ABDOMINAL INJURIES

PROF. RUTHERFORD MORISON
AND
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R.A.M.C.(T.)

OXFORD WAR PRIMERS

Dr Falk
Toronto

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PREFACE

Mr. D'Arcy Power asked me to write a short account of abdominal injuries to aid medical men who may be called upon in these strenuous times to act in emergency, and whose knowledge of abdominal surgery may have grown somewhat rusty.

Colonel Richardson has made all the diagrams with the exception of Fig. 5, which was drawn by Major D'Oyly Grange from a dissection, and I feel so much indebted to him for these as to have requested that his name should be coupled with mine in the publication.

RUTHERFORD MORISON.

Newcastle-upon-Tyne,
June, 1915.

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PENETRATING WOUNDS OF THE ABDOMEN

In all cases, whether arising from stabs, impalement, or fire-arms, it is essential, by such thorough examination of the wound as has been described, to make certain that penetration either has or has not occurred. This may be exceptionally difficult when a bullet has made a long track in the abdominal wall. X-rays may localize the bullet and prove its position in the abdominal wall, or a long, strong probe passed down the track with the help of the X-rays may determine this. In these cases it is proper to cut down on the end of the probe and inspect the position. To cleanse the track, a strip of gauze can be fastened to the probe and dragged through. The end of the track should be drained.

Recovery of the patient is no argument in favour of performing unnecessary laparotomy, and this will occasionally happen if such a rule be forgotten or neglected.

A point common to all serious injuries, which should never be forgotten, is that in the majority of those with multiple lesions, after apparent recovery in each, especially in those left without operation, suppuration with localized collections of pus, unless relieved by drainage, may be eventually the cause of death. Subphrenic abscess in the case of the stomach and liver, intraperitoneal abscess in connexion with the small intestine, retroperitoneal abscess in the case of the kidney and colon, may be offered as well-known examples.

These accidents are only avoidable by watching the

temperature chart and making abdominal examinations when the temperature shows any rise or when recovery is not straightforward. A blood-count may now be of considerable service, as a leucocytosis over 12,000 is highly suggestive of the presence of pus.

In every case the wound or wounds should be examined and a mental note made of their relation to underlying structures (Fig. 1). A history of the position of the patient at the time of the injury and the method of its infliction should also be considered as a helpful guide to the discovery of viscera which may have been wounded.

GUNSHOT WOUNDS OF THE ABDOMEN IN WAR

General Considerations.—Gunshot wounds comprise those produced by fire-arms—that is, guns carried by soldiers—and wounds from artillery. Rifle bullet wounds are the type of the former, shrapnel and shell wounds of the latter.

A rifle bullet may produce either a minimum or a maximum destructive action. Whether it does one or the other depends chiefly upon conditions independent of the bullet itself. When fired at short range—600 yards or under—it acts with explosive violence on solid organs or hollow viscera with fluid contents that it may strike, and with mortal effect. When fired at a long range, or striking with diminished velocity, only a perforating wound is produced, often without much harm being done, and rapid healing results. The size of the entrance wound may offer

no clue as to the amount of destruction effected inside.

Except in immediately fatal wounds, sepsis is of the greatest importance in the study of these cases.

Bullets are said to be seldom completely sterile when they leave the rifle, and on arriving at their destination infrequently; but, if this be true, they cannot have travelled very far in the tissues without wiping themselves clean. The truth is that buried bullets seldom do harm, and the more deeply they are buried the less likelihood there is of danger occurring. If a surgical rule was made to the effect that only bullets near the surface and easy of access should be removed, unless they were obviously producing serious trouble, it would be of considerable advantage to our sailors and soldiers. *In the abdomen no time should be wasted in searching for them, and only those within easy and safe reach should be touched.*

Bullets that are deformed, irregular in shape, or ricochet, or those with small velocity, carry septic particles into the wound. Other materials may be driven in by impact of the bullet and cause a wound, e. g. coins, keys, and other such possessions of the sailor and soldier have been discovered in wounds which have always been septic.

The chief sources of sepsis are clothing, skin, the environment of the wounded; and the amount depends to a large extent on the condition of these. For example, in summer, when heat makes frequent bathing possible and clothing lighter, the cleaner skin and lighter nature of dirty clothing traversed diminish

the septicity of underlying wounds. The condition of the surroundings also, as proved by the present war, has much bearing on the question of sepsis. During the Boer War septic bullet wounds were a rarity owing to the purity of the atmosphere and the cleanliness of the soil. In France and Flanders infection has been a frequent occurrence in all wounds.

Shrapnel Wounds.—Either the contained bullets, which are large and rounded, or fragments of the casing, large and small and of all varieties of shape and jaggedness—both of low velocity—may be the cause of shrapnel wounds. Shrapnel may, though not so often as rifle bullets, produce wounds healing quickly and with no serious sepsis, and so may small particles of shell. Large pieces of shell produce wounds corresponding to their size, and are always infected by dirt carried in from clothing and skin.

Shell Wounds.—These are the most serious of all, and a frequent result of them is terrible mutilation. In the least severe cases they generally cause multiple wounds; moreover, pieces of clothing are usually carried in with the shell fragments, and the wounds are lacerated and septic.

In all varieties **sepsis** can be either primary or secondary.

Primary Sepsis is influenced by the following factors:

Large wounds are always septic.

Small wounds, no matter how they be produced, often heal without manifestation of sepsis.

High velocity of the missile tends to diminish, low velocity to increase, sepsis.

Smooth surface and rounded shape of the foreign body diminish the chance of sepsis; a rough, jagged, flattened contour increases it.

The condition of the clothing, of the skin, and the influence of the environment have already been mentioned.

Secondary Sepsis.—Infection may come from the clothing, the surrounding skin, or from contact with dirty surroundings. The most important source, because preventable, is indiscreet manipulation or treatment of the wound. In all ordinary cases everything proper has been done when a wound has been immediately covered up by the first-aid dressing, when a hypodermic injection of $\frac{1}{4}$ grain of morphia and $\frac{1}{120}$ grain of atropine has been administered, and the earliest opportunity of sending the patient to a hospital has been seized.

In bad surroundings and with insufficient help, there are only two justifications for immediate operation in these cases; but, if it be at all possible, patients should be given a chance. They are hæmorrhage and protrusions of the viscera. Hæmorrhage may be severe enough to threaten life at once, or at any rate quickly, because high-velocity bullets can cut blood-vessels like a knife, and there is no natural tendency for bleeding to stop in the peritoneal cavity. This knowledge may influence judgement under difficult conditions. The second indication is to treat prolapsed and wounded viscera.

In hospital immediate operation should be the rule. An exception should be made in these cases where

more than eighteen hours have elapsed since the injury. If they are doing well in **every** respect they should be carefully watched, but no operation performed. A huge majority of cases, in which twenty-four hours have elapsed since the injury, do better without than with an operation, and should only have such treatment as is suitable for septic peritonitis. It should be a rule for operating in every part of the body, and is one of special value in the abdomen, that when active sepsis is present, only measures essential and limited to relief of the septic infection should be employed. Serious operations are always fatal in actively septic cases, and the majority die a few hours after their completion, because sepsis and hæmorrhage both predispose to shock, and their combined effect is overwhelming.

The least fatal perforating wounds of the viscera are those of the stomach, especially if it happens to be empty.

The most dangerous are those of the small intestine and transverse colon, and in the majority of cases perforation results in peritonitis.

Between the two, and in nearly equal percentage, come perforations of the colon, rectum, and bladder. In any of these a perforation may be extra- or intra-peritoneal, and in all of them the extraperitoneal perforations have a higher mortality than the intra-peritoneal, this being due to cellulitis and septicæmia.

The rule in operating should be first to stop hæmorrhage, and only then to look for perforating and other lesions.

PERFORATING WOUNDS OF THE ABDOMEN

General Considerations.—The abdomen may be perforated by gunshot, including rifle, revolver, and shrapnel bullets and shell, by stabbing instruments, or by impalement.

Rifle bullets in war time are most apt to cause wounds through the front and sides and back of the abdomen. Less commonly they travel through from distant parts, either from above through the neck or thorax, or from below through the different parts of the pelvis.

The following are in order of severity: 1. Wounds from above (thorax and neck); (2) from below (pelvis); (3) wounds from the side; (4) from the front and back; (5) wounds of the lower abdomen; (6) of the upper abdomen.

Ninety per cent of bullet wounds perforate one or more of the abdominal contents, and in the case of the hollow viscera the rule is that both walls are involved. The importance of remembering this during an operation is obvious; forgetting it, has cost many lives. The size and shape of the bullet and its velocity have some influence in determining the size and nature of the wound; but its bursting effect, a quality difficult to estimate, is of the greatest importance.

There has been for some years now general agreement with a surgical rule to the effect—

That every perforating abdominal injury should be operated upon without delay.

A special exception has been made for bullet wounds based upon experiences gained during the Boer War.

South African statistics showed a recovery rate of 40 per cent of cases shot in the abdomen and brought in alive to the hospitals. They also showed an appalling death-rate following operations on any and all abdominal injuries. In spite of this experience, it is incredible that surgeons in the future can advise such serious risks of disaster to be courted as are probable in these cases. Every decade shows fewer results left to chance, and surgeons are learning the value in surgical work of the old proverb, ' Prevention is better than cure '. At the present time these war statistics may be offered as an excuse—but not as a reason—for ' Expectancy '.

Stab wounds have least mortality ; next come rifle and revolver bullet wounds, and the gravest are produced by shell, shrapnel, and impalement.

A rough estimate of the mortal results of perforating wounds of the abdomen of every variety would offer these figures :

Of 100 fatal cases, 10 would die almost immediately from the severity of the injury ; 10 would be so badly damaged that the conditions are hopeless from the first. Of the remaining 80, not less than 70 would die as the result of hæmorrhage and peritonitis.

No one now would doubt that, in the overwhelming majority of cases, death from hæmorrhage or peritonitis is preventable by early operation, or that injuries of the viscera, regarded a few years ago as inevitably fatal, can be recovered from if the patient be given a fair chance.

Translated into surgical language, this means that

of serious abdominal injuries 20 per cent are hopeless, and of the remaining 80 per cent not less than 60 should recover if an early operation under satisfactory conditions can be performed. In the face of this belief, though it may in exceptional circumstances be wiser to limit treatment of bullet wounds to rest, the administration of opium, and abstention from food and drink, it is well to realize that, though expedient, it is not surgery.

All of this is not to be taken as indicating the need for immediate operation in any or every environment. Except for emergencies, such as hæmorrhage or protrusion of the viscera, abdominal operations are unjustifiable except in properly organized and equipped hospitals, but fortunately this can seldom now—even in war—be offered as an excuse for their non-performance. The majority of patients can be conveyed to a suitable institution within six hours, and this, which means the possibility of an early operation, is by far the most important factor making for success. Another but smaller percentage of good depends upon surgical skill. The hurried and overworked surgeon and the quick in and quicker out type of operator have mistaken their vocation if they tackle these cases. The requirements for them are steady, gentle, patient, persevering labour, without time-limit excepting what is demanded by a satisfactory execution of the work in hand.

ABDOMINAL OPERATIONS

A palatial operating theatre and the luxurious equipments of modern surgery are not essential to good work, and the absence of these is no excuse for slipshod methods. Wound infections such as result in peritonitis, cellulitis, deep suppuration, or erysipelas are a reflection on the surgeon and his methods, because they were banished by the simple and inexpensive treatment introduced by Lord Lister when carried out according to his instructions.

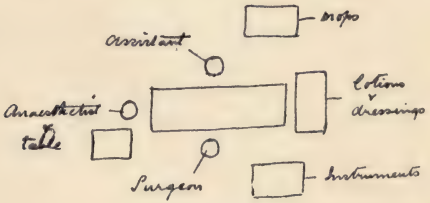

FIG. 2. PLAN OF OPERATING THEATRE.

Operating Theatre. — It is essential for these serious operations to have a clean, warm, well-lighted operating room, with an abundant supply of hot and cold water and suitable basins. It should be supplied with an operating table, and three smaller tables for instruments, sponges, lotions and dressings, and one for the use of the anæsthetist (Fig. 2).

