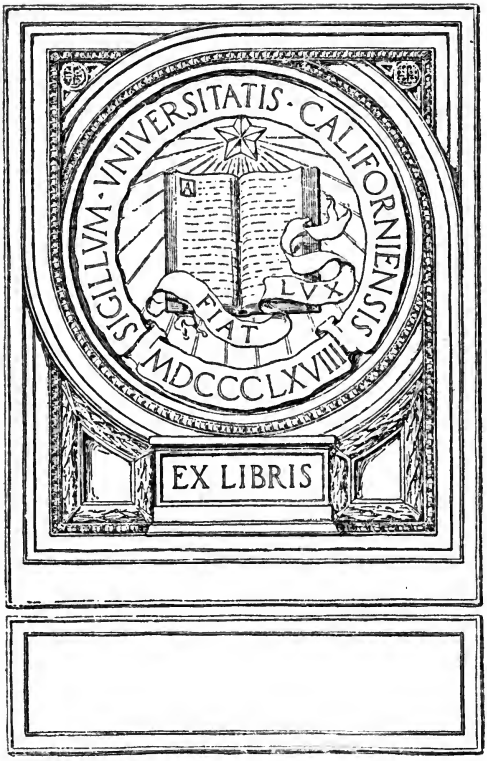
SURGICAL NURSING IN WAR

BUNDY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BY

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PREFACE

The surgical literature of the Great War already includes many scores of valuable and illuminating articles contributed to various periodicals, and a few books. From these voluminous sources, supplemented by letters from the front, it has been thought desirable to collect the lessons and descriptions which are of vital import, that they may be available for ready reference by those who contemplate joining the nursing corps of Military Hospitals (or have already done so), as their time is of necessity too limited for the wide reading involved. Useful suggestions have been received from those who have been personally in service at the front, and indebtedness is hereby acknowledged to the valuable work of Major Hull—"Surgery in War"—which has been freely consulted and quoted in regard to descriptions of methods practised by members of the Royal Army Medical Corps of Great Britain.

Any attempt at completeness in a book of this sort would be futile, as new methods are daily devised and daily reported; the final word concerning any

will not be uttered while the war lasts; but the principles upon which modern war surgery is based are well established, and upon those lines is built the groundwork, also, of surgical nursing in war time.

ELIZABETH R. BUNDY.

1831 CHESTNUT STREET.
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CHAPTER I

SURGICAL NURSING IN WARTIME

In the present wave of patriotism many nurses will offer themselves for service at or near the front. That they may understand some of the conditions which there exist and the consequent demands upon them, the following pages are written to set forth not only the problems to be solved, but some of the means which have thus far been devised to that end.

It is assumed that one who volunteers for surgical work in the war hospital has already mastered the general principles of nursing and by practice has acquired the requisite experience and skill to make her thoroughly efficient. While it is true that the great pressure of work will provide something of importance for every willing hand, the *responsible* nursing must be in the hands of *responsible* nurses, who by their thorough understanding of the situation and duties, can not only render valuable service themselves, but assume the very important duty of

directing inexperienced workers when only such are at hand to assist them, for in the large base hospitals where from 2,000 to 2,500 patients must be cared for, it is impossible to obtain a sufficient number of graduate nurses for the purpose; many who are untrained are necessarily employed, therefore it is all the more important that the *graduate nurse* should be fully prepared to master the situation.

Although in the following pages instruction in general nursing is omitted, this is not because of any lack of recognition of its importance, but because the design of the book is to aid the graduate nurse in preparation for the present emergency. The serious nature of her duties will require all of study and preparation which she can devote to the undertaking.

She will not forget her early training, by which she has become expert in such important matters as bed making, the moving and lifting of patients, the giving of baths, changing of clothing and bed linen with least disturbance to the patient, and the ability to secure by various devices—so far as possible, his comfort. Of utmost importance is the correct administration of douches, rectal irrigations and enemata, colon lavage, the preparation and use of hot and cold applications, and many other local remedies for various purposes. She will, of course, have been well drilled in bandaging and the preparation and use of splints. She will understand the importance

of the use of antiseptics and the handling of aseptic wounds. She will know so exactly how to prepare patients for operation that she will do this quickly and well; she will know for what symptoms to watch after an operation and will have these points so clear in her own mind that she can instruct her assistants concerning them and depend upon their reports with confidence. The care of surgical dressings and appliances may fall to her hands, as well as the preparation of surgical supplies. All these things must be literally "at her fingers' ends."

The *structure of the human body* and the relations of its parts must be well understood and constantly in mind, for only so may she be able to comprehend the derangements caused by accident or disease, or attain the skill which intelligence in nursing confers.

Therefore, her studies in Anatomy and Physiology may be profitably reviewed; this is especially important for surgical work and as most of her activities will be in that field, a number of illustrations (with which she is perhaps already familiar) are introduced with explanations adapting them to the cases which are most frequently entrusted to her care.

It is unnecessary to speak of the requisite personal qualifications of the nurse; such as patience, kindness of heart and manner, a power of unremitting attention and that indescribable quality called *tact*. But it is of first importance to call attention to the

fact that she can not meet the exacting duties which confront her without proper conservation of her own health and strength. She must religiously make use of her stated opportunities for rest and fresh air whenever possible, not only for her own sake, but for that of the cause to which she has pledged herself.

Her responsibilities will be great, beyond that of any work which she has ever before undertaken, not alone because of the kind of work itself, but because the demand is so continuous; each hour of day or night may bring its own emergency.

She should understand much from the surgeon's point of view in order to be his very efficient aid, and much also from the patient's point of view that she may the better minister to his needs. Here more constantly than elsewhere, alert attention, quick thinking and unhesitating action are demanded, and the unflagging interest which makes for endurance. The work is most arduous; the reward is of the highest.

A Few General Reminders Applicable All Along the Line

1. Against drawing bed covers down tightly so that they become binders. Nothing can be more disagreeable, especially for patients who must lie upon the back, than to have the toes bound down by covers.

2. Contrive to have at hand *pads* or *pillows* of many sizes. Upon their use and arrangement so much depends that their importance can hardly be overestimated. It is here that the nurse's knowledge of anatomy will serve her well, so that she will know just where to place them in seeking, for example, to exactly support the normal curves of body or limb. She will know the position of the patient's head which will bring no strain upon the muscles of the neck; the patient himself will not as a rule understand why his head is not always comfortable, therefore the wise and observant nurse must herself recognize the state of affairs, and find her reward in the look of relief and contentment upon her patient's face when a deft although slight re-arrangement has added to his comfort.

3. A thin bed transmits the body heat of the occupant to the iron frame which supports it; a non-conducting material placed underneath the mattress will prevent this. Nothing is better for the purpose than several layers of paper; news papers serve perfectly well, secured if possible to a layer of any sort of clean material; when that is not obtainable they may be overlapped and tacked firmly together. This device will contribute surprisingly to the comfort of a patient in cold weather, and such a provision for a case of shock is most valuable.

4. Do not attempt to give a high enema with-

out elevating and supporting the hips. If the case admits vary the patient's position during the administration, from the back to the left side and then to the right, that the water may follow the curves of the large bowel.

5. Concerning the wisdom of providing for personal use:

First.—As many rubber gloves as she can possibly procure, securely packed for transit; (the handling of dangerous infections will be so much more easily and therefore better done if one can work with the mind free from the thought of personal danger).

Second.—Several pairs of dressing forceps or hemostats, to prevent any necessity for touching dressings.

Third.—As many hypodermic needles as possible. You can not have too many. Also tablets—morphia, adrenalin, pituitary extract, scopolamin—will be needed most frequently. Supposedly these are furnished for use from the hospital stores, but it is hardly possible to have a sufficient number always on the spot, and the devoted nurse will be more than compensated for personal outlay by the sustaining knowledge that she is ready for the emergencies which will arise when supplies may be temporarily inadequate to a sudden demand and a life at stake may be saved by her hand.

In the succeeding pages no attempt will be made

to emphasize the terrible and distressing features of the work in Army hospitals, nor to call attention especially to the pressure under which it is carried on during much of the time, but in some situations, as for instance where 800 men are hurried in, scores at a time, all suffering for immediate attention—some fast slipping away from the reach of human aid—the nurse will wish that each of her hands could be multiplied to a hundred in order to accomplish all that she sees before her—crying to be done!

It is appalling! but there will be no time for dwelling on that, still less for being appalled. She will just go ahead—thinking fast, fast—and trying to persuade her willing hands and those of her assistants to keep the pace.

CHAPTER II

MISSILES USED IN MODERN WARFARE AND THEIR IMMEDIATE EFFECTS

Lieutenant-Colonel Pilcher, of the Royal Army Medical Corps, says of gunfire: "this war will be known to the minds of surgeons as the *pointed bullet* war." The special effect of these bullets is to cause deep penetration, with extensive shattering of bone and injury to the soft tissues.

Artillery fire also, so very large an element in the European war, deals in the use of explosive missiles, as *shrapnel*, *high explosive shells*, etc., the fragments of which pierce the soldier's body in every possible place. No part escapes and every sort of wound is caused, from a simple puncture or superficial laceration to those where tissues are mangled, bones shattered and nerves cut off from their terminations. The effect of this mutilation of the tissues by explosive missiles with the shattering of bone and scattering of fragments, is to cause wounds within wounds, deep recesses and pockets difficult of access by the surgeon, where anaerobic bacilli like nothing better than to hide undisturbed; hence their especially dangerous character. These bacilli flourish on dead or devitalized tissue; the latter are already in the wound; the

former soon will be. They crave a place devoid of oxygen—they find such in the recesses of a wound plugged with débris and damaged tissues so that air can not enter. They object to an acid medium—the blood is alkaline. They work in the dark; no light is here. In and around the wound their dangerous toxins are developed at once, and being rapidly absorbed they cause the most serious consequences.

In addition to the various results of gunfire, the use of *bombs* or *hand grenades*, *"liquid fire," asphyxiating gases* and *burning oil*, in the European war, has added to the list of bodily wounds. Extensive *burns* involving deep layers of skin and underlying tissues exposed to the infections of the battlefield without means of defense, have presented problems of treatment to both surgeon and nurse, as will be recognized; being superficial wounds they are mostly infected by the pus-forming microbes (*aerobes*) which can be adequately met and conquered by prompt treatment if only the strength of the patient be not too severely taxed.

The shock and exhaustion following extensive burns will be referred to later with descriptions of treatment (pp. 27, 90).

The immediate effects of *asphyxiating gases* encountered in volume, are difficult to relieve. The main hope for the soldier is in prophylaxis; by the use of a gas mask or respirator he will escape the

effects of the noxious fumes which have such a deadly effect. Once inhaled they cause intense suffering from the inability of the badly damaged lung tissue to properly carry on the process of respiration, the man literally gasping for breath, at the same time enduring agonizing pain. If he survive the immediate effects of the attack he must undergo a long period of disability due to the congestion and succeeding inflammation of the air passages and lung tissue.

As time goes on, remedies are sought and found for many conditions which at first seemed beyond alleviation, and improved methods of treatment may yet help the soldier through this as well as other well-nigh impossible difficulties.

Long and persistent attempts to revive by artificial respiration one who appears quite asphyxiated by gas, have sometimes saved the patient.

Injuries caused by *hand grenades* or *bombs*, *burning oil* and numerous other vicious weapons invented in the present war, can not be described in detail but may be classed under a general heading as wounds of *mutilation*, and *burns*.

The *clean bullet* wound at long range is often uncontaminated. Buried in the tissues it has been found sterile when extracted, but in the present war this does not often happen. Even when there is no infection, pressure symptoms may cause it to be

a source of danger, as in the spinal column or the vicinity of blood-vessels.

The *bayonet* wound, received with the force of the thrust undiminished, goes home usually to vital organs or causes internal hemorrhage, and the man will not live to reach the nurse's hands.

The term "*spreading wound*" is often used. This expresses the effect of a missile coming rapidly from a distance, and possessing sufficient force to penetrate the body but with diminishing velocity. It thus produces the effect of a blow resisted after entering the body, causing an injury which spreads laterally in the tissues which it meets. A *bullet*, being comparatively small and compact, usually makes a clean straight punctured wound; if it takes a "through-and-through" course the exit opening is larger than that of entrance; some velocity having been lost in transit, a slight spreading occurs.

Shrapnel or shell fragments cause far more spreading and the damage is correspondingly greater. Their shape and rough edges enhance their destructive character, while their "spreading" or scattering course multiplies wounds in all of the structures in their path.

Conditions of Warfare. Bacteriology

The most striking difference between surgical work in civil life and in the present war, appears in

the fact that the former deals with *clean wounds*, only at times with infected ones—while the latter deals with *infected wounds*, almost never with clean ones. The surgical cases with which we have heretofore been familiar in hospitals or at patients' homes, often present themselves with evidences of infection, but with a few exceptions this may be arrested by skilful treatment, as the wounds are accessible whether accidental or operative, pus-forming surfaces are under control, care and surroundings are of the best and serious consequences are averted.

War surgery, on the contrary, has to deal with wounds of a different character, in surroundings often most unfavorable and where a minimum of care is available for the patient. *The character of warfare* influences greatly the nature and severity of wounds. Life in the trenches with its confinement in unwholesome quarters and state of constant apprehension, and trench warfare itself where men are exposed to the effects of deadly explosives in a narrow space, produce their own consequences which follow no other conditions.

Modern destructive missiles cause wounds of peculiar severity and render more active all of the infective processes to which the man is exposed. These circumstances have led to a searching study of infective organisms and the means of dealing with them, whereby the results of treatment have become bril-

liant, notwithstanding the unfavorable conditions which are met on every side.

It has been said truly that the bacteriology of infected wounds in time of war is that of the battle-ground. By way of contrast, the experience of military surgeons in South Africa is often referred to, where much of the fighting was done over uncultivated plains in uncontaminated air; sepsis was not the rule and when present it yielded readily to treatment. The present war, on the contrary, is waged in countries long inhabited by a dense population, where for many generations the land has been under intensive cultivation with the use of fertilizers of animal origin which are an abounding source of dangerous bacteria.

The soil is full of them and infection is invited by the methods of modern warfare, where the men live in trenches for weeks at a time, and are constantly showered with earth thrown up by explosions on all sides.

Bacteria

Some knowledge of the special bacteriology of wounds is important to the nurse as well as to the surgeon and a very brief statement of the prominent features of the subject follows.

The bacteria with which we are principally con-

cerned belong to two general classes: the *aerobes* and the *anaerobes*.

Aerobes require the presence of oxygen for their development; common examples are the *staphylococcus*, the *streptococcus*, the *colon bacillus* and the *bacillus pyocyaneus*. One or more of these will be found wherever suppuration exists. They are the *pyogenic* or *pus-producing* bacteria. The most virulent of the aerobes is the *streptococcus pyogenes*, which is the cause of *septicemia* or general sepsis, and *pyemia* or abscess development in different organs (a secondary process).

The action of aerobic bacteria is familiar to all who have done much surgical work. When present extensively they have a devitalizing effect upon the tissues surrounding the wound, as is seen in the production of sloughs. Serious as these may be they are usually dealt with successfully by antiseptic methods.

Anaerobes can not grow in the presence of free oxygen; examples are—the *bacillus of malignant edema*, *bacillus of tetanus* and the so-called *gas bacillus* (or the bacillus perfringens).

Facultative aerobes or anaerobes form a class which may or may not grow in the presence of oxygen.

Anaerobes include those bacteria which cause the most serious and fatal infections. They develop their toxins where oxygen is not; they flourish in dead

or devitalized tissue, and must live in an *alkaline* (or at least a neutral) *medium;* also, they produce *spores* which are more or less resistant to heat or antiseptics, and remaining inactive for an indefinite time, may later develop.

NOTE.—Thorough and long sterilization, of all articles used in cases of anaerobic infection, as instruments, gloves, utensils, etc., is imperative. This is best accomplished by steam under pressure in the *autoclave.*

All bacteria cause their effects, not by their mere presence, but by the *toxins* or poisons which they produce. These toxins are distributed in the body and destroy the cells of various vital tissues. The *aerobic bacteria* flourish in all tissues where air can be provided and produce their toxins wherever they may be, in various parts of the body, being transported in the blood current; the *anaerobic bacteria* produce their toxins in the wounds where they find entrance and in the tissues that immediately surround the wounds, whence they (the toxins) are distributed through the body by way of the blood and lymph streams.

Immediate Effects of Certain Anaerobic Bacteria.—The bacillus of **malignant edema** causes a rapid exudation of blood-stained serum in the subcutaneous tissues and muscles. This so presses upon vessels as to obstruct the circulation and leave the parts unprotected against the attack of the bacilli, so that

death of the tissue and gangrene (not often *with gas*) soon follow. The toxin produced by this bacillus, when absorbed is quickly fatal.

The so-called **gas bacillus** (*bacillus perfringens* or *bacillus aerogenes capsulatus*) also causes an exudation of serum and in addition, the formation of gas, producing an *emphysema* which spreads rapidly, forcing itself through subcutaneous tissues and between muscles. This condition created by gas and serum, obstructs the circulation and damages the tissues. The effects are shown in pressure symptoms which so often are followed by atrophy of muscles and fatal gangrene, due to the obstruction of vessels and nerves (see p. 103).

NOTE.—General toxemia of the patient is not caused by this bacillus itself. When present it is due to other infective organisms or a "mixed infection."

The toxin of the **tetanus bacillus** attacks the *nerves* in the wound where it is produced and is carried to the nerve cells of the central nervous system, affecting first those which belong to the injured motor nerves; later, it invades very widely the cells of the brain including pons and medulla, where are found the vital parts of the nervous system. All these organisms produce a toxin which acts on the heart; in fatal cases the pulse fails while the mind is still clear.

CHAPTER III

EFFECTS OF BACTERIAL INVASION AND IMMUNITY

Reviewing your studies of the blood you will recall that it consists of fluid plasma with the red and white cells floating therein; also various substances in solution, among which is one called **complement;** this is an enemy to poisonous bacteria.

Certain of the white cells or leucocytes are called *phagocytes* from their property of absorbing and destroying (or devouring) bacteria. But the phagocytes are not attracted by living bacteria—on the contrary, they are repelled by them; therefore, the bacteria must die.

What happens in the blood when injurious bacteria gain entrance? At once they develop their toxins and pour them into the stream. Thus they poison the blood and when they are present in overpowering numbers they attack the tissue cells and general poisoning follows, constituting the fully developed disease which is attributable to the special order of bacteria present. If this process is not arrested death follows.

Immunity

Nature has her own method of resisting and overcoming the effects of bacterial invasion, thereby creating a condition of safety which is called **immunity** or insusceptibility.

The presence of bacteria with their toxins stimulates the production of *antitoxins* in certain tissue cells of the body. If only a few organisms gain entrance the quantity of antitoxin will be sufficient to neutralize all of the toxin produced. Meanwhile, the tissue cells under this stimulation produce other substances classed as *amboceptor*, which uniting with the complement always present in the blood attaches it to the bacteria; they are then promptly killed and further production of toxin is prevented. They are now ready for the phagocytes, which destroy them.

Notes.—Complement alone is powerless: armed with amboceptor it is deadly. Toxin stimulates the production of antitoxin which keeps the poisonous process in check until sufficient amboceptor is produced to attach the deadly complement to the bacteria.

When all of the bacteria are killed the patient recovers.

By a fortunate provision of Nature an *excess of amboceptor* always remains in the blood, ready for a future invasion of the same organism. *This constitutes* **immunity** to that special organism.

NOTES.—Phagocytes do not devour *living bacteria*, but the production of antitoxin occurs in their presence whether living or dead.

Amboceptor includes a variety of substances, as *agglutinins*, *opsonins*, *antibodies*, *immune bodies*, etc., all acting in the same way, to unite with complement and enable it to kill the bacteria so that the phagocytes will be attracted to the feast.

Immunity, then, consists of the presence in the blood of sufficient *immune bodies* or *amboceptor* to attach the deadly complement to the variety of invading bacteria which first stimulated its production.

Each immune body can act upon only one species of bacteria—the one which stimulates its own production. Immunity, therefore, is not a condition in general, but must be especially acquired for each separate infection.

Acquired immunity to any disease is enjoyed by the person who has successfully passed through an attack of that disease; the excess of immune bodies or amboceptor remaining, being able to guard him against a succeeding invasion of the organism which caused its production.

This form of immunity is not invariably permanent.

Natural immunity is hardly explainable; some races and some individuals simply do not "take" certain diseases.

Artificial immunity is acquired at will, by the introduction into the blood of bacteria living or dead, which stimulate the production of antitoxin and the appropriate amboceptor. The amboceptor remains and the person is immune or insusceptible to the bacteria in question for a variable time. This is the secret of successful vaccination as practised so long and successfully to protect an individual from smallpox. (The vaccine is skilfully prepared and the number of bacteria actually determined in the laboratory.)

NOTE.—In the case of antityphoid vaccination immunity continues for about two years. Where the danger of exposure is constant and can not be avoided it is best to repeat the vaccination at shorter intervals. In the present war the antityphoid vaccine is administered to every recruit when he is enlisted and repeated at each subsequent enlistment. When he is in a locality known to be infected it is repeated at intervals of two or more months during the time of exposure. (This system of frequent vaccination obtains in certain localities where the men have to encounter disease of an especially severe type.)

Summary.

1. *Complement* exists normally in the blood.

2. The production of *antitoxin* occurs in the presence of either living or dead bacteria; also the production of *amboceptor*.

3. While the antitoxin is neutralizing the *toxins* which are poured into the blood by living bacteria, the amboceptor is liberated and joins the complement.

4. When this is accomplished bacteria are killed and *phagocytes* devour them.

5. *Immunity* is conferred by excess of amboceptor remaining in the blood.

NOTES.—Phagocytes are attracted by dead bacteria. This attraction is explained as *positive chemiotaxis*. They are repelled by living bacteria; this is explained as *negative chemiotaxis*.

The word *antigen* is applied to any organized substance of animal origin which stimulates these processes of self defense. In the preceding studies *bacteria* are the *antigens*.

Serum Treatment and Vaccination.—The use of *antitoxin serum* is illustrated in the treatment of diphtheria and tetanus. It is obtained by means of a series of injections of bacteria into the body of the horse, whereby excessive quantities of antitoxin are produced in the blood. This is drawn from the veins and the serum with its load of antitoxin is separated from the blood. Its strength is then estimated and expressed in units. It is sealed in sterile bottles in measured amounts marked for administration. For a person who has been exposed to infection a certain

quantity called the *immunizing dose* is injected into the tissues. For a patient already suffering from the disease a larger quantity is used; this is the remedial or *therapeutic dose.*

In *vaccination* dead bacteria are introduced in an emulsion and the natural powers are stimulated safely to produce the necessary amount of antitoxin and immune body, or amboceptor. The effect is illustrated in the use of *antityphoid* or *antienteric* vaccine.

