandage is used. Bier's bandage furnishes the exact requirement in the way of supplying vaccine to stimulate the protective mechanism; it also provides for increased interchange of lymph in the focus. But it is clear that, as the focus of infection begins to clear up, the bacteria become fewer, the size of the autoinoculations become smaller and smaller, and hence less and less effective in raising the antibacterial power of the blood. In other words, when large dosage of vaccine is clearly indicated, the dosage obtained in this way is progressively smaller and less effective.

LOCALIZED STAPHYLOCOCCIC INFECTIONS

Furuncle.—When the patient appears for the first time with a small furuncle, originating perhaps from an infected hair-follicle, which is red, painful, and tender, to a degree depending on the location and the tenseness of the tissue, the treatment should be regulated according to the stage of the infective process. If there is as yet no evidence of liquefaction or slough, a single dose of 100,000,000 Staphylococcus pyogenes aureus stock vaccine will ordinarily suffice to abort it. After a few hours of somewhat increased local tenderness and swelling a marked improvement in the appearance and symptoms will become apparent, and twenty-four hours later the tenderness may have practically disappeared. An inoculation of 100,000,000 to 200,000,000 at the end of forty-eight hours, followed by a repetition after two or three days, may be necessary, but these two or three inoculations will generally suffice.

As an adjuvant to the vaccine, heat may be applied locally by means of a hot-water bag. It is applied with the greatest advantage during the positive phase when the blood is at its best, that is to say, six or eight hours after the first inoculation or more, depending on the size of the dose.

If, when first seen, the furuncle shows a tendency to point, and liquefaction of the tissue is in evidence, a minute incision should be made at such a point that it will drain readily. This should be more in the nature of a puncture than an incision. The pus should be expressed, so far as possible, and then a pad of gauze, thoroughly wet in Wright's solution of sodium citrate and sodium chlorid, previously described, should be applied and kept wet so long as any discharge is maintained. The action of the sodium citrate will be, of course, to prevent crusting, and of the sodium chlorid, to draw fresh serum through the opening, thus insuring a continuously acting free drainage and a consequent free bathing of the infected focus in a continuously fresh stream of serum from the circulating blood. We have, in the stream of fresh antitryptic serum, the best agent for the neutralization of the tryptic pus and an adjuvant to the destruction of the bacteria by the leukocytes. Wide incision, such as might break through the walling-off tissue, is in these cases bad, because it opens up fresh channels for the extension of infection. The dosage of vaccine under these conditions should be as given above. On the second day the drainage will ordinarily be found to be free through the opening, and there will be improvement in every sign and symptom. The application of heat will hasten the process of separation or liquefaction of the slough, and in forty-eight hours the furuncle should be well discharged. Subsequent dosage of 200,000,000 after two days, and 300,000,000 to 400,000,000 after a similar or slightly longer period, practically always effects a rapid cure. It should be remembered that in all cases where Wright's citrate and salt solution is used, the skin about the lesion should be protected at every dressing by the application of boric ointment in order to prevent pustulation, which the concentrated salt solution commonly induces.

A localized abscess of larger proportions will require an immediate and adequate incision, which should, at the same time, be as small as conditions will allow. Sodium citrate and salt solution should be applied as a dressing.

In all cases the patient should be given a cathartic, preferably calomel, followed in twelve hours by a Seidlitz powder if the bowels are at all constipated.

Furunculosis.—When the patient gives a history of recurrence of furuncles over a longer or shorter period, the problem for vaccine becomes more complicated. It has been the writer's experience that furunculosis commonly follows any change in diet or in mode of life, such as would be consequent to a railroad journey, to a camping trip, or residence in summer hotels. Overwork, overstudy, and over-exercise as well seem to predispose to furunculosis. Skin of a certain type is often associated with a tendency toward infection by pyogenic cocci. Such a skin is apt to be oily and pale, indicating poor circulation, and subject to comedones.

Every practitioner of medicine has had impressed upon him by experience the difficulty in the cure of these cases by ordinary methods. No sooner will one furuncle be incised and begin to heal than others develop. A repetition of surgical operation is associated with a repetition of furuncle. The patient complains often of headache, of being easily excited, of indefinite pains and exhaustion, malaise, or poor appetite, besides the irritation and pain consequent to the furuncles, repeated operative procedures, and the inconvenience of the constant application of dressings to the different parts of the body. There is no class of cases that is more satisfactory in the results achieved by vaccine therapy, and none in which the patient is himself better convinced of the efficacy of such measures.

It is always best in cases of this chronic type to isolate from the pus the particular organism that is causing the trouble, and to prepare a vaccine at once. In the majority of cases stock vaccine, composed of three or four virulent strains of staphylococcus aureus, will be satisfactory, and should always be used until an autogenous vaccine can be prepared. Better results will be obtained in the long run by using the vaccine prepared from the particular infecting organism. The first dose should be 100,000,000 to 150,000,000. It should be repeated on the third day, increased to perhaps 200,000,000, and four days later about 300,000,000 should be administered. After a few trials one will be able to judge efficiently as to the size of dose that is best borne. The following clinical data will be of assistance.

If, on the day following inoculation, the present furuncles become more inflamed and one or two new furuncles develop, and there is some general malaise, it is probable that a smaller dose will be more advantageous. If, however, on the day following inoculation there is a slight exacerbation, but on the next day marked improvement is evident in the patient's general condition, and no new furuncles put in their appearance, and if this improvement is maintained for two or three days longer, the proper dose has been arrived at. This dose can be repeated, and may be slightly increased, four or five days after the first injection. New furuncles may continue to come at intervals for some weeks, but they will be less acute, they will disappear more quickly, and will give much less trouble than the original crop.

Duration of treatment depends on the previous chronicity of the case and on the location of the furuncles. If they are situated chiefly on the back of the neck and many comedones are present, the outlook for immediate cure is not good. The writer has treated several cases of this kind for three or four months before the neck has entirely healed up. If the furuncles are scattered over the body, they will be found to be much more rapidly amenable to treatment than if localized on the neck.

Duration of Immunity.—Where treatment is being applied for the cure of a single boil or furuncle, and there is no history of previous attacks, usually there will be no recurrence within some months. In cases of recurrent furuncle, after a sufficiently prolonged course of treatment, it has been the writer's experience that, as a rule, there is no recurrence within at least six months following the cessation of treatment.

In chronic furunculosis of the back of the neck, with a duration, as often happens, of months or years, there will persist a chronic indurated condition of the tissues, often of considerable depth, and one or more small discharging sinuses. The prognosis after treatment with autogenous vaccine should be eventually favorable. The occasional development of a furuncle is to be expected, but its duration will be shorter, the tenderness less, and solution and resolution more rapid. A moderate dose of vaccine is sufficient to abort a new furuncle if given at the opportune moment.

In the course of the last two years the writer has had under treatment something less than 200 cases of localized staphylococcus infections, and feels able to speak with confidence of the efficacy of appropriate bacterial vaccines properly applied in the control of these infectious processes.

Guidance of Treatment.—The use of the *opsonic index* is generally unnecessary, if one has a thorough appreciation of what Wright terms the correlation that is known to exist between the condition of the opsonic resistance and the clinical condition of the patient and his lesions. The induction of a negative phase, that is, a period of lowered opsonic power, of lowered resistance, in fact, by the use of improperly large doses of vaccine, is signalized almost at once by local changes in the lesions, which give information that the process is on the increase. We find that local tenderness increases, inflammation extends, discharge becomes increased in amount, and there may be malaise, headache, and local pain. New furuncles may start within a few hours of the inoculation. The presence of these manifestations means that a condition of lowered opsonic resistance has been induced by the injection, as has been sufficiently well shown by many observers. The opsonic index gives a cue to the efficiency of the antibacterial substances in the circulating blood, but the clinical conditions just described give one about as efficient information as to the state of antibacterial resistance.

If the condition of lowered resistance gives evidence of continuance by persistence of the local manifestations described for over twenty-four hours, the dosage given was too large. This does not mean that if the patient is left alone the antibacterial mechanism will not recover itself and improvement become manifest after a few days. It does mean, however, that if another injection is given too soon, the same condition may again supervene. We must in such a case await the oncome of spontaneous improvement, as shown by local conditions, and then start with a much smaller dose. There should be such proper adjustment, size, and interval of dose as to produce a slight exacerbation, if any, in the first twelve hours after inoculation, followed by some improvement in the next twenty-four hours, and considerably more improvement in the following day. By the third day a slightly larger dose may be given, and three or four days later, perhaps, a still larger dose; then, if consistent improvement is taking place, the interval may be increased to four or five days, being careful not to use a dose of such a size as will produce an exacerbation of long duration.

Local Effects of Inoculation.—If the proper vaccine is used, and it may be either autogenous or a commercial vaccine of exactly the same character as the infecting organism, there will, in a few hours, develop at the point of inoculation an area of redness and slight induration and tenderness. The duration and severity of this reaction depend to some extent on the size of the dosage. It is always more marked in the early stages of treatment, and as the lesion improves and the dosage is pushed higher, the reaction may disappear altogether, only to reappear if excessively large doses are used. In the absence of any local reaction after repeated inoculation of a sufficient dose of vaccine one is almost justified in concluding that the infective process is due to some other organism than that which his vaccine contains.

What harm can large doses of vaccine do in these cases? If we desire to obtain from our treatment the maximum good, with the minimum of discomfort and unpleasant symptoms in our patients, we should guard against using large doses when smaller ones will accomplish the same results. If, being ourselves convinced, it is our desire to further the interests of specific therapy, we can ill afford, by injudicious use of vaccines, to furnish a foundation in the lay mind for the idea that vaccines are often brilliant in their results, but that one never can tell how much good they will do; that they will certainly make one sick before they make him well, as some of the victims of ill-conducted vaccine therapy have confided to the writer. We cannot always avoid the mistakes of too large doses, but we can make it a rare occurrence.

If the dose is not too large, it may be given too frequently. The patient may not suffer any great increase in discomfort, and the lesions may not grow much worse, but remain about stationary from day to day. To illustrate: A patient was referred to the writer because he had failed to recover completely from a carbuncle on the neck and scalp. Vaccine had been given for two months, but there was still a large area of induration and some discharge of deep-lying pus. Inquiry revealed the fact that 400,000,000 of staphylococcus aureus had been given every other day for a long period and daily for two weeks. Vaccines were withheld for five days, and then the same dosage given less frequently. In two weeks the induration had cleared up, and, except for a superficial pustule, was well. In this case, and in others where dosage is too large and too frequent, the clinical picture is corroborative of what would naturally be expected—*i. e.*, an almost continuous negative phase or condition of lowered resistance to the infection. It is a condition of hyperexcitation of the antibody-forming mechanism, from which the organism does not recover until the exciting agent is removed.

There can be no hard-and-fast rule as to the interval between dosage; it depends on the size of the dosage, the vaccinating qualities of the vaccine, and the manner in which the patient responds. Some writers whose experience has been large say that an interval of three days is proper. No doubt there is a dose which, if given at three-day intervals in a given case, will be followed by satisfactory results, but the size of the dose efficient at this interval will differ in different patients and with different vaccines. It should be the desire to so adjust the dosage that there should be as short a period of negative phase—with its lowered resistance—as possible, consistent with the production of a positive phase—the period of elevated resistance—of as long duration as possible. Patients and the vaccines are variable factors, and the doses must be adjusted so that the maximum benefit may be derived during the period, whatever it may be, between inoculations. In the early treatment of cases the interval may be one or two days, because, in order to avoid the exacerbation which would result from a long-continued negative phase, the early dosage is small. The smaller the dose, the shorter the duration of the negative phase. At the same time, the positive phase will be of brief duration. Hence, at first, to avoid exacerbation, small doses should be given frequently, and as improvement becomes evident, the doses are made larger and less frequent. In furunculosis the interval of dosage in a given case may vary from one to six or more days, depending on the stage of treatment.

Acne.—The pustular type of acne may be compared to a chronic furunculosis of the face, and is commonly amenable to vaccine treatment if properly conducted. The etiologic factor is the staphylococcus aureus or albus; if together, the albus usually predominates; more commonly, the albus will be found singly in practically pure culture in the pus from the lesions.

Kind of Vaccine.—A vaccine prepared of equal parts of Staphylococcus aureus and albus from virulent stocks is commonly satisfactory in the treatment of these cases, but it will be found that an autogenous vaccine frequently gives better results than such a stock vaccine.

Duration of Treatment.—Some cases will clear up after two or three months of careful treatment, and with only occasional subsequent development of new lesions. A few cases will be absolutely cured. One should not be discouraged if, after two or three months' treatment, there is definite improvement, but not a cure. Persistence will often bring final success.

Dosage.—At first 100,000,000 to 200,000,000 may be given, and repeated in five or six days. An increase of from 50,000,000 to 100,000,000 at each dose should be made up to the limit of 1,000,000,000, although the writer has only rarely found it necessary to give more than 500,000,000. Quite as good results have been achieved with such a dose given once in five or six days. A smaller dose, however, given twice a week, has oftentimes improved the condition where a larger dose, given once in six days, was followed each time by an exacerbation.

If the vaccine is given properly, a gradual improvement should be evident. Relapses are very common, however. The result of treatment depends fundamentally on the proper adjustment of size and interval of dose. A given dose would seem to be correct if, on the day following its administration, one or two new lesions begin to appear, but in the next few days disappear, with an accompanying improvement in the other older lesions. Such a dose may be continued until it is found that, on the day following the dose—*i. e.*, in the period of negative phase, which is characterized, of course, by diminished phagocytic resistance—there are no new lesions, but that an immediate improvement follows, and then, in the two days before the next dose, new lesions appear. Under such conditions it is evident that the patient is becoming tolerant;

that the vaccine is producing an immediate positive phase, but that the continuance of the positive phase is consequently short. We must, therefore, increase the dose until it will produce a negative phase.

Whitfield[1] says, concerning acne, "The treatment is uncertain; in some cases most brilliant, in others without the slightest avail." This appears to be the consensus of opinion among those who are dealing with considerable numbers of these cases, particularly in the chronic type of acne vulgaris, which runs for years, accompanied by comedone formation, deep-lying nodules, pustules, and areas of induration. Frequently there is temporary improvement, but relapses are common, and the fundamental nodular inflammatory condition may continue unabated. In view of this fact it seems probable that the staphylococcus may not be in all cases the etiologic factor. Unna, in 1893, found in smears from comedones and pustules a bacillus in large numbers. Sabouraud was able to grow it, and later Gilchrist expressed the opinion that it was the cause of acne vulgaris.

Pioneer work in the treatment of acne by this bacillus has been done by Fleming[2] in Wright's clinic in London. Perusal of his investigations would lead one to believe that the so-called acne bacillus is the probable cause of the disease; that it is an important factor in producing all types of the lesions; that staphylococcus may be associated with it in the production of pustules; and that treatment by vaccine derived from the acne bacillus, used in association with staphylococcic vaccine, promises better results than have heretofore been obtained.

Carbuncle.—The proper use of vaccines in the treatment of carbuncle can in almost every case be relied upon decidedly to modify the surgical necessities, and sometimes even to render surgical intervention unnecessary; in almost all cases (the exceptions being aged people or others who, for one reason or another, do not react to the inoculations of vaccine) the use of vaccines will distinctly modify and limit the course of the disease after operation.