Operating Table.—There are many varieties, each with special advantages, but the only essentials are that it shall be firm and strong, and of a suitable

length and breadth to hold the patient comfortably. The Trendelenburg position, which may be necessary in operating on the lower abdomen, can be obtained by drawing the patient downwards on the table till his knees can be bent over the lower end, and

FIG. 3. OPERATING MACINTOSH FOR USE WHEN THE ABDOMEN IS TO BE WASHED OUT.

raising this on any convenient and available piece of furniture. The table should be well covered, and for this purpose nothing is so suitable as a hair mattress. The painful back and aching limbs, so frequently a complaint of patients after operation, are not due to the operation itself, but are nearly always owing to the hard table, to the want of a small supporting pillow under the lumbar spine, and to rough or unskilful transport afterwards.

Operating Sheet.—In cases where the abdominal cavity may have to be washed out, the operating sheet (Fig. 3) instead of an ordinary macintosh saves sloppiness and mess. By blowing up the rollers with a bicycle pump before the flushing is commenced, fluids are prevented from spreading upwards and downwards under the patient's back.

Warmth.—In addition to warm clothing over the chest and legs, patients should have the benefit of artificial heat on the table. Some tables provide for this, but, as many do not, it has to be supplied by hot-water bottles or other means. An anæsthetized and physically depressed patient is so easily burned that special care must be taken to provide against this most unfortunate, because avoidable, accident.

The necessity for this care must be constantly emphasized, because all disagreeable experiences, especially when they concern others, are so soon forgotten.

Assistants.—A capable, sympathetic anæsthetist is the greatest blessing; failing this, one who is able and willing to carry out instructions is essential. Four capable nurses, accustomed to work with the operator, complete the necessary minimum of assistants. One helps with the operation, a second looks after the instruments, a third after the sponges, mops, and dressings, and the fourth is there to do what she is asked. Above everything else in importance, is that every one concerned should have mastered a technique which aims at keeping the wound germ free, and considers no trouble too great to accomplish

this. The best surgical technique has not yet reached a standard to satisfy bacteriologists ; until that has been attained there is room for further improvement.

Preparation for Operation.—Abdominal emergency operations, as these usually are, must undergo all preliminary preparation on the operating table. If there is hæmorrhage from the parietes the first indication is to arrest that temporarily by the application of hæmostatic forceps, and the wound should be packed with sterile gauze wrung out of salt solution, to be left till other preparations are complete. If viscera are prolapsed they should be cleansed with hot normal saline solution, and covered up with gauze wrung out of the same until they can be reduced, that is, after cleansing of the wound and skin has been accomplished.

Before administering the anæsthetic, if this has not already been done previously, a $\frac{1}{4}$th of a grain of morphia and $\frac{1}{120}$th of a grain of atropine should be given hypodermically, and the patient's mouth should be cleansed as a possible preventive of post-operative pneumonia ; the bladder, if distended, should be emptied—by the patient, if possible ; if not, by a catheter passed under the anæsthetic either at the beginning or the end of operation.

Morphia delays and diminishes shock, and atropine arrests the secretion of bronchial mucus, commonly excessive after all anæsthetics. Both diminish the quantity of anæsthetic required, and make the first hours after recovery more tolerable.

The Anæsthetic.—Local anæsthesia will not suffice

for any but the simplest abdominal exploration. Used in connexion with nitrous oxide and oxygen, the anoci-association method of Crile, it is a great aid.

Spinal is more dangerous than general anæsthesia, so that the anæsthetic of choice must be a general one.

In starved or exhausted patients an enema, containing half an ounce of carbonate of soda and half an ounce of glucose in one pint of water, should be given before commencing the anæsthetic, as a guard against acidosis.

Nitrous oxide and oxygen, with added ether during the most strenuous work, give perfect and safe anæsthesia with a minimum of bad after-effects in the hands of those specially trained to their use. The difficulties of their administration, of maintaining a sufficient supply, and the expense of administering them are objections unless in exceptional conditions. Ether and chloroform are so safe in the hands of skilled administrators that it may be truly said the danger from either depends upon the anæsthetist. In unskilled or inexperienced hands there is no choice. The margin of safety is so much greater with ether that 'open ether' has gradually ousted every other as the universal anæsthetic. With some patients satisfactory relaxation of the abdominal wall, often prevented by starting the operation too soon, is almost unattainable with ether alone. The careful administration of chloroform for a time will, in these cases, frequently convert an impossible into an easy situation, when anæsthesia can generally be continued by ether without any return of rigidity.

In skilled hands the intratracheal and intranasal methods of ether administration take a high place.

Preparation of Patient's Skin.—For cleaning the patient's skin nothing has been proved to be better in emergencies than 5 per cent carbolic lotion. It would have been more popular than it is now, if custom had not dictated for every case a preliminary course of soap and hot water. The effect of these is to diminish the efficiency of the lotion. Water causes swelling of the superficial layers of the epidermis and prevents penetration of carbolic acid to the deeper layers. To be satisfactory, carbolic lotion should be applied to the dry skin and rubbed into it with a gauze mop. The skin over the whole of the anterior aspect of the abdomen should be so treated with warm lotion, and then shaved. During the progress of shaving, warm carbolic lotion should be dripped on from a mop, the drops following the razor, which not only removes hair, but by mechanical shifting of dirt and dead epidermis makes the cleansing more thorough. When this has been accomplished, the parietal wound, if there be one, should receive attention. Its bruised edges should be cut away, its depths examined for dirt and foreign bodies, its extent ascertained and, if it be perforating, any discharge noted. Any opening in the peritoneum should at once be closed by a continuous suture and the remainder of the wound, after thorough cleansing, closed, not too closely, round a small drainage-tube with interrupted sutures, catgut for the deeper layers, and silkworm gut through all except the peritoneum.

If this is done before commencing the larger operation, a temporary dressing of spirit gauze can be fixed on by tying the long ends of the suture over it.

Instruments.—All instruments required, previously sterilized, should be placed in suitable dishes and covered with 1 : 20 carbolic lotion.

Immediately before commencing the operation this should be diluted with hot water to 1 in 60.

Ligatures and Sutures.—Catgut for deep sutures and ligatures and silkworm gut for ordinary sutures are most generally useful. The danger of using catgut which has not been sterilized by reliable methods must be emphasized, as tetanus has resulted from the neglect of it. Sterilized silk can be used for both ligatures and sutures, but it has an unfortunate tendency occasionally to delay wound-healing till it is discharged. For Lembert suturing of the gastro-intestinal tract silk alone should be employed with special intestine needles, and for blood-vessel suturing it is essential to have special needles and finest silk, both of which should be kept in sterilized tubes of vaseline and always ready for use.[1]

Mops.—These are conveniently made of three types —large square (1 foot by 1 foot), small square (5 inches by 5 inches), and long strips of folded gauze. Before using them in the abdomen they should be wrung out of warm normal saline. Dry mopping does incredible harm. Every mop should have attached

[1] Unfortunate laws in this country prevent practice of these methods upon animals, to the serious detriment of the inhabitants.

to it one foot of tape and a white pot ball or a metal ring at the other end of it. Two nurses should make a count of the mops, write the result in some prominent place before the operator begins, and repeat the count when closure of the parietal wound commences. On no account should any mop be cut during the operation, otherwise the count will be wrong at the end of it. It should be made impossible to leave unknown mops and forceps in the abdomen, but this will continue to be done till more than usual care is exercised.

Surgical Clothing.—Surgeons, assistants, nurses, and those immediately surrounding the patient should wear clean clothes, sterile overalls, masks, caps, sleeves, gloves, and boots. Visitors should wear clean overalls, masks, and caps. With all this care there are still weak links in the aseptic chain. The skin of the surgeon, the skin of the patient, and the air of the theatre are now the chief sources of accidental infection. The increased use in the wound of instruments instead of hands, so strenuously advocated by Lane, has diminished the danger from the surgeon's skin which the use of india-rubber gloves had already made small. The protection afforded by gloves depends, of course, upon the absence of pricks or tears in them. Unless the hands are clean when either of these happens, the wound is apt to be flooded with pent-up infected moisture. The same scrupulous care is needed for gloved as for ungloved hands. They should be washed for five minutes in spirit soap and running hot water, then swabbed in a basin of 1 : 1000 corrosive lotion for one minute, and finally rubbed

with alcohol for one minute. Scrubbing with a nail-brush does more harm than good, if nails are kept short and trimmed as they should be. Smooth india-rubber gloves are better than the roughened varieties, as these, if they get soiled, require to be taken off and sterilized again before they are fit for use. Smooth gloves are clean again after a thorough washing of the gloved hands with a mop in 1 : 1,000 corrosive lotion. Before gloves are put on, sterile sleeves covering the skin of the forearm should be already in place. The sterile gloves should be filled with 1 : 1,000 corrosive lotion, emptied, and then sprinkled with sterile boracic acid powder inside. Gloved hands during a long operation should occasionally be washed in 1 : 1,000 lotion and then in normal saline.

The skin of the patient should be made less dangerous by the use of two knives during the operation, one for the skin incision, to be immediately discarded when used, and a second for the deeper parts; by protecting the cut edges; and by introducing suture needles from within outwards through the skin, or by the use of subcuticular sutures or metal clips for the closure of the wound.

The air of the theatre should be made less dangerous by working quietly and talking little, by moist floors, and moist sterile towels round the wound, in addition to the other precautions as to surgical clothing already mentioned.

After preparation of the skin of the abdomen, transverse scratches are made across the line of the proposed incision as a guide for after-suturing (Fig. 4), and the

abdomen is covered by two layers of sterile gauze wrung out of 1:1,000 corrosive sublimate. Every part except the face and abdomen of the patient is then covered up by waterproof sterile towels and sheet. A towel wrung out of carbolic lotion is laid on the sheet, covering the thorax, and another on the legs. Blood-staining from the scratches shows

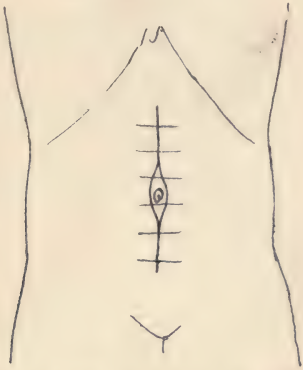

FIG. 4. MEDIAN LINE INCISION, SHOWING TRANSVERSE SCRATCHES AS A GUIDE TO INSERTION OF SUTURES AND ELLIPTICAL INCISION FOR EXCISION OF THE UMBILICUS.

through the gauze and serves as a guide so that the gauze can be cut by scissors and opened in the line of incision.

The Incision.—The abdomen can be opened by incisions of any shape and in any part of it, but there are only two incisions which inflict a minimum of damage and which can be most readily extended in case of need. The first is straight and in the middle

line (Fig. 4). The second, lateral and oblique (Fig. 5, B), runs parallel to and avoiding the sensory and motor nerves, but dividing the muscles of the abdominal wall. It is too often forgotten that muscle repair is readily accomplished, but that the effects of serious nerve division on the muscles are generally irreparable.

To do gentle satisfactory work in the abdomen it is necessary to gain easy free access through a long incision. To see what is being done is as important, usually more so, in this situation, than elsewhere, and all the disadvantages alleged against long incisions come to nothing if proper means are adopted to close them and allow of satisfactory healing. The incision should be made through layer after layer, catching bleeding vessels in hæmostatic forceps as they appear, till the extraperitoneal fat comes into view; then the peritoneum is exposed, caught between two pairs of hæmostatic forceps, drawn forward, and carefully opened. As soon as a small hole is made, air gets in, and separates the viscera from the parietal peritoneum, when the incision can be safely prolonged with either knife or scissors under the guidance of a finger or the eye.

Where is the abdomen to be opened ?