NOTES.—In the use of *serum* the antitoxin is supplied from without, with the confident expectation that by neutralizing the toxin that may be present in the blood it will give the cells time to produce the necessary amboceptor.

In the use of *vaccine* the body must rise to the occasion, producing its own antitoxins and sufficient amboceptor to meet a possible future invasion of *living* bacilli.

No one has ever seen complement or amboceptor, but the result of their action has been proven many times and the terms signify theoretically, a process which undoubtedly takes place in the blood.

The usual preparations before and after a puncture of the skin are to be made for the administration of serum or vaccine; the skin to be thoroughly cleansed and disinfected. Iodine may be used or not

as directed at the time. (Iodine should be omitted for a vaccination.) Sterile water or normal saline is to be used for the final washing or dressing after the cleansing and disinfecting.

Constitutional Symptoms or Reactions Produced by **Serum** (**"serum sickness."**).—The site of the injection may become slightly swollen and tender.

Rise of temperature occurs in from 24 to 48 hours, with, frequently, nausea and restlessness and often a fine rash, "*serum rash.*" There is slight disturbance of the bowels. The symptoms often persist for several days or a week, although they may subside within 48 hours. The nursing is of the simplest; the patient should rest quietly, the diet should be light and digestible. Cool drinks may be given freely and very little medicine is required.

Symptoms Produced by (*Antityphoid or Antienteric*) **Vaccine.**—These are headache, feverishness, a feeling of general malaise and possibly faintness, which sometimes makes the patient quite uncomfortable. They occur within a few hours (about six) from the reception of the vaccine. If the dose is administered rather late in the day the symptoms will not occur until bedtime and the patient will sleep through the most annoying stage of the reaction. The swelling and tenderness which surround the puncture begin to subside at the end of 24 hours.

Two days' relief from duty will probably find him in his normal condition.

In exceptional cases the symptoms are more serious—vomiting, diarrhea, fainting, fever; they will probably subside in two or more days.

CHAPTER IV

DANGERS OF INFECTION. SHOCK. HEMORRHAGE

Already, attention has been called to the character of warfare and the location of the battle grounds as elements which add greatly to the serious nature of infective processes. Not only are the wounds caused by modern missiles peculiarly dangerous owing to the wholesale destruction of tissues involved, but on account of the substances which are driven into them—skin—clothing and dirt—all with their freight of microbes more or less virulent.

The man himself presents a state which favors the rapid development of toxins and general sepsis. Exposure for hours or days as circumstances determine, during which the only protection for his wounds was possibly, a first aid dressing applied by himself amid unclean conditions, has sapped his vitality and undermined his power of resistance, thus providing opportunity for microbes to do their worst.

The *aerobes* or pus-producing bacteria (*staphylococci* and *streptococci*) are present in large numbers engaged in breaking down his tissues, while in deeply lacerated wounds the *anaerobes* find conditions to

their liking; they do not of themselves cause septicemia, the suppuration which often accompanies them being due to other organisms, in the presence of which the anaerobes themselves flourish the more abundantly in dead tissues thus provided for them.

When the wounded man reaches the nurse after exposure long or short, he has been subjected to the nerve strain of constant distress and apprehension and the terrifying experience of gunfire with explosives, bombing, etc., in addition to the physical exhaustion of actual fighting and the pain of wounds. Add to these contamination by soil, sepsis already developed, and the sufferings of transportation—first through narrow trenches by stretcher, then over rough ground by ambulance and later by not too comfortable railway train. He may be weakened by hemorrhage; he is suffering protracted pain; all these will react to reduce him to a condition of shock.

Shock

This may be the first problem which the nurse is called upon to meet. If she is fortunate enough to be stationed at a clearing hospital[1] (next removed to the field hospital or ambulance), she will meet such cases constantly, for the men are necessarily transported while hardly able to endure the hardships of the trip. At a base hospital the

[1] Evacuation hospital.

condition of the patient may be still more desperate, and the operations demanded for his relief will furnish many a serious case.

The appearance of a patient in *shock* is that of complete exhaustion, with vitality almost suspended. The skin is cold, clammy and pale, the features are pinched—the pupils wide open, the muscles relaxed. Respirations are slow, shallow and irregular; circulation is at the lowest ebb; the pulse is small, rapid and feeble, the temperature subnormal. All functions are depressed.

Accepting the teaching of Dr. George W. Crile we now believe that **shock** is a condition of *brain exhaustion* and *abnormally low blood pressure;* the causes being *pain, hemorrhage, fear and mental distress* and *sepsis.*

Long-continued **painful sensations** irritate or overstimulate brain cells to the point of exhaustion. For example, the shock and diminished vitality which accompany severe or extensive superficial injuries, as burns, are accounted for by the irritation of the many sensory nerves in the skin, each one carrying its message of pain to the overwrought brain and causing changes in the cells of brain centers. Structural changes are found also in the cells of the liver and adrenal bodies, and in addition, engorgement of veins of the portal system so that the blood is not properly returned to the heart.

Hemorrhage will contribute to these same changes and will be considered later (see p. 30). As an immediate effect of these disturbances the blood pressure falls.

The powerful effect of **psychic conditions** we can not estimate, but we know that every strong emotion affects the whole circulatory apparatus and that the recognition of sudden impending danger will blanche the face of the bravest. Consider then, the state of the helpless wounded man whose injuries, although severe, have not rendered him unconscious. He may not knowingly be afraid, but in his helplessness he can not forget that every moment may bring a message of fatal ending, and unavoidably he thinks of others far away of whose welfare he may not be sure. The inevitable physical depression so caused probably adds to shock, and certainly retards recovery from it.

No one can blot out the memory of his terrors no remove the cause of his apprehension, but a calm and cheerful manner on the part of those who are caring for him and a word of encouragement now and again may help toward restoring his moral balance until he regains his lost confidence.

Sepsis rapidly undermines the system and when already established is undoubtedly an influential contributor to shock. It always damages the heart muscle and wastes the vital powers, and by inter-

fering with normal metabolism it throws down Nature's defenses. This will appear in cases which for one reason or another have been beyond the reach of proper care at first. The *prevention of sepsis* begins with the first dressing; it will secure to the man his best chance when he meets trying ordeals such as hemorrhage, or operation so often accompanied by shock.

Nursing then will early have to do with shock. Remember the primary causes—*pain*, *hemorrhage*, *mental distress*, *sepsis*, all resulting in lowered blood pressure and lack of general functional activity.

Treatment of Shock.—The patient is cold and clammy—make him warm and dry if possible, by the application of heat and friction to extremities. The abdominal vessels are engorged—elevate the foot of the bed to send the blood toward the heart that it may be distributed to exhausted brain centers. If the pain is severe, morphia may be ordered at once; this aids also in diminishing the flow of blood in hemorrhage, thus serving two purposes.

If it is possible for the nurse to keep her stock of hypodermic tablets full, she will be ready to act on the instant of receiving the surgeon's order, a service which will be appreciated.

There may be minor causes of discomfort which in the exhausted condition of the patient he can not well bear, thus making unnecessary demands upon his

already diminished vitality. Is he lying upon disarranged clothing? or blankets "all in a hump?" Can his position be changed for the better, head supported, wounded parts protected from pressure? Are bandages too tight, or dressings dry and irritating? It is possible that the pain of a tight bandage may be made more endurable by releasing a single turn here and there, or by severing a cutting edge (this to be done only by *one who knows* whether any danger of hemorrhage or disturbance of dressings can possibly result); frequently the insertion of a bit of cotton will give temporary relief from roughened dressings and protect a part from irritation.

At once it must be determined whether a *tourniquet* has been applied and is still in position; if this is the case it must be reported promptly, as the pain so caused may well add to the shock from which the man is suffering.

NOTE.—Attendants should be cautioned against rough or careless handling of the patient (always inexcusable), especially if the case is one of compound fracture of the femur, as this injury appears more often than others to be accompanied by shock when the limb is disturbed.

If **hemorrhage** is present it will add rapidly to the effect of pain.

The nurse who is holding a responsible position,

must train herself to rapid inspection and to see everything at once.

She will discover without thinking, whether the escaping blood be *arterial*, with its bright red spouting stream; *venous*, with its darker steady flow, or *capillary*, with its constant oozing, and select the measures to be used in accordance with the indication, remembering that arterial blood is flowing *from* the heart and must be checked above the wound, while the venous blood is flowing *toward* the heart and pressure should be applied on the distal side of the wound; for capillary oozing she will quickly apply compresses with direct pressure upon the surfaces.

Review quickly and look for, *signs* of **internal hemorrhage**:—the rapidly increasing pulse with diminished volume and easily compressible; the pallor of the features with cyanosis appearing, especially about the lips, eyelids, fingers; the peculiar gasping respiration caused by *air hunger*, the restlessness of the patient as he gasps for breath, and the fall of the body temperature. These signs all indicate the escape of a large quantity of blood be the hemorrhage external or internal. If *external* it will probably be discovered before it is sufficiently serious to cause the symptoms; but if *internal* it will hardly be discovered until they appear.

Cause of Air Hunger.—The diminished quantity of blood is unable to appropriate sufficient oxygen from the air in the lungs to satisfy the wants of the patient's body. Consequently, the unusual effort of respiration appears and the necessity for abundant fresh air is imperative.

Other symptoms which result from the diminished quantity of blood, are *dimness of vision* and *"roaring" in the head;* (the latter is quite different from the sensation described as *roaring in the ears,* being far more overpowering).

NOTES.—In a military hospital it is more than ever important that everything should be in readiness for meeting the occurrence of sudden hemorrhage: soft absorbent material; blocks or some substitute for elevating the bed; hypodermic syringes with tablets; ice if possible, not forgetting that hot bottles may be needed later; blankets; bandages; appliances for administering saline or glucose solutions, etc.

The character of the cases under treatment may forbid a certain freedom of action in dealing with hemorrhage, for example—the *points of compression* of main arteries are not always accessible, owing to extensive damage of tissues in their neighborhood; nor is it always practicable to exercise *autocompression* by forced flexion of joints.

In the case of visible **external hemorrhage** it is well, as soon as it is discovered, to so dispose whatever loose absorbent material may be at hand that it will receive the escaping blood and thus give in-

formation of its volume and whether it is increasing or diminishing in amount (serious hemorrhage will soon appear through saturated dressings). Try to make the blood run away from the wound by elevating the part involved if the location of the bleeding and character of the dressings will allow, or with the same proviso, seek to exert pressure upon or above it; put ice to the surface and to the bleeding vessels. Severe hemorrhage, except from injuries to the head and neck, calls for elevation of the foot of the bed.

These precautions taken, further measures are in order for meeting the lowered blood pressure which occurs in both hemorrhage and shock. General compression-bandaging of the extremities will counteract in part the inequality of circulation and by driving the blood from the relaxed surface vessels to those nearer the heart, will give the heart something to work upon. To replace the volume of fluid lost, be ready for the introduction of *normal salines* (see p. 35) (with probably the addition of adrenalin or pituitary extract). Prepare for hypodermic medication with promptness, as *morphia*, *adrenalin* or *pituitary extract* will be needed.

NOTE.—The use of pituitary extract in shock is based upon the belief that it will cause contraction of the vessels of the abdominal viscera, which are in a state of engorgement.

Résumé.—Nursing then, in surgical shock, deals with a nervous system exhausted by *pain, fear and apprehension*, and probably *sepsis*. The measures instituted must control the pain and minimize the suffering. Secure rest if possible in the most comfortable position which can be arranged, as the patient may be obliged to lie still for hours; be ready to carry out orders instantly; protect him from excitement and signs of alarm; make him feel that he is in good and safe hands.

What not to do. Do not give stimulants, neither alcohol nor strychnin nor digitalis. Having given morphia, pituitary extract or adrenalin, put away the hypodermic syringe and depend upon aromatic ammonia, ice pebbles infrequently given; mustard over the heart.

Remember fresh air, bandages, and elevation; if *hemorrhage* is present have in mind that when bleeding from head, neck, or chest, the patient may be placed in a semi-upright position, the *heart's action being carefully watched* meanwhile. Secure fresh air, administer oxygen if necessary. Remember at the same time that *calmness* need not interfere with celerity and is most important for the sake of the patient; if he sees that his nurse meets the emergency which confidence, his own fears will be allayed and his chances will be improved because he is to that extent relieved from worry about

himself. It is said that soldiers fear hemorrhage more than gunfire.

If *internal hemorrhage* is suspected send for the surgeon by the speediest messenger available.

Introduction of Saline Solutions

This will be done by the *intravenous* route, if urgent; *subcutaneously* (*hypodermoclysis*), if less urgent; by *rectum* (*enteroclysis*) if time will allow. The latter method is preferable if circumstances permit because less painful; raise and support the buttocks, introduce the tube well beyond the rectal sphincters and control the rate of the flow, that it may be very slow. With low blood pressure there is very little absorption and time must be allowed.

If, in intravenous infusion the flow is rapid, the fluid will ooze through the vessel walls and accumulate in the loose tissues about the vessels, as for example, in the abdomen, where the œdematous condition thus resulting has been known to cause embarrassment of respiration by pressure upon the under surface of the diaphragm, thus preventing its contraction to secure free entrance of air into the lungs.

The temperature of the solution should be kept at 112° in the funnel. This devolves upon the nurse. Some surgeons advocate in certain cases, the ad-

ministration of a half pint each hour, repeated several times.

The introduction of saline solution by *hypodermoclysis* or subcutaneous infusion is familiar to all trained nurses and need not be minutely described. To the nurse will probably fall the care and preparation of the appliances needed, as containers with solution, tubing and glass connection tube, sharp needles, sponges, the indispensable testing thermometer, etc., and materials for sealing the puncture. All to be prepared and handled with sterile precautions.

The maintenance of the temperature in the flasks will be her duty and in the absence of the usual facilities she may have to exercise ingenuity; for instance, by careful wrapping with non-conducting materials, or the suspension of hot water bags around the flasks. Also, she must watch the flask to be sure that it does not become completely empty, allowing air to enter the needle. The temperature and quantity to be used will be prescribed (usually about 500 cc.).

For *intravenous* infusion, a scalpel, special needles, ligature silk and aneurysm needle, etc., are needed in addition, as well as forceps, sponges, and sterile protectors, as for minor operations. The temperature of the fluid must be scrupulously maintained and the rate of the flow controlled. More than ever it is important to prevent the possibility of the en-

trance of air into the needle, as a fatal result would probably follow.

NOTE.—Solutions of *Glucose*, usually of the strength of 5 per cent., are sometimes used in place of the saline.

CHAPTER V

SURGICAL DRESSINGS

The tremendous number and variety of wounds in the present war, necessitating the care of many thousands of men at one time, and the entirely new situations created by the character of modern warfare have led to an amount of labor and research heretofore unknown, not alone in order that lives may be saved but that the medical profession may be true to its traditions, never stronger than to-day, that the best methods which can be discovered must always be sought, and the best service in its power to bestow must be given. This obligation presents itself just as plainly to the nurse and is just as bravely met.

Never has the surgeon had to face greater difficulties; never has he recorded more brilliant successes. To accomplish this the modern pathological laboratory has contributed so largely, that it is not too much to say that the results would have been long deferred without it.

Where practically every wound is infected the problem of *antisepsis* has of necessity received unusual attention and the merits of different substances

having antiseptic qualities have been warmly discussed. Theory and practice have narrowed down to a very few principles and proceedings. The fact, not new, is emphasized, that antiseptics which are strong enough to *be antiseptic* must be used with great care, especially in cavities where drainage is not free, as a solution which injures the tissues does more harm than good by coagulating the albumen of surfaces and forming a crust which confines microbes. After many trials and much discussion the tendency of those of widest experience, however, is to reduce the problem to very simple terms which may be expressed thus: first, how to secure a clean wound; second, how to give Nature a chance with a minimum of interference, since Nature after all must do the healing.

The following is a brief list of familiar antiseptics among many newer ones, which have been used in the present war for their chemical and germicidal action:

Iodine, 2 per cent. solution in alcohol.

Carbolic acid, 2½ per cent. or stronger if indicated (beware of the coagulating effect of strong solutions).

Lysol, 1 drachm to the pint.

Bichloride of mercury, 1–20, 1–500 or less.

Potassium permanganate, 2 per cent.

Hydrogen peroxide, pure or diluted.

Hot boric acid solution (saturated).

These all depend upon chemical action for producing their effects and their value lies in the properties by which they destroy microbes in a fresh wound and prevent further invasion. They may well be used for cleansing purposes (the removal of dirt, etc.) and in the effort to *prevent* sepsis and infection.

To these must be added hypochlorous acid, either in the form of *gas* or in combination as a *hypochlorite* in *solution*, which has both germicidal and physical properties; and *sodium chloride* solutions for which similar claims are made, although their principal characteristics are physical.

How does Nature proceed with her share of the work? By increasing the *supply of material* with which to repair the damaged part. This must be obtained through the source of all nourishment and growth, namely: the blood; it is provided for the purpose in the form of *lymph.*

Lymph is a clear saline fluid derived from the blood, from which it receives its freight of nutritive substances; it is very like plasma, retaining many of the constituents dissolved in the plasma. This clear fluid passes through the blood-vessel walls into the minute spaces in all the tissues of the body (except cuticle, hair and nails). It has a circulation of its own in *lymph vessels*, bearing *lymph cells* from lymph glands.

From the ruptured spaces and vessels of a wound, lymph is poured freely into the cavity, the surfaces of which it bathes and thus the materials for repair

or healing are provided; not only this—the irritation due to injury causes an accelerated flow of blood and tissue fluids and if a proper outlet is available the lymph will escape from the wound in an appreciable quantity; in other words, the "drainage is good." A continuous flow of lymph into and from the wound is called "*lymph lavage*," which is now recognized as a thing of great importance and persistent efforts have been made to find remedies which will assist this outflow, while at the same time exerting an antiseptic action without damaging the tissues.

Importance of the Outflow of Lymph.—It brings, by the tissue cells floating in it, numerous antibodies which overcome the toxins produced by microbes. It also directs a current outward from the wound surfaces and thus discourages absorption.

Hypochlorous Acid and Its Use.—The value of this antiseptic has been demonstrated by Dr. Alexis Carrel. It is used either in the form of *gas* or in *solution*. A mixture, carefully measured by weighing, of calcium chloride or "bleaching powder" with sodium borate, moistened with a small quantity of water, will set free *hypochlorous acid gas*, a powerful antiseptic. A *solution* is made by adding a sufficient quantity of water to the same mixture, the measurements of powder and water being strictly accurate.

This is "Dakin's Solution" so called because as first given to the profession it was worked out by Dr.

Dakin as a practical form in which to utilize the antiseptic qualities of hypochlorites. Dr. Carrel gave to the powder (or tablet made of the same) the name *Eupad;* to the solution the name *Eusol.*

This formula has been varied from time to time; some surgeons use an acid solution (*anaerobes* do not live in an acid medium), others—an alkaline, while Dr. Dakin and Dr. Carrel—in the Dakin-Carrel treatment, avoid an excess of either quality. The solution now used by them is made according to the formula of Daufresne, in which the calcium chloride or "bleaching powder" is combined accurately with both *sodium carbonate* and *sodium bicarbonate,* making a nearly neutral product which contains from .45 to .5 per cent. of *sodium hypochlorite;* less is too weak, more is too strong.

The Carrel Technique.—All badly damaged tissues as skin, muscle, fat, etc., are carefully cut away and loose pieces of bone removed so that only sound tissues remain (see "Excision," p. 72).

The skin surrounding the wound is covered closely with layers of gauze (two or more) about 3 inches wide, which has been soaked in melted sterile petrolatum and the solution is then introduced through fine rubber tubes which are attached to the four branches of a glass distributor (Fig. 1). The fluid is conducted to this through a rubber delivery tube from a graduated container of glass (Fig. 2).

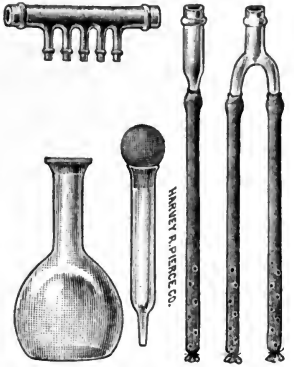


FIG. 1.—Carrel's instillation apparatus. Extra parts which may be used in small wounds.

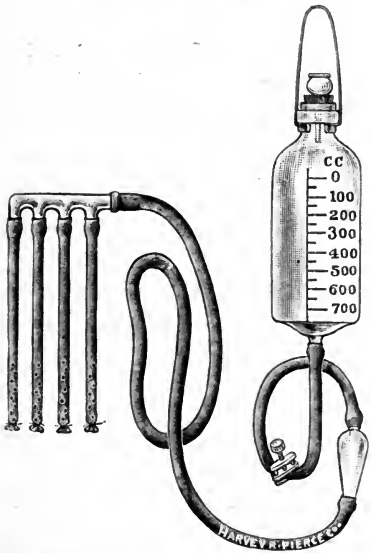


FIG. 2.—Carrel's instillation apparatus. The parts described in the text are easily identified.

The rate of the flow is regulated as it leaves the container, and again by the insertion of a glass connection which allows it to pass very slowly and through which it may be watched. The very small tubes or "*instillation tubes*" 6 mm. in diameter, are perforated on four sides for a few inches of their distal portion, and the end of each is securely tied with silk or linen thread. (By removing these threads the tubes may be perfectly cleaned, which could not be done if they were closed like a catheter). These are the "Carrel tubes." The whole assemblage of parts constitutes the *Carrel apparatus* used for the *Carrel technique.*

The size of a wound determines the number and length of the tubes, attached in fours to the four-branched distributors. A sufficient number is employed to reach every recess of the wound cavity. At first it was thought necessary to wrap them in fine bath towelling, to prevent them from slipping about and to keep the fluid in contact with the wound surfaces, but now Dr. Carrel omits the towelling since it is often mechanically irritating. If, however, the wound is large and many tubes are used, a little gauze is laid loosely about them to prevent them from falling together or "bunching." Thus the fluid delivered through the minute holes in the instillation tubes, is brought into contact with the entire wound surface. The whole is then covered lightly with gauze wet with the solution, or *eusol.*

The solution is allowed to flow very slowly, the quantity delivered being registered on the walls of the container. About 10 cc. is allowed for one instillation of four tubes; the fluid will reach the wound surfaces quite fast enough by oozing through the tubes. In about 2 hours they are again filled, and this is repeated at the same interval until the wound is approximately free of microbes as determined by bacteriologic examination.

The wound is inspected daily and redressed if practicable, with every antiseptic precaution; no *hand* touches it or the dressings. At the redressing the skin is cleansed with ether to remove the petrolatum, then sponged with some non-irritating alkaline preparation (neutral solution of sodium oleate is recommended). The wound also is very carefully and gently sponged with the same and finally with *eusol;* thus wound secretion and débris are removed and all is ready for fresh tubes and solution, as before. When circumstances forbid the daily redressing the gauze covering it may be changed from time to time.