The problem of treatment is more complicated than that of simple furuncle, for the following reasons: First, carbuncle of considerable size is commonly associated with fever, which, of course, indicates that bacteria and their poisons are being taken up by the blood-stream; that is, there is more or less continuous autoinoculation taking place. Second, whereas in furuncle the pus and necrotic material is ordinarily localized in a single pocket, and may be given efficient vent by a simple incision, in carbuncle we have a more generalized necrosis and infiltra-

[1] Trans. Sixth International Dermatological Congress, 1907.
[2] Lancet, April 10, 1909; Brit. Med. Jour., August, 1909.

tion of the tissues with pus; incision drains the immediate vicinity, but only that. Third, the tissues seem to offer little resistance to the extension of the process downward and laterally; in other words, there is apparently an absence of the tendency toward walling off which is so evident in furuncle. This may be due to the virulence of the infecting organisms and to the tryptic or dissolving power of the pus (a product of the broken-down leukocytes), by which it dissolves the fat and connective tissue and thus extends. Fourth, the circulation of the blood, upon which the body depends for the destruction of invading organisms, is cut off everywhere excepting at the extreme limits of the extending process, but even here the coagulation of lymph and the exudation tend to nullify the attempts of the body to furnish a suitably increased blood-supply.

These factors are particularly notable in certain locations, such as the back of the neck, where the columnæ adiposæ, by their anatomic relations, divide the subcutaneous tissue into numerous cells with connective-tissue walls. We should, therefore, expect that where a carbuncle exists in this location, extensive surgical measures would be more necessary than in other parts of the body, and this is actually the case. If, wherever the carbuncle is located, there is shown by elevation of the infected area above the normal skin surface a tendency toward walling off, the extent of the surgical requirements will be considerably lessened. If the infection is infiltrating and the tissue is brawny and not raised above the surface, thus indicating a defective walling off, surgical measures are of immediate and paramount importance.

If, in *carbuncle of the neck*, when first seen, the infection is extensive, without any discharging opening, the indications are surgical, namely, excision or crucial incision and removal of necrotic tissue, and the packing of the wound with gauze wet in Wright's sodium citrate and sodium chlorid solution. A culture should be immediately taken with the intention of preparing an autogenous vaccine. There will usually be an exacerbation in temperature following the operation, due, of course, to the autoinoculation which the operative procedure has induced. The dressing should be kept continuously moist and changed every few hours. There will be, in a few hours, a profuse purulent discharge. A flaxseed poultice, constantly applied over the citrate dressing, will be found distinctly advantageous in that it increases the blood-supply to the part. After twenty-four hours the tenderness at the edges of the carbuncle should be considerably less and the temperature should be somewhat lower.

The injection of vaccine should be delayed until the effect of the surgical autoinoculation has worn itself out. Ordinarily, by the third day after operation, the temperature will have become practically normal, and the opsonic index, if determined, will be found normal or elevated. At this time a small dose of vaccine, perhaps 100,000,000, is indicated; two days later it should be repeated, and three to four days subsequently increased to 200,000,000. If, on the third day following operation, the temperature is still elevated, it means that the opsonic power is deficient, but suggests that the dose of vaccine should be made small, in order not further to depress the resistance. In a febrile case the dosage would ordinarily be 50,000,000, repeated daily until the temperature is normal, then increased to 100,000,000 every other day, and then further increased, as indicated, with an accompanying increase in the interval between the doses. The sodium citrate dressings should be continued only until the wound is clean and has begun to granulate; thereafter the wound may be packed with sterile gauze or with gauze impregnated with balsam of Peru or some antiseptic powder. The urine, of course, must be examined for sugar, the presence of which is commonly accompanied by a lowered opsonic resistance to staphylococcus and with a predisposition toward such infection. Inoculation may properly be continued every four or five days until the wound is clean. The patient should be advised on discharge to report for inoculation whenever the slightest suspicion of recurrence develops.

On the face, the ideal to be aimed at is to produce as little disfigurement as possible. In the writer's experience, carbuncles on the face have never required excision. There is commonly found one or more small pustules where the pus has burrowed toward the surface; the necrotic skin covering these pustules should be cut away, that the discharge may be free. A sodium citrate solution is applied in the usual manner, and over it a hot flaxseed poultice. An immediate inoculation is usually given of from 25,000,000 to 50,000,000 staphylococci (aureus). This is followed in twenty-four hours by a dose of equal size, and on the following day 75,000,000 or 100,000,000 may be injected. After twenty-four hours ordinarily there will appear, in addition to the discharging openings seen at first, a considerable number of small, superficial pustules, corresponding with the mouths of the hair-follicles. These are each pricked, and as much discharge expressed as possible. Each day this procedure is carried out. By the third day the temperature may have reached normal, and the discharge have increased. At this stage it will be possible to provide for a larger opening by cutting some of the epithelial bridges with scissors and thus give exit to the slough. At the end of five or six days the wound should be clean and granulating. The vaccines are given every other day, after the first three or four days, and then at longer intervals until the crater is entirely closed in. After the first four doses, generally given daily, one or two doses may be skipped. Rarely is it necessary to administer more than 200,000,000 or 300,000,000 at a dose as the recovery progresses. In a half-dozen cases of facial carbuncle that the writer has treated the resulting scar has been scarcely noticeable.

Empyema.—The commonest causes of empyema are pneumococcus and streptococcus. Where drainage is free in adults, there is commonly little need of offering assistance to the patient in immunizing himself. If the discharge continues, it is very often due to poor drainage. Certain cases, however, continue to have a discharge which may be attributed to a lack of immunizing power. Such cases will be apt to show elevation of temperature, considerable discharge, and an opsonic index to the organism present which is below normal. In such cases bacterial vaccines are indicated.

Although several cases of pneumococcous empyema have come to the writer's attention with a question of the advisability of vaccine, it was found in all cases that the patient finally, in a fairly short time, immunized himself and vaccines were unnecessary, although they might have hastened the result. The dosage of pneumococcous vaccine in such cases may be from 10,000,000 to 100,000,000 or more, bearing in mind the axiom that the sicker the patient, the smaller the dosage that should be used. This means that if there is a temperature the minimal dose, repeated in twelve to twenty-four hours, will be indicated. If there is no temperature, and the general condition of the patient is good, slightly larger doses may be given every day, or every other day, with a gradual increase in dosage and in interval. Where the empyema is due to other organisms, such as streptococcus, or where a mixed infection is found, appropriate autogenous vaccines should be made and used if indicated. About one-half the cases of empyema in adults are said to be due to streptococcus.

Dr. Cleaveland Floyd[1] reports 6 cases of empyema in children, in which he considers that extremely favorable results were obtained. He has noted an immediate control over the course of the disease and a decided improvement in the condition of the patient.

Briscoe and Williams[2] report a case of empyema in a child of two, in

[1] Boston Med. and Surg. Jour., 1908, clviii, 5.
[2] Pract., London, May, 1908, 675.

which pneumococcus was the cause and to which vaccine therapy was applied; 10,000,000 killed organisms were given, and eight days later 40,000,000. Their opinion was that the temperature was diminished and the general condition improved.

Allen[1] states that good results may be anticipated in empyemata when vaccine therapy is directed against organisms found present; that there is apt to be a mixed infection and that a mixed vaccine should be employed; that improvement may be slow and prolonged treatment necessary. If streptococcus is found, the dose will be from 10,000,000, as a minimum, to 50,000,000 or 100,000,000.

Empyemata of the accessory air-cavities, where they do not respond to ordinary treatment, would naturally come within the scope of vaccine therapy.

Osteomyelitis.—In acute osteomyelitis, after drainage has been assured and the temperature reaches normal, there may be advantage in giving staphylococcus or other vaccine as indicated by culture. There are no statistics by which one can prove that a continuously elevated opsonic index after such condition will hasten cure, but it seems reasonable that such would be the case.

In certain cases the tendency of the infection is to continue in the soft tissues, producing a profuse discharge. Such infections may be definitely controlled by vaccine. As an example of such a case I may cite one referred by the author of this volume, who had osteomyelitis of the terminal phalanx of the thumb. Incision had been made and dead bone found, but was not, however, removed. For a month there were two discharging sinuses and a very severe infection of the soft tissues of the thumb. Inoculations of 100,000,000 were given every three or four days, gradually increasing to 300,000,000 at five-day intervals. At the end of two weeks the thumb had decreased remarkably in size and the discharge was much less. After three months' treatment about one-half of the terminal phalanx was discharged, and within ten days the sinuses healed.

Where discharging sinuses are all that is left of the disease, the use of vaccine, associated with measures to produce a determination of lymph into the sinuses (as described under Treatment of Sinus), has proved a reliable means of hastening recovery.

It has always seemed best to the writer, in this as well as other fulminating infections, to interfere as little as possible during the active febrile period; that persisting temperature in most cases means insufficient drainage or new foci forming in other parts. Certainly, in these

[1] Vaccine Therapy and Opsonic Treatment, 1908, 170.

conditions, vaccine cannot hope to compete with the measures calculated to produce free drainage. Vaccine may be given during the febrile period if it is held down to extremely minute doses, as 10,000,000 to 50,000,000 staphylococci daily, or 1,000,000 to 10,000,000 streptococci, as the case may be, but in the writer's experience it is a better course to rely on free drainage and the patient's own powers to immunize himself at first, and then, if conditions indicate that he is incompetent to do so, the exhibition of vaccine is decidedly indicated.

Infected Sinuses.—A successful outcome in the treatment of tuberculous lesions associated with discharging sinuses depends often upon the way in which any secondary infection of the sinus itself is treated. There are many cases in which the sinus is infected by Staphylococcus pyogenes albus, which is apparently of little virulence, and which the writer has been in the habit of neglecting, unless it is evident that its growth produces irritation and increases the discharge. The use of the opsonic index will give one a cue as to whether such an infection needs treatment. If the opsonic index is found to be repeatedly low—that is, below 0.75—it is reasonable to endeavor, by means of an autogenous vaccine, to elevate the index to above normal and maintain it so for as long as possible. Where staphylococcus pyogenes aureus, or streptococcus, or other pathogenic organisms are found, it is practically certain that a vaccine will be the best method of treatment. An autogenous vaccine should always be used, particularly in the case of streptococcus or colon bacillus.

Oftentimes, although the lesion at the base of the sinus may be discharging little, there may be a copious discharge, originating in an infection of its walls. The organisms in the sinus walls have decidedly suitable culture ground for their growth. They are walled off from active blood-supply by the fact that they are located within a tube, as it were, of rather dense connective tissue, in the interior of which there is plenty of such food material as coagulated fibrin and broken-down tissue and detritus. It is obviously necessary, in the first place, to do what we can to bring a supply of fresh serum to the part, and, in the second place, to provide for its free exit, in order that continuously fresh serum may come into contact with the bacteria. Wright's treatment of such a sinus is irrigation with the solution of salt and citrate, previously described, which prevents coagulation of lymph and secondary plugging of the sinus, and will, by osmosis, draw serum to the part and bring it into contact with the bacteria which it is our purpose to destroy. Besides the syringing, it will be best in many cases to apply to the opening of the sinus gauze pressings, wet in the same solution, being careful first to cover the normal skin thickly with boric ointment.

The dosage of vaccine in these cases often exceeds that of the other lesions infected by corresponding bacteria, because the organisms are so well walled off from the circulation, and it may be necessary to prolong treatment over a considerable period. Sinuses that lead to glands which have been infected with streptococcus, even if the glands have been removed, are apt to discharge for a long time.

As an illustration, a woman twenty-five years of age had a furuncle in the auricle excised. She developed subsequently enlarged glands in the neck, several of which suppurated, requiring a number of incisions for sufficient drainage. For three months, in spite of autogenous streptococcus vaccine in moderate dosage up to 100,000,000, only slight improvement in the discharge was obtained. A sudden attack of erysipelas facialis developed, lasting a week. On recovery from this attack every sinus immediately closed and the patient has been well ever since.

This would seem to indicate that in dealing with chronic infected sinuses, at any rate those infected with streptococcus, we have an indication for large dosage so long as no constitutional symptoms develop. Apparently in this case the high degree of immunity to the streptococcus, which developed accompanying the recovery from erysipelas, was sufficient to eradicate the streptococci which had been active in the perpetuation of the infection, and upon which the vaccine in ordinary dosage had practically no effect.

Erysipelas.—The ordinary type of facial erysipelas is of so short duration, and the temperature is so likely to fall at almost any time, that observations as to the efficacy of vaccine until a great many more cases have been reported will be of little value. When, however, in a case of erysipelas of the spreading type, we find that a series of inoculations will stop the progress of the disease, we must give vaccine perhaps a certain amount of credit.

If possible, an autogenous vaccine should be prepared, but until it can be obtained, a stock vaccine of several strains obtained from erysipelas cases is indicated.

So long as the temperature is elevated, we have a condition of auto-inoculation which contraindicates the use of large doses of vaccines. Such dosage would tend further to depress the antibacterial power of the blood or to maintain it in a lowered condition. We must, therefore, grade our dosage exactly as we would in a septicemia, and be satisfied with a slight rise in the antibacterial power and a repetition of this rise as often as possible. The writer's method has been to give daily inoculations of from 2,000,000 to 25,000,000 organisms.

The writer has treated four cases of the migrating type. One of them, in spite of the vaccine, developed patches in various parts of the body successively, practically cleared up twice, and finally had a third relapse. We cannot in this case say that the vaccine did no good, but certainly it did not effect a cure. The other three cases, of exactly the same type, previous to inoculation had shown no tendency to limit themselves, but after several inoculations, at one- and two-day intervals, the process in each case absolutely ceased. The dosage in these cases may be at daily intervals at first. If more minute doses are given, say 1,000,000 or 10,000,000, inoculations may be given once in twelve hours. Large doses are decidedly contraindicated, as they are in any active spreading infection associated with temperature.

Sycosis.—This infection, which is due to the staphylococcus aureus, has always been resistant to the usual methods of treatment. Schamberg and others[1] say that no treatment, save possibly the *x*-ray, has given in their hands as good results in cases of obstinate sycosis as vaccine therapy. They report 1 case entirely cured; 2 not improved; 1 greatly improved; 2 slightly improved; 3 almost well. When these cases are seen, they have been generally of long standing, and a condition of pustulation is commonly superimposed upon thickened and chronically inflamed skin.

In the writer's experience, early cases are very amenable to vaccine treatment. Measures must first be taken to prevent crusting, to provide for a free discharge from the pustules, and in some active manner to draw as much blood to the part as possible. The face should be kept as free as possible from crusts. The pustules should be pricked, and the pustular area washed frequently with ½ per cent. sodium citrate and 2 per cent. sodium chlorid solution, and hot applications made continuously as possible for two or three hours twice a day.

Vaccine should be prepared from the patient's own organism, which is usually staphylococcus aureus alone or mixed with staphylococcus albus. The aureus, however, is always the offending organism, and the vaccine should be prepared from this. The dosage in an adult should be at the start 200,000,000 or 250,000,000, and should be repeated in four or five days. Treatment may have to be continued for from one to two months, although the early cases may clear up in half the time. The dosage need not be pushed higher than 400,000,000 or 500,000,000.

The immediate improvement, after the first one or two doses, is so marked that oftentimes the patient will feel that he is immediately on

[1] Trans. Sixth International Dermatological Congress, 1907.

the road to recovery and will stop treatment. He will be fairly sure to relapse sooner or later, and will then show up for one or two doses and again disappear. If the treatment is persisted in, and every measure taken to improve the local condition, to provide for local blood-supply, and to raise the antibacterial power of the blood by vaccine, nearly all cases should be improved and all but a few cured.