It is a good rule to make the opening as nearly over the lesion as possible, and if it has been localized, this may be remembered as a useful guide in making the decision. The ideal incisions, oblique lateral and straight median, have already been considered. That should aid the choice. In the majority of cases emergency operations for injury may discover a lesion or lesions anywhere in the abdomen. The centre is

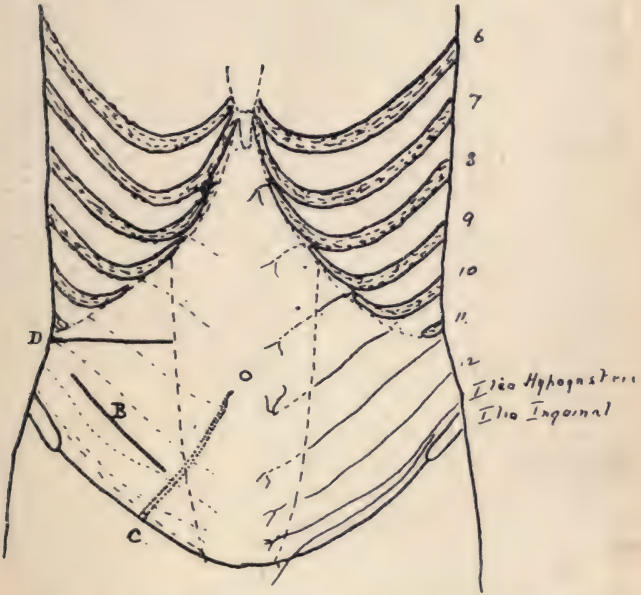

FIG. 5. The oblique incision is seen running between and parallel to the eleventh and twelfth dorsal nerves. On the right side it exposes cæcum and ureter, on left sigmoid and ureter. D, incision for liver and right kidney. A similar one on the left side serves for spleen and left kidney. C, deep epigastric artery.

therefore the most favourable place of any, but the umbilicus is in the way. This is one argument in favour of its excision ; others are that it is a septic focus, difficult to purify, and that it tucks down and fixes the abdominal wall in such an extraordinary way as to diminish considerably its elasticity.

For these reasons the incision of choice is in the median line, extending above and below the excised umbilicus (Fig. 4).

Treatment of Hæmorrhage

Before the peritoneum has been opened, if bleeding has been going on in the abdomen, the dark colour of blood shining through gives an early clue to diagnosis.

When the abdomen has been opened, the next step is to discover the injury or injuries.

If there has been or is bleeding, relief of the abdominal tension may suddenly increase it unless immediate action be taken. Large gauze pads should be packed in quickly one after another, till there is no longer easy room for more. Then the abdominal wall should be firmly and steadily drawn upwards with retractors to allow of the introduction of still more. It is well to remember throughout that rough manipulations are always injurious, and that though speedy action is desirable, roughness and hurry hurt more than they help. At this stage of the operation intravenous transfusion, if it has not been begun before, can be started with advantage. As soon as the abdomen has been packed, a systematic search for the

bleeding area should be made. By pressing the pads downwards, and by retracting at the sides and above, the contents of the upper abdomen, liver, stomach, spleen, and diaphragm can be inspected or palpated. If no lesion is discovered there, the abdominal incision should be surrounded with, and the abdominal wall covered by, large mops rung out of hot normal saline, still keeping up pressure on the intra-abdominal pads; these should be in turn removed from above, one by one, till the omentum is exposed. The omentum and the transverse colon with it are then drawn out and turned upwards on to the mops covering the upper abdomen, and inspected.

If bleeding be not found from them, they are covered up with warm moist mops, protected by a sterile heat-retaining india-rubber sheet, and left outside until the mesentery and back wall of the abdomen are searched and the bleeding-point found.

Four methods are available for stopping hæmorrhage in the abdomen: (1) ligature; (2) suture; (3) forcipressure; (4) compress.

Ligature is the ordinary method here as elsewhere in the body, and either catgut or silk may be employed. For large vessels silk is the more reliable; for small, catgut, if tied with three knots, is safe. Suture is useful for the arrest of bleeding from rigid areas, such as are found in wounds of the solid viscera, or tissues thickened and friable from inflammatory induration. Recent work has made the suture a valuable method in saving important vessels and the organs they supply from destruction. End-to-end (Fig. 6) or lateral

anastomosis and the suture of slits (Fig. 7) are some of its applications.

Forcipressure may redeem an apparently hopeless situation when bleeding occurs from vessels too deep, too difficult, or too awkward to tie with safety. For

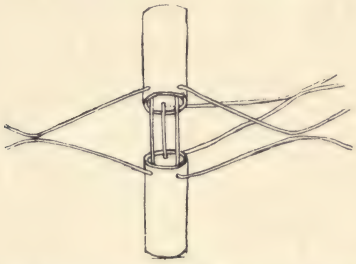

FIG. 6. GUIDE SUTURES IN A BLOOD-VESSEL—THE FIRST STEP IN END-TO-END ANASTOMOSIS. The intima at both ends should be everted and the ends sutured together through all the coats with a continuous suture of fine silk.

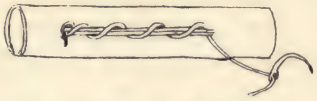

FIG. 7. LATERAL SUTURE OF A WOUNDED BLOOD-VESSEL WITH FINE SILK. The continuous suture, if properly used, everts the intima.

ordinary-sized vessels they should be left on for forty-eight hours. Large ones, such as the renal arteries, cannot be safely released at the end of this time, and the forceps should be left for at least seventy-two hours. Another use of forcipressure is to be found in the preservation of the lumen, or at least sufficient of it to allow of circulation in important vessels (Fig. 8).

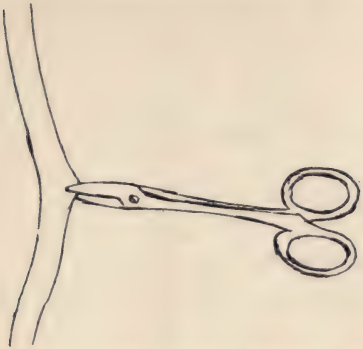

FIG. 8. FORCEPS OCCLUDING A SMALL HOLE IN AN IMPORTANT BLOOD-VESSEL AND SCARCELY ENCROACHING ON ITS LUMEN.

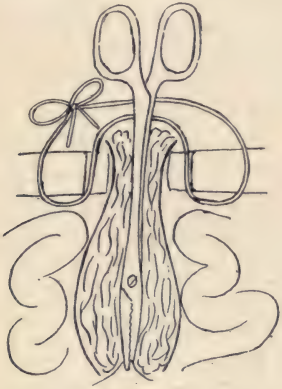

FIG. 9. THE TAMPON AND TEMPORARY SUTURE. The gauze tampon is surrounded on all sides by india-rubber sheeting. Either a tube or forceps or both may occupy the centre of it. The long suture through the whole wall is temporarily loosely tied with a bow-knot. When the tampon is removed, the suture is loosened, then tightened and tied up permanently.

For example, a small opening is found in the superior mesenteric vein or artery. Ligature of either vessel means certain death. Suture of the opening in each would be difficult and time-consuming, whereas forceps skilfully applied could close the opening without arresting the circulation in the trunks.

Tampons are chiefly used, in conjunction with catgut sutures, for the arrest of hæmorrhage from solid organs.

Many oozing-points are difficult to attack by any other means and require the tampon (Fig. 9).

Treatment of Perforation

On opening the abdomen there may be no signs of hæmorrhage, but complete evidence of perforation may be offered if gas and visceral contents escape when the peritoneum is opened. The character of these and their escape from certain areas may both help and localize the part injured. By following a stained track, the discovery of a lymph deposit, or by the finding of loops of congested intestine the perforation or perforations may be localized.

If there is no such evidence of either hæmorrhage or perforation, a systematic careful search of the abdomen is necessary. The viscera in the lower parts of the abdomen should be covered by a warm saline mop supported and retained by the outspread hand ; the edges of the incision are then retracted and the contents of the upper abdomen first examined. By this the liver, spleen, stomach, and the vault of the diaphragm, if there is nothing found amiss, can be quickly excluded as factors in the situation.

The next step is to draw out, turn up, and cover the omentum and transverse colon, remove the mops covering the small intestine, and retract the edges of the wound. The damaged area may now be brought into view.

If not, the commencement of the jejunum on the left side of the spinal column should be found by following the transverse mesocolon to that spot. During the whole of these manipulations intestines and viscera should be covered up by warm moist mops whenever it is possible to do so. Commencing at the origin of the jejunum, the small intestine should be followed down bit by bit, replacing each as it and the mesentery are examined, till the end of the ileum and the cæcum are reached. A survey of this, the the ascending colon, splenic flexure, descending and iliac colon, will bring to light as well any lesion of the posterior peritoneum and complete the abdominal examination.

If it be necessary to examine the pelvis, the patient should be placed in the Trendelenburg position and the small intestine lifted out of it and packed into the abdomen, when retraction will allow of a good view. The whole examination, if done systematically and carefully, ensures that nothing will be likely to be missed, and at the same time should cause little disturbance.

The discovery of one lesion, even though it appears sufficient to account for everything, may not do so, and it should not be forgotten that a number of lives have been lost after a promising

operation which has repaired considerable damage, but which has left something undone which ought to have been done.

Before doing anything else, when a perforation is found in any hollow viscus, it should be brought outside of the abdominal cavity if possible, and in any case isolated all round by packing the abdomen and surrounding the extruded portion with gauze mops. These serve to protect clean parts of the abdomen from further escape of visceral contents; they swab up some of what may have escaped, and help to hold the perforated part steady during its repair. The more simply this is done the better. A single continuous suture of catgut through all the coats to make the tear water-tight and to arrest hæmorrhage from it, and a row of interrupted silk sutures over this to bring the peritoneal coats into good apposition, are the only essentials. Bruised or damaged areas in the hollow viscera should be supported and invaginated by sutures. Every raw surface in the abdomen should be covered by sliding peritoneum over it, holding it there by sutures, and it is necessary to close all tears with a peritoneal suture.

Some Surgical Uses of the Omentum.—If a perforation be found in such a position, e. g. high in the cardiac end of the stomach or so deep in the abdomen or pelvis as to make a satisfactory closure difficult and uncertain, a patch of omentum should be excised and sutured over the dangerous area. A similar omental graft is useful in covering lacerated, bruised, or damaged intestine in any situation.

Drains and tampons should be surrounded for protection by the displaced omentum.

Cleansing the Peritoneum.—It has previously been stated that the peritoneum is capable of successful resistance against considerable dirt and infection; but there is a limit to this favourable reaction. It is important to help nature's efforts, but it is more important still not to forget that the delicate mechanism engaged in this work can be inhibited by too strenuous endeavour. Infection may be spread by unwise attempts to get rid of it, and the natural resistance of the peritoneum can be readily destroyed by rough measures taken to clear it, such as mopping and friction, especially if the mops be dry. Extravasated blood, though not so vicious as visceral contents, causes sufficient peritonitis to produce adhesions and as a rule it should be removed. If it is localized, gentle mopping with gauze wrung out of warm saline solution suffices. If it is diffused over the abdomen, it should be washed out with an abundance of warm normal saline. The infective capacity of the contents of the gastro-intestinal tract varies according to the portion from which they are derived. Gastro-duodenal contents are almost germ free; matter from the end of the ileum and the colon is swarming with organisms which have steadily increased in the more distant parts of the intestine. Normal urine and bile are sterile, but predispose to peritonitis by irritation and interference with the command the healthy intestinal walls maintain over their imprisoned bacterial inhabitants. Localized extravasations from

any of these sources are removed best by gentle mopping with warm gauze pads wrung out of normal saline. The less vicious extravasations, when diffuse, can be either left to be dealt with by the peritoneum aided by drainage, or washed out with suitable

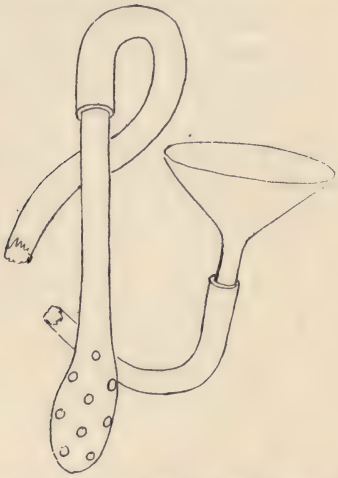

FIG. 10. LONG STRONG GLASS PIPE WITH INDIA-RUBBER TUBING AND FUNNEL ATTACHED FOR WASHING OUT THE ABDOMEN.

apparatus. This, when properly carried out, is the safest means of dealing with them (Figs. 3 and 10).

A large glass drainage-tube should be first so disposed as to reach from the depths of the pelvis to the lower angle of the wound, allowing the solution free escape and preventing such increased tension as will force the intestines to prolapse through the wound.