If this treatment is successfully carried out recent severe wounds containing septic matter may become clean in from three to five days and then closed and sutured. Precautions are taken to insure drainage and wounds are not closed while any infecting material remains.

It is claimed that the action of the solution extends a short distance into the tissues immediately surrounding the wound, destroying microbes which have gained entrance thus far.

A satisfactory way of dealing with a *perforating gunshot wound* is to introduce an instillation tube upside down in the whole length of the track. The fluid running in from below, oozes through the openings in the tube in the upper part of the wound and gravitates to the lower opening, thus bathing it throughout.

Dakin's solution is not only an antiseptic but an agent for inducing the *outflow of lymph* from the tissues. The *lymph itself has a remedial action*, inasmuch as it contains immune bodies which have formed in response to the presence of septic material.

NOTE.—Special care is demanded in using this remedy, (1) that the limb or part be disposed in a position as comfortable as possible; (2) that the temperature and rate of flow of the fluid be under observation continually; (3) that the skin be protected from its irritating effects; these are not felt within the wound where the albuminous content of the natural fluids exerts a neutralizing effect.

The method just described is that of *interrupted irrigation* and is the one most frequently used. Another is by *continuous irrigation* which name

explains itself. It is not often that this form of application is adopted. Drainage must be carefully maintained, the skin being well protected, and careful provision made for the prevention of overflow and for keeping the clothing and bedding dry.

If the solution causes pain it will be due to one of two reasons; it is either too strong and should be diluted, or it is not properly made and is too alkaline.

NOTE.—If it is necessary to dilute the solutions, use only sterile water.

When properly made it is not irritating to wound surfaces if used in the strength of .45 per cent.; they are protected by the reaction of normal tissue fluids.

A simple test for excessive alkalinity may be made thus: "take 20 cc. of the solution in a glass and add without stirring a small quantity of *phenolphthalein* in powder; if a deep red color appears the presence of *free caustic alkali* is proved."

Many experiments were made by Dr. Dakin and Dr. Carrel before they adopted this solution. As now in use it possesses the following advantages:

1. It is *antiseptic* but does not damage the tissues.

2. It is *non-toxic*, no danger is to be apprehended from absorption.

3. It is *hypertonic*, that is, the concentration of the solution is greater than that of blood serum and

tissue fluids, therefore, it produces an outflow of lymph.

4. If used as an acid solution it is available against anaerobic bacteria which require an alkaline medium.

Applications of **powder** or **tablet.** The powder may be dusted over open sores and lightly covered; it may be sprinkled on strips of gauze used for drainage; a portion may be placed in the first aid dressing pad; it may be well wrapped in gauze and placed in a wound cavity.

The use of *eupad* is really for the purpose of applying hypochlorous acid *gas*—the strongest antiseptic which can be used quite safely.

By contact with tissue fluids the powder is sufficiently moistened to evolve the gas, which penetrates to all recesses and is absorbed to some extent by the surrounding walls. If only lightly covered it may be left in place for a few hours (perhaps six) when the less irritating *solution* will be substituted.

For rapid effect on very foul wounds the gas may be confined in the cavity by covering the whole dressing with an air-tight material; 10 to 20 minutes is usually enough of this.

NOTE.—The powder or tablet must *always* be separated from direct contact with tissues, particularly vessels and nerves, which would inevitably be injured by the strong gas evolved. Hemorrhage or neuritis or both might be caused.

The fact that nearly all wounds in the present war are infected and the serious and fatal nature of the infections, has stimulated an unusual amount of research with the hope that *safe disinfectants* might be discovered. The importance of this lies in the fact that the tissues of the body are more easily affected by the disinfectant than the bacteria themselves, which fact alone defers the process of repair in the wound. In the use of the Dakin-Carrel solution the indication seems to be well met for the surfaces in the wound and near it, if frequently renewed as in the technique described, but a disadvantage accompanies its use in that it is extremely irritating to the skin. (This, however, is easily remedied by the use of petrolatum.)

A chemical action takes place between the solution and the tissue fluids in the wound and a new substance is formed called *chloramin*, which is said to possess a germicidal power four times greater than that of the solution itself. Successful attempts have been made to produce and utilize identical compounds having the same effects, and the benefit conferred by their use has been demonstrated in the Pennsylvania Hospital under Dr. LeConte and others, who some time ago reported a series of one hundred and sixty cases satisfactorily treated.

By dissolving these substances (*chloramins*) in an oily medium it is possible to keep them in contact

with the wound surfaces for a much longer time than can be done with a watery solution. The advantage of this is evident.

The solution which is used at present has been christened *dichloramin-T;* the medium is eucalyptol. It is said that a 10 per cent. solution of *dichloramin-T* in eucalyptol may be kept in a colored bottle for at least one month with very slight change.

It is applied to the wound surface in the form of a spray after the removal of infected and devitalized tissues. Deep cavities are filled with the liquid and drainage afterward provided for. The high percentage of disinfectant contained in this preparation renders it active for a period of 24 hours because of the slow liberation of the germicide. It would appear that when applied with strict attention to detail it is not only less expensive than the Dakin-Carrel method but will secure healing of the wound in a shorter time.

NOTES.—The slow elaboration of the remedy makes it particularly applicable in cases that can not be dressed often in transportation.

Dichloramin-T, *hypochlorites*, and *hypertonic salt* applications all have the power of dissolving dead tissues.

CAUTION.—If used near a vessel, hemorrhage may occur.

A similar preparation, called *chlorazene*, is advocated by those who are familiar with its effects.

Many other antiseptic applications are described, as used in various hospitals under the care of medical men of the different nationalities engaged in the war. They are prescribed in the form of pastes, powders, etc. These are particularly valuable when there is a great rush of patients and it is necessary to send them on rather hastily.

A *soap* dressing has been used with great success for cleansing, in a solution made by 25 grms. of Castile soap in a liter of water. Afterward the wound may be dressed with compresses dipped in a somewhat weaker solution. This is said to be an invariably painless application, and very efficient in promoting healing. It may be reapplied on the following day and if necessary, for a few days in succession.

A mixture of *dry calcium hypochlorite* one part, and pulverized *boric acid* ten parts, is used as a dusting powder for fresh wounds; it is said to be "a powerful sterilizer" and to ward off even the development of gas gangrene.

A paste of *bismuth* and *paraffin* is sometimes ordered, containing one ounce of *bismuth* with two of *iodoform and paraffin*, to make a thick paste. This has been christened *bipp* or B.I.P. The wound is filled with the paste with the object of sterilizing it and this object is apparently accomplished; as the wound "need not be often dressed,

sometimes for days!" This is available for transportation cases for whom redressing is difficult *en route.*

Picric acid (1 per cent.) has been used, applied on thin gauze with no other covering. A weaker solution may be carried into sinuses by syringing, and still weaker, when granulations reach the skin level.

Another preparation which has been used in recent wounds and in first-aid dressings, is *Menciere's balsam*, applied directly to the wound in cases where the injuries are extensive and the question arises as to the patient's ability to stand operation. Many cases thus treated have been saved for later operation and then have recovered, according to reports.

Of course, these various applications, to be efficacious, must be used early while sterilization of the wound is still possible.

The nurse need not be surprised to see a wound with abundant drainage and doing well, which has been treated with *pulverized sugar.* It is stated that more than fifty surgeons have successfully used this remedy. The degree of *lymph lavage* is so great that the wound does not need redressing at once, being washed from within. It appears to be especially valuable in its power to stimulate secretions, thus diluting and washing out the pus when it is present.

Fortunately the sugar obtained in the market is reasonably free from infective organisms.

NOTE.—Laboratory experiments are reported to have proved that the bacillus of gas gangrene can not grow in a 60 per cent. solution of saccharose. It may grow in broth containing 40 per cent. or even 50, but never in the stronger solution—60 per cent.

A method which may be used at the first dressing station is a modification of the Carrel-Dakin treatment without the apparatus used by Dr. Carrel. If the nurse finds that a wound contains a loose bag with something soft within, it will be accounted for as follows: A number of pieces of *agar* are placed on a square of gauze which is drawn up into a loose bag with the edges tied together. This bag is placed in the wound with the corners of the gauze lying free outside. It is then thoroughly wetted with some antiseptic solution, often Dakin's solution. This causes the agar to swell and spread the wound, so that the recesses are all opened and the disinfecting application is in contact with the tissues throughout. The disinfectant is added anew every two or three hours, or it could be supplied with a Carrel tube in a continuous drip. *Drainage* is provided at the lowest point of the cavity. This also is a practical early dressing for patients who must be transported at once. Results are said to have been "realized beyond the fondest dreams."

Flavine is another preparation which is warmly advocated by many. It is claimed that its special merit lies in these facts: first, it *retains* its antiseptic properties in the presence of blood serum; second, it is nontoxic to tissue cells; third, the degree of concentration favors the outflow of lymph.

Treatment with saline solutions has been developed by English surgeons who find it entirely satisfactory in their hands. It is not claimed that it is superior in itself, but that it is effective without certain disadvantages which accompany the use of antiseptics.

Both the strong or *hypertonic* and the normal or *isotonic* solutions are used, prepared with care to secure proper concentration and sterility; also the *dry salt* is employed in powder or in tablet. Antiseptics are employed in the first cleansing of a wound but the *hypertonic saline* solution immediately thereafter, for securing **lymph lavage** upon which the success of the treatment mainly depends.

The strength of the solution used is at first .5 *per cent.*, but after a suitable time this is reduced to .85 *per cent.*, which is normal or isotonic.

The theory upon which the technique has been worked out is stated somewhat as follows: The aim of treatment is to promote healing by:

First.—Removing or destroying bacteria.

Second.—Establishing free outflow of tissue fluids, thus bringing fresh antitoxin and immune bodies to neutralize toxins and overcome bacteria in the wound.

Third.—Securing the depletion of tissues by the quick removal of exudative fluids, thus relieving vascular engorgement and pressure, both of which contribute to gangrene.

NOTE.—All deep raw wounds caused by high explosives and missiles of various kinds, present in their depths tissues more or less devitalized. It is thought that a strong purely antiseptic solution may hinder their recovery to a normal condition, as all antiseptics are at least slightly toxic to the tissues with which they are in contact and thus microbic invasion is favored.

Further claims are: A *saturated solution* of sodium chloride will kill bacteria.

A 5 *per cent.* or even 2½ *per cent.* solution will inhibit their growth.

An .85 *per cent.* (the *normal solution*) does not kill bacteria in the wound but encourages the emigration of leucocytes, and of *phagocytosis* by the aid of the *immune bodies* provided by "lymph lavage."

Methods of Application.—By irrigation, soaks and drains, compresses, baths.

NOTE.—Both *eusol* and *hypertonic solution* are said to prevent coagulation of wound discharges and promote the separation of sloughs lying in the wound.

For irrigation, solutions of varying strengths are used continuously by means of a special apparatus described as follows:

The **rose irrigator** (Fig. 3).—This is similar in principle to the Carrel tubes. It consists of a good-sized test tube open at both ends and packed with gauze through which the solution flows at a very slow rate. A rubber cap with four fine flexible tubes depending from it is placed over the lower end of the test tube or *distributor*. The solution is held in a graduated glass container, from which it is conveyed to the gauze-filled tube and thence, by means of the *four small tubes*, it is distributed throughout the wound.

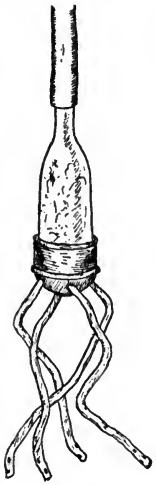


FIG. 3.—The rose irrigator of Sir Almroth Wright. (*After Hull.*)

For a large and deep wound with much mutilation of tissue one or more of these four-tube distributors may be used. For an injury of less extent a single tube will suffice. For *drainage*, strips of gauze or loosely woven cotton bandaging is disposed in the wound and carried to a basin of solution placed at least three feet lower. To insure contact with every bit of a large cavity, gauze wet with the solution is loosely packed around the tubes.

The irrigation is continuous, but not to the point of depriving the patient altogether of sleep or rest. It may be suspended at times for this reason, the

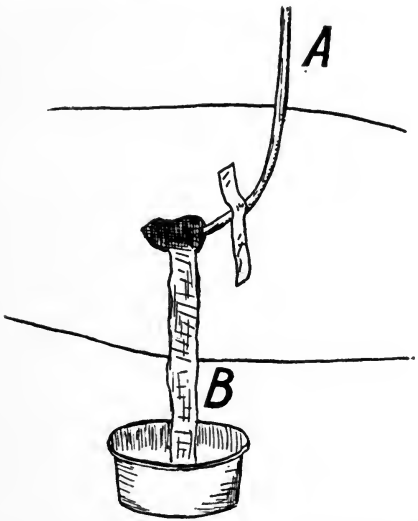


FIG. 4.—Combination of delivery tube and cigarette drain. The cigarette stiffened with aluminum and having rubber tubing attached, lies within the wound. The solution is conveyed to the wound by the tube *A*, while drainage is secured by means of the free end of the bandage *B*, which belongs to the cigarette. (*After Hull.*)

wound being covered meanwhile with gauze wet with saline solution.

NOTE.—In all irrigations the provision for *drainage* is a measure of prime importance. It is one of the basic principles upon which the success of the

treatment depends. This is usually secured by gauze or bandage strips or by tubing leading out from the wound, but whatever device is adopted it must act perfectly.

A useful device is the stiffening of the small tubes with fine strips of metal (aluminum is used) which render them easily adjustable to the depth and direction of wounds.

A combination of delivery tube and capillary drain is described and its application may easily be understood by referring to the illustration (Fig. 4). A narrow strip of aluminum is wrapped with bandage and rubber sheeting like a cigarette drain, with the bandage longer by 12 inches or more than the completed cigarette. A long fine rubber tube an eighth of an inch in diameter is attached along the side of the cigarette. The drain with tubing is inserted to the depth of the wound and bent over the edge so that it will remain in place, while the free bandage is carried into a basin of the solution placed at a lower level. The rubber tube conducts the solution into the wound, the capillary drain acting as a siphon, conveys it away. Any desired number of these capillary cigarette drains may be used in a wound.

As with Dakin's fluid, a *perforated wound* is made to drain most efficiently by reversing the insertion of the delivery tube and causing the bandage to drain from the upper opening downward through the track.

By many this dressing is considered inconvenient because of the danger of wetting the clothing of the patient, or the bedding, but this difficulty need not exist in competent hands.

Figure 5 represents a device which will confine the overflow from continuous irrigation to a limited area. Rings of cotton encircle the limb, and are covered with a preparation of gelatine and formalin, which is both waterproof and flexible. This can be molded over the cotton, and when dry it seals the barrier to the skin.

FIG. 5.—Irrigation barrier. (*After Hull.*)

Strength of Saline Solutions and their Effect on Bacteria.—As already stated, a saturated (or 10 per cent.) solution kills. One of from 5 per cent. down to 2½ inhibits their growth. .85 per cent. does neither, but favors emigration of leucocytes and *phagocytosis*.

Applying these facts to the treatment of wounds the reasons for the use of different percentages will be understood. For a very septic wound a beginning may be made with a 5 or even a 10 per cent. solution. After a time the wound begins to clean and the patient begins to complain. The strength will then be reduced gradually to that of the normal or

isotonic solution. Now a whitish film upon the surfaces will show the invasion of leucocytes and they with the *antibodies* in the lymph will meet any bacteria which may gain entrance.

Again, attention is called to the importance of *lymph lavage:* It carries out waste products, it washes away microbes and small bits of softened tissues, it removes lymph itself from the wound when the antibodies which it brought have become used up, and it encourages the flowing of lymph with *fresh active antibodies.*

Other Methods of Use.—The wound may be packed (always loosely) with gauze which has been soaked in concentrated salt solution and dried. Vigorous osmosis is set up and a profuse outflow of lymph. The gauze must touch every part of the wound surface.

Tablets of salt wrapped securely in gauze are used in the same way, that is, inserted into the wound, with the precaution that the tablet itself does not come in contact with the tissues. It would undoubtedly cause sloughing.

Col. H. M. W. Gray has devised the following method to enclose *powdered salt* in long slender sacs made from cotton bandaging: Between two layers of bandaging four of gauze are placed. The whole is then folded upon itself and the edges are sewn together. The sac should be at least 12 inches long.

This is filled with salt to a depth corresponding with the depth of the wound only; the remaining unfilled portion of the sac is to hang from the wound and act as a drain.

NOTE.—Again, a matter of first importance is *free drainage.* A septic wound is never closed. It *must* drain. It is proved by experiment that ordinary cotton bandage will convey more than a pint of fluid in an hour to a basin placed at a lower level.

Sacs of various sizes and lengths are made to fit various tracks and cavities; within the wound they are separated by loose gauze. *Drip irrigation* by fine rubber tubing attached to the sides of the sac may be carried out if desired in selected cases. It is found that the sacs may be left in place for several days if they can not be conveniently removed and replaced.

The use of salt sacs like that of salt tablets, without the addition of water, will cause moistening of the wound by the tissue fluids and *free lymph lavage.*

NOTES.—A rise of temperature may follow the removal of a salt sac. If this is apprehended, irrigate the wound for a few hours beforehand. The temperature is due to irritation of a dressing too long retained or rather carelessly removed.

"If a wound has to be dressed in order to remove a discharge that means that the dressing was simply corking it in. In a properly dressed wound re-

dressing will not lower a high temperature nor elevate a low one."

Summary.—By continuous irrigation Col. Wright uses salt solutions to bring fresh antibodies to the wound; and by interrupted irrigation Dr. Carrel uses Dakin's solution for the same purpose. The solutions are to be kept in continuous contact, whether by irrigation, bath or wet dressings.

Dry salt is used by Col. Wright and dry powder (called eupad) by Dr. Carrel, for the purpose of making a strong solution with the patient's own fluids or of applying hyperchlorous acid gas.

In both methods *success* follows painstaking devotion to detail, and strict adherence to the lines laid down for carrying out the treatment; it is accomplished in no other way.

Observe that in both of these methods of dealing with wounds, emphasis is laid upon the importance of avoiding tight dressings or anything like plugging the wound. With the virulent organisms which are dealt with in the present war this would be disastrous. The *anaerobes* in particular would flourish abundantly in confinement. In both methods the patient needs to be placed in a position of rest so far as possible, as the treatment is to him monotonous and tiresome. The nurse, however, has plenty of occupation in keeping temperature and flow of the fluids at the right points and in devising means to make him comfortable.

CHAPTER VI

THE WOUNDED MAN

The **care of the wounded** begins on the battlefield, with the collection by *stretcher bearers* of those who have fallen; by them they are taken to the *aid post* or *first dressing station*, situated in some sheltered place—often a dugout and very near the front line of trenches. Then by *ambulance bearer* they go to the *advanced dressing station* farther back or the *tent division* of the *field ambulance* or hospital so-called. Still farther away is the *clearing station* or *evacuation hospital* and after that the *stationary* and *base hospitals* which are permanent and have hundreds of beds.

Treatment begins in the *first dressing station* or *aid post* where only imperative needs are attended to. First-aid dressings are applied, measures for checking hemorrhage are instituted and fractures are immobilized if possible. Some minor injuries may be quite relieved and the man returned to his regiment.

At the *advanced dressing station* or *field ambulance*, measures already instituted are perfected so far as possible, wounds are dressed, splints applied. stimu-

lants given and some further measures (necessarily incomplete) are taken to prepare the patient for further transportation by *ambulance*. Only the most desperate cases may tarry, for in time of battle others are arriving by the score and room must be made for them.

To neither of these will the woman nurse go. Both are temporary and movable, following the army. Here, again, some men may go back to the front after treatment and a short period of rest, having only minor injuries, but most are sent on by ambulance to the *clearing* or *"evacuation" hospital*. (In some fields a *main dressing station* intervenes.) Here patients are arriving hourly in time of battle, all being serious cases and practically all operative, the only question being as to *time* and the *endurance* of the patient—shall he be operated now, or after going on to the base?

The *clearing hospitals* furnish facilities for a great deal of thorough work, although if stationed near the front where active service is going on they may be more or less temporary. Many of the patients need operation at once and the beds are filled with serious cases of every description—all surgical and urgent. In these stations women nurses are employed and greatly are they needed.

The *base hospital* is permanent and may have two thousand or more beds. Here operations are done

daily and patients are kept if possible until they may be transported "over seas" or distributed to sanitoria, according to their needs.

Although experience in temporary hospitals furnishes constant thrills and excitement, that in the more permanent institutions, if less exciting, is more satisfactory in the end, as one can there see the later results of one's work.

In either place there is no limit to the demands upon the nursing staff if sympathy and the desire to help prevail.

It is not practicable to outline in detail the work of the nurse, as quite naturally the nature of the cases and the circumstances of treatment will vary according to the distance from the battlefield.

The Condition of the Wounded Man

Upon inspection of a newly arrived patient certain things must be observed and noted for immediate report:

Fig. 6.—United States Army field tourniquet.

First.—Is a tourniquet in position, or is there constriction by tight bandages? (Fig. 6.)

Second.—Has a wound been tightly packed, thus preventing the escape of blood or discharges?

Third.—Has it been plugged for the suppression of hemorrhage? (Patients should be examined for these possibilities although it is customary to send with them a statement as to whether they exist, but this may have been lost in transit.)

Fourth.—Are evidences of general sepsis present? If so, secondary hemorrhage must be apprehended and precautions taken.

Fifth.—Has he a compound fracture of the femur or of the humerus? Here again hemorrhage is to be apprehended and the patient must be carefully handled, with the limb supported, and made as comfortable as possible.

If dressings are dry and adherent they may be softened by means of compresses wet with sterile saline solution—or, if permitted, by gentle irrigation, which will render their removal easier when the time for that arrives.

When the wounded man reaches the nurse he is inevitably suffering, perhaps exhausted by the pain of wounds in which sepsis may have already developed. He has had neither proper food nor drink; the suffering caused by hurried transportation has added to that of the wounds themselves, while hemorrhage and shock may have reduced his vitality to a still lower plane. In many the clothing is hopelessly contaminated; the nurse will long to remove it and order a bath, but must wait. She will see at a glance

if his position on the bed is as near to comfortable as the nature of his injury will permit and if not she will endeavor to correct it; she can at least support his head at the right angle and release him from the pressure of clothing or coverings upon sensitive parts.

She will note the location of wounds and instruct her assistants how to move or lift him; at the same time she will see if hemorrhage is or has been occurring, as evidenced by dressings or the presence of a tourniquet. The latter must be discovered promptly and the condition of the limb examined, that any signs of **threatened gangrene** (as swelling with discoloration) may be reported at once. This is of such importance that if the surgeon's aid can not be had immediately the nurse may be forced to act alone. Endeavor to apply pressure directly over the artery which supplies the blood in the wound. (The safest pressure here is by the nurse's own fingers because it is intelligently applied), then very gradually loosen the tourniquet (but not on any account remove it) watching for the appearance of fresh blood. The pressure of the fingers must control that if it appears.[1]

Whenever a *patient is badly shocked* the nurse can institute certain measures without waiting for orders.