Eczema.—Eczema will often be found associated with the presence of staphylococcus in the skin, either as a cause or as a secondary invader. In either case, appropriate vaccine treatment is indicated. Chronic eczema in cases of long-standing furunculosis have done extremely well under treatment by autogenous vaccines. The locations of the lesions have been indifferently in the axilla, sides of the neck, groins, and flexures of the knees and elbows, situations where irritation or increased bodily heat and skin moisture have induced a condition of lessened resistance to bacterial growth. In eight well-marked cases of spreading eczema of long standing, after a treatment varying from three weeks to two months, a cure resulted which, in each case, so far as the writer knows, has been permanent.

Varicose Ulcer.—Varicose ulcers are most commonly infected by staphylococcus, although other organisms may be found. If the conditions indicate infection, cultures should always be taken and the organism determined. If staphylococcic vaccine is used, the dosage should be carried on as usual in localized infections, and may be increased as the treatment progresses. In several cases treated by the writer a stock vaccine was used to advantage. The inflammatory condition about the ulcer cleared up after two or three inoculations, and the tendency to close in became immediately evident. The ulcer was washed several times a day with Wright's citrate and salt solution, in order to promote free discharge and bring as much serum as possible to the part. When this solution irritates and causes pain, it is necessary to dilute it one half; that is, $\frac{1}{2}$ per cent. sodium citrate and 2 per cent. sodium chlorid. Infection, of course, is only one factor in these cases, and unless other conditions are properly met, recurrence is likely.

LOCALIZED TUBERCULOSIS

Diagnosis.—Before specific treatment by tuberculin is applied in any case, clinical diagnosis should be, if possible, supplemented by exact laboratory diagnosis or by means of certain tuberculin tests. In the case of nodes especially, it is impossible to say, from clinical appearance and conditions, that the etiology is definitely tuberculous. In the question of tuberculosis of the genito-urinary tract, the absence of bacilli in microscopic examination of the sediment should lead one to further effort for diagnosis by inoculation of guinea-pigs. The diagnosis of cystitis or pyelitis is frequently made as being due to the colon bacillus, because of its presence in the urine in large numbers. In these cases tuberculosis should always be suspected and guinea-pigs inoculated. Where it is possible to obtain pus, such specimens should likewise be injected into animals if no bacilli are found in smears. In the case of fistula or sinus, scrapings from the wall or bits of tissue should be examined histologically. Where there is extensive involvement of nodes of the neck without suppuration, and operative procedures on account of the extent of involvement may not be deemed wise, a small portion of a single node may be excised for the purpose of diagnosis. In the case of closed infection, where it is impossible to obtain discharge or a specimen of the organ infected for histologic examination, some of the newer methods, such as von Pirquet's tuberculocutaneous test, the eye reaction of Calmette and Wolf-Eisner, and diagnosis by means of variations of the opsonic index following induced autoinoculation, may be used.

The Technique of the Ophthalmic Reaction.—The eye should be inspected to ascertain if it is perfectly sound. It should be irrigated with 2 per cent. boric-acid solution, then two or three drops of a sterile 1 or 2 per cent. solution of old tuberculin introduced.

Precautions and Dangers in the Application of the Eye Reaction.—The eye must be in good condition, the tuberculin sterile and pure; the patient must keep his fingers out of his eyes.

Untoward Results.—Calmette mentions 20,000 observations, in which he found but 80 relating to the production of ulcerative keratitis or serious conjunctivitis attributable to this test.

Delayed Reaction.—If, when there is no reaction at first, it develops some days later, Calmette believes that such patients are bearers of tuberculous lesions, though perhaps very minute; that proof of this can be furnished by subcutaneous injection and noting resulting thermic reaction.

In tuberculous patients the reaction becomes more intense sometimes when repeated.

Where neither the conjunctival nor the von Pirquet reaction appears, it may be necessary, if diagnosis is important, to use the inoculation method.

Von Pirquet's Tuberculocutaneous Reaction.—*Technique.*—The ventral surface of the forearm is sterilized, dried, and two minute drops of pure old tuberculin are placed three inches apart. The point of a sterile scalpel is then rotated, using slight pressure, in such a manner as to introduce some of the tuberculin into the skin. The knife may be rotated perhaps one-half dozen times. The excess of tuberculin is wiped off after five minutes. The patient is told to report in twenty-four hours. A positive reaction may be described as anything between a small, dull-red papule, perhaps ⅛ in. in diameter, to an inflamed papule, ½ in. in diameter, with a red areola, and swollen. After two or three days, in case of the severe reaction, the superficial layers of skin may become necrotic and whitened, and in this type there may persist for some months a brownish discoloration. In the writer's experience, the dull reactions unassociated with areola have been associated with tuberculous conditions of considerable previous duration, and the more brilliant reactions with the earlier processes. The points of inoculation need not be protected. I have never seen any untoward happenings following this method of diagnosis.

The interpretation of the different degrees of the von Pirquet skin reaction, as to the sort of lesion with which they are consistent, is more or less uncertain. The writer has, during the past two years, used the test in several hundred cases. In the last stages of pulmonary tuberculosis it has been in some cases either very slight or absent. In early pulmonary tuberculosis it has been commonly very intense. In active tuberculosis elsewhere it has been also quite intense. In localized lesions of long standing the reaction is commonly slight, dull in color, and the papule of small dimensions and without areola.

In the case of an otherwise healthy individual, the development of an acute adenitis associated with a negative skin reaction, or one of very slight degree, is strongly suggestive that the lesion is non-tuberculous. If the reaction be brilliant, in the absence of any demonstrable focus elsewhere, the lesion may be considered to be presumably tuberculous. It has been shown that 55 in 100 healthy adults give a positive reaction. In healthy children under three years there were reported but 4 positive reactions per 100. Given, therefore, a suspicious lesion in a child under three, the positive reaction would furnish confirmatory evidence of the tubercular nature of the process. In adults a positive reaction would by no means be so confirmatory. In the case of glands of long duration, a dull reaction would be consistent with a tuberculous nature. The same may be said of joints and bone disease of long standing. Cases of healed pulmonary tuberculosis commonly react with very slight intensity. Fresh tuberculous glands developing in these apparently arrested pulmonary cases has been, in the writer's experience, associated with an intense reaction.

It would appear that the ophthalmic reaction is being generally given up in favor of the reaction of von Pirquet. It is not at all certain that the former furnishes any more information than the latter. The skin reaction certainly has in its application no element of danger. This cannot be said of the eye reaction.

Given a clinical diagnosis of tuberculosis, and a skin reaction consistent in its character to that which would be expected to accompany the lesion, we are justified in the use of tuberculin as a therapeutic measure if other methods of diagnosis are contraindicated or not decisive.

If more accurate diagnosis is required, some one of the inoculation methods may be used. If the question is one of pulmonary tuberculosis, and the temperature is normal, an injection of $\frac{1}{10}$ mg. or more of old tuberculin will commonly produce elevation in temperature, a few hours after inoculation, and increase in the number of râles to be heard in the lungs, if the case is one of tuberculosis. In localized tuberculosis the same focal reaction in a gland, in a joint, or elsewhere in the soft tissues may be obtained and manifested by swelling, tenderness, local pain, and discomfort if the infection is tuberculous. The dosage in an adult which might be expected to produce such a focal reaction should be from $\frac{1}{1000}$ to $\frac{1}{500}$ mg. tuberculin B. E. or T. R. The reaction obtained is comparable to that obtained in the lung from the injection of old tuberculin. In many cases of localized tuberculosis, even though large doses are given, no focal reaction is obtained.

Choice of Tuberculin.—In the treatment of localized tuberculosis, we are commonly not dealing with a general condition of toxemia, because there is an absence of autoinoculation. It would seem, therefore, that we desire, above all, to produce an antibacterial immunity. We should, therefore, choose a tuberculin composed of bacterial substance. The bacillus emulsion, being composed of bacterial substance from which nothing has been extracted, would appear to offer all the effective stimulus which the bacteria are capable of affording. Tuberculin R. may be used with good results, but it has not, in the writer's hands, been as efficient as the bacillus emulsion (Tuberculin B. E.).

Methods of Giving Tuberculin.—*Clinical Method.*—Tuberculin is given, according to this method, with the idea of securing tolerance to very large doses. It takes for its guidance the production of toxic symptoms. When marked local or general reactions are produced, the dosage is considered to be too large, and the subsequent injection is always of a smaller amount. Amount of dosage is again gradually increased until toxic symptoms are again produced or the patient recovers. The increase in dosage is, of course, gradual, but, inasmuch as symptoms of intolerance are taken as an indication that the maximum dose has temporarily been reached, it would seem that production of toxic symptoms must be a common occurrence. We know that, associated with a condition of toxemia produced by an excessive dose of tuberculin, there is a condition of lowered antibacterial power of the blood-stream or a negative phase. We suspect, even in localized tuberculosis, associated with symptoms of toxemia, that living bacteria are actually being taken into the blood-stream, which fact, taken in connection with its low antibacterial power, may conceivably be a menace to the patient, in rendering the development of other foci of infection possible.

It appears to be a fact that tuberculin may be given by the clinical method with more rapid improvement and cure than when the opsonic method is used. Sufficient numbers of cases have not been reported to determine whether or not the general or focal reaction produced by large doses may be dangerous to the patient in the case of localized tuberculosis.

The use that Wright has made of the opsonic index in studying the bodily reaction against infection has formed a basis for the rational application of specific immunization methods. One of the most important conceptions that Wright has given us is that efficient immunizing response to minute doses of tuberculin can be achieved, and that when tuberculin is given in such a manner as to secure a sequence of such immunizing responses, clinical improvement and cure commonly result, without the usual toxic symptoms that have hitherto characterized attempts at immunization with tuberculin.

The treatment of large numbers of cases under guidance of the opsonic index has furnished a scheme of treatment that can be followed without the need of the opsonic index, and with approximately the same end accomplishment. Such a scheme differs from the clinical method of giving tuberculin in that it does not seek tolerance of large doses, but rather a succession of immunizing responses; it never reaches a dose of toxic proportions except by error, and it attempts to carry out the treatment from beginning to end without the production of toxic symptoms. Such a method is certainly the most conservative that could be used. It is to be commended as against any method that takes for its guide to dosage intolerance, as indicated by local or general toxic reaction following inoculation.

In practice, it means that the initial dose of tuberculin is always minute enough not to produce any symptoms; that the increase in dose is so gradual that any symptoms which might be associated with negative phase are avoided.

During the past two years the writer has treated over 100 cases of localized tuberculosis without the use of the opsonic index as a guide. The dosage has been increased as nearly as possible in the manner that Wright has used when guided with the opsonic index. The production of anything suggestive of toxic symptoms after inoculation with tuberculin has been almost entirely absent.

Local Measures Calculated to Render the Immunizing Response Efficient.—A condition of restricted blood-supply oftentimes renders the inoculation treatment of tuberculosis inefficient, because, no matter how much elevated the opsonic power of the blood becomes following inoculation, the new antibacterial substances can obviously only become effective in the lesion when the blood-supply is unobstructed. It is, therefore, quite as important in such cases to use measures to increase the local blood-supply in the focus of infection as it is to raise the antibacterial power of the blood-stream itself. The majority of cases of localized tuberculosis do not require the application of local measures, but, the absence of improvement after several months of treatment with tuberculin would suggest that measures must be taken to cause determination of blood actively to the focus; application of heat, of Bier's suction, and, if the location of the lesions makes it applicable, the guarded use of Bier's passive hyperemia by means of bandage.

Tuberculous Lymphnoditis.—Before treatment is started, careful physical examination should be made, in order to determine if there are other lesions which would lead one to modify the dosage of tuberculin. If there is an active pulmonary lesion, associated with temperature, the treatment should be directed toward the cure of this condition and the node temporarily neglected. If there is a tuberculous lesion found elsewhere, as, for instance, in the eye, in the bladder, testicle, etc., if the tuberculin be given according to the principles of Wright, treatment need not be modified or the dosage lessened on account of these conditions.

Surgical Indications.—In the case of a single encapsulated node without surrounding induration, in a locality where the scar resulting from operation would not matter, the quickest and best procedure would be to excise. If the same sort of node has been existant for a long time, and if the condition suggests that it be caseated, excision would always be the best treatment. The *x*-ray will often furnish evidence, if the node is favorably situated, as to whether or not caseation or calcification has taken place. It is obvious that against caseated and calcified nodes tuberculin can accomplish nothing. If the glands are very extensive, and still seem to offer assurance that extirpation, more or less complete, may be obtained, surgical measures would again seem to be indicated, inasmuch as tuberculin, if used postoperatively, is usually efficient in preventing extensive recurrence, even if all the infected tissue is not removed. When liquefaction has taken place, the pus should be drained. Drainage should be put off, if tuberculin is used, until as much of the node as is possible has been liquefied, in order that the problem for tuberculin may be less. We, therefore, should postpone incision until the skin shows evidence of thinning out and spontaneous rupture. In most conditions of this kind incision is quite unnecessary, and, if used at all, should be more of a puncture than an incision, as it is, with a small opening, much easier to prevent secondary infection than if a wide incision were made. Quite as satisfactory as incision, however, is puncture with a large aspirating needle and removal of pus by aspiration. In this way the pus is removed and the resulting scar is minute. Aspiration may be necessary repeatedly, but is ordinarily efficient. The resulting scar is in the form of a depression or dimple, which gradually smooths out and becomes less noticeable.

This leaves for tuberculin, then, cases of node involvement which are obviously too extensive in which to expect complete extirpation; in which the resulting scar would be undesirable; in which the nodes are too scattered to render anything but several incisions sufficient; for the after-treatment of cases where the attempt has been made completely to extirpate, partly to extirpate; and for those in which there has already been recurrence beneath the skin, or in which there is a chronic discharging sinus. Based on statistics of results in these glandular cases which are available, the surgeon may do much less extensive operation, and at the same time feel reasonably sure, if after treatment with tuberculin is conscientiously carried out, that, even though small nodes have been missed, the average ultimate results in the cases will be much better than in the past when attempts have been made to complete extirpation, and it has not been achieved on account of extensive involvement. At the same time, in the majority of cases, the surgeon may limit himself to the excision of the most prominent masses if this be deemed expedient, and trust to the efficacy of tuberculin to complete the cure.

The Rôle of Tuberculin.—The tuberculous lymph-node is, as a rule, so well walled off from the circulating blood that febrile conditions are uncommon. We may conclude that, as a result of this walling off, the blood does not take up in any amount tubercle bacilli or toxin from the focus of infection as it does in febrile cases of pulmonary, renal, or certain other forms of tuberculosis. We should expect, therefore, that, in the enforced absence of the specific poison of the disease, the blood would lack in specific antibacterial substances on account of this lack of stimulus to their formation. Corroborative of this are the observations of Wright, Bullock, and many others, that the opsonic index is subnormal in localized tuberculosis as in other local infections where the blood-supply is deficient. The opsonic power in these cases does not show fluctuation, because there is no stimulus to produce immunizing response, and the blood itself, by its continuous, although slight, contact with the lesion, gradually loses by combination with the bacterial substance and toxin the opsonic power which it normally has. Thus is explained the absence of fluctuation and also the low opsonic power found in localized tuberculosis.

We are here dealing with lowered antibacterial power, because there is a lack of excitation for the formation of antibacterial substances. We step into the breach, and furnish this exciting ictus by means of inoculation with the specific poison which the body needs for the formation of these substances.