Then, with the patient's shoulders and chest raised to an angle of 45°, the long flushing-tube (Fig. 10) is introduced through the upper end of the incision to the diaphragm and directed first to the right, then to the centre, and finally to the left side. Each in turn is freely sluiced with warm normal saline, which runs downwards into the abdominal and pelvic cavities, escaping from the pelvic tube (Fig. 11) and running, directed by the macintosh (Fig. 3), into receptacles under the table. The flushing-tube is next passed under the omentum, first into the right flank and under the liver, next into the left flank under the spleen, and lastly into the central area. When the solution returns clear the flushing should be stopped, and during its continuance the intestines may be held in the abdomen by pressure of the spread-out hand or partial closing of the abdominal incision with volsellum forceps over a large gauze mop. The abdomen may be closed usually without, but sometimes with a drainage-tube.

Drainage of the Abdomen.—There is quite an old rule to this effect: 'When in doubt drain'; but it is as little helpful as it ever was for individual cases.

In cases of hæmorrhage it is necessary to drain if all oozing cannot be arrested; but it is better not to rely on this alone. The best use of a tube in these instances is as conductor for a tampon.

If hollow viscera have been wounded and leakage is possible, **drain.**

If septic matter has been extravasated, **drain.**

If the tampon and temporary suture (Fig. 9) are necessary, **drain.**

The most useful drain is a pelvic one. When the patient is lying on his back, with head, shoulders, and body raised, fluids gravitate to the pelvis from all over the abdomen. The best drainage-tube is made of

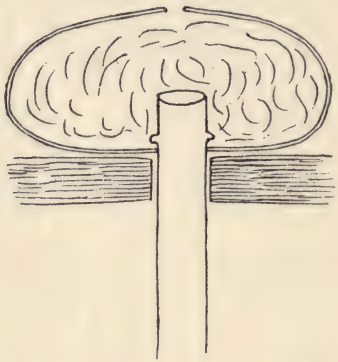

FIG. 11. GLASS DRAINAGE-TUBE. A small hole has been made in the centre of a square of india-rubber tissue. This has been stretched open, passed over the end of the tube down below the collar, and is gripping the tube tightly. A gauze dressing covering the tube is wrapped up in the india-rubber sheet.

toughened glass and is known as a Keith's tube (Fig. 11).

If the abdominal incision does not reach low enough, a button-hole opening should be made two inches above the symphysis pubis by cutting down on a finger pushing forward from inside (Fig. 12). Before putting the tube into this a suture of silkworm gut should be

passed and tied when the tube is removed. The drainage-tube should be long enough to reach from the pelvic floor and to project about two inches from the skin opening. A dressing of sterile gauze wrung out of spirit is then wrapped around the projecting tube. A sheet of sterile, dental india-rubber, eight inches square, is then put over the tube, as a dentist does when protecting teeth, by a small hole in it, stretching this and pushing it down below the collar

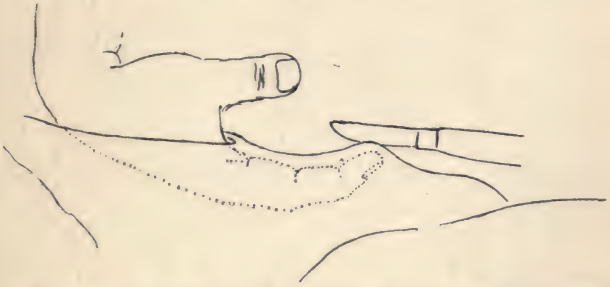

FIG. 12. The hand in the abdomen and one finger projecting the anterior parietal wall to make an opening in it for a drainage-tube. (The hand should have a glove on.)

(Fig. 11). The tube is covered up, the wound dressed, the bandage adjusted so as to leave the tube free, and the tube end covered with a final dressing made into a packet by folding the india-rubber over it (Fig. 11). This method saves touching any part of the dressing except the small portion covering the tube, and sufficiently frequent aspiration with a syringe (Fig. 13) keeps both the former and the wound dry and clean. It is necessary to take the precaution

of using a tube on the syringe smaller than the bore of the drainage-tube and not pumping too hard ; otherwise a vacuum is caused, making it possible for omentum and even intestine to be sucked into the drainage-holes with serious results. In three or four days the tube can be taken out ; but, if any discharge has been escaping from it, an india-rubber one should replace it till all the discharge has ceased. Then the temporary suture should be tied. The need for drainage of other parts of the abdomen is rare ; but

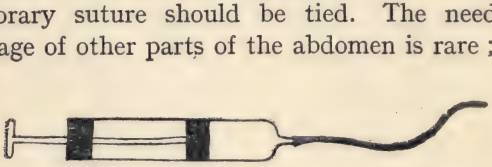

FIG. 13. ASPIRATION SYRINGE FOR KEEPING THE DRAINAGE TUBE EMPTY.

in these situations an india-rubber tube is more comfortable and convenient than a rigid one. For drainage on a smaller scale a piece of rubber tissue folded into a convenient shape suffices, and this has superseded the use of gauze for this purpose.

Transfusion.—Hæmorrhage may be severe enough to cause death ; but a sufficient number of the corpuscular elements of the blood are doubtless left, even in the most serious cases, to enable the patient to live, if these are supplied with a sufficient amount of fluid to enable them to circulate. It is this belief which has established the value of transfusion. The most rapid and probably the most efficient method of increasing the circulating fluid is to introduce a solution into a blood-vessel, and on the median basilic vein

at the bend of the elbow the universal choice has fallen. Sterile normal saline solution (one teaspoonful of sodium chloride to one pint of water) is in general use for this purpose.

There are certain points to be attended to if this operation is to be done with the minimum of risk.

1. The temperature of the fluid should be 100° F. **at its entrance into the vein.**

2. It should be given slowly—one quarter of an hour to each pint.

3. Too much should not be administered at one sitting—two pints should seldom be exceeded.

4. Asepsis should be strictly maintained.

With these precautions it is of special use in hæmorrhage. It is also a valuable means of preventing the onset of shock, though its value is doubtful when this has once been established. The general indications for its use during operation, as previously stated, are a pulse rising to 100 or blood-pressure falling below 100 mm. Hg.

Transfusion of blood,[1] if available, is even more efficient than saline. Patients apparently moribund have been resurrected by its use.

In less serious cases hypodermoclysis is a useful substitute as a preventive of shock. By this method, sterile, normal saline solution is introduced into the

[1] The blood transfused should, if possible, be taken from a relative, and the closer the blood relationship the better. American experiences, though not disregarding the dangers of hæmolysis, prove that in an emergency the risks of blood transfusion are so small as to be negligible in them.

cellular tissue for absorption. A favourite site for injection is in the neighbourhood of the breast and inner axillary wall, where loose cellular tissue abounds. The apparatus required consists of a long, strong hypodermic needle with india-rubber tubing and a receptacle attached. By raising or lowering the receptacle the flow can be increased or diminished, and during a long operation several pints can with advantage be absorbed.

When a serious operation has been completed, one pint of coffee and a tablespoonful of sugar injected into the rectum is a useful preventive of shock, and if the colon has not been wounded large quantities of warm water can be safely administered therefrom to be absorbed. The rectal tube in these cases requires careful watching and some skill in its management in order to obtain the best results.

Closure of the Wound.—The longest incision will cause no subsequent weakness of the body wall if it be properly closed, and healing is as satisfactory as it ought to be, whereas even the shortest incision can allow of hernia through the scar. It is impossible to deal satisfactorily with such lengthy wounds as are required in these cases by means of a single layer of sutures. The peritoneum should first be closed with a continuous suture of catgut, and, especially above the umbilicus, this is difficult, on account of its thin and brittle nature, unless a special suture be used. Strong, thick catgut is needed, and No. 8, corresponding to No. 19 wire gauge, can be relied upon. With a strong curved needle a bite of the peritoneum and the

back sheath of the rectus, or transversalis fascia and muscle in the case of the oblique incision, is taken and the suture is tied at the upper end. It is continued down as a mattress suture (Fig. 14) which,

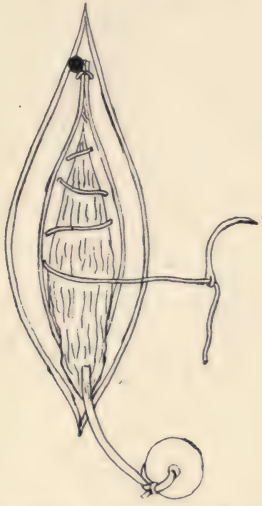

FIG. 14. CONTINUOUS MATTRESS SUTURE OF CATGUT CLOSING THE DEEP LAYERS OF THE ABDOMINAL WOUND OVER A GAUZE PAD WITH TAPE AND BALL ATTACHED. When the suture has nearly reached the lower end of the incision the lower angle is caught and drawn forwards by a pair of catch forceps, the pad is removed, omentum drawn out with it is replaced, and the wall, held forward by the suture above and forceps below, is entirely closed.

when tightened, draws the peritoneum with its raw edges everted into accurate opposition, leaving no raw surface inside. These are important steps, since, if

any hole is left in the peritoneum, a portion of the omentum, which should always be drawn down over the intestine, will find its way through and then enlarge and stretch the opening, thus making a way for further protrusion, and again because a raw surface is certain to result in adhesion, which may cause future trouble.

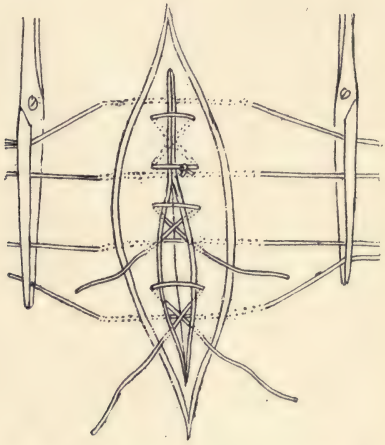

FIG. 15. STAY SUTURES OF SILKWORM GUT OR SILK PASSED THROUGH THE WHOLE DEPTH OF THE PARIETES EXCEPT THE PERITONEUM, AND THE ENDS HELD IN CLIP FORCEPS. The median line aponeurotic tendon is partially closed by figure-of-eight catgut sutures.

After the peritoneal suture, interrupted stay sutures of silkworm gut or silk are passed through all the layers except the peritoneum, and their ends are clipped on either side of the wound (Fig. 15). They

are inserted one inch apart, noting the original position of the skin by the scratch marks, and are passed through the skin one inch from its incised margin. The middle line aponeurotic tendon or the muscles in

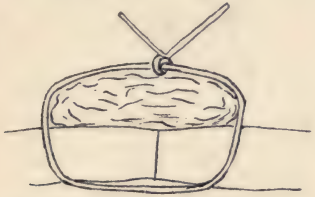

FIG. 16. SUTURE TIED OVER GAUZE IN TRANSVERSE SECTION.

the oblique incisions are brought into apposition by a series of figure-of-eight stitches (Fig. 15) and the stay sutures are tied. In tying sutures everywhere it is

FIG. 17. SUTURE TIED THROUGH DRAINAGE TUBING.

difficult to resist the temptation to pull them too tight. To avoid cutting the skin and to fix the dressing it is a useful plan, provided the wound be clean, to tie them over gauze (Fig. 16). If there is a probability of the wound being infected it is a better plan to protect the skin from the sutures by small bits of drainage tubing (Fig. 17). In either case the divided skin should

be brought into accurate apposition by a sufficient number of interrupted sutures closely applied to its edge. When gauze is used, these of course require to be put in before the stay sutures are tied.

Dressings.—Next the wound in these cases, sterile gauze wrung out of 1 : 1,000 corrosive spirit, and over this a voluminous dressing of wool, held on by a many-tailed bandage, is useful. The dressing, by maintaining heat and elastic compression, diminishes shock, and the large quantity of wool allows of a certain amount of distension without discomfort.

AFTER-TREATMENT OF OPERATION CASES

Post-anæsthetic Care. — Patients require careful watching till recovery from the anæsthetic is sufficiently advanced to prevent any vomited matter from being drawn into their lungs.

Shock.—A certain amount of shock follows all abdominal operations, but can be minimized by preventive measures, the most important still being to keep the patient warm. Nevertheless, a serious amount of shock may follow severe operations, or operations done upon weakened patients. A warm bed is of the greatest importance. The entire bed should be heated before the patient is placed in it and the body heat should be maintained by carefully applied hot-water bottles and abundant clothing. It may be advantageous to again lay special stress upon the **careful** application of hot-water bottles. If they are not carefully wrapped up, these unconscious

patients are sure to be burned by too assiduous applications made in the endeavour to restore body heat.