[1] The transportation of a man with a tourniquet is strictly forbidden by many medical officers of the British Army.

She can give him a hot drink; she can place hot bottles about the person, carefully *avoiding wounds*, as the heat may encourage hemorrhage. She can protect him from unnecessary interference, placing him with the head lowered and proceeding in accordance with general directions.

What not to do. She *is not* to give him hypodermic injections of strychnia or other stimulant. She *is* to be ready for the use of adrenalin or pituitary extract that no time may be lost if they are ordered. (She *may* give aromatic ammonia, or weak tea.)

It is supposed that preparations are already made for the introduction of saline solutions and as this will probably be left to the watchfulness of the nurse, a few words of caution are here repeated. The *maintenance of the temperature* of the solution is of importance and also the rate of flow which should be very slow, hardly more than drop by drop. *Intravenous* injection will be supervised by the surgeon, but there also the watchfulness of the nurse in controlling the *rate of the flow* will be helpful. This is still more important in intravenous injection because it is found that the fluid quickly leaves the vessels for the looser tissues in which they are imbedded; as has been known to occur in the abdomen, where great quantities of loose connective tissue exist, around vessels and organs, which may receive so much of this fluid as even to embarrass

respiration. Remember then these two points—maintenance of the proper temperature and the control of the rate of flow of the solution.

Another very important thing is the maintenance of drainage from infected wounds. In order to insure the perfection of drainage the wound should be loosely packed and lightly covered. This is important because otherwise infecting microbes multiply, tissues become damaged and devitalized, *sepsis* is promptly caused and rapidly increases.

The injuries, as we already know, are of every imaginable sort. Each tissue in the body—skin, fascia, muscle and bone; head, trunk and extremities; vessels, nerves and viscera, all are invaded by the missiles of warfare. The developments of modern surgery to meet these dreadful injuries are not short of marvelous in their accomplishment, and the share of the nurse in this great work is acknowledged and appreciated.

What are the guiding principles in the treatment of every wound?

1. It must be made clean.

2. This must be accomplished with thoroughness and great gentleness, that sensitive tissues be not unnecessarily disturbed and new avenues of infection opened up.

3. Once clean, the wound must remain so.

In these conditions the satisfactory exploration

and cleansing can hardly be made without anesthesia. Foreign material is to be removed, such as fragments of missiles and of bone, bits of clothing, skin, dirt, etc. Collections of débris, such as damaged tissue and blood clots, are acting as plugs to shut in discharges, making cavities not entirely air tight—so that *aerobes* or pus-forming bacteria are still at work, but forming recesses where *anerobes* also find spaces to their liking. Therefore, the entire area must be laid open and the invaders dislodged.

In modern hospitals, especially in war hospitals, the motto may well be "Always ready;" therefore preparations are assumed to be sufficient and complete for whatever is to be done, and space is not given here to enumerating the "list of things needed," (moreover, the nurse who needs a list at such a time will not be able to fill the demands of the situation).

These will include a multiplicity of instruments *in duplicate* (see page 72)—gloves, gowns, etc., sterile dressings, antiseptics, outfits for nurse and assistants as well as for surgeon, anesthetics, hypodermic syringe and tablets, infusion apparatus, etc., etc., always ready and always in order, with an abundance of sponges, drains, and gauze. The usual preparation of the patient—bathing, sterilizing of surfaces, is carried out in all cases. The complication always to be apprehended is *hemorrhage*, as in the early cleansing and removal of foreign matter vessels

may be opened; therefore, it is important that instruments for arresting hemorrhage and all appliances for this purpose also be at hand.

If the patient is not seen very soon after his accident, the tissues are already harboring microbes which may be beyond the reach of antiseptics and for this reason a proceeding will follow which has been well developed in the present war, namely, **excision of wounds.**

This is made necessary, not only by microbic invasion, but because of the conditions which immediately surround the wound. Only when extensive invasion has already occurred, with much engorgement and infiltration of tissues at a distance beyond the lesion, is the measure not applicable, and even then the skin and superficial structures may be removed with advantage. When seen in time, all damaged tissues which are accessible—skin, fascia, muscle and bone—may be gotten rid of and the process of healing will begin promptly.

The object of **excision** then, is by removing the infected area to *prevent the spread of infection* and *facilitate rapid healing.*

The tissues surrounding the wound caused by gunfire are more or less in a state of **local shock** and quickly become devitalized. The stasis of the vessels and injuries to nerve filaments prevent recovery, and the whole condition favors the multiplication and

action of the invading bacteria carried to the wounds by missiles and foreign material.

The irregularities of the wound surfaces form pockets and recesses making it very difficult to perfectly drain the cavities; they also form resting places where blood clots and damaged tissue are retained. To correct this condition the removal of the entire infected area is the ideal method of proceeding.

Method, as described by Col. Gray, the originator.

The wound is laid open, thoroughly washed with disinfectants (iodine in a 10 per cent. alcoholic solution is advised), carefully dried, all bleeding stopped if possible (the iodine assists), and the damaged tissues are boldly removed. The surfaces now brought into view are supposed to be surgically clean and are dealt with accordingly. They are again carefully dried and packed very lightly with sterile gauze for temporary protection.

Now a complete change is made of all instruments and implements; the nurse will see that the clean set is ready to replace every article used, as the wound is now aseptic and must be treated as such. After suturing, a dressing is applied, probably something like the following which has proved highly satisfactory:

A varnish which has the property of drying rapidly is painted over the sutures and for some distance on either side. When dried, this will be covered by

two layers of *gauze* extending about two inches beyond all parts of the wound. Smoothly stretched over the varnished sutures, it is ready for a thin covering of wool and a suitable bandage. This dressing gives support to the wound and relieves the tension of stitches. Another advantage is the ease of inspection gained by removing all but the deepest layer of gauze without disturbing the stitches which are plainly seen through it and the transparent varnish.

All wounds are looked upon as infected and experience has taught that a wise precaution is the administration of **tetanus antitoxin** as soon as practicable after the patient arrives, since the *tetanus bacillus* is prevalent in the battle-grounds of the present war. A standing order to this effect is sometimes given and the instruments therefor should be at hand, ready for use.

Bullet wounds are often but slightly infected, and if the bullet can be easily extracted the wound may be covered with sterile dressings and considered aseptic, but, with this exception, practically all wounds are infected and the nurse must be ready for whatever treatment is adopted.

CHAPTER VII

MECHANICAL APPLIANCES

Extension Apparatus.—The application of **"Buck's extension"** apparatus is or should be familiar to every nurse, who will have occasion to apply it frequently in caring for surgical cases in military hospitals. The principle involved is, that by drawing injured surfaces away from each other we place them in the best position for repair; not that they actually need to be separated, but they should be protected from the pressure which muscle contraction causes them to exert upon each other, as in the case of *fractured bones*, and again in the case of *inflamed* or *wounded joints*. To the part *below* the injury a wide strip of adhesive plaster is securely applied on either side, extending well below the extremity of the limb. To these strips a weight is attached by means of a cord and pulley, with an intervening foot piece, which will keep the part at rest. *Counter-extension* is secured by some device which pulls the upper fragment of bone in the opposite direction. For example, when a lower extremity in extension is *elevated* and the foot of the bed as well, the weight of

the body inclining toward the head of the bed furnishes a means of counter-extension.

The use of extension appliances is more and more depended upon for securing *immobilization*, the splints being utilized for the necessary *support* of the damaged structures, and in some instances supplying a point of attachment for extension plasters.

Splints.—The primary object of all splints is *immobilization* and *support* of the wounded part (usually a fractured bone or joint) to prevent displacement of fragments with injury to the soft tissues, and the irritation which would be caused by friction. Therefore, splints are made of unyielding material as wood or metal.

NOTE.—Always, in all fractures, the *joint above* and the *joint below* must be immobilized.

Simple or *closed* fractures where only the bone is injured, can be enclosed in fixed dressings which need not often be disturbed, but in war surgery nearly every fracture is *compound* and many are *comminuted*, with much damage of muscle and fascia and tearing of vessels and nerves, conditions which demand frequent attention; therefore, splints are chosen which not only secure fixation but give access to wounds without disturbing the relations of the bones themselves or the position of the splint. Also they must be made of material which can be disinfected. Wooden fracture boxes or frames, or

long straight splints are sometimes used in necessity, but the choice is for some sort of skeleton splint or metal framework, strong but not cumbersome, adapted to various purposes and conditions.

The splints now in use are so devised that they provide for not only the fixation of the wounded part but a fairly comfortable position of the same, whenever the nature of the injury will allow. Sometimes a long stiff splint like the old fashioned Liston, must be used, in which case the nurse, by skill in arranging pillows and bedding, cotton padding, etc., can alleviate so far as may be, the inevitable discomfort accompanying its use, as for instance, needless pressure on one special part, like the heel, which may be remedied by a soft small pad of cotton inserted under the ankle, or by a ring in which the heel rests, without changing the position of the foot or of the splint itself. Likewise under the knee, a compress may be placed which will give the patient a sense of support by filling the hollow of the popliteal space.

In the following pages are brief descriptions of a few splints in common use in the hospitals of the present war. Numberless modifications exist, suggested by the necessities of special cases.

The genius of the surgeon aided by the cleverness of artisans in orthopedic appliances (attached to the best stationary hospitals), has developed a variety

of such for all sorts of conditions; it may be added that they are distinguished by a multiplicity of names although modeled upon simple and similar lines.

The *Hodgen* splint, the *Thomas* hip and knee splints, the *McIntyre*, and others of similar design

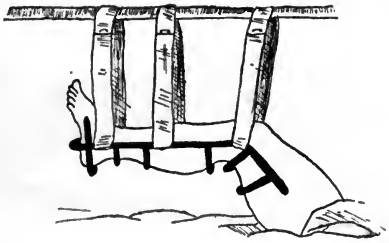


FIG. 7.—Skeleton splint resembling the Hodgen splint. (*After Hull.*)

are most frequently used. The *Hodgen*, for fractures of the femur, consists of parallel rods or bars of strong metal connected at either extremity and once near the middle by cross pieces of proper curve. Strips of webbing are attached to the side bars and support the limb in a series of slings as it lies upon them. Extension is applied above the knee; slight bending of the frame at the knee allows both thigh and leg to rest more comfortably because it prevents some of the strain of the flexor muscles at the back of the limb (see Fig. 7).

The *McIntyre splint* for injuries of the thigh or leg

is in two parts composed of metal, hinged at the bend of the knee and provided with a foot piece. It is placed behind the limb. The metal pieces are curved to form a gutter in which the limb rests. The position of the thigh depends upon the angle between the two parts and can be adjusted by means of sliding rods which control the joint. This is adapted for

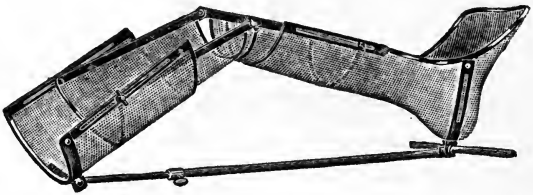


FIG. 8.—De Puy's double inclined plane splint constructed and used very much on the plan of the McIntyre splint.

support and comfort, but for convenience in changing dressings it would have to be modified by sectioning the splint (see Fig. 8).

The *Thomas Hip Splint.* This consists of a single flat piece or stem of iron which is placed vertically at the back of the patient, being moulded to fit the curves of the body. At the upper extremity is a metal ring large enough to pass around the chest at the level of the axilla; another ring encircles the thigh and still another the leg just above the ankle. Two strong straps or bands attached to the uppermost ring, are crossed and pass over the shoulders

like suspenders to prevent it from slipping down. This splint immobilizes both hip and knee, with the pelvis as well. With an elevated shoe on the

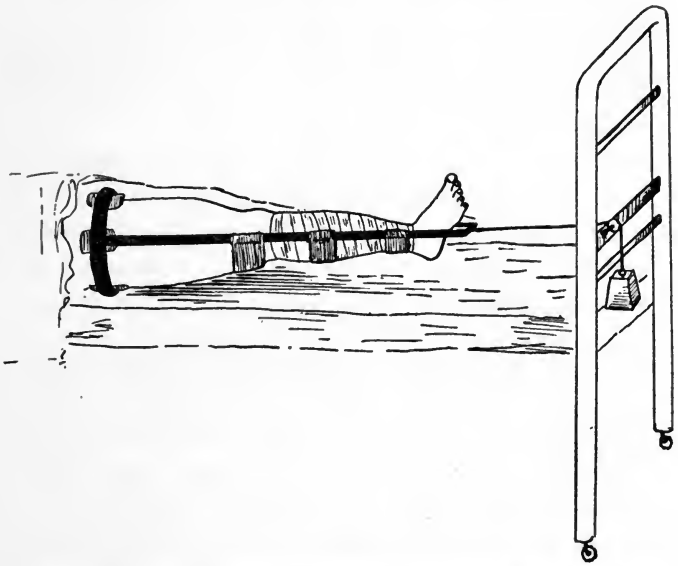


FIG. 9.—The Thomas knee splint applied with extension. The cord and weight are attached to adhesive plaster strapping not shown in the cut. (*After Hull.*)

sound side, the patient may walk about with crutches without disturbing the injured joint.

The Thomas Knee splint (Fig. 9) is found to be indispensable, as it can be varied to suit special cases and in different sizes may be used for thigh, leg, arm

or forearm. It consists of two metal rods, connected above by a ring of the same metal well padded and covered with leather or other appropriate substance which can be disinfected, and again at the lower extremities by a smaller ring. These parallel rods should reach from shoulder or pelvis to points several inches below the hand or foot as the case may be. The upper ring is large enough to slip over the thigh in its whole length if used for the knee, and may be fixed obliquely so that one side rests close to the pubic arch and the other beneath the crest of the ilium. The lateral rods are connected with each other by slings of leather or several pieces of metal which hang like a hammock from the two bars to support the leg and thigh from beneath. This sling being in sections, a wound of any given part may be made accessible for dressing. Sometimes strong bandaging is used for parts of the sling, which still more easily allow access to the wound. The splint is kept from slipping down by a strap which crosses over the opposite shoulder. By elevating the lower extremity of this double splint the whole limb may be swung in a long cradle. If *extension* is needed the usual adhesive plaster strips are applied as in other cases, and attached to a weight by continuations of bandaging and a cord which passes through the foot piece or lower end. *Counter-extension* may be secured by fastening the bandages directly to the foot piece.

The advantages of this splint are several:

1. A wound may be dressed without removing it, the sling being in sections so that any part may be reached without disturbing the whole.

2. It is light in weight and in a smaller size may be used for the upper extremity also, with the large ring resting in the axilla and over the shoulder.

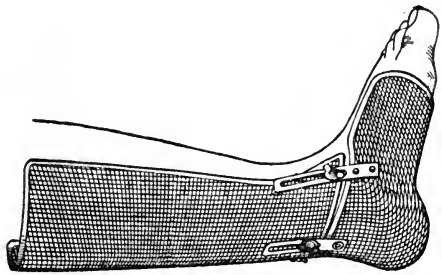


FIG. 10.—DePuy's wire-netting splint—light, adjustable and convenient.

3. It may be made to fit an extremity with the joint slightly flexed which adds greatly to the comfort of the patient.

4. With it wet dressings may be used or irrigation—continued or interrupted, while bedding and patient are kept perfectly dry.

If a patient is brought in resting securely on a frame, with both lower extremities extended, abducted and motionless, himself lying flat and in apparent comfort, the *abduction splint* of Major Robert Jones,

R. A. M. C. (of Liverpool) may be recognized. This is an adaptation of a double Thomas splint, for fractures of the hip or upper part of the femur, by means of which the pelvis and both limbs are immobilized and the injured side extended, with counter-exten-

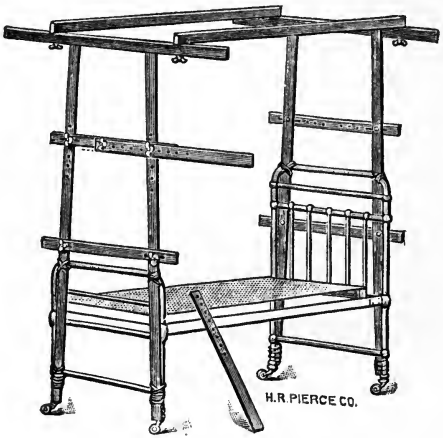


FIG. 11.—"Balkan" frame.

sion from the opposite side of the pelvis. It is a most ingenious and successful adaptation of the principles of the Thomas splint to a troublesome condition. Upon this frame the patient may be lifted or carried, with safety to his broken bones.

Frequently there is complaint of skin irritation by pressure of the pelvic or axillary ring of the Thomas splint; the nurse is not allowed to move the ring but

may press the soft tissues down and draw a different portion of skin under it from time to time.

By means of the *Balkan splint* very ingenious arrangements are made for immobilization of extremities in different positions. A simple method of construction is as follows: an overhead wooden frame is made of two upright pieces, placed at the head and foot of the bed and connected by a strong bar. A more elaborate and very useful frame embodying the same features is now supplied by the instrument maker (Fig. 11). To these, pulleys and cords are attached, and by them various parts or whole extremities may be suspended in slings, or held in extension, or both, as required. The body of the patient even, may be lifted by slings. The great advantage of the *Balkan* splint or frame is that limbs may be slung and extended in any position most desirable for the union of fractured bones or healing of wounds. It may be used for the suspension of irrigation flasks also; indeed its possibilities are without number.

For **fractures of the humerus a triangular** splint (p. 116) made of three strips of wood or other material, is applied with the base of the triangle at the side of the chest, while the arm and fore-arm are supported by the two other sides. It is so fastened to the chest by strips of bandaging that the upper angle just reaches the axilla, while the forearm is

flexed and the elbow rests at the apex of the triangle, with the arm in the abducted position.

The "*aeroplane*" is the name given to a splint constructed of strong wire or metal rods upon similar principles. It is attached to the chest of the patient by means of broad metal plates, curved to fit the

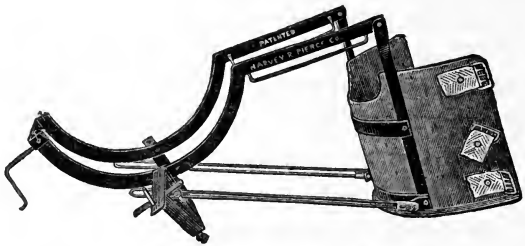


FIG. 12.—Leyva's aeroplane splint.

body; and is provided with devices to vary the position of the arm or forearm while affording firm support, and it may be adapted to the securing of extension.

Plaster Bandages and their Application.

It may fall to the nurse to prepare plaster bandages and apply them. No new principles are evolved by recent practice. The rules are few: *Keep your plaster dry* being a cardinal one. This applies to the supply of plaster itself as well as to bandages, and is most important. It must be kept in air-tight and damp-proof boxes, sealed, and stored in a dry place.

The bandages most frequently used are five yards long and from three to four inches wide. After rolling, each one is to be securely wrapped in waxed paper containing some loose plaster, and a number packed in tin cans which are sealed with adhesive plaster and kept in a dry warm place. As an extra precaution each bandage may be wrapped snugly in old muslin in addition to waxed paper, as for transport across the ocean.

When about to apply a plaster dressing, wash, dry, and powder the patient's limb or the part to be covered and bandage it with flannel or flannellette. Have ready two basins; one to contain the salt and water (*not too hot*) in which the bandages are wetted—and deep enough for the bandage to be covered with water while standing on end; another for occasional dipping of the hands of the operator, and a smaller dish for plaster "cream," a box of dry plaster, hot and cold water in pitchers, towels, protectors for the floor and patient, and a knife. Also non-absorbent cotton to protect from pressure upon special parts.

When all is ready, open the box of bandages and place them one at a time in the water as needed and called for. Meanwhile, mix the dry plaster to make a "cream" and place it where the doctor can reach it easily, for reinforcing and "finishing off."

The limb or part must be supported exactly in the

position which it is to retain after the plaster is set. (Someone should be detailed to place the succession of bandages in the water as the surgeon indicates, as of course, all can not be wetted at one time.)

NOTE.—If the bandages are soaked in water too cool the patient will be chilled; if in water too hot, he will be burned.

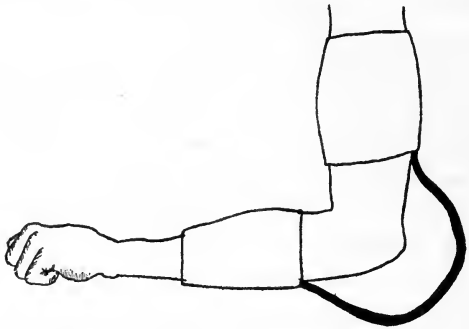


FIG. 13.—Showing a method of using plaster of Paris for a damaged joint having a wound to be dressed. (*Modified from Hull.*)

It is of special importance to maintain the correct position of the limb during the entire proceding, in order to insure the drying of the cast in just the right shape.

In the exercise of the ingenuity which has been so greatly developed by the necessities of the present war, plaster of Paris dressings or casings have been adapted to a great variety of injuries in addition to their common uses for simple fractures.

For example, the necessity for early transportation of the man with severe lesions of long bones, or joints, has led to the extensive use of *interrupted plaster casings*, whereby the injured parts are fully secured against the mechanically harmful effects of the journey and at the same time may receive the care which open wounds demand (Fig. 13).

The portions of the casing above and below the lesion are connected by unyielding strips of metal, arched over the wound and protecting the dressings perfectly, as well as guarding against pressure upon the sensitive part.

One skilled in the handling of plaster will find a multitude of opportunities for its use. It forms the very best support for transportation, and by means of *windows over the wound*, necessary dressings may be done.

With very large fractures of pelvic bones about the hip, or for other joints as the elbow or knee, plaster can be used above and below the wound and connected by the curved metal bands referred to, which secure the desired immovability while protecting the wound from pressure and allowing facilities for redressing. Many cases are thus transported with safety, to reach the base hospital where alone the necessary treatment can be had for those requiring care during a long period of time, which it would otherwise be impossible to give.

Many special applications might be described; they necessarily vary with the requirements of different patients, but the indispensable requisites for success in their use may be repeated: keep your plaster dry; secure the maintenance of the proper position until the cast is hard, then it will almost take care of itself.

NOTE.—The removal of the cast will be facilitated by cutting it down to the lower layers while the plaster is still soft. If you have time to consider esthetics varnish it and bind with adhesive plaster.

CHAPTER VIII

BATH TREATMENT. BURNS. TETANUS. GANGRENE

The Bath Treatment in Surgical Work.—This, like some other methods, is not a demonstration of new ideas, but an adaptation to present conditions.