The determination of the opsonic index before and after inoculation has shown that minute doses of tuberculin may be calculated upon to cause an immediate rise in the opsonic power, but the continuance of this elevated opsonic power may be of brief duration; that slightly larger doses will be followed on the day succeeding inoculation by a diminution in the opsonic power, varying in its degree and duration upon the size of the dosage; that a slight fall, lasting a few hours, though indicating a temporarily diminished phagocytic resistance, still does not commonly produce anything apparent in the way of subjective symptoms, locally or generally; that, following this stage of diminished resistance or negative phase, there will succeed a stage characterized by increased opsonic power, lasting for a longer period than when a smaller dose was used which did not produce a negative phase. If a still larger dose be injected, the negative phase may be considerably prolonged and associated with constitutional disturbance, such as headache, malaise, and possibly a febrile reaction, and locally characterized possibly by tenderness, slight swelling, and pain. The febrile reaction can mean nothing but the presence in the blood of bacilli and toxin which have been liberated from the focus of disease. This is uncommon in lymphnodular tuberculosis, even though large doses are used, but where there is a great involvement of tissue and less complete walling off, it may be readily conceived that sufficient bacilli may be thrown into the circulation to constitute a menace to the individual from the possible production of new foci in other parts of the body. Clinically, we have instances of generalized tuberculosis, tuberculous meningitis, etc., following inoculation of large doses of tuberculin in some local infections.

We obviously desire to avoid the slightest danger to the patient as the result of our treatment, and our aim is, therefore, to achieve the maximum immunizing response, with as brief a period as possible of lowered resistance and its attendant danger. This danger is certainly less in lymphnodular tuberculosis than in any other type, excepting perhaps lupus. As a means of registering the response of the organism to tuberculin inoculation, in order to guide the dosage, Wright has used the opsonic index. It is not to be taken as a measure of anything but the opsonic power. It may be considered as an indicator of the state of excitation of the antibody-forming mechanism, showing whether or not it is or has been favorably stimulated in the production of antibodies by the vaccine or autoinoculation.

The giving of tuberculin, with the opsonic idea in mind, is the most conservative method that can possibly be devised, because it safeguards the patient against the effects of excessive dosage. The treatment of large numbers of cases with careful opsonic measurements have furnished those who have worked under these most favorable conditions with a scheme for the giving of tuberculin which may be calculated to do no harm, and to achieve consistent results without the labor necessary in the estimation of large numbers of opsonic indices.

Method of Treatment.—In the case of adults the initial dosage of tuberculin R. or B. E. may be $\frac{1}{30,000}$ to $\frac{1}{20,000}$ mg. The increase should be very gradual, and may at the end of six months to a year reach as high as $\frac{1}{2000}$ mg. The interval between doses should be approximately one week. No dose should be increased until one feels satisfied that the patient is not improving under it. Ordinarily, three or four doses of $\frac{1}{20,000}$ mg. may be given, four or five of $\frac{1}{15,000}$ mg., the same number of $\frac{1}{12,000}$, of $\frac{1}{10,000}$, of $\frac{1}{7000}$, and $\frac{1}{5000}$, and so on. It is not at all uncommon, if dosage is too large, for the patient to complain of swelling and tenderness in the gland being treated. If this is not severe, the same dosage may be repeated, and this commonly without any exacerbation. If such occurs, a longer period may be allowed to elapse before the next dose. If after one month's treatment there is no evidence of improvement, the dose may be more rapidly increased. It should always fall short of producing local or general symptoms. Some patients will require much larger doses than others even at first. The largest dose that I am giving, among about fifty glandular cases treated over a period varying from three months to eighteen months, is $\frac{1}{600}$ mg. weekly.

It is rather common after the first few doses of tuberculin for some of the nodes to break down. This is, in a way, a favorable happening, because it renders the problem for tuberculin of much less magnitude. The pus is never evacuated until there is danger of spontaneous rupture. We delay interference, with the hope that as much of the node will break down as is possible. Aspiration is much more satisfactory than incision, because there is less danger of secondary infection. It meets every indication that surgical measures can meet, because it produces free drainage, admits of free circulation of lymph into the cavity, than which extensive surgical measures cannot furnish more. The resulting scar is commonly negligible.

Sinuses.—Secondary infection is common. The most serious, and the least amenable to treatment, is the streptococcus. Vaccine treatment of any infected sinus is commonly unsatisfactory, unless certain active measures are used to promote antibacterial action locally, because the blood-supply is deficient, and even though the antibacterial power of the blood is high, it may not be effective, since it does not come into contact properly with the bacteria in the sinus. We must promote discharge in order to bring about free and rapid replacement of lymph. This is accomplished by means of syringing and local application of the sodium citrate and salt solution. These secondary infections must be treated ordinarily if results are to be obtained. I have, however, neglected in several cases these secondary infections and given tuberculin alone with satisfactory results.

Several cases that I have treated have only healed after treatment extending over at least a year. One case is interesting, in that it would indicate that much larger doses of streptococcus vaccine may be necessary in order to achieve results, and possibly that some modification in the method of preparing the vaccine may be necessary. This patient had several discharging sinuses in the neck, which failed to improve after several months' treatment with streptococcus vaccine. She suddenly developed an acute erysipelas, and coincident with recovery all the sinuses healed.

Lymph-nodes Developing in Supposedly Arrested Cases of Pulmonary Tuberculosis.—Examination of the lungs in these cases may show no activity in the focus. Nevertheless, the patient is apt to give a history of having lost some weight, and of not having felt as well during the period in which he has noticed the development of a node in the axilla possibly, or in the neck. There commonly will be found to be no temperature associated. We may find the development of nodes associated with extension of the process in the lungs. If this is the case, the nodes should not be treated, but the pulmonary condition should receive attention.

Where the node has developed in an apparently arrested case, with no increase in pulmonary signs and without temperature, tuberculin must be given more guardedly and in smaller doses at first, on account of the possible danger of lighting up the pulmonary lesion. In the cases the writer has treated he has found the von Pirquet cutaneous test gave a brilliant reaction, whereas in supposedly arrested cases, without new glandular involvement, we commonly find a dull and limited reaction to this test. It is the writer's custom to start such cases with a dose of $\frac{1}{50,000}$ mg. B. E., and gradually work up in the course of six months to $\frac{1}{1000}$ mg., given at weekly intervals. At first the patient's activity should be extremely moderate and absolutely under control. For the twenty-four hours after inoculation the patient should rest. If possible, during the first few doses of tuberculin, examination of the lungs on the following day should be made. Temperature observations three times a day should be required, and as soon as the patient is allowed to exercise or walk about, temperature should be taken before and after such exercise. If this activity causes a rise in temperature of a degree or even less, the patient should be kept absolutely quiet while the tuberculin is gradually being increased in dosage, realizing that febrile reaction at any time means autoinoculation induced by exercise or as a result of the tuberculin. Some of the most brilliant results the writer has ever seen in the treatment of glands by tuberculin have been accomplished in this type of case. Treatment extending over one or two years may be necessary.

Prognosis in Tuberculous Lymph-nodes.—In the group of about 50 cases the writer has treated in the past twenty months about 25 have been cured. The minimum of treatment in cured cases was three months, the maximum, eighteen months. The nodes in children under ten yielded more readily than between ten and fifteen years, and those in young adults have yielded better than in the older. The nodes of short previous duration yielded better than those of long duration. Nodes that are caseated do not yield at all to treatment, excepting so far as perinodular inflammation is concerned. Cure is taken to mean total disappearance of the node or diminution in size to that of a pea or slightly larger. Ten per cent. of this group of cases have shown very little improvement during this period of treatment. The rest have all shown definite gain in that the nodes have become smaller. In nearly all cases there has been an improvement in the general condition, and reasonable gain in weight, in spite of the fact that in most of them the conditions of hygiene have not been ideal, and have been improved very little over the conditions before treatment was begun.

Human tuberculin has been used in all cases; in several that did not improve after six months' treatment with tuberculin R. a like preparation of the bovine bacillus was used without any apparent improvement in results. In the early part of the treatment of this group of cases tuberculin R. was used in all cases. While improvement was distinct, it has been found that since bacillus emulsion has been used improvement has been much more rapid and definite.

A very careful and unbiased account of the tuberculous cases treated in Wright's clinic, St. Mary's Hospital, London, has been published in the British Medical Journal, August 28, 1909, by Dr. Carmalt Jones. There were 367 cases of all types treated in the out-patient department. The treatment was carried on under the disadvantage of lack of control over the conditions of life of the patients, irregularity of their attendance, and poverty. It was extremely common for patients to cease in their attendance when improved. Under these conditions he states that the method that achieves good results deserves full credit. Of 155 cases of adenitis end-results were obtained in 87. Tuberculin B. E. was used in minimal doses at the outset, repeated every ten days, and dosage not increased until it ceased to have therapeutic effect. The minimal dose was from $\frac{1}{15,000}$ to $\frac{1}{20,000}$ mg., the latter always in the case of children. The maximal dose for children under five was $\frac{1}{10,000}$, and for adults rarely exceeding $\frac{1}{4000}$. Of 79 cases treated without surgical measures, 27 were cured, 22 much better, 18 improved, 8 unchanged, and 4 worse. Cure is defined as either disappearance of the gland or reduction to the size of cherry-stones. Forty-three in 79 cases had been previously operated. Of the cured cases, 9 out of 27 had been operated; of the much better class, 14 of the 22 had been operated; of the improved, 14 out of 18 had been operated; of those worse or unchanged, 9 out of 12.

Prognosis, based on these results, will be that in 8 cases treated 5 will show marked improvement and 2 or 3 will be cured, 2 improved slightly, and 1 or 2 will fail. We must anticipate the best results in young children and young adults from fifteen to twenty-five years of age. After this time results are not so good. The worst results are ordinarily between ten and fifteen years of age, or about puberty. Success depends upon treatment of secondary infections. In the first five years of life the results are satisfactory, in the next less satisfactory, and so on, until after the age of puberty, when there is apparently a rise in the resistance or in the ability to react favorably to tuberculin. During the period from ten to fifteen years the numbers of cases of improvement are low, and there were more failures than at any other age.

In 11 cases the nodes disappeared; these were, with four exceptions, between eighteen and twenty-three years. The most favorable age for recovery would seem to be about twenty. Where the nodes are of short duration, recovery may take place within a few months. In only 3 cases did treatment at this age exceed a year. Relapses after improvement occurred in 11 cases.

Hartwell and Streeter[1] report the treatment of 20 cases of glandular

[1] Boston Med. and Surg. Jour., January 6, 1910, p. 5.

tuberculosis, using the method of Trudeau, which seeks to gain tolerance to tuberculin by giving fair initial doses and constantly increasing by minimal amounts. Initial dosage was $\frac{1}{10}$ mg. B. E., increased by adding the same decimal at each successive inoculation at weekly intervals. The maximal dose in this group was 3 mg.; duration of treatment was from two months to twenty-one months. Five were nine years or less of age, the rest were thirteen to twenty-five years. Ten cases showed as end-results good palpable glands; the others were described variously as pea-, hazel-nut, and almond sized. The patients were seen at periods from six months to one year treatment. They state that tolerance to tuberculin was obtained in most cases uneventfully. In a few instances intolerance was manifested by constitutional disturbance a few hours after inoculation, associated with apathy and lassitude, accompanied by headache and backache. No temperature observations were made. No focal reaction was noted associated with constitutional disturbance. Their guide as to intolerance has been the general reaction. When this occurs, the dose is diminished considerably and gradually increased again. They saw no ill effects in uncomplicated glandular tuberculosis. A tuberculous epididymitis was observed, however, to flare up under treatment. They gave as a period for curative treatment of moderately enlarged glands a year, in the massively enlarged, a longer time.

In this group of cases excellent results were secured by the use of tuberculin, without reference to its action upon the opsonic power of the blood, although attempt was made to avoid systemic reactions. Although such were at times produced, they do not appear to have been of serious consequence. According to Jones' statistics of cases treated by Wright, using the opsonic index as a guide, at best 3 out of 8 cases were cured. Applying the same criteria of cure in Hartwell's smaller group of cases, we should have approximately 95 per cent. of cures against 37½ per cent. by the opsonic method. If this record of cure can be kept up in a larger series of cases, and if our requirements are rapid results, irrespective of occasional unavoidable production of constitutional disturbance due to intolerance, the use of larger doses than would be allowable under the opsonic method of treatment might be justified. Realizing the significance of constitutional disturbance in indicating a period of lowered resistance to the infecting organism, it would seem possible that in a larger series of cases some untoward results might reasonably develop in association with these periods of lowered resistance. If the results of a larger series of cases indicate that glandular tuberculosis can be treated with approximately 100 per cent. of cure, and with no untoward results, we may consider that we have in tuberculin, applied by the clinical method, by all odds the most remarkable and efficient medy that has yet been offered for the cure of disease.

In comparing the dosage of tuberculin, as given by different workers, we must consider certain fundamental differences in the preparation of the tuberculin. The dosage of tuberculin, as indicated by the writer, is based upon the fact that in the case of bacillus emulsion the content of each cubic centimeter is stated by the manufacturers to be 5 mg. of bacillary substance. A dosage of $\frac{1}{10,000}$ mg., therefore, would mean that fraction of a milligram of actual bacterial substance. In the case of Tuberculin R., the original solution, as put out by the manufacturers, commonly contains 2 mg. of bacillary substance per cubic centimeter, and on this content dosage is based. Certain workers, however, do not base their dosage on the content of the original tuberculin solution in bacillary substance, but give certain fractions of a milligram of the original solution as a dose. It is obvious, then, that a maximum dose of 3 mg., as Hartwell has used, would be equivalent to a dosage of $\frac{1}{66}$ mg. of solid bacillary substance. This maximum dose of 3 mg., compared to the maximum dose used by the writer of $\frac{1}{600}$ mg., is, therefore, not so widely different as the figures would make it appear It would appear at first sight to be 1800 times the writer's maximal dose, but it is actually only 10 times that dose.

In order that easy comparison of dosage may be obtainable, it would seem advantageous to base the dosage upon the actual content of the fluid preparations of tuberculin, as sent out by the manufacturers, in bacterial substance.

Hawes and Floyd[1] report the treatment of 20 nodular cases, of which 18 were improved, 2 not improved. They used a combination of bacillus emulsion and bouillon filtrate.

The method used was that of Trudeau.[2] They state that larger doses of tuberculin can be used in lymphnodular tuberculosis than in any other form of the disease. They agree with Jones and others that improvement is apt to be more rapid in children, while in adults they do not disappear so rapidly but seem to become encapsulated.