In ordinary cases this treatment, namely the application of warmth and quiet in bed, is sufficient. For worse or debilitated patients the foot of the bed should be raised ; the face rubbed with a dry towel ; the mouth and pharynx swabbed with a sponge wrung out of brandy and held in forceps ; a coffee and sugar enema should be administered, and a pint of normal saline run into the cellular tissue. When shock has assumed serious proportions, two pints of normal saline with or without adrenalin should be run into a vein. Prolonged anæsthesia lengthens the duration of shock, and patients are apt to pass into a feeble, drowsy, apathetic condition afterwards. If they exhale an odour of acetone or acetone be discovered in their urine, the use of sodium carbonate ½ oz. and glucose ½ oz. in the enema every six hours is indicated.

All patients suffer, after every injury or operation which widely opens the peritoneum, from sickness, thirst, and gripes.

If all goes well, ordinary sickness will disappear after the second, thirst after the third, and the wind pains after the fourth day.

Sickness.—Skilled anæsthesia is one of the best preventives of sickness after operations. In ordinary cases while the sickness lasts abstinence from food is essential. This is in accordance with the feelings of these patients, and should be regarded as a guiding instinct. A continued nausea is often relieved by small hourly doses of ½ a grain of calomel, but,

whether from its medicinal virtue, or from the comforting feeling, not to be despised, that something is being done, scarcely matters.

Up to the third day moderate sickness and vomiting need cause no anxiety if the patient looks well. Vomiting persisting after this period, especially if it increases on the third day, and if the vomited matter be green and in considerable quantity, is an anxious symptom ; for it is often one of the early indications of a commencing peritonitis. A tumblerful of hot water containing a small teaspoonful of carbonate soda dissolved in it may stop obstinate vomiting but any serious sickness can only be dealt with by washing out the stomach. A frequent result is that continuous nausea and urgent vomiting which have resisted all the usual remedies tried, both cease after the first washing. It is important that the use of the tube and stomach lavage should not be too long delayed, because vomiting is often the result of a condition which is fatal if overlooked, and which generally yields to this if applied in time. This condition is known as :

Acute Dilatation of the Stomach.—The first symptom noted is a sudden turn for the worse. Then the patient feels deadly sick, is overwhelmed with thirst, restless, and mentally depressed. The first sign is epigastric distension, with frequent vomiting of mouthfuls of dirty fluid, and this, together with other bad features, suggests septic peritonitis, for which it is too often mistaken. The abdominal bandages should be loosened, the stomach washed out as often as it fills up, and the patient should be

either laid on his side—that most comfortable—or in the prone position. The stomach lavage may require several repetitions, as an extraordinary quantity of fluid is secreted by the gastric mucous membrane in this condition. The intense thirst should be relieved by water as an enema through a funnel and tube, since the pumping action of an ordinary syringe is more apt to be followed by irritation of the rectum and discharge of the fluid.

Loosening the bandage has been mentioned. If any patient complains of a tight bandage it should always be loosened without delay. A quick pulse and every appearance of commencing serious disturbance may be relieved at once by this measure.

After the third day some nervous patients continue to retch and bring up mouthfuls of what they have swallowed. A glass of champagne with a little food, such as a raw meat sandwich, will sometimes put an end to this trouble, and if not sufficient, a small hypodermic injection of morphia ($\frac{1}{6}$ of a grain), provided the bowels have been well moved, or, if this has not occurred, 1 oz. of castor oil may be administered unless the intestine has been damaged.

Condition of the Bowels and Gripes.—Gripes are relieved by the passage of flatus and probably depend upon irregular contractions of the muscular coat of the intestines. Wearing a rectal tube at frequent intervals and a hot dry bag over the dressings may give some relief. By the end of the second day, if flatus has not passed, and it is **this** that matters, an enema of 2 drachms of glycerine should be adminis-

tered. This can be repeated if necessary. On the fourth day, if the intestines have not been damaged, 1 oz. of castor oil should be given ; but, if they have, it is advisable to rely on enemata for a few days longer. Occasionally diarrhœa follows the operation instead of the usual constipation. In a moderate degree this may be beneficial and requires no treatment. If the stools are offensive, ½ an oz. of castor oil with 5 minims of tincture of opium should be given, unless the intestine has been damaged, when 5 grains of salol and 5 grains of pulv. ipecac. co. every eight hours (so long as required) should be tried. If the stools are not offensive, a powder containing 5 grains of pulv. ipecac. co. with 5 grains of bismuth trinitrate and 1 grain of hydrarg. c. creta repeated every eight hours is usually effective.

Thirst.—One of the most difficult symptoms to relieve after abdominal operations is thirst. It may be relieved by rectal enemata of warm water, by the transfusion of normal saline solution, or by leaving saline solution in the peritoneal cavity ; but it is never entirely prevented or completely relieved. The patient's craving is for cold water, and there is no good reason why this should not be gratified, though it should be slowly sipped in small quantities at a time and often repeated. Allowed a feeding-cup, constantly replenished with cold water, and sipping at it continually gives these patients greater pleasure than anything else. Ice, a favourite remedy in all sickness, should be avoided. It makes the tongue sore and dry, increases the flatulence, already

troublesome enough, and, melting in the stomach, promotes vomiting.

Bladder.—The fashion of passing a catheter after all abdominal injuries and operations has disappeared, and, on the whole, with advantage to the patients. It is, however, well to remember that a patient with no marked urinary symptoms, but with a dry tongue and only complaining of 'the stomach', may owe both of these to a bladder sufficiently distended to be felt in the hypogastrium.

Pain.—The pain following an abdominal injury or operation is worse than anything occurring ordinarily. For the first hours after operation, if morphia has preceded the anæsthetic, the patient dozes and makes little complaint; but later the pain may cause such restlessness as to be hurtful. If ordinary measures fail to relieve it, $\frac{1}{4}$ of a grain of morphia hypodermically is the lesser of two evils.

Diet.—During the first twenty-four hours, or until flatus has been passed, nothing should be swallowed but water in sips. Water by the rectum may be relied upon to keep the patient going during this time. On the second day a cup of tea, sweetened and with cream in it if desired, may be allowed; after this, barley-water and milk in equal parts and gradually increasing in quantity. During the first four days fluid diet, and by the end of the week ordinary food, should be the rule.

The Nurse.—In the after-treatment nothing counts so much as a good nurse, and surgeon and patient are both to be congratulated if they get one with a knack

of doing well in abdominal cases. Skilful turning over and raising up into a half-sitting posture during the early days is much appreciated by all patients.

Prognosis.—In the majority of cases a prognosis can be offered as soon as the operation is completed. If it has been made certain that all hæmorrhage has been arrested, that every source of septic infection has been satisfactorily cut off, and that the patient's general condition is good, it is unlikely that any harm will befall.

If a patient has made entirely satisfactory progress up to the fourth day it is seldom anything goes wrong afterwards.

Removal of the Stitches.—If it is probable that infection of the wound has been avoided, there is no good reason why dressings should be removed before the time has come to take the sutures out. Skin sutures, if unabsorbable, and there are no other considerations, are best removed in a week or ten days.

By using fine catgut, either interrupted or subcuticular, this necessity may be avoided. In any case, if the skin sutures have not been too tightly tied, they do no harm, and the danger of removing the stay sutures at this time is so real that it should never be done.

The important Stay Sutures should be left for Three Weeks.—In a fair percentage of cases in which this has not been done the healed wound has burst open and the viscera protruded. Any surgeon to whom this experience has occurred is unwilling to again run such a real risk.

COMPLICATIONS FOLLOWING THE OPERATION

Hæmorrhage.—Intraperitoneal hæmorrhage may occur after the patient has recovered from shock. If a drainage-tube has been left in this will make it obvious. If not, increasing pallor, diminished tension and increased frequency of pulse, a feeling of weakness and restlessness, thirst, sighing respiration, yawning, cooling of the head and extremities with clammy sweat, blurred vision and dilated pupils with some abdominal pain and dullness in the flanks make it evident that the abdomen must be reopened without delay.

Peritonitis.—A septic focus, such as a torn intestine, which has resisted attempts to deal with it, may be the centre of a spreading infection and the cause of general peritonitis.

Septic infection may be the result of leakage from a viscus damaged sufficiently to allow of its walls giving way later, **but** experience has proved that the most frequent cause is leakage from a perforation which has not been recognized during the operation. Whatever the cause of the peritonitis may be, it is usual to note nothing extraordinary till the end of the second or the commencement of the third day. The patient is usually depressed and sickly, the pulse steadily increases in rapidity, some distension of the abdomen, first noticed in the epigastrium, appears, and the passage of flatus is interfered with. Vomiting, increasing distension, rapid progress downhill usually follow, and on the fifth to the eighth day the

patient dies. A further operation seldom does any good, and often hastens the end. The best course, and one not without some hope, is to stop all food, drink, or purgative by the mouth, to wash the stomach out frequently so long as there be sickness, to maintain the body heat by artificial means, including large hot applications to the abdomen, to administer as much fluid by the rectum as the colon will absorb, to help the heart's action by $\frac{1}{20}$ grain hypodermic injections of strychnine every eight hours, to give small doses of morphia hypodermically often enough to relieve restlessness, and, if the patient recovers, to keep a careful daily look out for localized collections of pus in the abdomen.

This should of course be evacuated as soon as discovered.

If the abdomen, though distended, be not tense, there will be some chance of recovery left—a tense distended abdomen is wholly unfavourable.

Pneumonia.—The prolonged administration of anæsthetics, especially ether, necessary for abdominal operations, and the inability to cough afterwards, owing to the pain of the abdominal wound, predispose to collections of mucus in the bronchi, lung collapse, and resultant pneumonia. One type commences with the operation, and on the following day the patient will have an elevated temperature, a quick pulse, more or less cyanosis and difficulty in breathing, with moist râles all over the chest. The administration of atropine previous to operation helps to prevent this condition, and treatment of it, if vigorous and undertaken at once, may put a sudden end to the whole trouble.

The patient must be raised up in bed, held in this position by some one supporting his back, and, whilst the abdominal wound is supported by strong hands on either side, an honest attempt must be made to get rid of the accumulated mucus and lung collapse by coughing and deep breathing.

Another type is due to septic inhalation from the mouth, nose, or throat, and develops usually during the first week after operation. Attention to the mouth, nose, and throat before operation, to the condition of the apparatus by which the anæsthetic is to be administered, and to prevention of the inhalation of vomited matter during and after the operation are measures which should not be omitted, since they can all help to minimize the risk. The treatment is medical, and unless the patient be feeble the prognosis is unusually good.

Cystitis.—Since the abolition of catheters in the after-treatment of abdominal cases, cystitis has become a rare complication. Many patients have had, after recovery from an operation, their future lives ruined by this trouble, and the teaching that dirty doctors and nurses are responsible for it has had something to do with its disappearance.

Intestinal Obstruction. — After every abdominal operation there is a possibility of intestinal obstruction. Text-books describe one cause as the inclusion of a loop of the intestine in the suture used to close the abdominal wall; but this accident is avoidable with small care and needs no further consideration. The common cause is adhesions, and it is fortunate that

trouble seldom occurs during the first week, and that the usual time for the occurrence is the second and third weeks, when convalescence seems to be assured, because this is a considerable aid in diagnosis. Prevention of it involves the prevention of adhesions, and this means knowing their cause. Known causes are rough manipulations, dry mopping, gauze packing without india-rubber protection, the use of strong antiseptics in the abdomen, septic infection—this is the greatest of all—and leaving raw surfaces uncovered by peritoneum. All of these it is possible to avoid. Others due to unknown causes are unavoidable. Early diagnosis of obstruction and prompt treatment by operation mean recovery of the great majority of patients. Delay means death.

If there are severe paroxysmal pains with vomiting, inability to pass flatus, and evidence of increased peristalsis—visible, palpable, or audible—the sooner a second operation is performed the better. If there be doubt, one ounce of castor oil followed by an enema is likely to clear it up by making the patient either worse or better and so deciding for or against immediate operation.