Various containers are devised which allow the immersion of a limb wholly or in part—or even the greater portion of the body. The success of the treatment will depend upon continuous immersion in the right solution at the right temperature and with the limb in the right position. The limb or body is supported by strapping, by sheeting, by netting or other material fastened to the tub or around it, to keep the part floating in the water, the temperature of which (usually 100° or higher) is maintained at the proper degree by various devices; these are necessarily under the control of the nurse. Frequent supervision is needed and the position of the patient, as well as that of the limb, is to be carefully preserved.

The effect of hot immersion is to increase the circulation, thus bringing to the injured tissues the nutritive principles of the blood, to be utilized for

future repair. When it can be managed, no treatment is better for large septic surfaces or for infected burns. Suitable boxes or containers of some sort should be obtained almost anywhere for an arm or for a leg.

The *general immersion bath* is sometimes the only comfortable dressing for large sluggish superficial wounds. The securing of a requisite quantity of sterile water may be a problem too great, but at least plain boiled water can be had; sometimes it will be medicated by mild antiseptics, as *boric acid* or (brief immersion in) a 0.5 per cent. solution of *picric acid.* A very great advantage obtained by the use of the bath is, that for such wounds long and painful dressings are avoided. The disadvantage lies in the necessity for lifting the patient from the tub from time to time, but the benefits outweigh the annoyances.

Burns

The use of liquid fire and asphyxiating gases in the European war, has added to the list of battle wounds. Extensive burns involving the deep layers of skin and underlying tissues have presented problems of treatment to both surgeon and nurse. They have been exposed to infection on the battlefield without defense or prompt treatment, but being superficial wounds they present mostly the effects

of pus-forming microbes only, which, the patients' strength being sufficient,—can be overcome by suitable treatment.

The time-honored method of dealing with burns is by the application of bland and soothing remedies to exclude the air The experiences in the present war have led to the perfecting of such methods with the addition of antisepsis. *Paraffin* is the basis of various mixtures which have been used to make an airtight covering without irritation. By many it has been determined that a pure article of paraffin of suitable texture and consistency will answer the purpose without the addition of various medicaments included in the published formulæ; most of these contain small quantities of rosin, wax, and petrolatum. *Ambrine*, the most widely and very successfully used, contains oil of amber with other substances in combination.

The method of applying is as follows: the wound is disinfected (usually with hydrogen peroxide or ether), cleansed and very carefully dried. Then a thin coating of paraffin at melting temperature is applied either by spray or with a soft brush (the spray is difficult to manage, many use the brush). This is covered with a thin layer of cotton and another coating of paraffin is added. Cotton and light bandaging are used to keep the dressing in place. As the surface has been made aseptic the dressing may be so

applied as to prevent both the entrance of air and the escape of fluids; although by many this is not considered an advantage, the process of healing is probably encouraged (see Fig. 14).

NOTE.—Should the application of the paraffin be very painful a preparatory layer of sterile petrolatum is advised and frequently used to precede the paraffin.

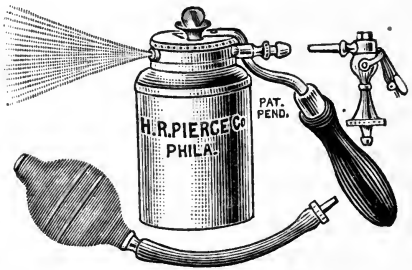


FIG. 14.—Pierce's ambrine atomizer. In this the difficulty of preserving the proper temperature is overcome and the fine spray is delivered satisfactorily.

Other methods of treatment of burns have been practically superseded by this one in many war hospitals. They are not especially new and are not described here, but the use of the *continuous irrigation bath* of normal saline or medicated solutions should not be disregarded, and for very extensive areas of injury it is one of the best of procedures. It meets the important indications to alleviate pain and keep the sensitive part at rest, with a minimum of

disturbance for re-dressing, the importance of which will be understood by recalling the effect upon the brain and other vital organs of long continued painful sensations (see p. 27). Meanwhile the patient's strength is to be conserved by nutritious and carefully digested food.

TETANUS

Of the three anaerobes which are common in war wounds the *bacillus* of **tetanus** is most dreaded. The frequency of tetanus infection in the early days of the war caused many deaths.

A description of the disease is hardly necessary here but it is well to mention characteristics and symptoms which the nurse will wish to understand and watch for. The *period of incubation* is of very uncertain length but it is usually long. The deadly work of the bacillus tetani goes on very slowly as a rule, showing no symptoms whatever meanwhile, until the mischief is extensive. The toxin of this bacillus is formed at once *in the wound* and attacks the injured nerves promptly; *by them*, not by the circulation, it proceeds to the motor cells of the central nervous system, affecting first those in the spinal cord which belong to nerves in the wound; later it goes on up to the brain, including the pons and medulla, where are found the vital parts of the nervous system.

Because it secures so firm a footing before the infection is recognized, the main hope for the patient lies in attacking it at the earliest possible moment and this can not be too early. No opportunity is given for identification of the bacillus; the time required for laboratory work is time lost for the patient and the enemy must be convicted upon circumstantial evidence. Many methods of treatment have been tried but few have proved equal to that of *antitoxic serum* and none have superseded it, either for immunization or as a remedy for the fully developed disease. Therefore, *tetanus antitoxin* will be administered to thousands of men, in immunizing doses, every day while the war lasts and the nurse's armamentarium for the proceeding must be kept as complete as possible.

NOTE.—The practice is now established of administering an immunizing dose to every wounded man as soon as it may be done upon his arrival at the hospital. By many surgeons this is repeated before any operation which he may need a few days later. And because of the insidious nature of the toxin and the short period of immunity, another dose is often given although no signs of infection may be visible. Again it may be repeated when the man is sent away to convalesce, and even after he arrives at a convalescent hospital. All these will be prescribed, with the doses, either for special individual cases or as routine measures.

Early detection may enable the surgeon to institute treatment before it is too late. What are the warning symptoms? Just a drawing of the muscles of the limb that is wounded; sensitiveness to sound or to a slight draft is suspicious—never overlook these; slight difficulty in swallowing must be recognized at once, and as to stiffness of the muscles of the jaw or the least tendency to spasmodic action of these, everyone knows the meaning of that; be on the watch for these symptoms in every wounded man.

In addition to the antitoxin other remedies are used for palliative effects; *magnesium sulphate* among them, in a 25 per cent. solution injected into the muscles four times daily, minimizes the severity of convulsions and thus conserves the patient's strength while the more radical effect of the serum is becoming established.

Chloretone also has been used with favorable results. Several other remedies have been proposed but none of these alone is to be trusted; the main dependence is upon the *serum* and we may almost say that with the early and frequent use of this remedy the others will not be required.

NOTE.—It goes without saying that thorough cleansing of wounds is, if possible, still more imperative than ever where tetanus infection has taken place, as if any tetanus bacilli remain, fresh supplies of toxin will be produced continually, and even with

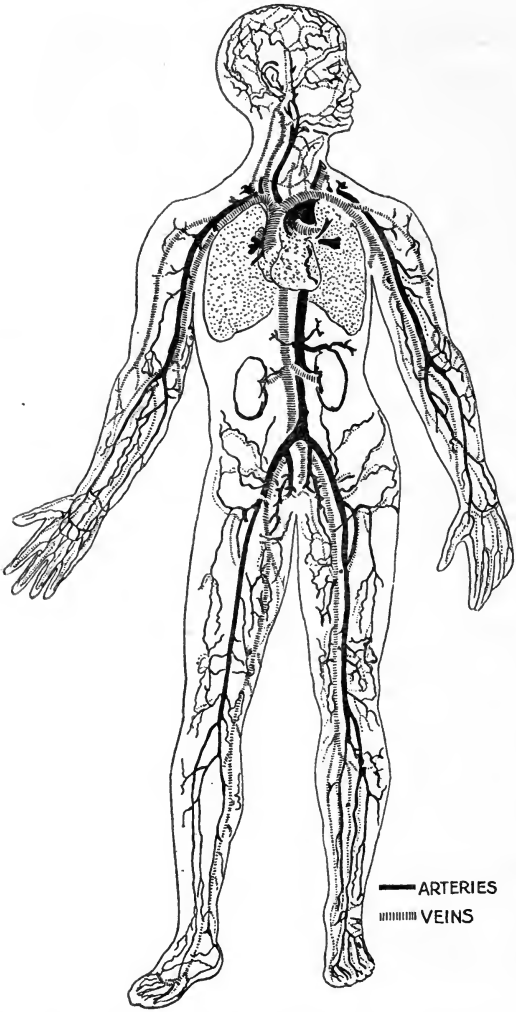


FIG. 15.—Showing the main arterial supply to the human body and the veins which return the blood to the heart. The sources of severe hemorrhage may be understood from this figure.

the aid of serum the tissues will not furnish antibodies indefinitely.

Injuries of Blood Vessels

The importance of this subject is due to the danger of hemorrhage for which the nurse must be constantly on the alert. Bullets, fragments of shell, or shrapnel, may be lodged in the vessel walls without quite penetrating them, therefore constant vigilance is imperative as severe hemorrhage is almost inevitable when the weakened vessel gives way. Or, the ends of severed vessels which have been closed by nature's method, that is, the formation of a clot, may be reopened by mechanical injury in the course of dealing with the wound which contains them, and again serious hemorrhage follows. This is particularly liable to occur in septic cases.

As a temporary measure a wound may be packed with gauze which has been soaked in a strong salt solution or an antiseptic, and a firm bandage applied. In most cases this is better than the use of a tourniquet. If a tourniquet must be used a pad or some hard object must be applied over the main artery which supplies the vessels in the wound, as a bandage or any other constricting material which exerts equal pressure upon the entire circumference of the limb, is capable of doing as much harm as good—*first*, by preventing return of blood through the large veins

and thus bandaging it into the limb; *second*, owing to the possibility of gangrene if the tourniquet is tight enough to shut off all circulation. (This possibility must be kept in mind when dealing especially with the common femoral and the popliteal arteries). *Third*, it is probable that the pressure thus exerted upon the nerves is in part responsible for the occurrence of *gangrene*, because it cuts off the vasomotor supply to the great vessel walls.

When a wounded artery bleeds into the tissues surrounding it, the swelling is called a *hematoma*. If the tissues are very firm as in Hunter's canal, a well defined cavity filled with blood will be formed, called a *false aneurysm*. The natural cure for this is by formation of a clot, but if the injury is too extensive the only relief is by operation.

Space is lacking for mention of various other conditions caused by injuries of arteries and veins and their treatment.

After *ligation of arteries*, which is done when hemorrhage is otherwise uncontrollable, it is necessary to keep the part well supported and the patient *absolutely at rest*, that the circulation be not hurried in any way. The heart's action is not to be stimulated.

Keep the extremity of the injured part sufficiently wrapped or covered to preserve the normal temperature.

In all injuries of blood vessels the effect of sepsis is unfavorable, as it promotes secondary hemorrhage, consequently the care of an infected wound must be carried out most scrupulously according to orders and with antiseptic precautions.

The repair of vessel walls by the use of *grafts of deep fascia* is now constantly practiced, especially for injured cranial sinuses.

The latter is a very beautiful proceeding, calling for surgical skill of a high order. A piece of fascia lata of the proper size is placed upon a slightly larger piece of delicate rubber tissue, called jaconet. The sheath of the vessel having been carefully removed from the wounded area, the fascia is applied over the wound by a delicate manipulation which coaxes it to remain in place by holding it gently but firmly against the vessel wall for a minute or two; when the rubber is taken off, the fascia remains adherent.

Vessels are often repaired by suturing as they possess good powers of healing.

The only uncertain factor in the proceeding is the possible danger of infection during the operation or from suture material. Frequently such sutures are covered by a fascial flap like that already described.

The skill exercised by modern surgery has made it possible to repair wounds of vessels which formerly were inevitably fatal. It remains to be shown that

the skill of the modern trained nurse will conduct the case to a successful termination. Nothing can replace the responsibilities which she must assume in such cases. The patient should be absolutely protected from emotional or other unnecessary disturbance; he must be able to rest in a comfortable position; his wants are to be met by prompt and skilful attendance; his food should be suitable, and *secondary hemorrhage* is never to occur unexpectedly.

Secondary hemorrhage may be anticipated oftenest *after ligation* of vessels in any part of the body under the following conditions:

1. Where a branch of good size has been severed or ligated close to the main trunk.

2. In a septic wound where tissues are necrotic and sloughing and the walls of the vessels themselves are probably softened.

3. Where primary hemorrhage has occurred and, as in many vessels of the skull, it was necessary to adopt some form of *plugging* or *stopping*, because the vessel was not accessible.

4. Wherever the vessel is *surrounded by damaged tissue* as in the lung.

5. In *compound fractures*—where spicules of bone are lodged in or near a vessel or where a tablet of eupad or of salt has been allowed to come in contact with a vessel in the depth of a wound.

Repetition will not emphasize the importance of

watchfulness wherever the possibility of hemorrhage exists, nor enforce the instructions already given in regard to the measures for meeting the accident should it happen. All have been described and will undoubtedly be instituted with promptness and successfully carried out.

NOTE.—It is a remarkable fact that *complete division* of the third part of the *axillary* artery and lower part of the *femoral*, the *tibial*, *radial* and *ulnar*, has been seen with no serious hemorrhage, in the present war.

GANGRENE

Gangrene is defined as "the death of a part of the body from failure in nutrition."

Dry gangrene is not common in war, because although it may follow injury to an artery in battle, it usually follows disturbances of circulation due to either vaso-motor spasm or diseased vessel walls.

The fingers and toes are the parts oftenest affected. An early and continuous symptom is severe pain. The skin is at first white and bloodless, later it becomes red and later still black. A white line appears to mark off the black portion, which does not recover. When this is positive, amputation is done. The foot or hand should be kept warm with the hope of securing a return of circulation if possible and the patient should rest quietly in bed.

Moist gangrene is the more common form and is seen after injuries. The characteristics are swelling, œdema, and a white surface soon becoming mottled and presenting *blebs* which are filled with bloody serum. After bursting they leave a raw surface with foul odor. The soft tissues of the limb are soon invaded and the process is a rapidly advancing one; the life of the patient is saved only by amputation well above the diseased portion.

Gas Gangrene.—The majority of cases of gangrene among the soldiers is due to *anerobic* infection and takes the form known as *gas gangrene*. In former times this serious disease amounted to a scourge but owing to the better understanding of the cause and the development of recent methods of war surgery, the cases now are comparatively few, although they are more numerous than could occur in civil life. The infecting agent is called the *bacillus perfringens*, or the *bacillus aerogenes capsulatus* or the *bacillus Welchii*. (The *bacillus* of *malignant œdema* causes a similar condition.)

If the microbes are lodged in a small but deep wound these bacteria multiply rapidly with the formation of gas and great destruction of tissue. How much more serious then, are the large wounds with ragged tissues, numerous recesses and pockets, and the whole obstructed by fragments of broken down and dying or dead muscles and other tissues, so that

air does not penetrate to the depths; there the gas bacilli can work under circumstances most favorable to their activities. If the wound is seen in time and the devitalized tissues are excised, recovery may be expected, but probably it will not be considered safe to dispense with antiseptics or hypertonic saline remedies. These measures, with *excision* and all of the nourishing food which can be provided, may save the man.

The course of the disease varies somewhat, being at first a *local* condition; bubbles of gas appear in the discharges from the wound and gas may be felt in the tissues of the immediate neighborhood, but these symptoms may be brought under control by prompt discovery and treatment by free incisions, and thorough disinfection and drainage. By the use of these measures the process may be restricted to a limited area. Certain muscles will be lost, and with them the corresponding motions, leaving the patient crippled to that extent; but beyond this, recovery will follow.

A more serious and fatal form is the *diffuse* or rapidly spreading process. The skin is discolored, the limb is extremely swollen and œdematous, gas penetrates the cellular tissues and advances rapidly, so pressing upon the muscles as to render them useless and obstructing vessels and nerves; the pulse is small and rapid, the extremities are cold, vomiting

and hiccough may occur. The patient is profoundly toxic but he may not feel very ill; at first he is hardly able to realize the gravity of his situation. If improvement can not be secured by thorough exposure of all pockets and excision, a fatal ending soon comes—the gas spreading rapidly upward to the abdomen, chest, and then the neck, causing distressing pressure symptoms and death.

At another time the whole limb is involved suddenly, beginning within a few days of the initial injury. A wound which is doing fairly well at night may reveal a condition of gangrene—swollen, tense, and discolored in the morning; the patient, already in collapse, succumbs before the gas itself has spread far enough to cause death. This form is called *gangrene en masse.*

NOTE.—The toxin of these infections weakens the heart especially; the patient becomes pulseless and circulation fails in advance of other functions.

White gangrene presents a white and shining skin, moist, cold, and pitting on pressure. The patient's condition is dangerous from the first and symptoms of collapse followed by death often occur within 12 hours. If the patient lives longer than this his skin becomes spotted with black color and the discharge will be exceedingly fetid but with very little pus.

Early amputation gives the man his only hope; the delay of a few hours may cost the patient's life.

In all of these forms of gangrene, conserve the patient's strength in all possible ways and try to build it up by food and stimulants. Protect the surfaces from cold, try to keep the extremities warm —this is very important.

A peculiar board-like hardness followed by *rigidity of muscles* in a definite area, has been reported as a fore-runner of gangrene. It has been observed in the leg, below a wound.

Injury of a deep vessel is suggested by the condition which has been invariably followed by gangrene of grave nature.

It would be well for the nurse to watch for this sign and report it if discovered; an opportunity might thus be afforded for early operation and the saving of life.

NOTE.—As the result of a number of bacteriologic tests *anerobic bacteria* were found not only on all of the uniforms of a number of Belgian soldiers who had come directly from the trenches, but in the meshes of all the examined samples of the new cloth from which the uniforms were made! How could any escape infection?

IMPORTANT NOTE.—Experiments are reported which go to prove that an antitoxic serum has been made which is "protective and curative against gas bacillus infection in pigeons."

CHAPTER IX

BONE INJURIES

The graduate nurse will have had experience in the care of fractures during her course of training. By far the greater number will have been *simple* or *closed* fractures in which the injury is simply a broken bone. Briefly, the treatment and nursing must be such as to secure a position of comfort as far as possible and to insure the *immobility* or *fixation* of the part by proper support during repair.

Review the process of repair and union.

First.—The mechanical irritation results in freer blood supply; then a certain amount of animal substance like cartilage is thrown out about the fracture forming a *callus* which joins the upper and lower fragments together. When this is hardened by deposits of mineral substance the callus becomes bone and in time the bone is as strong as ever. The object to be secured in treating the fracture is that the bone shall be so supported while the callus is soft that its former shape will be retained.

In all fracture cases a certain routine is observed:

First.—Extension, to prevent friction or irritation between the broken surfaces; not that they must

be actually pulled apart, but the muscles which are attached to the bone need to be steadied and involuntary contractions have to be discouraged. To accomplish this, the limb must be not only extended, but comfortably supported. The extension should secure the *continuous* effect of a definite and unchanging weight; intermittent extension *causes* rather than overcomes *muscle action.*

Second.—Immobilization (or *fixation*) to keep the fragments in apposition during the process of repair. This is accomplished by means of splints which are bandaged firmly to the limb.

These measures taken, the care is left to the nurse who will see that the bandages which hold the splints in place are not too tight, thus interfering with circulation and causing painful pressure upon nerves; or on the other hand that they are not too loose, thus failing to keep the splints in place, and if necessary she will report concerning them.

It is important that in all handling of the patient such as lifting or turning and changing of bedding or clothing, the fractured limb be supported by a sufficient number of assistants to avoid disturbing it in any manner. In the case of large bones this will include special support on both sides of the fracture until new bone is formed.

All these things become a matter of routine for which untrained assistants may well be instructed

to take responsibility while the nurse in charge is necessarily occupied with patients whose conditions are more acute, the care of which could hardly be entrusted to inexperienced hands.

Such will be the care of **compound** or *open* fractures. These present a wound to be dealt with also. In civil life the wounds may be sterilized, the limb extended, the bones immobilized and drainage established, when it is expected that satisfactory union and healing will follow. Their care requires that, more than ever, vigilance be exercised in handling the injured limb or moving the patient, since there is danger of not only disturbing the fragments of the bones but of injuring the soft tissues about them.

Always such wounds received in battle are infected and not only are they open fractures but usually the bone is splintered or broken into several pieces or crushed, and another danger arises—that of injury to blood-vessels and nerves by fragments of bones.

Consider the situation at the depth of the wound. This may have been caused by a missile of explosive character, seriously damaging the muscles and other soft tissues, and nerves and blood-vessels as well, creating a condition favorable to the development of bacteria carried in by fragments of missiles, of clothing, or dirt, and causing rapid development of

sepsis. Any injury due to careless handling might easily cause the spread of infection by further mutilation of tissues already damaged, causing severe sepsis, perhaps secondary hemorrhage and gas gangrene. Could the patient be seen in time it might be possible to sterilize such a wound, but facilities for this do not exist at the field dressing stations, and the patient must be sent on to a clearing station for his first thorough treatment.

Therefore, when a patient arrives with limbs in splints, the nurse will think at once to observe if a *wound* exists. She will look to see in that case that drainage is not obstructed; she will instruct her assistants how to support the patient and the limb during necessary changes of position, placing in bed, removal of clothing, etc., remembering that *always* the *wounded limb* is to be uncovered *last.*

Fractures of the Lower Extremity

Fractures of the **pelvis** usually involve the **hip,** and all are immobilized together. Wounds when existing, are large and ragged; muscles are mutilated and furnish bleeding surfaces; vessels are numerous and of good size and one is reminded that hemorrhage may occur. These conditions have to be treated as such are dealt with elsewhere, that is, by *excision* if practicable and sometimes, closure; but more often

they are left open for irrigation and drainage or the dressing favored by the surgeon, being too badly damaged to permit the complete excision which would make closure safe.

Immobilization includes the trunk up to the shoulder and the extremity down to the knee, as only so can all of the muscles concerned be brought under control. For this the *Jones Abduction splint* (see pp. 81 and 82) or something like it is applicable, or well applied plaster of Paris.

NOTE.—It is necessary to fix the entire pelvis when either side is injured, for since it is composed of bones united by immovable joints, any motion of one side inevitably disturbs the other.

Here again the nursing insures perfection of drainage, the care of the bed and dressings, the procuring of as much nourishing food as can be obtained, with success in persuading the patient to take it.

Compound Fracture of the Femur.—In the majority of cases, prepare for immediate operation, as the conditions are already desperate, microbes having invaded the tissues about the wound, with gangrene often present. Retained foreign bodies must be searched for, concealed bleeding discovered, damaged tissue removed; and there is special danger of shock as well as hemorrhage.

NOTE.—Severe shock is very common in the hand-

ling of compound fractures of the femur. Be prepared then to keep the patient warm, to administer saline solutions, etc.

These, like other cases, will require extension, fixation and *drainage*, which must be carefully watched.