Tuberculosis of Bone.—Unless as much of the diseased bone is removed as is possible, the problem for tuberculin is extremely difficult. With the dead bone cleared away, this form of tuberculosis is amenable to prolonged treatment with tuberculin in a large majority of cases. Here infected sinuses often complicate and require appropriate vaccines before the discharge will cease. In caries of the spine, where the disease is extensive and drainage is imperfect, and there is temperature associ-

[1] Boston Med. and Surg. Jour., January 6, 1910, p. 5.
[2] Amer. Jour. Med. Sci., June, 1907, p. 18.

ated, the results cannot be expected to be satisfactory unless autoinoculation is eliminated by operation. Cases reported from Wright's clinic by Jones (*loc. cit.*) consist of 2 which were cured and 3 were much improved. Western[1] reports 15 cases, 7 of which were cured, 5 showed improvement, and 3 no improvement. Hawes and Floyd (*loc. cit.*) report 3 cases of bone and joint infection, in which 2 were improved, 1 not improved. I have treated 6 cases of bone disease, of which 4 completely healed after from nine to eighteen months' treatment. One case, tuberculous ribs, still has very slight discharge from one sinus, previously having had profuse discharge from eight or ten. In all these cases there has been a definite improvement in general condition and most have gained weight. The maximum dosage of tuberculin B. E. used was $\frac{1}{2000}$ mg. of solid substance. The sixth case was one of tuberculosis of the lumbar vertebræ, in which it is impossible to maintain good drainage. The temperature continued elevated, and after six months' treatment there was apparently no change in the condition for the better.

The dosage of tuberculin in bone and joint cases is generally about the same as that used where lymph-nodes are treated. In the case of joints of short duration the initial dosage should be a little smaller. Supplementary treatment, such as fixation, is usually imperative. The duration of treatment depends upon the previous chronicity and extent of the involvement and the age of the patient. In the case of bone involvement, removal of carious bone renders the problem for tuberculin much more simple.

Tuberculous Joints.—The problem for tuberculin in these cases depends largely upon the character of the tissues involved. If it be merely the soft tissues, without extensive necrosis and without much bone involvement, the expectation of improvement will be much greater than in cases of long duration with bone involvement. Improvement or lack of improvement in these conditions depends largely upon the state of the blood-supply to the infected part. If the blood-supply is cut off by fibrous or caseated tissue or pus from coming into contact with the bacteria in the focus, it is obvious that, even though the blood-stream be fortified in its content of antibodies, results will not be forthcoming. Tuberculin should only be used in conjunction with other measures which have proved themselves clinically valuable in the conduct of these cases. Western reports 14 cases cured, 5 cases improved, 5 cases with no improvement, and 2 cases with slight improvement, in 26 cases treated. Of the 5 cases showing no improvement, 2 were over sixty years of age.

[1] Lancet, November 23, 1907, p. 1450.

Raw [1] reports 27 cases which were chronic or subacute, and obtained the best results where there were suppuration and sinuses. My own experience has been limited to the treatment of 4 cases, in 1 of which there was decided improvement after six months' treatment, in a second there was complete cure and function was apparently obtained, and the other 2 were lost sight of.

There is not the slightest question but that tuberculin has distinct value in many cases of joint infection. Its curative value is limited by the condition of the focus as to whether or not the blood-supply can be made sufficient. Methods for diagnosis and for decision of cure by means of the opsonic index have been discussed.

GENITO-URINARY TUBERCULOSIS

Renal Tuberculosis.—It is decidedly unwise for any one, no matter how expert in the giving of tuberculin, to institute treatment in any case of genito-urinary tuberculosis until the question of extent of involvement of the kidneys and other structures, and the question of extirpation, has been thoroughly investigated and considered by the surgeon trained in the special methods of genito-urinary diagnosis and treatment.

Expectation that the exhibition of tuberculin in extensive renal involvement, associated with disintegration and extensive caseation of the kidney, will take the place of extirpation of the organ is entirely unfounded. It may reasonably be expected that the proper use of tuberculin may maintain the blood-stream in a condition of increased resistance to the tubercle bacillus, but, both in theory and in practice, it is unjustifiable to risk the patient's life by leaving unmolested a disintegrated useless kidney, on the expectation that the blood-stream will, by means of its high antituberculous power, be able to produce resolution. It is obviously impossible to transfer the antibacterial elements of the blood-stream into a mass of caseated material, or even to conceive of a sufficiently active circulation in the infected tissue surrounding such a mass of caseous material to cause the destruction of the tubercle bacilli present.

Involvement of both kidneys, if extensive, may contraindicate extirpation of either. The use of tuberculin in such cases has been found to produce distinct amelioration in the pain, frequency of micturition and temperature, and may be considered a decidedly useful measure for the temporary relief, although from the start such cases are beyond hope of cure.

[1] Lancet, February 15, 1908, p. 480.

A case of this type is reported by Walker,[1] and briefly is as follows: After three weeks' treatment with tuberculin, pain and hematuria disappeared, and frequency of micturition diminished. Temperature fell to 99° F.; weight increased. After six weeks, no bacilli were found in the urine. After three months, the patient died of renal failure.

He states that renal tuberculosis with occlusion of the ureter, producing a resulting accumulation of caseous material, offers no expectation of cure under tuberculin. The frequent involvement of the ureter in the tuberculous process renders possible in such cases occlusion and accumulation of pus under pressure. Walker (*loc. cit.*) refers to Fenwick's statement that actual harm may result from administration of tuberculin when the ureter is involved, on account of the swelling in the mucous membrane which may follow its use with possible occlusion resulting.

Such increase in swelling might result from a "*focal*" reaction in an already infected and swollen mucous membrane of the ureter, induced by a large dose of tuberculin. These considerations furnish earnest reason for the use of small dosage of tuberculin, and of an increase in dosage so gradual that nothing in the way of reaction, local or general, is produced in the treatment of any case of renal tuberculosis.

Tuberculin should be of the most advantage in the early stages of renal tuberculosis. It is uncommon, however, to arrive at a diagnosis at this early period, because the first evidence noted by the patient, such as cystitis, may not appear until long after the disease has gained considerable headway in the kidney.

Given a diagnosis of tuberculous kidney in its early stage, the question of tuberculin as against extirpation cannot be settled until more cases are reported with ultimate results, and compared to those obtained by extirpation. A trial of tuberculin cannot be dangerous if it be administered carefully.

Walker reports the treatment of an apparently early case as follows:

A history of sudden attack of pain in kidney, shooting into groin and testicle, followed by dull renal ache. Passed blood. No bladder symptoms. Pott's disease twelve years before with cold abscess. At about the same time amputation of left foot for tuberculous disease. Kidneys not tender; right slightly enlarged. Tuberculin $\frac{1}{25}$ mg. once a month, gradually increased to $\frac{1}{2}$ mg. "Almost from the first weight increased. Blood has not appeared in the urine since treatment commenced." For eight months the pain in the kidney continued troublesome. After that, it suddenly diminished, until January, 1906 (seventeen months' treatment), when it disappeared. Reduction in the dosage of $\frac{1}{1000}$ mg. was followed by a noticably increased pain. In July, 1906, dose was raised, and in February, 1907, patient stated he had had no pain since the increased dose. There was less pain with larger doses.

[1] Practitioner, London, May, 1908, p. 723.

Carmalt Jones reports the cases of renal tuberculosis treated in Wright's clinic. Of the cases treated, 2 were considered cured, 2 "better," 2 "somewhat better," and 1 dead.

The writer has used tuberculin in 1 case of renal disease in which the organ was considered to be not sufficiently disintegrated to demand extirpation.

The patient, a man of about fifty, had suffered from cystitis for over a year. His ureters had been catheterized. The urine from the right kidney was cloudy, due to colon bacilli and pus. That from the left kidney was more clear. The writer was advised that no tubercle bacilli had been found in the sediment, and he was asked to treat the case as one of colon pyelitis and cystitis. In order to rule out tuberculosis he inoculated a guinea-pig, which died six weeks later, from generalized tuberculosis. During this period colon vaccine was given, with some temporary improvement, manifested by lessened frequency in micturition, almost total disappearance of colon bacilli, and diminution in the amount of pus. The von Pirquet skin reaction was intense.

Tuberculin was given at weekly intervals as soon as a diagnosis had been made for a period of four months. Dosage from $\frac{1}{20,000}$ mg. of bacillus emulsion to $\frac{1}{7000}$ mg. At the end of the fourth month's treatment the patient complained of dull pain and a sensation of fulness in the right side of the abdomen, high up. There was suggestion of a mass to the right of the umbilicus, deeply situated. He was referred back to the surgeon, operated, a large collection of pus, involving pelvis of the kidney and ureter, was found. He soon after died of pneumonia. Dosage of colon vaccine was from 10,000,000 to 100,000,000 every four or five days.

This case is of interest for several reasons: First, in diagnosis, the presence of colon bacilli in large numbers in catheter specimens of urine from the ureter should suggest the possibility of tuberculosis as a fundamental cause, inasmuch as the two organisms are so commonly associated in these infections; second, the absence of tubercle bacilli in the smears should lead one to inoculate a guinea-pig with the sediment in order to secure final evidence for or against tuberculosis; third, it suggests the difficulty of determining the extent of the tuberculous process in the kidney; fourth, it illustrates the possibility of occlusion of the ureter in any case where the same is involved in the diseased process.

We may have, therefore, at the outset, through disintegration, without any definite evidence one way or another, or we may have developed later, through occlusion of the ureter, an impossible problem for tuberculin, which could in no way be foreseen.

Vesical Tuberculosis Associated with Renal Involvement.—Renal tuberculosis is commonly complicated by secondary bladder infection by the same organism. It may be difficult to say which is the original seat of infection, bladder or kidney. Cystitis, associated with renal disease, may clear up after extirpation of the diseased organ. Walker (*loc. cit.*) states that in some cases the cystitis appears to be due, not to actual tuberculous infection of the bladder, but to the irritation caused by the deposit from the kidney. In claiming cure of tuberculous cystitis by removal of the kidney, this possibility must be borne in mind.

When, in spite of extirpation, the cystitis persists, the use of tuberculin is indicated. Walker concludes that it is a valuable adjunct to operation. He reports the following case (*loc. cit.*):

Patient had constantly aching left kidney eight months. Worse in morning, aggravated by exercise. Nocturnal micturition for six months. Blood in urine. Frequency, half hourly in day, two hourly at night. Left kidney large and tender. Cystoscope showed general tuberculous cystitis, left ureter retracted. One month later large tuberculous left kidney removed and a month later tuberculin begun. During twelve months' treatment there was increase in weight, frequency of micturition became hourly instead of half hourly, pain less; improvement was slow but undoubted.

A brief summary of a case of this type treated by the writer is as follows:

Increased frequency for over five years. Three months before operation cystitis became severe; incontinence of urine. Much pus and many tubercle bacilli found.

At operation right kidney and ureter were found to be extensively tuberculous and were removed.

When seen by the writer, two months ofter operation, there was a free discharge from two operative wounds. Urine foul, cloudy, contained pus and tubercle bacilli, and large numbers of colon bacilli. Micturition during the day every twenty minutes, at night ten or fifteen times. Excessive vesical pain. Temperature 100° to 102° F. Prostration, emaciation. Bad prognosis given by the attending surgeon.

Tuberculin R was given at weekly intervals, beginning with $\frac{1}{20,000}$ mg. (bacillary substance). Temperature normal after two weeks. Dosage of $\frac{1}{8000}$ mg. at end of two months. General condition, strength, weight, appetite, showed at this time a decided gain. Pain and frequency did not improve commensurately. A colon bacillus, isolated from urine, was agglutinated by the patient's serum at a dilution of 1:128. Colon vaccine prepared and injected twice a week at first. Initial dose, 10,000,000.

Before the end of two weeks there was less pain and frequency, the urine appeared a little less cloudy and less foul. In the second month of treatment, with the combined vaccine, the urine became comparatively clear. After six months from the start, the wounds had healed, the urine, no longer foul, contained very little sediment. Urination every two hours in day, less often at night, associated with very slight burning. At this time patient had been up and about increasingly for two months; had gained considerable weight.

At the time of writing (March, 1910), the patient had received tuberculin weekly twenty-one months with occasional breaks. The maximum dosage, $\frac{1}{2000}$ mg. For six months colon vaccine was given, at first twice weekly and later once a week. Maximum dosage, 60,000,000. It was omitted about a year ago. The urine sediment was slight, and few colon bacilli were to be found on recent examination. It still contains tubercle bacilli, as recent inoculation experiment proved. Micturition every three to five hours, occasionally once or twice at night. No pain. Gain in weight approximated at 30 pounds. Is able to attend to household duties and to go about without discomfort. She states that she feels better than she has for several years.

There are certain features of this case that are worthy of note: First, the immediate improvement in the cystitis following the administration of colon vaccine, there having been no improvement in this regard during the two months of exclusive tuberculin treatment; second, the fact that the colon bacilli were but few in the urine after six months of treatment with colon vaccine; third, that, although the maximum dosage of colon vaccine was but 60,000,000, and the last dose was given approximately a year ago, the immunity established has apparently continued to the present time; fourth, the presence of living tubercle bacilli in the urine indicates that the process is still active somewhere, but the patient's excellent condition, the absence of temperature, indicates that she has at present a well-defined degree of immunity; fifth, the presence of these bacilli indicates that every possible measure should be made use of to increase the patient's resistance, and, particularly, that we must maintain the antituberculous power of the blood-stream at as high a degree as possible by the use of tuberculin; sixth, it is interesting to note that the patient is able to say, based on her subjective symptoms of well-being, or the opposite, following a dosage of vaccine, as to whether the dose as given is increased or diminished. It has been found in every instance in which the dosage has reached $\frac{1}{2000}$ mg. the patient does not feel as well for three or four days after inoculation. It has been found that a dosage of from $\frac{1}{8000}$ to $\frac{1}{5000}$ mg. (bacillary substance) is the most satisfactory dosage with which to maintain the present excellent condition. It is planned gradually to increase the dose by minute increments, that is, from $\frac{1}{8000}$ to $\frac{1}{7500}$, and then to $\frac{1}{7000}$ mg. and so on, with the expectation that in the next six months a dosage of $\frac{1}{1000}$ mg. weekly may be well borne. There has been in the treatment of this case at no time any suspicion of severe subjective symptoms following either the colon vaccine or the tuberculin.

Vesical Tuberculosis Without Apparent Renal Involvement.—There may occur, according to Walker (*loc. cit.*), a considerable number of cases of tuberculous cystitis, unaccompanied by demonstrable renal involvement. Of 42 cases, he found 10 in which the disease was apparently confined to the bladder, and 32 in which foci were found in other parts of the urogenital system. In 23 of these 32 the other involvement was in the genital system.

When, as a result of the application of the usual methods of diagnosis, it is concluded that the bladder is the chief seat of involvement, we have a condition unsuitable for surgical treatment and unsatisfactory with other usual methods.

We have to deal with a tubercular infection of a mucous membrane, ulcerated and indurated. Such lesions are definitely known to be amenable to tuberculin.

Again quoting Walker (*loc. cit.*):

"In such cases the best results may be obtained from tuberculin treatment." He states that sometimes, after two or three injections, the patient will report improvement. Less often the symptoms persist in increased or lessened severity, and improvement is only obtained after many months of treatment. The patient first experiences increased vigor, pain diminishes and disappears, and calls to micturition become less troublesome. From a frequency of fifteen minutes during the day and incontinence at night, improvement to two hours through the day and once or twice at night may be obtained in several months. Hematuria gradually ceases. The urine remains for a long time without change, but may eventually become clear, and the urinary pigment, which was deficient, increased. The patient puts on weight.