Femoral Phlebitis.—Phlebitis is a painful, sometimes a dangerous, and always an incapacitating complication after abdominal operations. With remarkable frequency it appears about the tenth day, usually with a bad aching pain in the upper part of the thigh, preferably the left, and extending down the leg, with a rise of temperature to even 103° F. and with a feeling of decided illness, which lasts from a week

to a month. Swelling of the leg soon follows. Rarely is the patient able to get about with any comfort in less than three months, and as a rule more or less serious traces of the trouble are left for the remainder of life.

The causes of it are unknown, but septic patients and those who have lost much blood are more predisposed to it than others. It is rarely fatal and seldom gives rise to embolism. Preventive treatment consists in rubbing the legs upwards twice daily, commencing three or four days after the operation, and at the end of a week exercising the legs in bed, the patient lying on his back, by such movements as are performed on a bicycle. When the condition has developed, nothing does any good but rest.

Parotiditis.—This may be a very serious complication during convalescence and is always painful and incapacitating. The cause in nearly all cases is sepsis spreading from the dry mouth up the duct. It can be prevented by keeping the mouth clean and moist, and if the patient is well enough he should play with chewing gum to stimulate the flow of saliva.

Ventral Hernia.—A certain percentage of patients —it should be a very small one—get a ventral hernia after abdominal operations. This may be unavoidable. It occurs when the wound suppurates, again in fat muscular persons who are growing fatter, and it may take place in the wrecks of humanity who suffer from multiple hernia, proptosis of the viscera, and general laxity of all tissues. The treatment is to cure, if possible, by an operation, and if not, to give support by a belt.

DIRECTIONS APPLICABLE TO ALL OPERATIONS

Note the position, inspect if possible the lethal instrument, and listen to the history as a guide to localization of visceral injury (Fig. 1).

Step 1. Pack any wound present with gauze wrung out of warm normal saline solution.

2. Disinfect the skin covering the abdomen, and the arm at the bend of the elbow.

3. Explore and clean the parietal wound and suture any opening in the peritoneum. Pack the wound with gauze wrung out of methylated spirit.

4. Mark with cross scratches the line of incision (Fig. 4).

5. Cover the line of incision and surrounding skin with two layers of gauze wrung out of 1 : 1,000 corrosive lotion.

6. Fix sterile towels and sheets.

7. Make the incision down to the peritoneum.

8. Arrest parietal hæmorrhage.

9. Open the peritoneum and complete the operation.

10. Remove a bullet if it can be seen or felt, or if the operation is easy; but make no serious search for it.

11. Close the operation wound in layers (Figs. 14 and 15).

12. Close any parietal wound in layers round a small drainage-tube.

13. Dress the wounds.

Wounds and Prolapse of the Omentum

The omentum is more likely than any other of the abdominal contents to prolapse through a perforating parietal wound. The following steps should be taken in such a case :

1. Cover the protruding mass with a mop wrung out of warm saline solution.

2. Cleanse the skin of the abdominal wall.

3. Clean the omentum with warm normal saline solution.

4. Enlarge, cleanse, and examine the wound and the omentum.

5. If the omentum be undamaged, replace it in the abdomen and examine the abdominal cavity through the wound for other injuries. If the omentum be bruised or visibly dirty after enlarging the wound and covering the skin all round it with gauze mops, draw some more of it outside and excise the damaged, dirty portion through a clean part. In doing this, split the omentum into strips with a pair of closed, blunt scissors and clamp each strip as it is separated through the openings already made (as in Fig. 20). When the whole width has been clamped, remove each clamp one by one, placing a catgut ligature in its track. Tie each ligature firmly with three knots, and, when all ligatures have been fastened, cut the ligatured portions half an inch beyond the knots and return the stump to the abdomen. Examine the abdominal contents if there be any doubt of further mischief.

6. Close the wound in layers, leaving in a small drainage-tube, and open the abdomen by a middle-

line incision. Bleeding vessels in the omentum should be occluded by a catgut ligature on a needle.

Injuries to the Stomach

Fragments of shell—even bullets striking and grazing but not perforating the parietes—may cause injury and rupture of the stomach. These, however, are more usual after perforating wounds from bullets and stabbing weapons. The wound may involve one or all of the coats, may be a small hole or an extensive laceration, or may pass entirely through the stomach cavity involving both walls. Natural recovery may follow small perforations if the stomach is empty at the time the wound is inflicted, but as a rule some extravasation of its contents leads to septic peritonitis or subphrenic abscess in all varieties of perforation. The treatment in all cases, seen early and in suitable surroundings, is operation.

Step 1. Open the abdomen and cover the skin on either side of the wound with large gauze mops wrung out of warm normal saline.

2. Draw down the stomach by holding and pulling on the greater curvature and examine its whole anterior wall. The escape of gas or stomach contents or the size of the wound may make discovery of the perforation easy. If not, a blood-stained area on the front of the stomach may give a clue as to its position. Any doubt as to perforation should be cleared up by the use of a probe in this area.

3. Close the perforation by a continuous catgut suture through all the coats and invaginate this with

an outer layer of interrupted, fine-silk, Lembert sutures.

4. Clean the peritoneum all round by gentle mopping with gauze wrung out of warm normal saline. If there has been a diffuse extravasation of the contents, a suprapubic opening, sufficient to admit a good-sized drainage-tube, should be made (Fig. 12) and peritoneal lavage established.

5. In bullet wounds palpate the stomach to ascertain whether or no a bullet has been arrested in its cavity. It is a serious thing to make a posterior examination first and then to find that the bullet has not passed through the posterior wall, but has been arrested in the cavity. If it has not—

6. Turn the omentum and transverse colon up on to warm pads over the lower thorax and expose the transverse mesocolon.

7. Take the omentum, transverse colon, and lower edge of the stomach in the left hand, and holding the greater curvature of the stomach between the index-finger and thumb, press the stomach against the mesocolon with the remaining fingers of the left hand.

8. Tear with a pair of dissecting forceps through an avascular part of the mesocolon into the lesser sac, and pass the posterior surface of the stomach (bit by bit) in review from the pyloric to the cardiac end through the hole in the mesocolon.

9. Close the posterior stomach opening in the same way as the anterior, with two layers of suture, and mop out the lesser sac.

10. Close the opening in the mesocolon, in such a manner as to leave no raw edges.

11. Close the abdominal wound.

12. Remove the drainage-tube, if the wash-out is quite clear, and tie the suture associated with that opening. If doubt is felt as to the efficiency of any part of the operation the drainage-tube should be left in for a few days.

Injuries to Liver

Violence applied over the liver can cause rupture of it without apparent damage to the abdominal wall. Crushing injuries are often associated with injuries to other viscera and with fractures of the overlying ribs. Fire-arm wounds, too, are likely to be associated with other injuries, as also may stab wounds. In all cases, blood at first escapes into the peritoneal cavity, and if the patient lives, at a later stage, bile, as in the case of gall-bladder perforation. In both, jaundice may appear a few days after the injury, and this may be either most marked or only visible around the umbilicus.

Step 1. With the patient's body well drawn over to the right, with head and legs in the straight line, and his right side convex so as to open up the ilio-costal space—

2. Open the abdomen by a transverse incision over the middle of the ilio-costal space from the back to the outer edge of the right rectus muscle (Fig. 5).

3. If hæmorrhage be active, arrest it at once by passing the forefinger of the left hand into the foramen

of Winslow and compressing the structures in the outer edge of the gastro-hepatic omentum (hepatic artery, portal vein, and bile duct) between the finger behind and the thumb in front. If a big laceration be present and blood freely lost, the finger and thumb should guide and be replaced by padded forceps. If the hæmorrhage, as is usually the case, be controllable by the pressure of a gauze pad on the wounded surface—

4. Take measures for its permanent arrest. In bullet wounds a small gauze strip packed into the track suffices. For all other wounds mattress sutures of thick catgut are ideal. A thick, strong probe, curved to suit the situation, is the best extemporized needle. Its eye should be threaded with fine silk tied in a loop to take the catgut suture and draw it through the liver substance. Sutures should be lightly tied, as blood-pressure in the liver is low and its substance easily torn. If all hæmorrhage cannot be arrested by the suture alone, a gauze tampon and sutures tied over it can be relied upon to accomplish this.

5. Wash out the abdomen if much blood has run down into the pelvis.

6. Close the wound in layers (as in Figs. 14 and 15). If sutures only have been employed to arrest the bleeding, drain the hepatic pouch with an india-rubber tube brought out posteriorly. If a gauze tampon has been used, bring it out through the back part of the wound, surrounding the portion passing through the parietes with sheet rubber.

Wounds of the Gall-bladder

Contusion injuries, gunshot and stab wounds have all been known to open the gall-bladder and allow of bile leakage into the abdomen. Rupture of the gall-bladder is a very rare injury.

The gall-bladder should be exposed by the same transverse incision used for the liver. If the opening in it can be closed without difficulty, this should be done with catgut sutures. It may be easier to close it round a tube in a similar way to that used in gall-stone operations, and still be a satisfactory method. If neither is easy, it is all-sufficient to drain the hepatic pouch with a good-sized india-rubber tube through the back, and before closing the wound the abdomen should be cleansed by lavage with normal saline.

Injuries of the Spleen

The whole or part of the spleen—either healthy or injured—has been seen prolapsed through a parietal wound with the stretched pedicle possibly strangulated.

Step 1. Cover the prolapsed spleen with gauze wrung out of normal saline.

2. Disinfect the skin.

3. Clean and enlarge the parietal wound.

4. Clean and inspect the spleen.

5. If it be not torn or bleeding, and if clean, return it to the abdomen. If, on the other hand, it be torn and bleeding, but clean, suture the tears with catgut, and, if this stops all bleeding, return it.

If it is much lacerated or cannot be cleaned, or

continues to bleed, tie the vessels in its pedicle by transfixion with strong silk ligatures and fasten them tightly, leaving half an inch between the ligatures and the portion to be cut to prevent slipping, finally excising the spleen.

6. Close the parietal wound in layers (as in Figs. 14 and 15).

7. Drain the abdomen through the wound with an india-rubber tube for three or four days.

Contusions of the abdomen without a wound are the most common causes of injury to the spleen, though it can result from gunshot or stab wounds. Splenic injuries are less often complicated by other serious abdominal injuries than lesions of the remaining viscera, though some of the ribs covering it are not uncommonly broken at the same time. Diseased conditions, which are of more frequent occurrence than is usually believed, are serious predisposing causes to its rupture, which may then result from very trivial violence. The great vascularity of the spleen makes death from hæmorrhage after laceration and wounds an event to be anticipated, and this may occur with appalling rapidity. Fortunately, sufficient warning to allow time for arrest of the hæmorrhage is generally given if the danger signals be properly understood.

Step 1. Open the abdomen by a transverse incision extending from the back of the left flank in the middle of the ilio-costal space behind, to the outer edge of the left rectus in front (Fig. 5), exposing the spleen (on left side, same incision as right).

2. Examine the injured spleen and determine whether it is possible to arrest the hæmorrhage by sutures, or sutures and tampon. Extensive lacerations are contra-indications.

3. Excise the spleen after transfixing the pedicle and tying it with strong silk. Leave half an inch of tissue beyond the ligatures.

4. Wash out the abdomen if much blood has got into the pelvis. Drain the abdomen through the wound. Close the wound in layers.

Gunshot and stab wounds are much more frequently complicated by other injuries than contusion ruptures of the spleen. Their treatment is the same; but splenectomy is rarely required, since the hæmorrhage can usually be arrested by sutures.

Injuries of the Diaphragm

Contusions of the chest may, though rarely, produce rupture of the diaphragm without any other injury. The rule is that other injuries, either in the chest or abdomen, or in both, accompany it. Gunshot and stab wounds of either the thorax or abdomen, provided they involve the diaphragm, must of necessity include both cavities. A diagnosis has probably never been made except by the discovery of hollow abdominal viscera in the pleural cavity, and for this reason surgical interest is roused because strangulation of these may demand immediate operation, which should mostly be limited to relief of the emergency.

Injuries and Wounds of the Pancreas

Injuries and wounds of the pancreas produce no special early symptoms from which a diagnosis can be made, and they are usually discovered during life, as part of a larger injury which has involved other viscera. Injuries to this organ, often overlooked, have so frequently been the cause of surgical calamities that its importance should not be forgotten when any abdominal operation is undertaken. To expose it:

Step 1. Open the abdomen (Fig. 4).