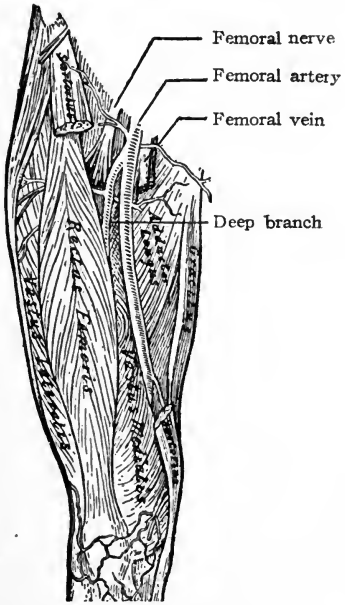


FIG. 16.—Structures in Scarpa's triangle; portion of sartorius removed. These vessels may be injured in fracture of the femur.

It is important to keep an accurate record of symptoms and to sustain the patient's strength by food and such stimulants as are ordered. The patient

will already be septic and his strength must be maintained in every possible way.

Many cases will require amputation and most of these operations will be performed by what is called the open method, that is, no attempt will be made to close the surfaces of the stump, as the injured bone and the injured tissues surrounding it are particularly liable to the effects of microbic invasion. They may be already infected and to close the surfaces from the air is to encourage the development of anaerobic bacteria. The closure of the wound by Nature, after amputation, is encouraged and secured by a plan of extension of the *soft tissues* which draws them down gradually, so that finally the end of the bone is covered during the process of healing. The after treatment of compound fractures requires that the wounds shall be accessible for the constant application of antiseptics or saline or other solutions. Many splints have been adapted to these cases whereby drainage is not obstructed and the wound can be frequently dressed, while the limb is supported in the proper position (see pp. 77–79).

The Knee Joint.—This is such a large joint and so complicated, that injuries are proportionately serious. It is a hard-working joint also and exposed to violence by reason of its location in the body, therefore accidents are bound to happen to it. By reason of the extent of *synovial membrane*, inflammation and infection are greatly dreaded even when no wound

exists. Still more serious, therefore, is the condition of the knee joint which has received a battle wound, perhaps with a bullet or fragment of shell lodged in one of the articular bones or lying in a pocket of

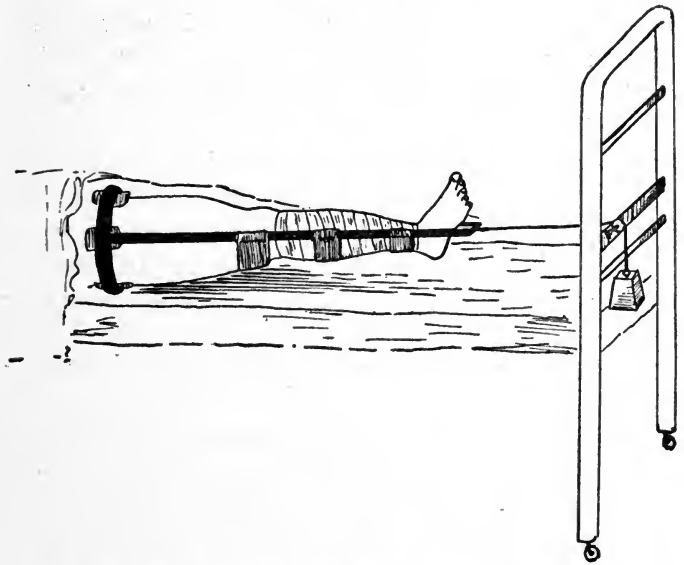


FIG. 17.—The Thomas knee splint applied with extension. The cord and weight are attached to adhesive plaster strapping not shown in the cut. (*After Hull.*)

the joint. The danger of sepsis, involving a long and painful experience, is to be warded off if possible, and here also, by thorough exploration and *excision*, the best promise of recovery is given to the patient.

When a positively clear tract has been created in this way, the wound is sutured and the various structures composing the joint are trusted to Mother Nature who so often justifies the confidence reposed in her powers of healing.

For extension and fixation the *Thomas Knee Splint* or one somewhat like the illustration (Fig. 18), is used; it will make the patient comfortable and the nurse will do the rest.

Fractures of the leg are common in war time and are usually compound. In fact, the simple fracture of any bone is more often a civil than a war injury.

Extension is secured in the usual way and immobilization by some form of skeleton splint which allows irrigation and whatever dressing is ordered. The leg may be swung from a *Balkan splint* or frame and supported in a *Thomas*.

These fractures, unless they involve the ankle, are not difficult to care for, if the-always-to-be-observed rules are to be kept in mind—the limb is to be motionless, the bandages are to be neither too tight nor too loose (as evidenced on the one hand by swollen toes or on the other by movable splints and pain), and the extension must act steadily and continuously.

Ankle injuries, if extensive, are not so easily disposed of. It is difficult to apply an extension apparatus satisfactorily, although there are ways of doing so, as by a sling, including the heel and instep, but

this is not always possible. **Crushed feet** just have to lie still in their dressings and hope that antisepsis and care will help them over their hard road.

Fractures of the Upper Extremity.—For immobilizing the **humerus** or the bones of the **forearm** a small *Thomas splint* has been used with the large ring fitted over the shoulder and extension at the elbow or wrist, as may be desired. (See Injuries of the Shoulder, p. 116.) For compound

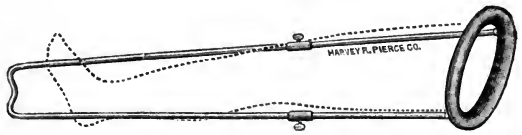


FIG. 18.—Robert Jones' leg splint, modification of Thomas'.

fracture of the bones of the **forearm** the *bath treatment* is available in the early stages. Where much inflammation exists this serves an excellent purpose; later the *triangular* splint seen in the illustration, the "aeroplane," or the *Thomas* splint already referred to, can be used (see p. 116). By ingenious management, with this splint fractures of the humerus, injuries of the elbow and fractures of the forearm—all in one extremity—may be immobilized, extended, and supported, so that the patient can walk about. Always in the use of a Thomas splint judgment and ingenuity must be exercised in saving the skin from the effects of pressure by the ring.

Little pads of cotton or linen inserted under the ring may be moved from place to place, or the *skin itself* may be moved by gently pressing under the

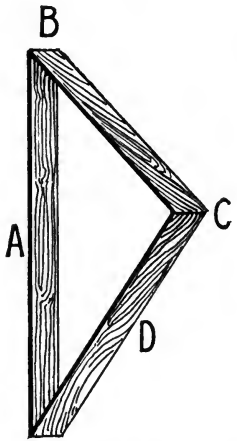


FIG. 19.—Triangular splint. The base *A* is applied to the side of the chest; the angle *C* fits the flexed elbow. The forearm rests upon the side *D*. The splint is held in position by adhesive straps or bandaging.

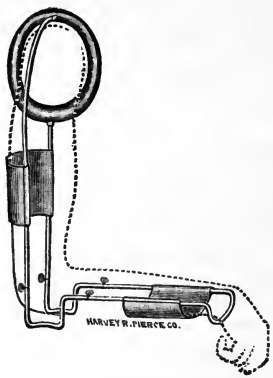


FIG. 20.—Robert Jones' humerus extension splint (modified Thomas').

ring and pulling it, so that pressure shall come over a new area.

Compound fractures of the **wrist** and **hand** are also well treated in the bath, the temperature of the water being first simply warm and then gradually raised to a degree as hot as can be borne without

burning, thus increasing the blood supply to the part and assisting it to overcome sepsis.

It is hardly practicable to apply special splints to fractures involving many bones of the **hand.** Therefore, the bath and the saline solution are more than ever valuable. Contraction of the fingers in the flexed position is apt to follow this injury and to prevent this, various appliances have been devised, as *dorsal extension* by pieces of rubber tubing attached to the fingers and to a circle of light metal like aluminum fixed to an arm splint. This arrangement permits the exercise of the fingers by voluntary contraction of flexor muscles without the bad effect of over-action. The adjusting and regulating of the pieces of tubing will naturally be a part of the nursing care.

Injured Joints

Much that is said of the care of fractures applies to injured joints, with the addition of some special measures, as for instance, *aspiration*, to relieve the tension caused by effusion of fluid into the cavity of an inflamed joint which is not open and is presumably aseptic. For this, it is advised to have some antiseptic fluid at hand with which to fill the needle before insertion, that no possibility of entrance of air through the needle into the joint will exist (a

mixture of iodoform and ether or alcohol is often used).

When the patient has reached the nurse he will already have had some treatment but as in compound fractures, radical measures can hardly be undertaken in the field dressing stations; bandaging, splinting, and immobilization as well as possible are there done to prepare the man for transportation, and he is then sent on.

Immobilization is important for two reasons, not only as in fractures to keep the bones in proper position (*not apposition*), but because friction within the joint cavity increases any inflammation of the serous membranes already existing, tends to encourage sepsis, and delays healing.

The same care is required upon the reception of the patient as is already described for other cases. In preparing for operation, which is often inevitable, the usual routine is observed, including provision for irrigation, which is frequently necessary.

Where the articular ends of the bones are injured, special effort is made to render them aseptic if possible, because of the danger of free absorption in the cancellous tissue. Such surfaces are extremely painful and if the joint cavity is packed, irrigation will be ordered before the daily change of packing in order to make the removal as easy as possible. Should the bone be injured in the neighborhood of the medullary canal, amputation will probably be done.

In injuries of the **hip joint** (see p. 122) the pelvis as well as the femur has to be immobilized to secure perfect rest for the joint surfaces and this is often accom-

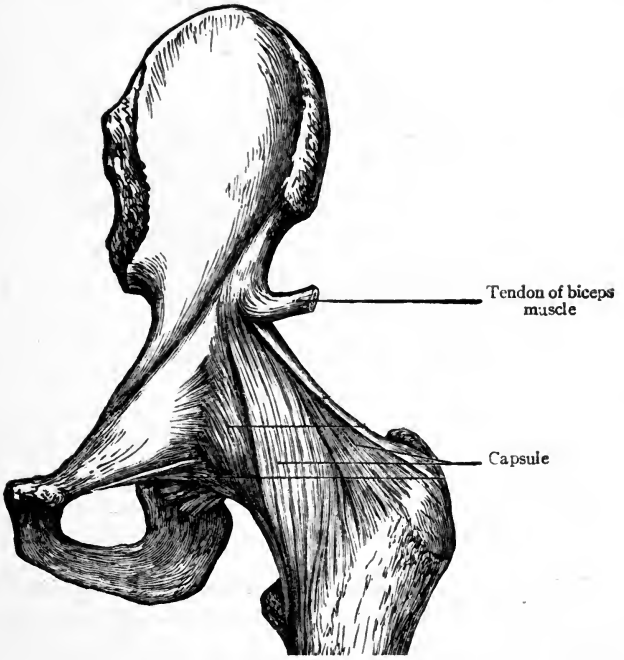


FIG. 21.—Hip-joint. (*Morris.*)

plished by the use of plaster of Paris around the pelvis, interrupted by some such device as is seen in the illustration (Fig. 21), to prevent pressure upon the sensitive parts or the occlusion of drainage. The

long *Thomas splint* from the shoulder to the foot may be used, or one of the modifications described on p. 78 whereby the splint immobilizes both hips and knees and supports the whole body.

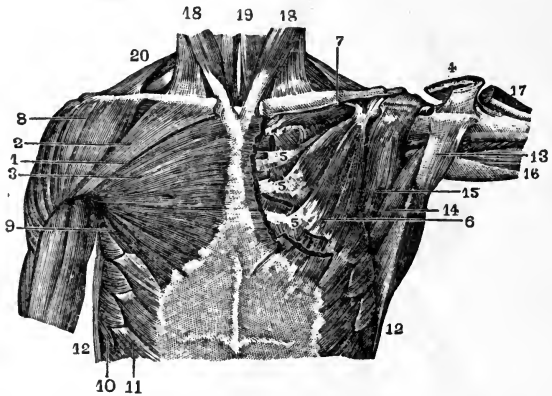


FIG. 22.—Muscles of anterior aspect of thorax and shoulder. Note the large muscles attached to the upper portion of the humerus. Others are quite as important on the posterior aspect. These would prevent union of fragments if the head were crushed or severed from the shaft.

Injury to the **shoulder joint.** With extensive damage to the head of the humerus *excision* will be performed, as the bone can not be so treated as to heal in the proper shape. Septic tissues can then be removed and the wound cavity treated either with antiseptics, or saline irrigation, or hypertonic saline by the use of salt sacs. Recall the important structures around the shoulder joint to be avoided or

treated. The axillary artery and vein with their branches, the brachial plexus of nerves with its branches; also the large synovial cavity of the joint itself; the pouches of the synovial membrane which extend under tendons and along the bicipital groove

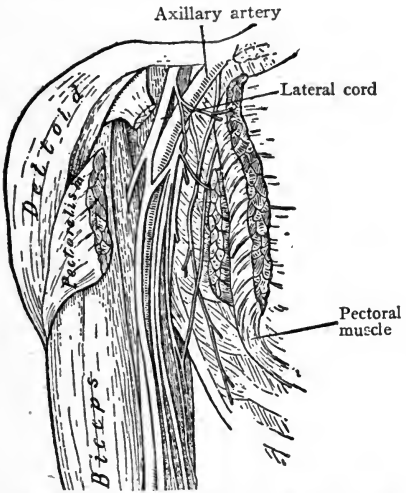


FIG. 23.—Axillary space. Axilla laid open by division of anterior wall. These structures may be injured in fracture of the humerus and of the shoulder.

are all to be drained and perhaps continuous irrigation will be instituted. The slender drains stiffened with wire are found useful in these cases. The triangular splint commonly used is mentioned on p. 83.

For wounds of the **elbow joint** similar treatment is carried out; removal of damaged bone and other structures including all septic matter, followed by irrigation and drainage. The saline bath is here practicable. Skeleton splints of aluminum bands with transverse pieces curved to fit the arm and forearm allow free access to the joint for dressing. Extension may be made by the use of a modified Thomas splint and irrigation still continued. These furnish good work for the nurse in keeping the splint undisturbed, the irrigations administered, and the patient comfortable, with the skin free from irritation (see Fig. 20).

Wounds of the **wrist** and **ankle joints** are treated like those already described; and in both the saline bath may be utilized. In all joint affections, a knowledge of the anatomy of the parts involved will not only add interest to the work of nursing but will render it more efficient.

A brief review follows of the gross anatomy and relations of parts of the principal joints, with illustrations, as an aid to understanding the easiest position in which they may be placed without undue tension of the muscles and ligaments about them. The application of the principles involved will be greatly facilitated by the possession of the faculty of putting "one's self in another's place."

Injuries of the **hip joint** present serious complica-

tions, involving as they do important vessels and nerves, and muscles of unusual size and strength. Fortunately, the *capsule* and other ligaments are so attached that they are not subjected to strain in the *supine* position. Only an extreme range of motion makes any of the ligaments tense. The same is true of the muscles. The only position which puts any of the muscles on the stretch is *extreme abduction*, which is most unlikely to be assumed. A semi-flexed position is, however, most comfortable as in the case of the other joints. Injuries of the **shoulder** almost always mean crushing or breaking the upper end of the humerus. Recall the number of strong muscles attached to this portion of bone and realize how impossible it is to keep it in position when fractured. The head is useless, therefore it will be removed and the arm put up in an "*aeroplane*" or a *triangular* splint to fix it when healed, in a strongly abducted position; the man can then have excellent use of the arm proper. Recall the fact that the arm is swung from the scapula and the scapula from the spinal column and the side of the thorax. The scapula glides freely forward and back, or upward and downward and the arm moves with it, while the flexed position of the elbow joint will permit a good range of motion for arm and hand.

The Knee Joint.—So much of weight-bearing devolves upon this joint that loose ligaments can not

be allowed. Here also semi-flexion relaxes the greater number. If the leg is extended upon the

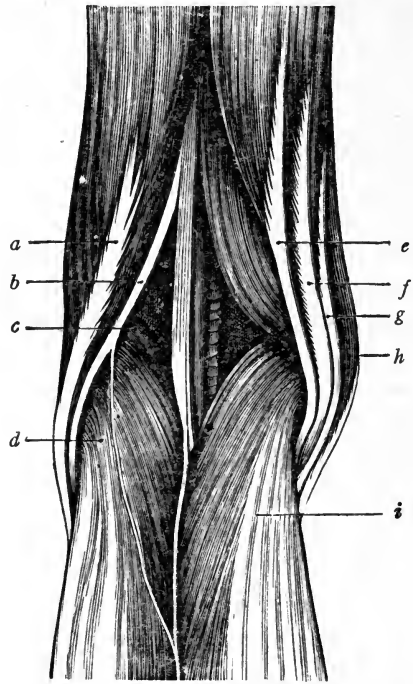


FIG. 24.—Popliteal space. (*Holden.*) Observe the tendons behind the knee joint—their muscles will be put on the stretch in extreme extension. *a*, Biceps; *b*, peroneal nerve; *c*, plantaris.; *d*, lateral head of gastrocnemius; *e*, semitendinosus; *f*, semimembranosus; *g*, gracilis; *h*, sartorius; *i*, medial head of gastrocnemius.

knee to the fullest degree a strain falls upon the *posterior ligament*, and also upon the tendons of the flexor muscles behind the joint—the biceps, semi-

tendinosus and semi-membraneous, and the popliteus as well.

NOTES.—Wherever very large vessels and nerves cross a joint, they are placed on the flexor aspect, where tension most seldom exists. The semi-flexed position is that of repose and in the upper extremity it is that of activity also, very much of the time.

Observe by testing, that if in any case it is necessary to place the hand in *extreme extension*, a flexion at the elbow joint will make this act less difficult.

Nothing can make extreme extension of the foot endurable. The same is true of the elbow, unless the forearm is in pronation. Here it is the biceps which is put on the stretch in extension, and the round pronator in supination; in pronation, nothing is badly stretched.

CHAPTER X

INJURIES OF THE HEAD

Practically all injuries of the *skull* involve the *brain* and one or more cranial nerves. The cases are always grave and of great interest. The wounds vary in character from a single puncture or one which appears to include only the scalp, to those with much damage of all structures involved. Serious symptoms with seemingly trivial external wounds, are found later to depend upon deep injury of bone with pressure upon the brain, and require from the first, intelligent observation and the careful handling which is demanded in the care of all cranial injuries.

It has been found that a man whose injuries do not actually forbid transportation, will do better if operation be deferred until he reaches the stationary or base hospital, than when it is done at once and the necessity for transporting him too soon afterward can not be avoided. The post-operative condition is a critical one and after-treatment is of vital importance to recovery, therefore the greater number of head injuries will fall to the care of the graduate nurse.

The man will probably be X-rayed as soon as

possible after arrival and then placed in the care of the nurse.

A good rule for general guidance is that a patient with an injury of the head (especially if hemorrhage is imminent or if the brain itself is injured), should be placed in a half-sitting position, and here is one of the instances where the nurse who is a master of pillows will score highest. (Remember the tendency to slip down in the bed, and provide pillows or rolls of some sort to prevent this—pillows under the knees strapped or tied to the head of the bed, and firm rolls at the feet. It is supposed that Fowler beds are not always available.)

For satisfactory inspection the scalp is always shaved; and as a routine measure a laxative will probably be ordered at once, and perhaps frequent doses of *urotropin* with the hope of protecting the cerebrospinal fluid from infection.

(NOTE.—In connection with the latter remedy the possibility of *bladder irritation* is to be remembered.)

It is probable that many such cases will be moved on for observation and diagnosis or treatment later, but it would be well for the nurse to understand symptoms of intra-cranial hemorrhage or other suspected conditions, that she may promptly report them and thus assist the surgeon in his disposition of the patient.

The man may have only a headache, and yet there may be a depressed fracture of the skull and even lodgment of a fragment of bone in the brain substance.

Intracranial hemorrhage causes pressure symptoms which vary with the location of the injury and are very like those of *bone compression.* Among the earliest are *headache* slight or intense, *drowsiness, mental dullness, giddiness* and perhaps *vomiting; irregularity* of *pupils* (the one on the injured side being widely opened) and *slow pulse.*

Any one or more of these should fix the attention of the nurse. A pulse still slower, with *rising temperature, flushing conjunctivæ,* conjugate *deviation of head and eyes* and *disturbance of vision,* with decided *loss of muscular power* in any part of the body, indicate advancing trouble and complete paralysis soon follows.

There is no established order for the appearance of the symptoms. Paralysis may be noticed first, but it is possible (or probable) that less conspicuous signs might have been discovered had they not been overlooked.

The prompt recognition of the necessity for operation will secure such gratifying results in the quick relief of symptoms from compression or hemorrhage, that the nurse will be more than satisfied with her share of the treatment. A cranial opera-

tion always means *excision* of the wound and **trephining,** and the nurse can not too soon learn to assemble the instruments and appliances for this proceeding and those which follow it. Methods for the control of hemorrhage are well established, but there is often much loss of blood and saline infusion or transfusion may be necessary. Be prepared therefore for both. The apparently bold handling of brain tissue may excite wonder, but if bold, it is no less gentle and accurate. If damaged brain tissue is found it will be removed, because it easily becomes septic and at best is only a foreign body after it has ceased to be normal. The wound is undoubtedly contaminated and without early operation sepsis is sure to occur.

The results of surgery of the head and brain are brilliant in the war hospital as elsewhere and even more spectacular; a patient with such serious symptoms as paralysis, loss of sensation, aphasia and epileptiform attacks, soon presents striking changes for the better and every promise of recovery, after appropriate operation upon the skull and brain.

It is impossible to describe in detail the numerous injuries and the great number of operations devised for their relief. But mention may be made of some matters of special interest in the conducting of brain surgery in a military hospital.

First.—Brain tissue is treated like any other tissue.

That infection has already taken place is the rule, and that possibility is never forgotten even while signs are lacking. Wounds are excised, foreign bodies and devitalized portions removed; if necessary, drainage is established. Rubber tubes, metal tubes, silver wire loops, capillary drains, salt sacs, gauze, all are used (the latter not often, as the soft brain tissue becomes entangled in the meshes).

The track of a bullet may be explored as in other parts of the body, and (if pus is discovered) a drain introduced. If this is done very soon after the injury is received further effects of sepsis may be avoided.

Control of hemorrhage by patches of temporal or occipito-frontal muscles, repair of wounded sinuses by fascial flap or pieces of fascia lata (cut large—it shrinks), the washing out of wound tracks and, still more wonderful—*rapid recovery.* Great delicacy of manipulation makes these things possible, aided by expert X-ray work and an accurate knowledge of cerebral localization.

"*Axiom.*—For head operations to be successful the incisions must heal before the hair grows." (*Major Hull—"Surgery in War."*)

Add to the above the operations for those most dreadful of war wounds which cause mutilations of the **face.** The great destruction of tissue renders them peculiarly distressing to the feelings of the

patient, as well as difficult of repair. Time and persistent effort added to great surgical skill have accomplished remarkable things for the sufferers from these injuries. Plastic surgery has here achieved signal triumphs; noses, cheeks, and eyelids have all been supplied and invention has provided ways by which the patient may be fed while repairs are going on. The Dental units have manufactured jaws and have almost persuaded teeth to grow in them. Fig. 25 illustrates a useful splint.