He selects the following case from a few in which the tuberculous process has apparently been arrested:

Man, thirty-one, in July, 1903, had hematuria and hemoptysis. For four years cystitis symptoms had increased gradually. Cystoscope showed ulceration left side of bladder. Groups of fine tubercles found. Four months treated with drugs. Symptoms the same. Steadily lost weight. Tuberculin begun November, 1903, $\frac{1}{280}$ mg., repeated every two weeks. January, 1904, urine unchanged. He ceased to lose flesh, held his urine four hours during the day, rose once at night. Much stronger, and had regained former figure. Cystoscope showed groups of tubercles, but less ulceration. Hemoptysis in March, 1904, and about weekly during the early part of the year. He began to gain flesh, and appearance showed improvement. In 1904 burst of hemoptysis and hematuria. September, 1904, to January, 1905, had gained one stone and a half in weight. Cystoscope, June, 1905, showed few fine tubercles; ulceration had healed. September, 1905, no pain or hematuria. Urinated three or four times a day, not at all at night. Urine still hazy, trace of pus. January, 1906, injection reduced to $\frac{1}{10000}$ mg. for three weeks. Blood appeared in urine and was present some weeks. It disappeared and the urine gradually cleared, with increased doses of tuberculin. Urine became absolutely clear, remained so several months. July, 1907, attack of cystitis. Urine cloudy, no T. B. found, numerous staphylococci. Recovered from this attack of staphylococcus cystitis and feels well.

Jones reports the cases of tuberculous cystitis treated in Wright's clinic as follows:

Two cases cured, 4 much better, 8 better, meaning either some relief from pain or frequency of micturition. One case was no better, 1 worse, and 1 unknown. There were relapses in 5 cases. In 13 cases there was secondary colon infection. In 10 of the successful cases initial dose was less than $\frac{1}{15,000}$, but often $\frac{1}{25,000}$ mg. After a time it was raised gradually to $\frac{1}{4000}$. Serious results may follow large initial doses. Treatment of successful cases averaged one year two months. Five or 6 were treated six months or less.

The writer has treated a case of genito-urinary tuberculosis, which in its early history furnishes an excellent illustration of the course of an untreated case of tuberculous bladder, apparently unassociated with renal disease:

In early October, 1908, "F. G.," male, about twenty-eight years old, was referred for treatment. For ten years he had suffered from frequent micturition, generally every two or three hours. For three or four years had passed a little blood once or twice each year. At times there was considerable pain and burning on micturition, but this was not constant. Four years before the above date the symptoms of cystitis became marked, and when blood appeared, he was referred to a surgeon for observation. Cystoscopy was at the time performed by J. H. Cunningham, Jr., who found several ulcerated areas in the mucous membrane and made a positive diagnosis of tuberculosis. During the following four years he occasionally passed blood, had some pain on micturition. Frequency, every two or three hours, once or twice at night. Urine generally not cloudy. His general health continued to be fairly good although untreated. In October, 1908, he developed a swollen testicle, which was, when the writer saw it, the size of a clenched fist. It had become swollen in a few days; was only slightly tender. His physician believed it to be due to the gonococcus, but there was no history of exposure or clinical evidence of the disease. The von Pirquet cutaneous reaction was intensely positive. In a short time the tissues broke down, fluctuation was made out, and considerable thick pus was aspirated. No pyogenic organisms were present. A guinea-pig inoculated, killed after four weeks, showed tubercle bacilli in the mesenteric glands, inguinal glands, and tubercles were found studding the peritoneum.

The sequence of events in this case and the observations furnish clean-cut evidence of a tuberculous cystitis extending over a period of years and final extension to the testicle.

It indicates that in an apparently healthy individual tuberculosis may exist in the bladder for a long time, and illustrates the tendency of bladder tuberculosis to extend to other organs of the genital system. It is particularly interesting, because of the sequence of events in the same case following the use of tuberculin as treatment over a considerable period. The treatment of this case will be considered under the next heading.

Vesical Tuberculosis Associated with Tuberculosis of the Genital System.—In 23 cases cited by Walker (*loc. cit.*) tuberculosis was found to be coexistent in the bladder and in some of the genital organs. This association is very commonly met with.

He states that his patients steadily lost ground under various local and general treatment, and that he considered them eminently suited for tuberculin treatment; that in none of them was he able to bring about a cure, though he treated them over long periods. In most cases a considerable amelioration of symptoms was obtained. The distressing frequent and urgent micturition is sometimes diminished to a remarkable degree.

One illustrative case, a man of thirty-eight, when seen had symptoms of cystitis for eighteen months. Left seminal vesicle was hard, and in the left lobe of the prostate was a large, hard nodule. Tubercle bacilli found in the urine. Cystoscope showed a cystitis without definite tubercles. During six months tuberculin was given. Dosage, $\frac{1}{200}$ to $\frac{1}{800}$ mg. He gained weight; there was no blood in his urine since the early part of the treatment. Micturition less frequent.

A second case for four months urinated every ten minutes and was incontinent at night. Urine thick and milky, prostate and seminal vesicle affected. After four months there was a gain of weight, lessened pain, urination every one and a half hours during the day, every two hours at night. After twenty-one months' treatment urination was every three hours and twice at night, still milky. At the end of twenty-eight months' treatment the urine was clear, frequency every three hours in the day time, once at night.

The case "F. G." will be here continued as one of tuberculous cystitis with secondary testicular involvement:

Beginning October 7, 1908, tuberculin R. was injected once a week, initial dosage $\frac{1}{20,000}$ mg. (bacillary substance), the second $\frac{1}{15,000}$ mg., the third $\frac{1}{10,000}$ mg., the latter repeated weekly until December 22, when it was increased slightly to $\frac{1}{8000}$ mg. After the pus was aspirated from the testicle, a sinus continued to discharge until the last of December. The testicle gradually lessened in size, and the epididymis could be felt as a somewhat enlarged, hard mass. After the first four doses of tuberculin, micturition became less frequent (for several years it had averaged every two or three hours). On December 22, 1908, after about three months' treatment, the patient stated that for the past week he had several times held his urine seven hours without much discomfort, and had not been up at night to micturate for some time. June 15, 1909, the dosage had reached $\frac{1}{2000}$ mg. T. R. Urination every four or five hours and not at all at night. August 3, tuberculin B. E. was substituted for T. R., inasmuch as results in other cases appeared to be superior than those obtained by the use of T. R. Initial dose $\frac{1}{20,000}$ mg. December 24, 1909, dosage had reached $\frac{1}{1000}$ mg. B. E., and the last dose, March 4, 1910, was $\frac{1}{800}$ mg.

The testicle is now of practically normal size, the epididymis hard, but smaller than at first, micturition three or four times a day, never at night; pain after micturition, as experienced at first, has almost disappeared; no blood in the urine since treatment was begun; weight about as usual; general condition excellent; subjectively and objectively perfectly well; has been able to attend to business from the start of treatment as he had previously, but with less discomfort. He has received no local or general treatment other than tuberculin and advice as to hygiene.

There has been no suspicion of constitutional or focal reaction following injection of vaccine.

This case is of interest in the matter of diagnosis. The finding of tuberculous ulceration in the bladder in 1904 indicates that the bladder symptoms, extending over from five to ten years, were within reasonable probability due to a condition of tuberculous cystitis; the testicular involvement, which occurred four years after the ulcerations were found, and proved to be tuberculous by animal inoculation, confirms the accuracy of the cystoscopic diagnosis.

The case is further valuable as indicating the efficiency of tuberculin so far as indications may be obtained from the study of any one case. The symptoms had gradually gotten worse over a long period previous to the beginning of tuberculin treatment, and the involvement of the testicle came as evidence of unfavorable progression of the tuberculous process. The improvement associated with the exhibition of tuberculin may not only be taken as evidence of its efficiency in cystitis, but also in an early tuberculous process in the epididymis.

The outcome of the case also shows that tuberculin may be given successfully without the production of any symptoms of intolerance of either a general or a local nature.

The question of when to stop tuberculin treatment in a case of this kind can be determined only by the method of trial and error. The writer proposes to inoculate a guinea-pig with the centrifugalized sediment of the urine. If bacilli are to be found in the urine, the treatment will be continued; if not found, tuberculin will be stopped for a month or two and the patient kept under careful observation. Tuberculin will be started again if increased frequency of micturition, pain, or other symptoms of cystitis develop.

Tuberculosis of the Genital System.—The chief danger of tuberculous infection of the genital system is that it may infect the bladder. Walker (*loc. cit.*) considers the onset of cystitis to indicate extirpation, if possible, of the organ involved, but otherwise does not make use of extensive operative procedures, this because of the tendency of these lesions to contract and become walled off as a result of the benefit of tuberculin and general hygienic measures.

He reports a case of tuberculous epididymitis, prostatitis, and vesiculitis, in which decided improvement took place after four years' treatment. The lesion in the epididymis in this case was of nineteen years' duration.

Jones (*loc. cit.*) reports the following cases of tuberculous testicle treated in Wright's clinic—3 cases were cured, 2 "much better," 2 "better," and 2 doubtful as to the result.

Jones sums up 34 cases of genito-urinary tuberculosis treated with tuberculin in Wright's clinic as follows: The results would indicate that great improvement may be obtained in 3 out of 7 cases, and slight improvement in 2 more cases; treatment may last a year or more. There were secondary infections in one-half the cases.

Genito-urinary Tuberculosis Associated with Tuberculosis Elsewhere.—If the complicating tuberculous lesion is other than pulmonary, there is no contraindication to the use of tuberculin in the dosage which consideration of the genito-urinary condition would indicate.

If there is an active pulmonary lesion, the dosage of tuberculin must be modified according to the special requirements for treatment of a case of the pulmonary type. If there is pulmonary involvement of a more or less inactive character, tuberculin may be guardedly given. We must, at first, insist that the patient be kept quiet during the twenty-four hours after inoculation, in order to eliminate the possibility of superimposing an autoinoculation upon the inoculation already given, and thus avoid what might constitute a toxic dose of tuberculin.

Tuberculin Treatment

There is no form of tuberculosis, except the pulmonary, which requires more careful attention to dosage than renal tuberculosis. In febrile cases we are dealing with autoinoculation. Extremely minute doses, of course, must be given. The initial dose may be $\frac{1}{50,000}$ mg. (B. E. solid substance) or less, repeated in from five to ten days for several inoculations, when it may be increased to $\frac{1}{40,000}$ mg. The next gradation will be to $\frac{1}{30,000}$, and hereafter the increase must be more gradual, using several doses of $\frac{1}{25,000}$, $\frac{1}{20,000}$ and $\frac{1}{15,000}$ before any further increase. The safest method of giving tuberculin is to bear in mind that the aim should always be to fall short of the production of clinical symptoms. That this will be in some cases impossible at some stage of the treatment is evident. We have in the clinical symptoms a guide which indicates when any dose is too large. There may be rise in temperature, increased frequency in micturition, increased pain or tenderness, headache, malaise, nausea, etc., during the twenty-four hours after inoculation, which are known to be correlated with any marked reduction in the opsonic index. If such symptoms occur, we should always await spontaneous improvement before again inoculating, and at the same time give a considerably smaller dosage. We must use greater care in further increase of dosage as the treatment progresses.

In afebrile cases, in the absence of subjective evidence which indicates that the antibacterial resistance is being unnecessarily lowered by the dosage of tuberculin used, we may have positive evidence that the tuberculin is doing good in the sense of well-being that the patients frequently experience for several days after each inoculation.

Where it is impossible to observe any local changes, as in tuberculosis of the kidney or in the seminal vesicle, prostate, or testicle, following single inoculations, when there is no temperature, we can begin with the usual minimal dose, and gradually increase at about the same pace which would be used in the case of bladder tuberculosis when signs would manifest themselves if the dosage were too large. In the same way, based on experience in treating cases of this type, using the opsonic index as a guide, we are able to obtain a scheme which, if used consistently, will gradually promote tolerance to tuberculin by a very gradual increase in dosage, and at the same time will not provoke any extended period of lowered opsonic power with its attendant lack in progress or retrogression which may be associated with a series of prolonged negative phases.

The danger of producing constitutional disturbances following inoculation in cases of extensive tuberculosis of soft tissues, such as we are here dealing with, is much greater than the danger from such reactions which may be produced in glandular cases. Severe constitutional symptoms, following inoculation with tuberculin, mean nothing else than the presence in the blood of living bacilli and poisons, and are associated with a period of diminished tuberculotropic power of the blood-stream. Dissemination of bacteria with the blood-stream at such a period cannot be anything but dangerous to the patient, not only from the standpoint of the possibility of the development of new foci elsewhere, but also through the extension of the process locally, when the local and general barriers of resistance are temporarily partially broken down. If we take the signs of intolerance to tuberculin as a guide for dosage, we shall have no guide unless intolerance is produced. That repeated constitutional disturbances following the inoculation are consistent with more or less rapid recovery in a large number of cases is well known. That the use of large doses of tuberculin with production of constitutional reactions has been repeatedly followed by disaster is quite as well known. It no doubt takes a somewhat longer course of treatment to arrive at tolerance to the same amount of tuberculin if we use the opsonic method of treatment than when the clinical method is used, but, theoretically and practically, there is no reason to think that the results of treatment will be less good if the same dose is finally arrived at. By the opsonic method we arrive at the large doses only after a considerable space of time, and during this time we have produced no periods of constitutional disturbance and attending dangers. The largest dose of tuberculin that the writer is giving in genito-urinary cases is $\frac{1}{800}$ mg. B. E. after two years' treatment.

Extirpation of tuberculous organs in the genito-urinary system is, in the majority of cases, palliative, because the process is apt to involve other tissues that cannot be removed. These cases are rendered difficult and often impossible as surgical problems because of the many avenues for extension of the process; because, in the case of the kidney, the proper functioning is interfered with; where the ureter is involved, it may become occluded and render useless the corresponding kidney; where symptoms of cystitis are intense, surgery may offer no relief.

There is no doubt that some patients recover after removal of some seriously involved organ and that the body is, by its removal, enabled to hold in check lesions elsewhere. But we know that it is through the specific antibacterial power of the blood fluids and through cellular reaction in walling off the lesions that this takes place. We know that the blood-stream itself is, in the vast majority of cases, deficient in tuberculotropic power, and have seen the reason for this in the segregation of these foci from the circulation and the consequent lack of effective bacterial stimulus to induce the formation of a sufficiency of tuberculotropic substances. It does not seem an irrational procedure to make use of an agent, tuberculin, to furnish an artificial stimulus to the immunizing mechanism when it gives every evidence of being in default for lack of this stimulus. In fact, the knowledge that it is possible to increase the power of the blood-stream to destroy tubercle bacilli, and thus better safeguard the rest of the body and, perhaps, prevent further extension of lesions already under way, would appear to render the use of tuberculin imperative when operative procedures have accomplished all that is to be expected or when they are contra-indicated. Clinical evidence derived from the treatment of other localized infections with tuberculin is overwhelmingly in support of this view.

It has been the unfortunate custom in medicine to base on brilliant results achieved by new methods in certain types of infection extravagant expectations as to their efficiency in others. That it is unreasonable to anticipate that masses of tuberculous tissue should suddenly melt away under tuberculin treatment should be evident from consideration of the conditions in tuberculous foci. We cannot expect the leukocytes or antibacterial substances to have any effect upon bacteria that they cannot reach. In fact, clinically, tuberculin may not appear to reduce the size of a tuberculous prostate or seminal vesicle to a marked degree, even though given for several years. It may be reasonably assumed, however, that with a blood-stream high in protective substances the danger of extension of the tuberculous process will be lessened. On the other hand, in tuberculous conditions of mucous membranes, as that of the bladder, we should anticipate more rapid disappearance of lesions, and this appears clinically to be a fact.

Theoretically and practically, the indications for the use of vaccine in chronic localized infections, of tuberculin in chronic localized tuberculosis, when surgical conditions have been efficiently met and cure is not forthcoming, are insistent and essential in a degree no less than the surgical procedure as leading to the immunization and cure of the patient.