2. Draw down the stomach so as to expose and stretch the gastro-hepatic omentum above its lesser curvature. Hæmorrhagic extravasation into the lesser sac will show through this.

3 *a*. If access be easy from laxity of the visceral attachments, tearing through the gastro-hepatic omentum gives a good approach, but this state of affairs is rare.

b. The best method ordinarily is to open the lesser sac through the gastro-colic omentum. Tear through it about one inch below the greater curvature of the stomach, pull the stomach up, and the transverse colon covered by the omentum down. Pack the hepatic pouch with gauze mops wrung out of warm saline.

4. Separate the colon and stomach by retractors, mop out the lesser sac, and expose the pancreas lying across and on either side of the spinal column.

5. Repair injuries and arrest hæmorrhage with catgut sutures if possible, covering the whole injured

surface with peritoneum, drain the lesser sac through the gastro-colic and parietal openings, and close both round the drainage-tube. If this be impossible, drain the lesser sac through the opening in the gastro-colic omentum by a tube in the centre of a tampon held in position by sutures temporarily tied (Fig. 9).

Injuries of the Kidney

The kidney may be injured either alone or as part of other damage from contusions or wounds. The most dangerous injuries are those near the hilum and involving large blood-vessels, usually from stabs and gunshot. Those most damaging to the kidney itself are generally from contusion injuries, which may result in such trifling lesions as a mere tear in the capsule or in such mutilation that the kidney may be smashed into many fragments. Early deaths, and they constitute the majority, are from hæmorrhage; but later mortality results from sepsis and suppuration.

To explore the kidney and, if necessary, also the abdomen:

Step 1. The patient lies on his back and, in order to open up the iliocostal space, is so curved as to make the side to be operated upon convex. Make a transverse incision on the injured side (Fig. 5), extending from the flank behind to the outer edge of the rectus muscle in front and through the muscular layers of the abdominal wall down to the transversalis fascia.

2. Retract the edges of the wound above and below, pack the front of it with a gauze mop, and separate, with the fingers, the transversalis fascia behind till

a deposit of perirenal fat is seen shining through. Open the transversalis fascia with scissors, exposing the perirenal fat. If this is not done sufficiently far back, the peritoneum in front is liable to be opened by mistake. If this should happen, close it before going any further with a *fine silk* ligature by drawing the edges of the hole forward and together with clip forceps, or if it is too large by a continuous suture.

3. With a retractor in the fascial opening press on the gauze pad and retract the peritoneum and fascia covering the abdominal contents to the other side. Separate the kidney from its fatty surroundings and draw it forward and outside.

4. Suture tears. Remove separated portions of kidney, suture lacerations, or, if the kidney is hopelessly damaged or the renal artery or vein wounded, excise it after ligaturing the pedicle with catgut, leaving half an inch of tissue beyond the ligature. In the case of gunshot and stab wounds, suture them. A bullet or portions of clothing should be looked for in the kidney. If left they form a nucleus for stone.

5. If the wound is not quite dry, pack gauze in front of and behind the kidney of sufficient thickness to exert some pressure on it, and drain between the two.

6. Close the wound, leaving the drain posterior. Later developments, such as collections of pus and urine in and around the kidney, may require drainage or even nephrectomy.

Injuries of the Ureter

The ureter may be torn at its upper part or into the pelvis of the kidney by extreme violence, or it may be cut by a stab wound or divided by a bullet in any part of its course.

There may follow slight hæmaturia or the escape of urine from the wound ; but the probability is that no diagnosis will be made till extravasated urine forms a cystic swelling in the retroperitoneal space. Repeated aspiration of this has been occasionally successful, but drainage offers better prospects. If a urinary fistula remains, a plastic operation on the ureter, though not promising, may be tried, but nephrectomy may be the only cure. At a later date hydronephrosis may result from cicatricial stricture of the ureter or pyonephrosis from secondary infection.

Injuries of the Duodenum

Tears from contusion, wounds from gunshot, or stabs of the first and second part of the duodenum in all essential respects resemble those of the small intestine and require similar treatment. After their closure the hepatic pouch should be drained with a large tube behind, through a special opening. If leakage occurs the chance of healing is so small that gastro-enterostomy should be performed without delay and at the same time the pylorus should be closed to deflect the gastric juice, as it is this which prevents the duodenal fistula from closing. The third part of

the duodenum lies hidden behind the peritoneum, and wounds of it leak into the retroperitoneal space and are likely to be overlooked unless the peritoneum covering the posterior abdominal wall be wounded at the same time. Inspection or palpation may lead to the discovery of a lesion by showing the presence of œdema or blood extravasation or the crepitation of gas in the retroperitoneal space. Any one of these should lead to exploration through the peritoneum, as there is no chance of recovery unless the opening can be completely closed and the space drained. To close it two layers of catgut suture should be employed, then the wounded area should be covered up by omentum sutured into position all round, and the surroundings should be tamponed and drained (Fig. 9).

Injuries of the Intestines

Ruptures of the small intestine from contusions and perforations from bullets or stabs are relatively common, those of the colon rare. Both require similar treatment if the risks of death from septic peritonitis, due to escape of their contents, are to be diminished. In simple cases, even though the injuries be multiple, the prognosis after early operation is good and the problem not one of difficulty.

Step 1. Open the abdomen.

2. Search for and draw out the leaking portion of intestine. Protect this and hold it forward in a warm, moist gauze mop.

3. Retract the abdominal wall on either side and

pack the abdomen all round with warm moist gauze. Surround the wounded portion of the intestine with the same.

4. Cleanse the intestine and wound by gentle pressure on either side of it and by mopping with warm moist mops. Close the opening or openings by two rows of sutures: (1) a continuous, water-tight, post-mortem stitch of catgut; (2) a row of either continuous or interrupted Lembert sutures of fine silk. The closure may be made either in the longitudinal or transverse axis of the bowel, as seems best in each individual case. Longitudinal closure diminishes the lumen of the bowel, and, if the first suture line be too much infolded, may do so seriously, especially if more than half be obliterated. Transverse closure has not this defect. As a general rule longitudinal closure is preferable because the intestinal vessels run round the bowel circularly, and this method interferes less with the blood supply.

5. Mop the sutured bowel with hot normal saline, clean and dry it, remove the abdominal mops, look round for other injuries, draw the omentum down, and close the abdominal wound either with or without drainage. If there has been much escape of intestinal contents, the abdomen should be washed out and drained.

Wounds and Tears of the Mesentery

The danger of wounds and tears in the mesentery is both immediate and remote. Hæmorrhage is the immediate danger: later, gangrene of the bowel may

occur, and at any time later still intestinal obstruction from strangulation through a hole.

Contusion tears are more dangerous to the intestine than stab or gunshot wounds. The small vessels near the mesenteric attachment are terminal and have no collateral anastomosis. Further back in the mesentery the anastomosis is free. Wounds which separate the mesentery at its attachment to the intestine, such as occur in contusions, are followed by gangrene of the bowel. Ligature of a fair-sized vessel wounded by gunshot or a stab further back may cause no circulatory difficulty whatever. Catgut ligatures tied in three knots are best for securing the vessels, and care should be taken that all tears are carefully closed with a continuous suture.

Ligature of a large mesenteric vessel is so likely to be followed by gangrene of the corresponding loop of intestine that it is safer to excise it.

Excision of Intestine

Hopeless damage to mesenteric vessels is a definite indication for excision of the corresponding intestinal loop. It is often safer to excise damaged and bruised intestine, though if doubt be felt concerning its recovery an omental graft wrapped round it and fixed by sutures may be the method of choice.

Loops of intestine bruised or with damaged mesentery and multiple perforations should be excised. Excision of the intestine in consequence of these claims is an important operation and requires serious consideration. The dangers frequently supposed to

be associated with it do not belong to the operation itself, but depend upon (1) the condition of the patient at the time the operation is performed; and

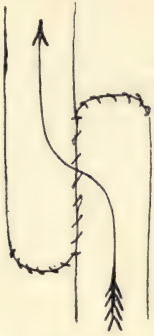

FIG. 18. THE BEST TYPE OF ANASTOMOSIS IN BOTH SMALL AND LARGE INTESTINES.

(2) the technique of the surgeon performing it. There is no difference in the risk between removing two inches and two feet, and in competent hands it is the same for enterectomy as for appendicectomy. Lateral

FIG. 19. END-TO-END ANASTOMOSIS OF INTESTINE.

anastomosis with an inner layer of catgut sutures and an outer of silk is the safest method in both small and large intestine (Fig. 18). End-to-end anastomosis

(Fig. 19) in the small intestine has small risk, but in the large the risk is greater, both requiring considerable practice for their satisfactory performance. Consequently such a safe, simple method is to be desired as follows:

Step 1. Open the abdomen.

2. Draw outside the damaged portion of intestine.

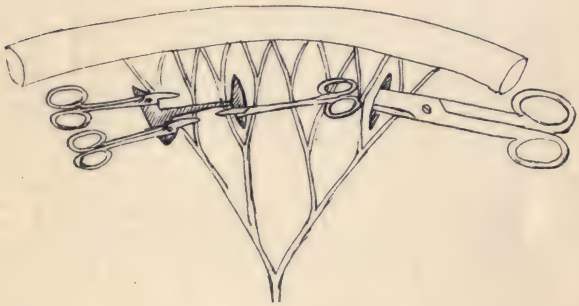

FIG. 20. SEPARATION OF MESENTERY INTO STRIPS AND APPLICATION OF CLIPS ABOVE AND BELOW. In the drawing this has been made the first stage of excision. In the text it is advised that division of the intestine at one end should be done first.

Protect it by covering it with, and holding it forward in, a gauze mop wrung out of warm saline solution.

3. Retract the abdominal wall on each side and pack warm gauze mops into the abdominal cavity all round. Surround the prolapsed intestine with the same.

4. Select the points at which the gut to be excised should be divided (a little more rather than a little less

than what is apparently necessary should be taken away). Apply two clamps at either end (Figs. 20 and 21).

5. Divide the intestine between one pair of clamps (Fig. 21). The section can be made with either scissors, knife, or cautery—preferably the cautery as causing less sepsis.

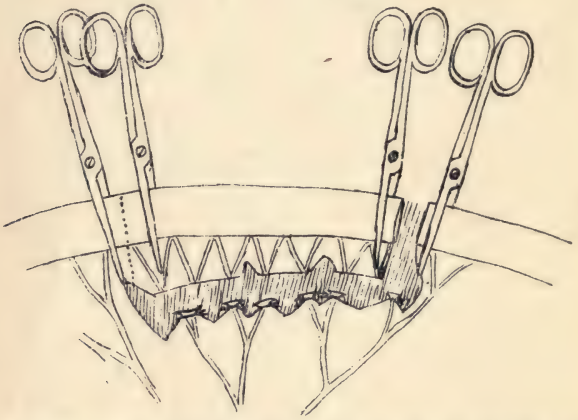

FIG. 21. The intestine has been divided at one end and the divided mesentery ligatured. The dotted line shows the place of section at the other end of the intestine.

6. Tear through the mesentery with closed blunt-pointed scissors and isolate strips of it, clamp these with hæmostatic forceps, proximally and distally, and divide it between them (Fig. 20) till the mesentery corresponding to the portion of intestine to be excised has been separated. Divide the intestine at the other end. Cleanse both ends of the divided intestine with dossils of dry gauze held in forceps.

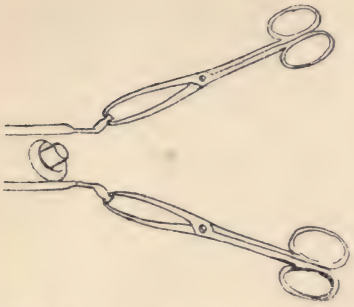

FIG. 22. The edges of the cut intestine are held and opened up by catch-forceps, and half of a Murphy button has been placed in the lumen.