FIG. 25.—Dorrance's intermaxillary splint.

Danger of *post-operative hemorrhage* is due to the size and great number of severed arteries and in the early stage of recovery it is momentarily apprehended.

Further results of injuries of the head include those of the *cranial nerves*, with resulting paralysis or pain, or loss of sensation, in accordance with their location (see Fig. 26).

A wound or blow received at the side of the head and behind the ear causes loss of hearing, or if above and in front of the ear, loss of the power of articulation. At the back of the head a severe injury would

be followed by disturbances of vision, the visual centers having suffered. The parts involved may

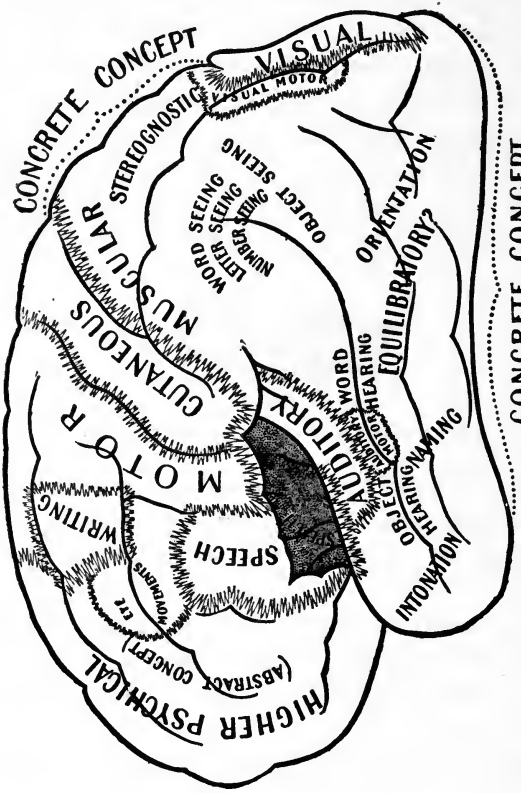


FIG. 26.—The areas and centers of the lateral aspect of the human hemicerebrum. (*C. K. Mills.*)

be seen in the illustration and the effects of their injuries are readily inferred.

At the side of the face loss of sensation and paralysis show that the fifth and seventh nerves are injured.

Fractures of the *base of the skull* are accompanied by hemorrhage and pressure symptoms; the escaping blood may appear at the external ear, or by the nose or mouth, according to the location of the injury. These are not always operative cases in the usual acceptance of the term; possibly decompression may be done for the immediate effect when an increase of intra-cranial tension is evident.

What share has the nurse in all this? To her is entrusted the securing of the final successful results of these wonderful operations, by protection of the patient from outside disturbance and from himself, that he may be content to rest without exertion and forget for a time his injuries and forebodings; by scrupulous care of drainage and dressings, and by the detection of any change of symptoms and recognition of their importance. No one else can accomplish these things and they are indispensable. The administration of suitable food is also of the very first importance. It must be nutritious and easily digestible and given in moderate quantities at regular intervals.

CAUTION.—Never leave the patient in the hands of an uninstructed assistant; attacks of excitement or of sudden delirium may occur.

Never Leave any Patient Without Instructing Your Substitute.

Shell Shock or Air Concussion.—The sudden rarification of the atmosphere produced by a passing shell is thought to cause intimate changes in the nerve tissues and perhaps gas emboli in the blood. The immediate effect of the air set in motion by the rapidly moving shell, may be to hurl the man to the ground and thus produce *concussion of the brain*, perhaps with hemorrhage in brain and cord; poisonous gases from the shell, or sudden emotion or fright all leave their mark, showing later as mental confusion, great depression, accelerated pulse, eye and ear affections, paralysis and wasting of muscles; all these may develop and still no external wound be discovered as the cause. Frequently the man is possessed by hallucinations and inability to exercise self control. The condition in these cases has been classed by a Russian writer as "air traumatism of brain and cord."

The symptoms are all more difficult to deal with than those caused by actual wounds. The rules for the care of individual cases can not be classified; all must be dealt with kindly and patiently as nervous cases. *Rest*, if possible in quarters removed beyond the sound of firing, and security from depressing influences are essential to recovery.

It has been suggested that the institution of pro-

phylactic measures in the way of preparing the soldier's mind for what is before him, might result in a diminution of the number of such conditions of the nervous system, since it is probably true that apprehension and terror have much to do with the complete breakdown of the man's resistance. He may be seeing himself a hopeless and helpless invalid. It might be pointed out to him beforehand that such need not necessarily be the case, that the majority do recover from such accidents; he then would, if one of the hysterically liable, recover more promptly—especially with intelligent care.

Many times a man is brought in from the firing line in a state of *unconsciousness* when he was perfectly well a few minutes before, the explosion of a shell near by having produced this condition without any external sign of physical injury. The symptom is due to compression, rather than to shock as the word is usually applied, and may last a long time—perhaps for several hours. One method to be applied consistently for his restoration is artificial respiration, long continued—not abandoned for 4, 5, or 6 hours, since "it is better to treat a dead man as though he were alive, than to treat a live man as though he were dead."

The effects of these accidents are always grave and recovery long deferred; both mental and physical powers return but slowly and sometimes the nervous system does not regain its balance.

For cases of long protracted unconsciousness, when it is impossible to detect by the eye the usual signs of circulation, a test has been made by the introduction hypodermically of a harmless stain in solution; fluorescin in a dilute alkaline solution was used for the purpose. If the blood is moving at all, this stain will show in the conjunctivæ in a few moments, "the eye-ball looks like an emerald in its orbit," proving that there is still some heart action although not appreciable by ordinary methods of detection.

Shell Deafness.—This is another *traumatic neurosis* associated with many other symptoms among which are tremor, sweating, increased tendon reflexes, insomnia, headache, unsteady gait, vertigo, etc. There may be total loss of hearing in one ear only and partial in the other. Recovery is slow and still slower is the ability of the man to grasp what is said to him or to remember it. Of course, destruction of the internal ear will cause total and permanent deafness, but if any sense of hearing remains training will improve it; this must be persistent as in other nerve affections, with careful avoidance of over-stimulation.

The nurse who has had experience with nervous cases will be most successful in these, as many symptoms caused by air traumatism resemble those of hysteria and neurasthenia, and while they are not altogether alike yet the care of the cases is very similar. Patience, gentleness, and tact are indispensable, and the ingenuity which will divert the

patient's mind from himself. If she is successful, the re-education of the auditory power will be steadily progressive.

The results of accidents with no external wound, but showing in changes in the nervous system, are numerous.

They include *amnesia* or loss of memory, *aphonia* or loss of voice, *visual disturbances* and even *blindness, deafness, paralyses* and contractures and many evidences of a nerve system completely demoralized. The diagnosis of the physical basis of these manifestations is not always easy, but as time goes on and experience broadens, it appears to many close observers that actual pathologic changes do underlie the majority. This is not difficult of understanding when the very delicate structure of nerve tissues is considered. Such affections are numberless and no attempt is made to include them in these pages.

Although not *surgical cases* strictly speaking, they will, as injured men, appear among such until assigned to the neurologic service now being rapidly organized.

CHAPTER XI

INJURIES OF THE NECK AND SPINE

Recognizing the fact that no square inch of the soldier's body is missile proof, one might classify wounds by the location in which they are received and enumerate for each one separately a list of damaged structures, but neither time nor space permit, and it is here attempted only to call attention to the importance and the vulnerability of the organs involved, in certain regions of the body, and to suggest the general principles of treatment appropriate to them.

The Neck.—It would be thought that a man could hardly escape with his life if the *jugular vein* were wounded, but such has been known to occur without proving fatal. Although bullets, etc., do not omit the region of the neck in their effects, they seem often to miss certain vital structures like the carotid arteries and the pneumogastric nerves, but bones, muscles with their nerves, and many vessels, are frequently severely injured. The attachments of the tongue and the lower jaw may be torn or destroyed, causing most distressing mutilation, and still more when the muscles of deglutition are de-

stroyed. The number of arteries is large and with their numerous anastomosing branches they bleed freely, while fractures of the cervical vertebræ cause damage to the spinal cord with all its attending and far-reaching consequences.

The *larynx*, *trachea*, *pneumogastric nerves* and *carotid arteries* all offer subjects for fatal injury and the sad reason why many of these cases are not seen in the wards is that the wounds *are* fatal, for they do undoubtedly exist.

Injuries of the Spine

All injuries of bones cause pain and more or less loss of motor power, owing to the disturbance of muscle attachments, but injuries of the bones of the spine or *vertebræ* result in damage to vastly more important structures than bone and muscle, because they involve the bony canal which contains the *spinal cord*. The effect of sudden violence upon the tissues of the cord and spinal nerves may be serious without external evidence of local injury to the bones themselves, but when lesions of the vertebræ exist they do of necessity involve the tissues of the cord or nerves or both. Owing to these close relations we include in the term **"injuries of the spine,"** lesions of the spinal column and the spinal cord with the nerve roots, and we measure the gravity of such

injuries by their effect upon other structures as evidenced by sensor and motor changes elsewhere.

Concussion of the spine may be caused by accidents, as the falling in of trenches or similar occurrences, the consequences of which are due to the sudden jar or pressure from external force, producing disability—as loss of motor power, impairment or loss of sensation and perhaps also a mental condition due to sudden yielding to the terrors of the situation. All these symptoms are more or less temporary if the conditions causing them are soon relieved; for instance, if the man is at once extricated from his dangerous position he will soon improve, and gets no farther than the second division of the field ambulance, or the "clearing station" at the farthest, and may not come to the care of the nurse at all. *Severe concussion*, however, leaves more serious effects, being usually caused by the forcible impact of a missile with actual damage to the tissues of the spinal cord; the vessels within the membranes may be ruptured or those within the cord itself, resulting in hemorrhages which quickly cause their effects, as seen in loss of motor power amounting to paralysis, or pain more or less severe. If the damage is extensive, time and rest may see the man recovered. The accurate observation of the nurse, however, is here of value, as the surgeon's decision in regard to further treatment will be founded upon the tendency

of symptoms, whether toward improvement or in the opposite direction. So long as she can see increasing muscle power and control of movements, operation may not be advised. On the contrary, loss of power and no abatement of pain should be daily reported that operation if decided upon may be done early.

Gunshot wounds of the spine produce all the lesions of both cord and column which can be inflicted—fractures of the vertebræ with displacement of bone and pressure upon nerve tissues; extensive fracture with missile lodged in the canal, and accompanying hemorrhage with pressure upon the membranes of the cord and upon the cord itself; crushing of bone with pressure of fragments which have passed through the membranes and are even imbedded in the cord.

The symptoms of all these will be paralysis, and either loss of sensation or pain, according to the locality and extent of the damage. These cases are all serious and demand the closest observation. The operation which may save the man to future usefulness, or at least, comfort, will be decided by a few comparatively slight indications. If only a *few* muscles below the level of injuries can move, if only a *little* sensation remains, the case may come to operation with ground for hope that the damage is not too great for repair. The X-ray examination

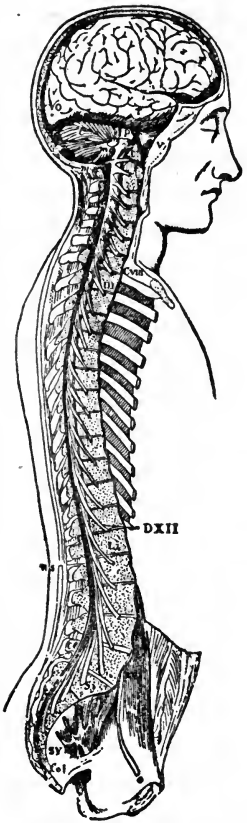
will show if a foreign body be present and removal indicated. The importance of early operation upon wounds of the spine is due to the fact that the delicate tissues of the cord are quickly injured by continued pressure and the impairment of nutrition which follow depressed bone or hemorrhage. It is a matter of note that pressure or the presence of a foreign body in the tissues of the brain or cord *influences the whole circulatory mechanism;* it seems to inhibit the processes of circulation, and to thus pave the way for devitalization of the tissues.

The spinal cord once severely damaged will not regenerate and loss of function of all parts below the level of the lesion will be inevitable and incurable; if once the tissues become devitalized. The difference in symptoms between *concussion or contusion* and *actual lesion* of the cord, resides in the temporary character of the former, in which the paralysis, lost reflexes, diminished sensation and weakened sphincters early manifest improvement, while in the latter case they grow progressively marked and serious, forming a positive indication for operation.

Operation once decided upon, the usual preparations are made—sterilization of the field and sterile dressings applied two hours before, etc. A local anesthetic will probably be chosen in order to avoid the danger of increased shock, hemorrhage, and

chest complications, which are more liable to occur in these than in other major operations because of the possible involvement of the systemic nerves and impairment of function. The patient may be placed for operation in the lateral position, therefore, a firm hard pillow should be provided, because while he lies upon the side the opposite knee and thigh are to be flexed and supported. After operation he may be placed in the prone position or on his back. The latter is the position of choice, but in some cases the patient must remain prone. In either case, study his comfort so far as possible. Not much can be done to vary his position, but little changes of head and feet are possible, and of the arms. Pads and small pillows may be brought into service and points of pressure changed here and there.

The nurse who remembers even a little of her anatomy will not be puzzled to know why an injury of small extent can cause so much more trouble in the cord than in the brain. A depressed fracture or a foreign body within the skull, as a bullet or fragment of shell, may not do so very much harm if uninfected and located at a reasonable distance from a vital part; at most it destroys some one or two powers of motion or sensation but does not affect the whole body. A lesion of the same size in the cord, however, involves wide areas of nerve distribu-



tion in its consequences. This may be understood by reference to the illustration (Fig. 27).

What are the results of serious damage to the cord? Paralysis of parts below the level, loss of reflexes, probably loss of sensation, and loss of control of sphincters. In addition to these, the effects of gunshot wounds show invasion by infected organisms which are carried in by missiles, etc.; and sepsis spreads rapidly along the membranes so that it is here more than elsewhere, a menace.

One of the dangerous complications of spinal cord injury is septic infection of the genito-urinary tract, to avoid

FIG. 27.—The brain and spinal cord. Serious injury in any portion of the spine above the 12th dorsal vertebræ cuts off motor and sensory nerve fibers which are connected with many parts of the body below that level. The higher the location of the wound the wider will be the area affected, since more nerve fibers are contained in the tracts in the upper part of the cord. (*Quain, after Bourgery*).

which the greatest care in nursing is necessary and even this may not be successful, therefore, the risk of operating is worth undertaking.

Another distressing condition calling for operation in an otherwise desperate case, is intense pain caused by pressure of fragments of bone imbedded, probably, in sensory nerve roots and not controllable by ordinary measures.

Nothing can be more gratifying than the successful operation upon the spine. The removal of laminæ (*laminectomy*) reveals the cause of the symptoms; as depressed fragments of bone, or it may be, a bullet and hemorrhage, with all the distribution of symptoms which have been mentioned. The removal of these will be followed by recovery provided complicating conditions elsewhere are not too serious. In one case reported in Major Hull's book, "Surgery in War," a portion of shell had fractured the laminæ of the 5th cervical vertebra and a piece of bone half an inch square was pressing upon the cord. All four limbs were paralyzed and there was loss of control of bladder and rectum. Twenty-four hours after operation signs of recovery appeared, which later was complete. Many such instances might be related of spinal surgery in the present war.

Injuries of Spinal Nerves.—Wounds of the extremities almost always involve nerves. The injuries

vary in severity, from bruising and shock to complete severance, and the results accord with the lesion, the nerve which is simply shocked showing some paralysis from which it soon recovers, but no permanent injury unless the bruise is severe enough to cause local irritation, when an area of fibrous tissue may develop which will cause more lasting weakness and probably, later, pain. A *partially divided* nerve is usually involved in the damage sustained by surrounding tissues and a painful condition will be caused by the adhesions and scar tissue which enclose it. If the nerve is *completely divided,* the peripheral portion will degenerate if left to itself, while the portion still connected with its centers will be able at times to grow, sometimes to an astonishing extent.

Nerves of every part of the body suffer from wounds in war but most frequently those of the extremities, especially the *ulnar* and *radial* in the arm and the *sciatic* in the thigh (Fig. 28).

Injuries by fragments of bone or other foreign bodies will receive attention when the wound is first treated, when, of course, all these will be removed. As nearly all gunshot wounds are infected even if only slightly, this fact is taken into account in deciding upon the time for operation upon injured nerves themselves.

If *a damaged nerve is not recovering* the fact may be known by loss of motor power, perhaps traceable to the pressure of scar tissue.

Trophic changes are visible effects of nerve injury, as seen in the condition of the finger nails which are curved and brittle, and the rapid growth of hair over

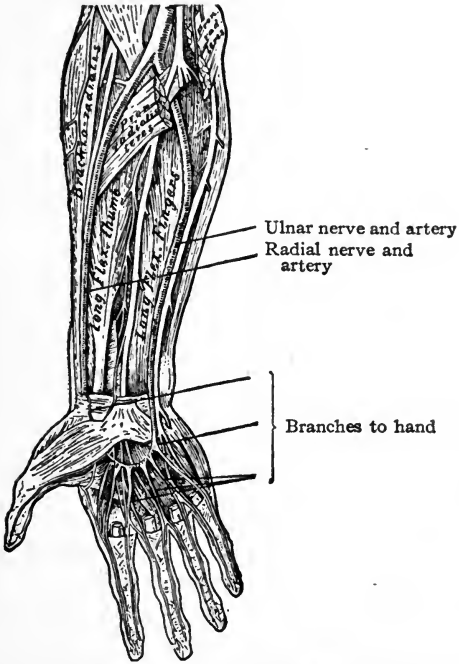


FIG. 28.—The forearm, anterior. Showing ulnar and radial nerves and their relations.

the parts supplied by the affected nerve; these accompany loss of sensation. *A tendency to ulceration of the skin* upon very slight injury is due to the

same cause; hot water which would not burn any other portion of the skin may produce a blister and ulceration. (An important part of the treatment of this local condition is to keep the lesions warm and protected from infection.)

Vasomotor disturbance is shown by sweating over the parts supplied by the nerve; for instance, if the median nerve is damaged, the part of the hand supplied by it becomes red and sweats continuously. It has even been observed that half of the ring finger may be moist while the other half is dry.

The *sensory* condition in the skin supplied by a damaged nerve should always be watched and reported. Knowledge thus gained is important in the light of possible operation. Burning, throbbing and aching sensations may exist and changed response to pressure, temperature and touch.

The electrical reactions of the muscles or nerves will be tested by the physician.

Operations will be done for the purpose of relieving severe pain or for restoring the use of muscles, by either freeing from damaged tissues the nerves which are distributed to them, or by splicing and suturing these with other nerves which are uninjured.

NOTES.—After the operation of nerve-anastomosis it is of the utmost importance that the limb be kept perfectly quiet.

Any motion or position which would cause even

the slightest stretching must be forbidden, and although massage and passive movements will be begun as early as possible, nothing of the sort should be attempted without explicit orders from the physicians.

CHAPTER XII

WOUNDS OF THE CHEST AND ABDOMEN

The Chest

Brief Review of Structure and Contents.—The boundaries of the chest or thorax are the spinal column at the back, the sternum in front, and the ribs at the sides, with the intercostal muscles in the intercostal spaces and the diaphragm in place of a floor. It is deeply covered behind by the muscles of the back, while the anterior serratus, the broad abdominal muscles, and the pectorals are closely applied to the sides and front.

The *intercostal* arteries and nerves are protected from injury ordinarily, by their position under the borders of the ribs, and are severed only when the bones are fractured or in a wound caused by penetration in an upward direction.

All muscles which are attached to the ribs are *muscles of respiration;* the intercostals have considerable power, but the diaphragm is most important. When it contracts it is depressed, increasing the depth of the thoracic cavity (while the other muscles broaden the cavity by lifting the ribs) and thus room

is made for expansion of the lungs in *inspiration*. As the ribs fall and the diaphragm ceases to contract,

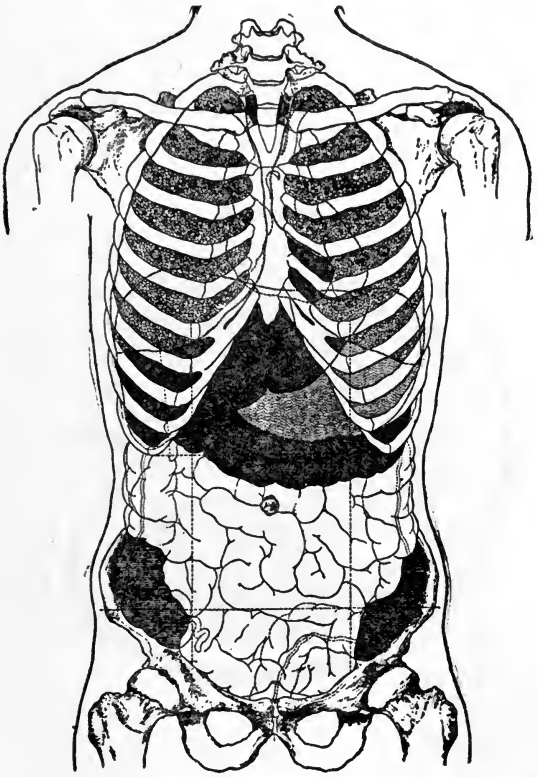


FIG. 29.—Thoracic and abdominal viscera, anterior. (*Deaver.*)

it rises, returning to its dome shape, and the air is pressed from the lungs in *expiration*, therefore paraly-

sis of this important muscle, or anything which prevents its contraction is a serious matter for the patient to whom it occurs.