DOSAGE TABLE

The vaccinating qualities of different vaccines, composed of the same species of organisms, but of different derivations, may vary to a considerable degree. The dosage of one may necessarily be twice that of the other, to produce the same immunizing response. Hence, numerical standardization, although it must be accurate, is only tentative. The final standardization is that derived from clinical use.

Fig. 262.—Inoculation.

Withdrawing vaccine from bottle by plunging sterile needle through rubber cap.

Fig. 263.—Inoculation.

Sterilizing point of injection by touching skin with a pledget of cotton wet with pure lysol.

Fig. 264.—Inoculation.

The arm is grasped so tightly that the skin is under tension.

Dosage of tuberculin B. E. and T. R. is based on content of each cubic centimeter of the original solution in actual bacterial substances.

The following table represents dosage as has been used by Wright at St. Mary's Hospital, London:

DOSAGE OF VACCINES

	Minimum.	Maximum.	Average.
Tuberculin R. or B. E.	$\frac{1}{50,000}$	$\frac{1}{4000}$	
Staphylococcus	25 m.	1000 m.	250 m.
Streptococcus	1 m.	300 m.	10 m.
Gonococcus	½ m.	10 m.	½ m.
Pneumococcus	1 m.	300 m.	10 m.
Diplococcus intracellularis meningitidis	10 m.	100 m.	
Micrococcus catarrhalis	1 m.	300 m.	10 m.
Micrococcus neoformans	10 m.	50 m.	25 m.
Bacillus coli	2 m.	1000 m.	100 m.
Bacillus typhosus	5 m.		
Bacillus pyocyaneus	2 m.	1000 m.	100 m.
Bacillus of Friedländer	4 m.	8 m.	6 m.

The writer has varied the dosage in his own practice:

INITIAL DOSAGE (FEBRILE CASES)

Tuberculin R. or B. E.	$\frac{1}{100,000}$ mg. in children; $\frac{1}{50,000}$ mg. in adults.
Streptococcus	1,000,000 to 5,000,000.
Gonococcus	1,000,000 to 5,000,000.
Pneumococcus	1,000,000 to 10,000,000.
Bacillus coli	2,000,000 to 10,000,000.
Bacillus typhosus	5,000,000 to 10,000,000.
Staphylococcus	20,000,000 to 50,000,000.

INITIAL DOSAGE (AFEBRILE CASES)

Tuberculin R. or B. E.	$\frac{1}{30,000}$ to $\frac{1}{20,000}$ mg.
Staphylococcus	100,000,000 to 250,000,000.
Streptococcus	10,000,000.
Pneumococcus	10,000,000.
Gonococcus	10,000,000.
Bacillus coli	10,000,000.

CHAPTER LIII

COLEY SERUM FOR MALIGNANT TUMORS

DR. WILLIAM B. COLEY, after long and careful experimentation, described in 1891[1] a method of treatment for sarcoma which is familiarly known as the subcutaneous treatment with Coley toxins. The agent employed is a filtrate of the combined toxins of the streptococcus of erysipelas and the Bacillus prodigiosus. Its use was suggested by the fact that certain malignant tumors, which had been partially removed by operation, were observed to be at least temporarily inhibited if inoculated with erysipelas. In the original cases this inoculation was, of course, accidental. Coley determined to use this clinical observation as the basis for accurate treatment with small but continued doses of the erysipelas toxin, and, to make this possible, sought to procure a filtrate of unvarying strength. This he has succeeded in doing, and has made it more effective by adding the toxin of the Bacillus prodigiosus. These combined toxins, as made by Dr. Martha Tracy (now at the Huntington Institute for Cancer Research, Germantown, Pennsylvania) from Dr. Coley's directions, are much more powerful than the original liquid or the preparations offered by manufacturing chemists.

The initial dose should never be more than ¼ minim; it may be put into the tumor or under the skin in any convenient part of the body; it is, at least theoretically, safer to give the early injections away from the growth, as injections given into the tumor mass itself may be absorbed irregularly, either slowly or very rapidly, and it, therefore, seems better to give the early injections at least into normal tissues. If there is no reaction following the initial injection, ½ minim may be given on the following day, and the amount gradually increased on successive days until a reaction is obtained. The reaction consists, subjectively, in a feeling of malaise, with headache, chill, fever, general pain, nausea, and, if the dose be excessive, vomiting and collapse, and the objective signs of rapid pulse, small in volume, temperature elevation to 103° to 105° F., sweating—all the signs of an intense intoxication. Death has been reported in several instances and has occurred once in our own hands.

[1] Ann. Surg., 1891, xiv, 210.

The gradually increasing dose will ultimately produce a reaction of moderate severity, which may present all the symptoms enumerated or emphasize one or two of them particularly; after a reaction, one or two days should intervene before another injection is made, and the amount should be only very slightly increased. Occasionally a moderate increase of the amount injected may make a terrific increase in the character of the reaction, as in the case cited below. The object should be to produce reactions as powerful as the patient can withstand without too great subsequent prostration, and to continue these at two- or three-day intervals, until either the growth begins to disappear or it becomes obvious that toxins will not affect the disease. In successful cases the treatment may continue two or three months, and, after an interval of rest, be again instituted if signs of the disease still remain or reappear.

Results.—It would seem, from Coley's paper,[1] that rather more than 10 per cent. of otherwise hopeless cases have been cured subsequent to this treatment. Among the cases treated immediately under Coley's observation the percentage is higher.

It seems only justice to the patient to recommend a thorough trial of this method in every case of sarcoma in which it is known or suspected that operation has failed to remove the disease *in toto;* and in every operative case in which there is recurrence or the suspicion of recurrence. Operation should be done in every case in which there is prospect of removing all or almost all of the growth without serious danger to the patient's life, and the Coley toxins should follow. Occasionally a course of the toxins has been instituted before operation, and perhaps with some benefit, but it should never be prolonged in the face of an advancing disease. It would seem indisputable that some cases, otherwise certainly and rapidly fatal, have been restored to health after the thorough use of Coley toxin and without other medication or treatment.

Fatal Case.—Within three years a reputable practitioner, residing in the suburbs of Boston, reported (orally) the case of an individual past middle age with a large sarcoma, upon whom the toxin treatment was to be used. The first dose was $\frac{1}{4}$ minim of the toxins, given by the physician himself. Almost immediately after the injection the patient went into sudden collapse, and in spite of all efforts died within a few minutes. No autopsy.

A patient suffering from so-called Hodgkin's disease, with extensively enlarged cervical, axillary, and inguinal nodes, was being treated with slowly increasing doses of the toxins. Immediately following an injection of less than 1 minim more than the previous dose, after which little or no reaction

[1] Boston Med. and Surg. Jour., 1908, clviii, 175.

occurred, there was a sudden collapse, with extreme weakness—pulse 160 and almost imperceptible; nausea and vomiting, cold sweat, sighing respiration, and diarrhea. This improved slowly, but left the patient very weak for forty-eight hours. It is fair to say that this patient was one in whom the normal resistance was greatly diminished.

In conclusion, it seems certain that the spindle-cell sarcoma is most likely to be benefited by the toxins; the large round-cell to a lesser degree, the small round-cell, with many mitotic figures, least of all.

Dr. Leo Loeb[1] says, "I have written to a number of prominent surgeons, asking for a statement concerning their experience with Coley's fluid. Fourteen of these surgeons had had personal experience with this mode of treatment. The majority state, without giving the number of patients treated, that they have not seen any successful cases. From some surgeons I obtained the number of cases treated, and the result was as follows: Among 78 cases of sarcoma, in 4 cases a cure was obtained; therefore, in not quite 5 per cent. of the cases treated a positive result was observed. On the other hand, in a number of cases in which no cure was obtained, the injection of the toxins seemed to have a marked weakening influence on the patient, and sometimes it produced a sloughing of the tumor.

"It is, therefore, likely that the treatment of inoperable sarcoma with the toxins of streptococcus and Bacillus prodigiosus leads to a cure in approximately 4 to 9 per cent. of cases, and some results obtained so far suggest that this method of treatment may prove of value as a postoperative procedure in diminishing the number of recurrences, and that in a certain number of cases it might limit the necessity for amputation of the limb in cases of sarcoma of the long bones. As to its mode of action, nothing definite can be stated, but it is likely that the toxins themselves, as well as the local and general reactions they produce, frequently affect the life of the sarcoma cells unfavorably."

We have had several cases where no improvement followed treatment. One case has been encouraging:

R. A. H., nineteen, single, was referred to us by Dr. D. H. Judd, of Boston, with a soft, movable, nodulated tumor of the left parotid.

June 12, 1909, operation removed all the tumor, which was grossly visible, amounting in volume to the size of an egg, more or less encapsulated. Pathologic examination showed this to be a small round-cell sarcoma. Coley serum was begun at the first sign of recurrence about six weeks later, and has been continued every alternate six weeks since (two and one-half years). The quickest result in the way of diminution of the recurring tumor in this case seems to follow local injection, rather than that given at some remote place.

[1] Jour. Amer. Med. Assoc., 1910, liv, 263.

APPENDIX

SOME INVALID AND CONVALESCENT FOOD RECIPES

Many times a surgeon is asked, "Doctor, what may I have to eat?" or, "Doctor, I am getting so tired of this, or that, can't you let me have something different?" He will find that, in the long run, it will be an asset of no mean value to be able to direct whoever is in charge in the making of a few simple and tasty dishes. With a trained nurse on the case, he can usually relegate the responsibility in this matter to her, but even under these circumstances it is sometimes unwise to allow too much latitude in the choice and construction of dishes, and in serious cases the surgeon should know exactly what the patient is getting and how it is being prepared. It is for the purpose of supplying a number of nutritious and appetizing recipes, simple to make, and of proved value, to which the doctor may refer, that this section is added.

Apple Meringue.—Stew 1 pound of apples until soft, beat thoroughly until quite smooth. Beat in the yolk of 1 egg and sugar to taste. Turn the mixture into a glass dish. Beat up the white of 1 egg stiffly and add to it a little sugar. Pile the meringue over the fruit.

Apple-water.—Slice into a pitcher 6 juicy sour apples. Add a tablespoonful of sugar, and pour over them 1 quart of boiling water. Cover closely until cold, then strain. Slightly laxative.

Arrowroot.—Mix a teaspoonful of Bermuda arrowroot with 4 teaspoonfuls of cold milk. Stir this slowly into ½ pint of boiling water, and let it simmer for five minutes. Keep stirring all the time, to prevent lumps and keep it from burning. Add ½ teaspoonful of sugar, a pinch of salt, and one of cinnamon, if desired. (In place of the cinnamon, half a teaspoonful of brandy may be used, or a dozen large raisins may be boiled in the water. If the raisins are preferred, they should be stoned, and the sugar may be omitted.)

Cornstarch or rice-flour gruel is made in the same way.

Baked Custard Pudding.—Beat 2 eggs, add to them 1 dessertspoonful of castor sugar and ½ pint of milk, and stir until the sugar is dissolved. Strain into a buttered pie-dish and bake in a slow oven until set.

Barley-water.—Wash thoroughly 2 ounces of pearl barley in cold water. Add 2 quarts of boiling water and boil until reduced to 1 quart—or about two hours—stirring frequently. Strain, add the juice of a lemon, and sweeten. For infants omit the lemon.

Beef-essence.—Mince finely 1 pound of lean, juicy beef from which all the fat has been removed; put into a wide-mouthed bottle or fruit-jar, and cork tightly. Set the jar into a kettle of cold water over a slow fire, bring the water to a boil, and let it boil for three hours. Strain and season with salt and red pepper.

Beef-juice.—Place ½ pound of lean, juicy beef on a broiler over a clear hot fire, and scorch each side. Press out the juice with a lemon-squeezer into a hot cup, add salt, and serve hot with toast or crackers.

Beef-tea Jelly.—Scrape ½ pound of beefsteak with a sharp knife, having first carefully removed all the fat. Soak in 2 gills of water for a short time, then place in a saucepan with seasoning and ½ ounce of gelatin. Put over a slow heat until the meat changes color, but do not allow to boil. Stir until it commences to set at the sides. Pour into a mold and allow to set, then serve.

Beef-tea, Peptonized.—To ½ pound of raw beef, free from fat and finely minced, add 10 gr. of pepsin and 2 drops of hydrochloric acid. Put in a large tumbler and cover with cold water. Let it stand for two hours at a temperature of 90° F., stirring frequently. Strain and serve in a red glass, ice cold. Peptonized food does not keep well, and should not be used more than twelve hours old.

Beef-tea with Oatmeal.—Mix 1 tablespoonful of well-cooked oatmeal with 2 of boiling water. Add 1 cupful of strong beef-tea and bring to the boiling-point. Salt and pepper to taste, and serve with toast or crackers. Rice may be used in place of the oatmeal.

Blanc-mange.—Put ½ pint of milk into a saucepan with ¾ ounce of castor sugar, the rind of half a lemon, and ¼ ounce of gelatin. Let this mixture stand by the fire until the milk is well flavored and the gelatin dissolved. Stir until beginning to set at the sides. Pour into a mold. When it is quite set, turn it out and serve.

Broth, Chicken.—An old fowl will make a more nutritious broth than a young chicken. Skin, cut it into small pieces, and break the bones with a mallet. Add the washed neck, gizzard, and liver. Cover with 2 quarts of cold water, add ½ tablespoonful of salt and 1 small onion, and boil slowly for three or four hours. Strain, return to the stewpan, bring to a boil, sprinkle in 1 tablespoonful of rice, and simmer for twenty minutes. Add 1 teaspoonful of finely chopped parsley and season to taste.

Broth, Clam.—Take 3 large clams, washed clean, and let them stand in enough boiling water to cover them till the shells begin to open. Drain out the liquor, add an equal quantity of boiling water, 1 teaspoonful of finely pulverized cracker crumbs, a little butter, and salt to taste.

Broth, Mutton.—Cut up fine 2 pounds of lean mutton, without fat or skin. Add 1 tablespoonful of pearl barley, 1 quart of cold water, and a teaspoonful of salt. Bring to a boil, skim well, then cover, and allow to simmer gently for three hours. When ready, take out the meat and bones, cut the meat into tiny dice, replace in the broth, allow to cool slightly, and add ½ teaspoonful of chopped parsley. Season to taste and serve.

If preferred, the broth may be strained and served simply with the chopped parsley. If rice is used in place of the barley, it will not need to be put in until half an hour before the broth is done.

Broth, Oyster.—Cut into small pieces 1 pint of oysters; put them into ½ pint of cold water, and let them simmer gently for ten minutes over a slow fire. Skim, strain, add salt and pepper.

Chicken Omelette.—Put ½ ounce of butter into an omelette pan and allow to become hot without browning. Skim well, add 3 eggs well beaten and 2 tablespoonsfuls of finely chopped chicken. Stir well and turn the mixture into the pan. When lightly set, fold into two parts. Have ready a hot dish, decorate with parsley, and serve at once.

Chicken Panada.—Pound the white meat of a chicken to a cream, stir in 1 teaspoonful of bread-crumbs. Season and simmer slowly in a little white stock for a few minutes, allow to cool slightly. Serve with toast.

Chicken, Potted.—Pound 4 ounces of boiled chicken to a paste in a mortar with 1 ounce of butter. Add 1 dessertspoonful of chicken stock. Press into a jar and pour over it a little melted butter. When required for use, spread between thin slices of bread and butter, sprinkle a little salt over it, and cut into dainty shapes.