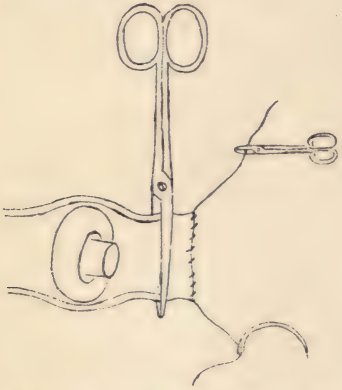

FIG. 23. The clamp has been reapplied and the cut end of the intestine has been closed by a continuous catgut suture through all the coats. The half Murphy button is seen in the closed intestine.

7. Hold the edges of the cut intestine with catch-forceps, remove the clamp, slip into the bowel one half of a Murphy button and reapply the clamp,

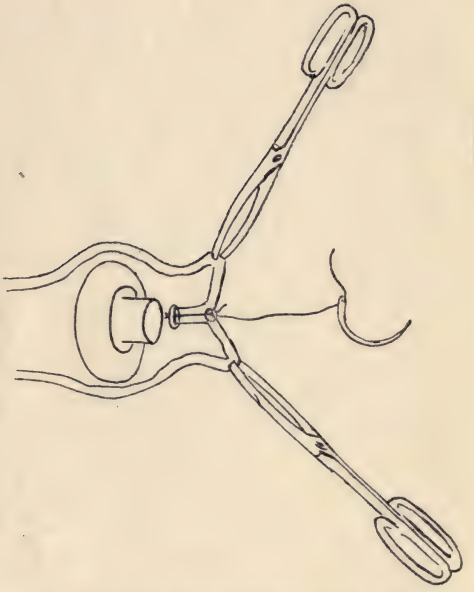

FIG. 24. The first sutured layer is infolded.

leaving $\frac{1}{4}$ inch of the bowel stump projecting beyond it. Do the same at the other end (Fig. 22).

8. Suture the bowel ends with: (1) a continuous catgut suture through all the coats (Fig. 23) and depress it; (2) a continuous catgut suture through the outer coats and depress it (Fig. 24); and (3) a Lembert

silk suture (Fig. 25). Find the two halves of the Murphy button through the coats of the bowel, and, taking them between the finger and thumb, guide each in turn close to the doubled-in ends of bowel and

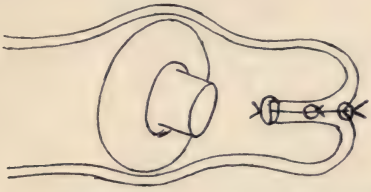

FIG. 25. The second sutured line is infolded.

FIG. 26. The Murphy button is caught between a finger and thumb and pressed forward against the antimesenteric side of the bowel. (The hand should have a glove on.)

project the tube against the intestine on its antimesenteric side (Fig. 26).

9. Holding the half-button and the bowel in each hand (Fig. 26), either with knife or cautery have the

bowel stretched over the tube of the button divided sufficiently to allow the tube to be squeezed through, and press the halves of the button firmly together (Fig. 27).

10. Wipe the anastomosis with warm salt solution, apply a row of interrupted Lembert silk sutures, not too closely, all round outside the button area, fix the ends of the bowel to each other by tying the

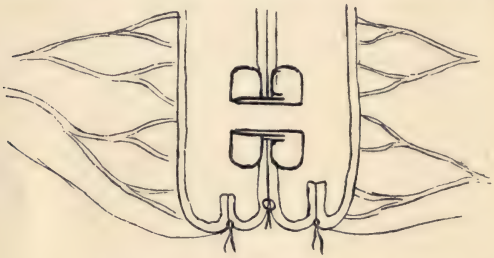

FIG. 27. LONGITUDINAL SECTION OF THE BOWEL MESENTERY AND BUTTON, showing the two halves of the Murphy button clamped together and the bowel ends in apposition. The button should be closer to the ends, and the end sutures should be tied together.

outside silk sutures of each together, close the mesentery and cover its raw surfaces by plaiting it.

11. Return the anastomosis and close the abdomen. This anastomosis (Fig. 27) does not look so nice as the one made like Fig. 18; but it gives equally good results, and there is less chance of retention of the Murphy button in the end pocket resulting in disaster.

There are three positions in the intestinal tract where large transverse ruptures of the gut are

produced by violence, and all are at the junction of a fixed with a movable portion. They are the duodeno-jejunal junction, the end of the ileum, and the junction of the descending with the iliac colon. The last two are amenable to ordinary types of anastomosis; but the torn end of the duodenum, owing to difficulty in applying a satisfactory suture, has occasioned insurmountable trouble. If half a Murphy button be placed in the jejunum, its end sutured (Fig. 25), and the other half fixed by a running suture surrounding it into the torn end of the duodenum, an end (duodenum) to lateral (jejunum) anastomosis can be easily made. A row of interrupted silk sutures all round the anastomosis makes it safe.

Colon

Wounds of the cæcum and transverse and pelvic colons are intraperitoneal, produce similar effects to those of the small intestine, and require the same treatment. Injuries to other parts of the colon may be either intra- or extraperitoneal. Intraperitoneal wounds of the colon demand early operation and closure.

Extraperitoneal wounds cause greater difficulties, are often followed by fæcal fistulæ, and have a high mortality. The difficulties and the occurrence of fistulæ arise from the absence of a peritoneal covering at the wounded part which makes satisfactory suture more difficult and the result uncertain; and the dangers arise from septic infection of the abundant cellular tissue in the neighbourhood of the wounded bowel.

A doubtful diagnosis in the extraperitoneal variety may be cleared up by the introduction of a rectal tube and the forcing of air through it with a bicycle pump ; but this should never be done if there be any suspicion of an existing intraperitoneal perforation as well.

An early operation allows of a successful effort to close the opening with two or more layers of catgut sutures, the first going through all coats ; and if the patient be in good condition and the wound clean, the exposed bowel should be covered and supported by a patch of fascia lata taken from the thigh and sutured into position over the wounded area. A sufficient opening should always be left in the parietes to admit of free drainage from the depths of the wound, and if septic infection be present or follow, enlargement of the wound, to admit of the easiest discharge of fæces and the products of infection, is essential.

Rectum

Injuries to the rectum are likely to be complicated by intraperitoneal lesions if perforation has been produced by impalement, stabs, gunshot, or the introduction of foreign bodies with surgical or other intent. If there be evidence of this, laparotomy should be performed. After opening the abdomen the patient should be placed in the Trendelenburg position, and the small intestine lying in the pelvis should be lifted out, passed in review, cleansed, packed upwards and retained by a warm gauze mop in the abdomen. The pelvic peritoneum and viscera should then be exposed by retractors, two lateral and one below, and cleansed

by handled mops. With a curved needle held in long forceps the opening should be closed, first with a through and through catgut suture, and over that interrupted catgut sutures through the outer coats. An omental graft should then be spread over the front of the rectum, retained by a few catgut sutures, and packed snugly into position by a strip of warm moist gauze. A glass drainage-tube reaching from the pelvic floor to the abdominal wound (Fig. 11) serves both to conduct and protect the gauze strip brought out through it, and drain the pelvis. A large-bore, india-rubber drainage-tube should be passed into the rectum, fixed to the anus by a suture, and retained for a week or ten days. Rectal wounds which perforate the cellular tissues surrounding the bowel should be treated by a deep incision extending from and through the posterior wall of the anal canal in front to the tip of the coccyx behind and travelling in the middle line. Any incontinence resulting from this can be dealt with later by operation.

Ruptures of the rectum and colon have been reported as a result of firing off compressed air in the near vicinity of the anus. All of these cases have resulted from 'practical joking' in works. The effects have been multiple lesions, ruptures, and lacerations of rectum and colon and extravasation of their contents into the peritoneal cavity. The majority reported have been rescued from death by early operation.

Bladder

The bladder may be ruptured or lacerated by blunt violence from without or from within (rectum or vagina), or it may be perforated by gunshot or a variety of stabbing and impaling instruments. When it is distended with urine, there is increased liability to either accident, and alcoholic excess may be regarded as a predisposing cause.

The rupture is extraperitoneal in about one-fourth of the cases, intraperitoneal in the remaining three-fourths. The danger of the first is from urinary extravasation and cellulitis; of the second, from septic peritonitis.

Treatment in the Extraperitoneal Form may be limited to free incisions for drainage purposes, or include suture and drainage of the bladder. A tube in the bladder, if connected up with a Cathcart pump, keeps the wound quite dry.

Step 1. Incision in mid line from three inches above the pubis down to the symphysis pubis.

2. Separate the pyramidales and recti muscles in the mid line and retract them on either side.

3. Place the patient in the Trendelenburg posture and pump boracic lotion through the urethra into the bladder with a Higginson syringe in order to localize the opening.

4. If possible suture the opening with two layers of catgut, the second infolding the first, but neither passing through all the coats.

5. Tie in an india-rubber catheter, drain the supra-

pubic space with a large india-rubber tube, and close the wound with stay sutures of silkworm gut tied through drainage tubing (Fig. 17), except at the lower end where the tube emerges.

This operation may be difficult or infection may bar it. In either case the risk is diminished if a tube can be left in the bladder in addition to cellular tissue drainage.

For Intraperitoneal Perforation

Step 1. Open the abdomen from below the umbilicus to above the **symphysis pubis**.

2. Separate the recti muscles in the mid line, open and wash out the abdomen.

3. Place the patient in the Trendelenburg posture and lift the small intestines out from the pelvis, pack them into the abdomen above, and retain them there with a large gauze mop.

4. With retractors, one on either side and one below, expose the pelvic contents, draw forward the bladder, and close the opening in it with two layers of catgut sutures, neither passing through all the coats. Before closing it palpate to discover the presence of a possible bullet therein.

5. Mop out the pelvis and close the abdominal wound with or without peritoneal drainage according to the amount of confidence inspired by the bladder suture.

6. Drain the bladder by an india-rubber catheter tied into the urethra.

In both varieties pelvic fractures may require attention.

Abdominal Injuries peculiar to Women

Rupture of ovarian cysts or of the spleen enlarged by pregnancy or other causes may occur from violence in women possessed of either. Any of the abdominal viscera may be perforated, lacerated, or torn from violence applied either through the vagina or the uterus or during the performance of intra-uterine operations. The female pelvis possesses such a remarkable immunity to rough treatment that death rarely results from shock. Hæmorrhage and peritonitis in these cases are the causes of death. The treatment of them all is operation at the earliest opportunity. A ruptured cyst requires ovariotomy; the ruptured spleen, suture or splenectomy. It is well to remember that pregnancy, though it may increase some of the difficulties, adds little, if anything at all, to the dangers of abdominal section.

The Pregnant Uterus

The pregnant uterus has been ruptured by contusion and perforated by gunshot stabs or impalement from above through the abdominal wall, and from below through the vagina. If it has been shot through, the probability is that the fœtus has been killed. If it has been stabbed or impaled, some guess at the amount of damage done may be made if examination of the lethal instrument be possible.

Though some of these patients recover after a dead baby has been born, there should be no hesitation in

advising operation as offering the better, and often the only, chance of saving life.

Step 1. Open the abdomen in the middle line by an incision large enough to allow the extrusion of the wounded uterus.

2. Extrude the uterus by pushing it out from behind with two hands outside or with one in the abdomen. Pack the abdomen behind it and all round the uterus with gauze mops. Close the upper part of the incision temporarily over the gauze and behind the extruded uterus with volsellum forceps.

3. Make a transverse incision across the fundus of the uterus and open it, take hold of any conveniently presenting part of the baby, and deliver it.

4. Wrap the uterus in large, warm moist mops, take it in both hands and compress it between them. Clamp the umbilical cord in two places, cut it, and separate the child.

5. Remove the placenta and empty the uterus by compression between hot, moist gauze mops.

6. Sew up the uterine wound with, first a layer of interrupted catgut sutures through all but the inner wall, and over this a continuous fine-silk suture through the peritoneal coat. Repair any injury wounds in the same way. Close the abdominal wound **entirely**.

7. Where the violence has been from below and sepsis of the uterus is a probability, supravaginal hysterectomy should be done and, when a tear involves the cervix and vagina, total hysterectomy should be performed. In this case it is advisable to drain the

pelvis into the vagina with a strand of gauze, suturing the pelvic peritoneum over it from above.

Before closing the abdominal wound in any case look for further damage. In obstetric cases it is not uncommon to find considerable portions of bruised intestine separated from the mesentery, and excision and anastomosis of the intestine have then to be done in addition to the hysterectomy.

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