Chocolate.—Scrape fine 1 ounce of chocolate, add 2 tablespoonfuls of sugar and 1 tablespoonful of hot water; stir over a hot fire for a minute or two until it makes a smooth paste, then pour into it 1 pint of boiling milk, mix thoroughly and serve at once. If allowed to boil after the chocolate is added to the milk, it becomes oily, and loses flavor.

Coffee.—Stir together 2 tablespoonfuls of freshly ground coffee, 4 of cold water, and half an egg. Pour upon them 1 pint of freshly boiled water, and let them boil for five minutes. Stir down the grounds, and let it stand where it will keep hot, but not boil, for five minutes longer. In serving put sugar and cream in the cup first, and pour the coffee upon them.

Coffee, Crust.—Take 1 pint of crusts—those of Indian bread are the best—brown them well in a quick oven, but do not let them burn; pour over them 3 pints of boiling water, and steep for ten minutes. Serve with cream. This is a nutritious substitute for coffee.

Coffee and Egg.—Boil together for five minutes a tablespoonful of ground coffee, ¼ egg, ¼ pint of milk, and ¼ pint of boiling water. Beat the rest of the egg and 4 teaspoonfuls of sugar together until stiff and light, and strain the boiling coffee into it, stirring all the time. Add 2 tablespoonfuls of hot cream. This is only to be given in small quantities.

Coffee, Nutritious.—Dissolve a little gelatin in water. Put ½ ounce of freshly ground coffee into a saucepan with 1 pint of new milk, which should be nearly boiling before the coffee is added; boil together for three minutes; clear it by pouring some of it into a cup and dashing it back again. Add the gelatin, and leave the coffee on the back part of the range for a few minutes to settle. If desired, beat up an egg in a breakfast-cup, and upon it pour the coffee.

Coffee, Rice.—Parch, and grind like coffee, half a cupful of rice. Pour over it a quart of boiling water, and let it stand where it will keep hot for a quarter of an hour, then strain, and add boiled milk and sugar. This is nice for children.

Cream of Tartar Lemonade.—To a quart of boiling water add ½ ounce of cream of tartar, the juice of one lemon, and 2 tablespoonfuls of honey or sugar. Let it stand on ice until cold. This is a widely used diuretic beverage.

Custard, Boiled.—Warm ½ pint of milk. Beat up 2 or 3 eggs, pour on the milk, and add ½ ounce of sugar. Stir over a slow heat until thickened, allow to cool slightly; add a flavoring of vanilla or lemon.

Custard, Soft.—Take 2 tablespoonfuls of cornstarch to 1 quart of milk; mix the starch with a small quantity of the milk and flavor; beat up 2 eggs. Heat the remainder of the milk to *near* boiling; then add separately the mixed cornstarch, the eggs, 4 tablespoonfuls of sugar, a little butter, and salt. Boil the custard two minutes, stirring briskly.

Egg Broth.—Beat together 1 egg and ½ teaspoonful of sugar until very light, and pour on 1 pint of boiling water, stirring well to keep it from curdling. Add salt and serve hot.

Egg Jelly.—Put ½ ounce of liquid gelatin into a saucepan, add the strained juice of 1 lemon and the rind thinly cut. Beat in 1 egg and sugar to taste. Add ½ pint of water. Stir the mixture over a slow heat, and then beat with an egg-beater until light and frothy. Strain and turn into molds until set, and serve when required.

Egg-nog, No. 1.—Beat the white of an egg stiffly, then stir into it in turn a tablespoonful of sugar, the yolk of the egg, a tablespoonful each of ice-water, milk, and wine. Do not beat, but stir very lightly.

Egg-nog, No. 2.—Beat up 1 egg with a tablespoonful of sugar. Stir into this a cup of fresh milk, 1 ounce of sherry, or ½ ounce of brandy, and add a dash of nutmeg.

Egg-nog, Hot.—Beat together the yolk of an egg and a tablespoonful of sugar, and stir into it a pint of milk at the boiling-point. Add a tablespoonful of brandy or whisky, and grate a little nutmeg over the top.

Eggs, Scrambled.—Take 4 eggs, half a teaspoonful of salt, one pinch of pepper, one-quarter cupful of milk, one tablespoonful of butter. Put the butter into a saucepan; when melted and hot, add the other ingredients. Stir over hot water until of a soft, creamy consistency. Serve on buttered toast.

Eggs, Soft-boiled.—Drop 2 eggs into enough boiling water to cover them. Let them stand on the back of the stove where the water will keep hot, but not boil, for eight minutes. An egg to be properly cooked should never be boiled in boiling water, as the white hardens unevenly before the yolk is cooked. The yolk and white should be of a jelly-like consistency.

Gruel, Cracker.—Pour 1 pint of boiling milk over 3 tablespoonfuls of fine cracker-crumbs. Butter-crackers are the best to use. Add half a teaspoonful of salt, boil up once all together, and serve immediately. Do not sweeten.

Gruel, Flour.—Mix a tablespoonful of flour with milk enough to make a smooth paste, and stir it into a quart of boiling milk. Boil for half an hour, being careful not to let it burn. Salt and strain. This is good in cases of diarrhea.

Gruel, Indian-meal.—Mix a scant tablespoonful of Indian-meal with a little cold water, and stir into 1 pint of boiling water. Boil for half an hour. Strain and season with salt. Sugar and cream may be added, if desired.

Gruel, Indian-meal and Flour.—Mix 4 tablespoonfuls of Indian-meal and 2 tablespoonfuls of flour and stir into a little cold water. Add this slowly to 2 quarts of boiling water. Boil slowly three hours, adding water from time to time to keep up the quantity to 2 quarts. Salt to taste. To serve, mix a portion of this with an equal quantity of milk, and warm to taste.

Gruel, Oatmeal.—Boil a tablespoonful of oatmeal in a pint of water for three-quarters of an hour, then put it through a strainer. If too thick, reduce with boiling water to the desired consistency.

Gruel, Oatmeal, with Milk.—Soak ½ pint of oatmeal in 1 quart of water over night. In the morning, add more water, if necessary, and boil for an hour. Squeeze through a fine strainer as much as you can, and blend it thoroughly with a pint of boiling milk. Boil the mixture for five minutes, and salt to taste.

Irish Moss.—Wash thoroughly a handful of Carrageen moss, pour over it 2 cups of boiling water, and let it stand where it will keep hot, but not boil, for two hours. Strain, add the juice of one lemon, and sugar to taste.

Slippery-elm may be used in the same way, a teaspoonful of the powder to each cup of boiling water.

Junket.—Put ½ pint of cold fresh milk into a clean saucepan and heat it lukewarm (not over 100° F.); then add 1 teaspoonful of essence of pepsin, and stir just enough to mix; divide quickly into small cups or glasses and let stand until firmly jellied, when the junket is ready for use, just as it is, or with sugar; or it may be placed on ice and taken cold.

Junket, Cocoa.—Put an even tablespoonful of any good cocoa and 2 teaspoonfuls of sugar into a saucepan; scald with 2 tablespoonfuls of boiling water; rub this paste smooth; then stir in thoroughly ½ pint of cold fresh milk; heat this mixture lukewarm (not over 100° F.); add 1 teaspoonful of essence of pepsin, and stir just enough to mix; divide quickly into small cups or glasses and let stand until firmly jellied, when the junket is ready for use; or it may be placed on ice and taken cold; or it may be served with whipped cream.

Junket, Egg.—Beat to a froth one strictly fresh egg; sweeten with 2 teaspoonfuls of sugar; then stir in thoroughly ½ pint of cold fresh milk; put this mixture into a clean saucepan and heat it lukewarm (not over 100° F.); stir in 1 teaspoonful of essence of pepsin, and divide quickly into small cups or glasses and let stand until firmly jellied, when the egg-junket is ready for use, just as it is, or with grated nutmeg; or it may be placed on ice and taken cold.

Lemonade, Flaxseed.—Into 1 pint of hot water put 2 tablespoonfuls of sugar and 3 of whole flaxseed. Steep for an hour, then strain, add the juice of a lemon, and set on ice until required. This is an efficient bronchial sedative.

Lemonade with Egg.—Beat 1 egg with 2 tablespoonfuls of sugar until very light, then stir in 3 tablespoonfuls of cold water and the juice of a small lemon. Fill the glass with pounded ice, and drink through a straw.

Lime-water.—Pour 2 quarts of hot water over fresh unslaked lime of the size of a walnut; stir until slaked, and let it stand until clear, then bottle. Lime-water is often ordered with milk to neutralize acidity of the stomach.

Milk and Albumen.—Put into a clean quart bottle a pint of milk, the whites of 2 eggs, and a small pinch of salt. Cork and shake hard for five minutes.

Milk-punch.—To ½ pint of fresh cold milk add 2 teaspoonfuls of sugar and 1 ounce of brandy or sherry. Stir until the sugar is dissolved.

Milk and Water, Hot.—Boiling water and fresh milk, in equal parts, compose a drink commended in cases of exhaustion, as it is quickly absorbed into the system with very little digestive effort.

Milk, Peptonized.—*Immediate Process.*—Put 2 tablespoonfuls (1 oz.) of cold water into a goblet or glass; dissolve in this one-quarter of the contents of a peptonizing tube; add 8 tablespoonfuls (4 oz.) of warm milk—not boiling; drink immediately, sipping slowly. If ½ pint of milk is required, double the proportion of water, peptonizing powder, and milk. Cold milk may be used instead of warm, if preferred.

Milk, Peptonized.—*Cold Process.*—Put a teacupful (gill) of cold water into a clean quart bottle and dissolve in it by shaking thoroughly the powder contained in a peptonizing tube; add a pint of cold fresh milk, shake the bottle again, and *immediately* place it on ice—directly in contact with the ice. Shake the bottle before and after using. Peptonized milk prepared by this recipe is especially appreciated by patients who dislike the taste of warmed or boiled milk, and ordinarily it is readily digested and assimilated.

Milk, Sago.—Wash a tablespoonful of pearl sago and soak it over night in 4 of cold water. Put it in a double kettle with a quart of milk, and boil until the sago is nearly dissolved. Sweeten to taste, and serve either hot or cold.

Orange Albumen.—To the juice of one sweet orange add the white of one egg and stir the mixture thoroughly for two minutes, being careful not to beat it. Add ice-water to fill the glass.

Possett, Treacle.—Bring a cupful of milk to the boiling-point and stir into it a tablespoonful of molasses. Let it boil up well, strain, and serve.

Raw-meat Sandwich.—Scrape the pulp from a good steak, season to taste, and spread on thin slices of bread. Sear the bread slightly and serve as a sandwich.

Soup, Rice.—Take ½ pint of chicken stock and 2 tablespoonfuls of rice. Let them simmer together for two hours, then strain and add ½ pint of boiling cream and salt to taste. Boil up once and serve hot.

Soup, Tapioca Cream.—Remove all fat from ½ pint white soup stock (or use milk and water instead), put into a saucepan and bring to a boil. Sprinkle in ¼ ounce of fine tapioca and cook until clear. Beat up one yolk of egg, add seasoning of salt and pepper, then stir in ½ gill of cream. When the tapioca is quite clear, strain the egg and cream and add them; after this addition the soup must not boil. It should be sufficiently thick to hold the tapioca in suspension.

Soup, Tomato.—Peel and slice one onion, cut ½ pound of fresh tomatoes into small slices. Fry the onion a nice light brown in ½ oz. butter, add the tomatoes and fry them a little, then put in ¾ pint of water and a small bunch of mixed herbs. Allow all to cook till tender, rub through a hair sieve. Return to the stew pan, season to taste with salt and pepper. When boiling, gradually add ¼ ounce of crushed tapioca and cook for ten minutes longer. Serve with small croutons of fried bread.

Soup, White Celery.—To ½ pint of strong beef-tea add an equal quantity of boiled milk, slightly and evenly thickened with flour. Flavor with celery seed or pieces of celery, which are to be strained out before serving. Salt to taste.

Sweetbreads.—Keep the sweetbreads in cold water until ready to use; then remove the fat, ducts, and membranes. Put them into boiling salted water, add one tablespoonful of lemon-juice, and cook twenty minutes. Drain and cover with cold water. Let them stand a few minutes, then drain, and they are ready for the tray.

Tamarind-water.—A very refreshing drink may be made by adding 1 pint of hot water to 1 tablespoonful of preserved tamarinds, and setting aside to cool.

Tea.—Tea should be made in an earthen pot, first rinsed with boiling water. Allow a teaspoonful of tea to each half pint of water. Put in the tea, and after letting it stand for a few minutes in the steaming pot, add the water freshly boiling, and let it stand where it will keep hot, but not boil, for from three to five minutes.

Tea, Corn.—Parch brown a cupful of dry sweet corn, grind or pound it in a mortar. Pour over it two cups of boiling water, and steep for a quarter of an hour.

Toast, Milk.—Take 1 cupful of milk, half a tablespoonful of corn-starch, half a tablespoonful of butter, 2 slices of dry bread, 1 saltspoonful of salt. Scald the milk. Melt the butter in a saucepan; when hot and bubbling add the corn-starch. Pour in the hot milk slowly, beating all the time until smooth. Let it boil up once. Then add the salt. Toast the slices of bread. Pour the thickened milk over the slices. Let it stand five minutes; serve.

Toast, Peptonized Milk.—Over 2 slices of toast pour 1 gill of peptonized milk (cold process); let stand on the back part of the range for thirty minutes. Serve warm or strain and serve fluid portion alone. Plain light sponge-cake may be similarly digested.

Toast-water.—Toast 3 rather thin slices of stale bread to a very dark brown, but do not burn. Put into a pitcher and pour over them a quart of boiling water. Cover closely, and let it stand on ice until cold. Strain. A little wine and sugar may be added if desired. Good in diarrhea.

Vanilla Cream.—Rinse a mold in hot and cold water. Make a custard of two eggs and ¼ pint of milk, and when thickened strain into ¼ pint of whipped cream; add ½ teaspoonful of vanilla essence. Dissolve ¼ ounce of gelatin in ½ tablespoonful of water until it is quite smooth, add a little of the mixture to the gelatin, and then add the remainder of the gelatin to the mixture. Add ½ ounce of castor sugar. Beat out all lumps. Pour into the mold and allow to set.

Veal Jelly.—Cut 1½ pounds of veal, free from fat and skin, into small pieces, put in 2 ounces of sago and season with salt. Pour on two teacups of water, cover the pan and allow to simmer for five hours, then strain, boil up, and allow to partially cool, and pour into a mold. When cold, it will turn out a firm jelly.

Wine, Mulled.—Into half a cup of boiling water put 2 teaspoonfuls of broken stick cinnamon and half a dozen whole cloves. Let them steep for ten minutes and then strain. Beat together until very light 2 eggs and 2 tablespoonfuls of sugar, and stir into the spiced water. Pour into this, from a height, a cupful of sweet wine, boiling hot. Pouring it several times from one pitcher to another will make it light and foamy. Serve hot. The wine should not be boiled in tin.

Wine Whey.—Heat ½ pint of milk to the boiling-point, and pour into it a wineglass of sherry. Stir once round the edge, and as soon as the curd separates, remove from the fire and strain. Sweeten if desired. The whey can be similarly separated by lemon-juice, vinegar, or rennet. With rennet whey, use salt instead of sugar.

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