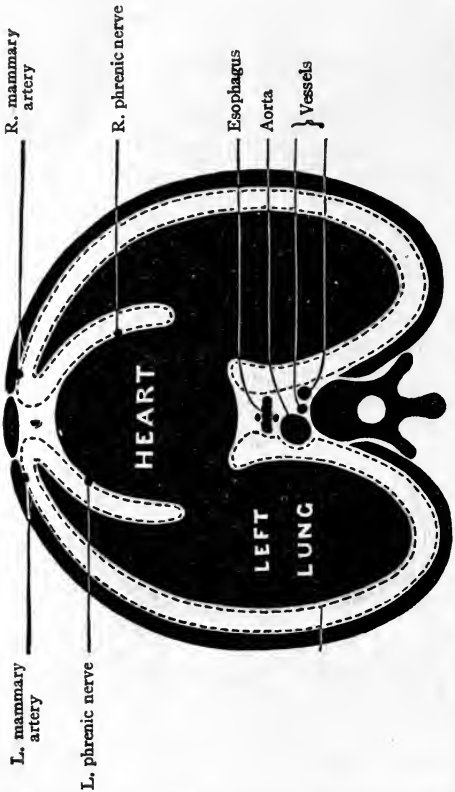


FIG. 30.—The pleural sacs. The dotted lines indicate the pleural sacs, with space between the layers. (*Holden.*)

The **thoracic viscera** are the *esophagus*, *trachea and bronchi*, *lungs*, and *heart*. The *esophagus* lies close

to the spinal column; and the *trachea* is in front of the esophagus, dividing into the large bronchi, whose

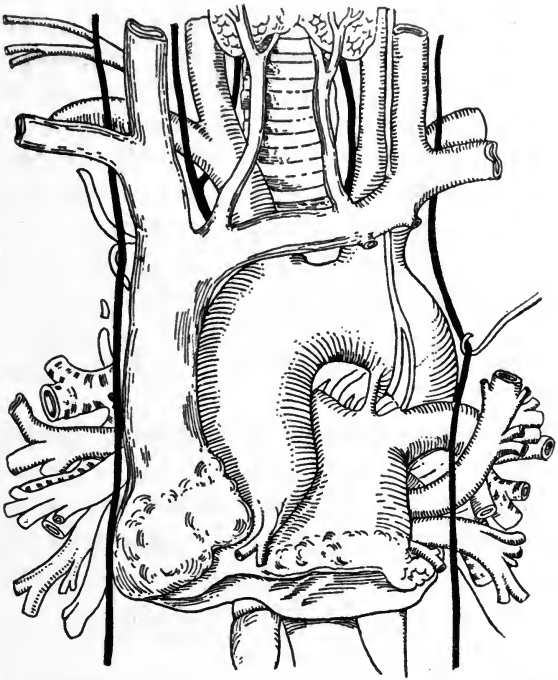


FIG. 31.—The phrenic nerves, right and left, run downward on either side of the great vessels and the heart. (*After Morris.*)

branches are the bronchial tubes. The *heart* and large vessels are in the anterior and middle part of the thoracic cavity (Fig. 32).

The *heart* is wrapped in the *pericardium*, and each *lung* is wrapped in a *pleural sac* which is placed between the lung and the chest wall. An incision through that part of the wall which is bounded by the ribs would pierce the *costal pleura* and open the *pleural cavity*. A wound of the lung would injure the *pulmonary pleura* as well (Fig. 30).

The large nerves in the thoracic cavity are the *vagi*, lying close to the esophagus, the *sympathetic*, whose branches form cardiac and pulmonary plexus, and the two *phrenic* nerves right and left which, arising in the neck from the cervical plexus pass downward into and through the thorax on either side of the pericardium to the diaphragm. Their importance is obvious (Fig. 31).

The **mediastinum** is the space between the lungs. In it all of the thoracic viscera except the lungs are situated, the most important being, of course, the heart and great blood-vessels with their nerve plexuses.

Wounds of the Chest Wall

These, if uninfected, are serious only because of the involvement of other structures. For example, fracture of the ribs is accompanied by hemorrhage from intercostal arteries and laceration of intercostal nerves, while sharp points or rough edges of the bones injure the lung tissue.

A comparatively simple wound in the region of the lower ribs will cause rigidity of abdominal muscles (which are attached to these ribs) and suggest a penetration of the abdomen. The patient should be kept quiet even if no other symptom appears until observation has decided the location of the internal injury.

The impact of a missile at short range or an apparently slight wound *without* penetration may still bruise the nerves and lung and perhaps cause spitting of blood. Temporary inhibition of the heart's action and unconsciousness may easily occur when no external mark is seen. Fractured ribs with pleurisy and (rarely) pneumonia are common and require the treatment with which the nurse is already familiar—strapping, enforced rest, ice bags if the lung is injured, careful observation, record of pulse, temperature and especially respirations, and all other symptoms.

Wounds of the posterior wall which involve the spine and spinal cord, have been mentioned and their consequences indicated (p. 141).

Wounds of Thoracic Viscera

Although the thorax (or chest) is occupied entirely by organs which are essential to life, many injuries in this part are sustained without a fatal result.

If they are sufficiently serious to bring the man to

the hospital he will present a condition of *shock*, and if infection has already occurred it will involve the pleura and the case will ultimately become one of *empyema*. Other symptoms will be influenced by

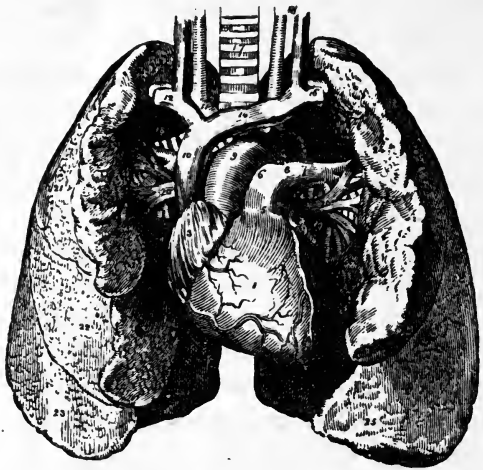


FIG. 32.—The lungs with heart between them.

the location of the wounds and the character of the missile.

Here, as elsewhere, *rifle bullets* and *shrapnel balls* cause least injury because the wounds are straight punctures. If they penetrate the lung they meet so little resistance that they pass directly through, leaving a small track only. Pieces of shrapnel *shell*

cause more damage, and from their shape are more likely to be retained in the injured tissues. Again, because of their shape they lose velocity and the effects are spreading (see p. 11).

Recalling the position of the organs in the mediastinum and their importance (Fig. 32) it is readily understood that the nearer to the median line the bullet enters, the greater the damage.

Also, just outside of the mediastinum the bulk of lung tissue is greatest and the vessels are large. The severe symptoms caused by injuries of large blood-vessels, however, do not always come on at once. Remembering this, observe carefully any signs of *increasing* weakness, or shallow breathing, and provide that the patient shall not be disturbed in any way. He should rest in the semi-sitting position and be absolutely quiet. No physical exertion is to be allowed. If it is necessary to remove clothing it should be cut off rather than removed in the usual way. Every precaution of this kind should be continued until the danger of severe hemorrhage is passed and the patient can be transferred to a base hospital.

Where there is great damage to the lung tissue the patient will be shocked to the verge of collapse. The heart sounds will be hardly audible for hours; the pulse will be almost imperceptible with a rate of 140 or more; respirations will be painful and difficult,

shallow and frequent even to 60 or 80 per minute, causing a distressing sensation of want of air.

Spitting of blood is common and hemorrhage is to be apprehended.

The temperature rises after recovery from shock, varying between 100 and 102° for a few days usually. If infection has taken place it reaches a higher mark, assuming a septic character and the systemic effects are similar to those in other parts of the body. When pus is formed drainage will be instituted.

NOTE.—Wounded lung is exposed to infection from two directions; first, by organisms carried in *with the missile* and again by those in the atmosphere which is inspired *through the mouth*, therefore endeavor especially to protect the patient from dust or other atmospheric impurities for the reason that they add to the danger which already exists.

The appearance of the patient and the temperature as well are much like that of pneumonia, with the respirations rapid and shallow and the pulse running at about a hundred, and the "*pneumonic flush.*" Cough is troublesome with free expectoration of purulent substances and the movements of respiration are restricted. In cases which recover the duration of the symptoms will vary from ten days to a month. With suppuration going on in the lung the greatest care must be taken to persuade the patient

to exercise cleanliness. The internal remedies selected will be such as to act as disinfectants and more particularly as deodorizers, such as creosote given by mouth and by inhalation, turpentine, etc.

NOTE.—In administering the inhalation it is not necessary to cover the patient's head as is usually done. It is enough if his nose and mouth are included in the funnel which conveys the steam. Otherwise he emerges with moist, sensitive skin, damp hair or beard, and an almost inevitable chilling of the head and neck succeeds the treatment.

The operations for which preparation is most frequently to be made are *aspiration* and *resection of ribs*. In the latter case, the care of the drainage tube is of first importance. Sometimes this tube is connected with another, long and flexible, which leads to a basin of mild antiseptic solution. When the patient coughs air from the lung is forced through the tube by the expiratory act, and as a rather deeper inspiration follows a little of the fluid will be drawn up into the tube, so that it is partially filled, and sealed with antiseptic solution. The motion of suction thus caused is beneficial as it tends to assist the free flow of the material to be drained away from the wound.

COMPLICATIONS

Hernia of the lung sometimes occurs, for which moist, sterile dressings (kept *always* moist) are used.

Constantly and persistently followed up, this measure has accomplished satisfactory results.

Bronchitis is serious, requiring most scrupulous care and every precaution against exposure to drafts of air, especially if it is laden with irritating particles which would cause coughing. **Pneumonia** is still more serious. It exhausts the patient's vitality so that he improves slowly, if at all. Abundance of fresh air is important, but on no account must he be allowed to feel chilled. In a badly damaged lung *abscess* will probably form, especially if other organs, as the liver, be included in the track of the missile.

The occurrence of **pneumothorax** or escape of air from the lung into the thorax, requires that the patient be placed in a semi-sitting position unless it is impossible to make it comfortable for him, in which case he himself must decide how many pillows the nurse shall place under his head and shoulders. Rest is here more than ever imperative for at least ten days or two weeks, as muscular effort will cause an increasing volume of air to pass into the chest with each act of breathing.

Unfortunately this is often a fatal complication.

It is quite different from *artificial pneumothorax* produced for the purpose of compressing a diseased lung which is not wounded, by the introduction of air or gas into the thorax from without.

Hemothorax or hemorrhage into the pleural cavity presents the usual signs of hemorrhage elsewhere, with *air hunger;* the bleeding is not always rapid and symptoms do not develop suddenly, therefore one need not be taken by surprise.

It is a frequent complication. If moderate in amount the pulse rate will diminish to 85 or 90 in a few days, the respirations will number less than 30 and the temperature also will mark the improvement; but when the amount of the effusion is greater —perhaps displacing the heart—the pulse rate goes above 100°—and respirations reach to 35 or more per minute; then aspiration may be performed and several ounces of blood withdrawn.

The combination of *pneumothorax* with *hemothorax* is unfavorable, increasing both the distress and the danger of the patient. When air is entering through an external wound in the chest wall an operation is sometimes done for closing the wound either entirely or partially, to give relief. A firm bandage, or strapping over the dressing, may be resorted to for the same purpose.

Infection of the fluid in hemothorax is common, and serious; the symptoms to be watched for are pallor of the face with perhaps a flushed area, dry tongue, anxious expression, elevation of pulse, respiration and temperature, and perhaps nausea or vomiting—in other words, the signs of empyema.

Again, aspiration will probably be performed, and perhaps resection and drainage.

Involvement of abdominal organs in the wound which invades the thorax. The possibility of this complication will be recognized by recalling the fact that the floor of the thorax (the diaphragm) is dome

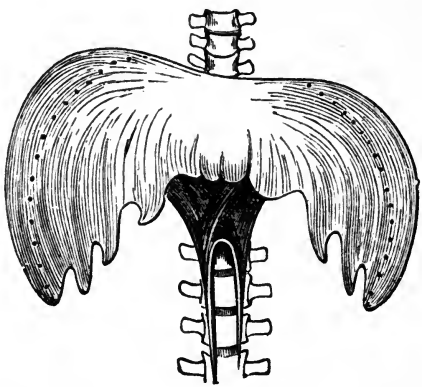


FIG. 33.—The diaphragm. Dotted lines indicate descent in contraction. (*Holden.*)

shaped, rising to the level of the fifth rib on either side of its central tendon (Fig. 33). The abdominal organs which lie immediately beneath the hollow of this dome are inevitably wounded by a missile which enters *transversely* into the lower part of the thorax, as for example the liver, stomach, or spleen. In this situation, however, there is but a thin portion of lung to be pierced, but a missile which takes an

oblique direction either upward or downward, would injure not only an abdominal organ but a greater bulk of lung tissue; the consequences would be doubly serious and often fatal. To the shock of thoracic is added that of abdominal injury, with perhaps hemorrhage of grave character, and the dangers accompanying the laceration of organs.

All of the complications named constitute grave cases, requiring much care and long treatment with special attention to diet and supporting measures.

Wounds of the Abdomen

In the case of wounds of the abdomen the possible complications, owing to the number of vital organs in close juxtaposition, present serious problems to the surgeon and therefore to the nurse as well. A wound with a non-infected weapon in a non-poisonous atmosphere, administered by a keen thrust through clothing not specially infected, might not leave serious consequences, but in the present war these conditions do not exist. Infection and sepsis are to be expected, the patient's condition carefully watched, the symptoms scrupulously noted and reported.

Note.—All abdominal wounds produce severe shock.

Brief Review of the Nine Areas of the Abdomen and Their Contents (Fig. 36).—On the anterior surface of the abdomen observe the *linea alba* between the two

rectus muscles, and the semilunar lines (or *lineæ semilunares*) at the sides of the recti. The *transverse*

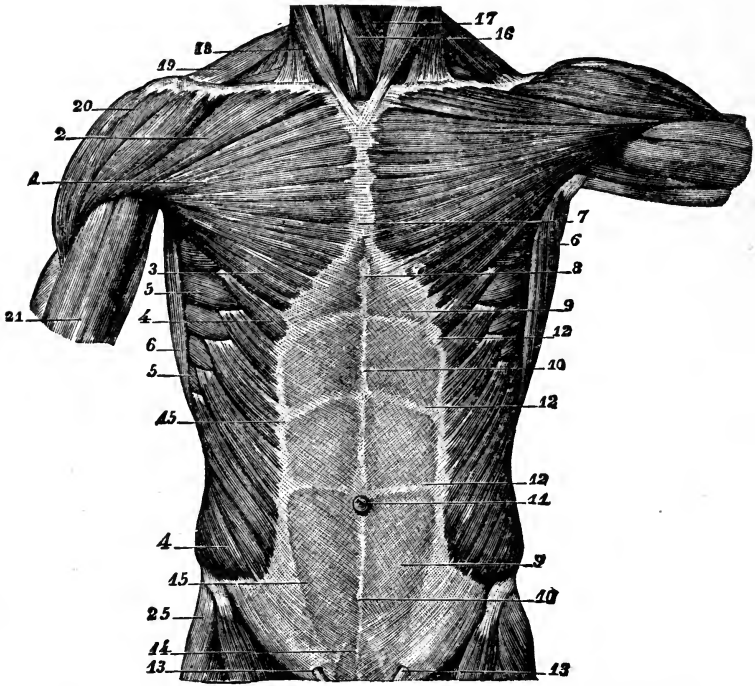


FIG. 34.—Showing the *linea alba*, the *semilunar* and the transverse lines. In a muscular subject they are very evident.

lines (*linæ transversæ*) may be seen when the recti contract. An important outline is made by the lower ribs, between the thorax and abdomen, the two sides

meeting in the *subcostal angle* just below the sternum. The *scrobiculus cordis*, or "pit of the stomach," is a slight depression at the very point of this angle,

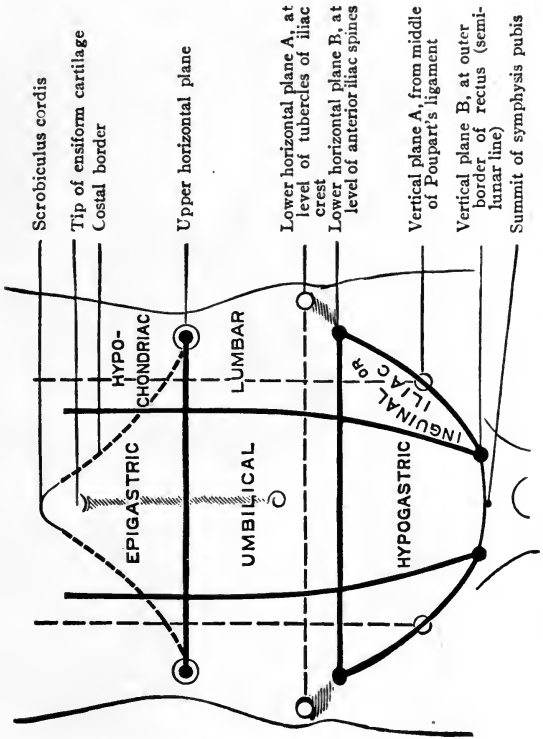


FIG. 35.—Diagram of the abdominal regions. (*Morris.*)

caused by a weak spot in the attachment of the abdominal muscles. If the abdomen is greatly distended, the depression disappears (Fig. 35).

When abdominal distention has reached the point of obliteration of the scrobiculus cordis, the action of

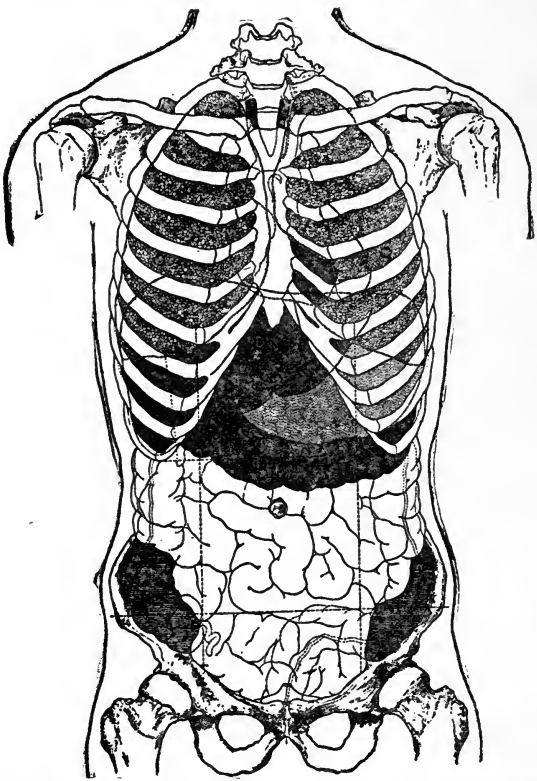


FIG. 36.—Thoracic and abdominal viscera, anterior. (*Deaver.*)

the diaphragm is embarrassed and respiration is interfered with (see p. 151). Paralysis of intestinal

walls, as in the relaxation and loss of peristalsis in shock and some major operations, is a frequent cause of this unfortunate complication.

The **abdominal viscera** (Fig. 36) are the *stomach*, *intestines*, *liver*, *spleen*, *pancreas*, *kidneys*, and *adrenal bodies*. The *great vessels* are at the back. The *sympathetic ganglia* are at the sides of the vertebræ, with the celiac and other *plexuses* situated on the large vessels.

The *kidneys* are behind all of the other viscera, and the *ureters* run down close to the posterior wall of the abdomen on their way to the bladder.

The *receptaculum chyli*, or beginning of the *thoracic duct*, is in front of the second lumbar vertebra. The *inferior vena cava* lies on the right side of the aorta.

The principal organ in the *epigastric* region is the *stomach;* in the *right hypochondriac*, the *liver;* in the *left hyp chondriac*, the *spleen*. The *umbilical* region is occupied mostly by *small intestines*. The right and left *kidneys* are in the two *lumbar* regions, with the *ascending colon* in front of the right, and the *descending colon* in front of the left kidney. The *cecum* and *appendix* are in the *right inguinal* region; the *bladder*, in the *hypogastric*.

Each region contains portions of several viscera in addition to those named. Scarcely any organ save the spleen and cecum can be said to belong to but one

region. The small intestine, for example, is seen in all but those of the upper zone.

The **peritoneum** is a closed sac of serous membrane like a water-bag, which is placed between the abdominal wall and abdominal viscera. It is practically in front of the viscera, and tucked in around them at the sides. One side of the sac is closely applied to the abdominal wall, and is called the *parietal peritoneum*, while the other side is fitted to the viscera, and called the *visceral peritoneum*. Normal peritoneum is perfectly transparent, and the viscera are plainly seen through the visceral layer. The *peritoneal cavity* contains little serous fluid and nothing else.

An incision in the abdominal wall, including the *parietal peritoneum*, opens the peritoneal cavity. An incision into one of the organs involves the *visceral peritoneum*, with these exceptions:

The posterior surface of the liver.

The posterior surface of the ascending colon. The kidneys.

The transverse portion of the duodenum. The front of the bladder behind the symphysis. *These parts have no serous layer.*

It is stated by some surgeons in the present war that wounds caused by bullets passing through the three *medial* regions (the *epigastric*, *umbilical* and *hypogastric*) are more serious than those of the lateral regions (the *hypochondriac, lumbar* and *inguinal*), and that those of the umbilical region are most serious of all. Others consider the "side to side"

wound, lower down, more dangerous, and equally so, the antero-posterior buttock and hip wounds.

Recall the organs which occupy the *umbilical*

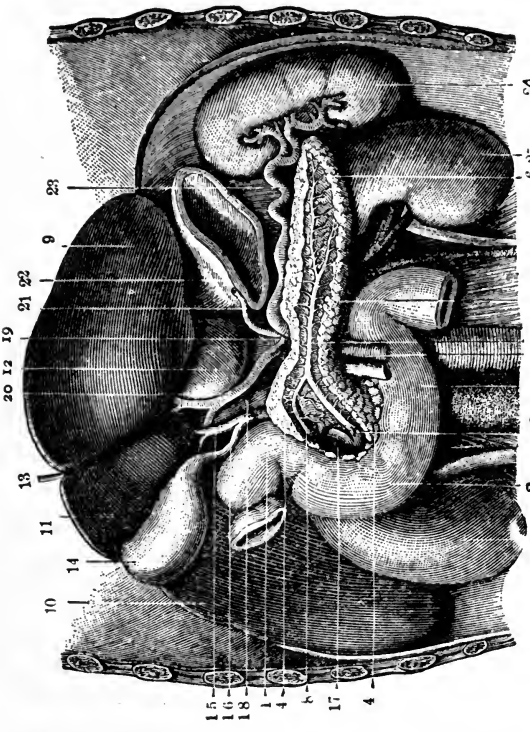


FIG. 37.—Showing the *pancreas* and *duodenum*, large vessels, and ducts of the liver (the stomach is removed and the liver turned upward to reveal these structures). The location of the spleen and kidneys also is seen.

region—several coils of small intestine are there to be punctured—always a serious accident; the omentum in front and the mesentery behind with its

many vessels, will be damaged; the pancreas may be injured, large arteries and nerves may be severed and the duct of the pancreas or liver as well (see Fig. 37). Operations for wounds in this region are therefore very serious; the patient may be already in a critical condition and collapse is to be apprehended. Therefore preparations must be made for shock, and for hemorrhage in which the symptoms are quite similar, for here are many large arteries with a network of anastomosing branches.

When the condition is very grave, operation will not be attempted.

In the *epigastric* area there are few structures to be injured (if the large vessels escape); probably the stomach will be punctured, but this although a serious is not necessarily a fatal wound, especially when it is inflicted while the stomach is empty, as is apt to be the case in battle.

In the *hypogastric* region, wounds of the bladder, rectum and other portions of the intestine are more serious. In the *lateral* regions the wounded liver or kidney may recover without operation. The colon may be punctured but with less probability of general peritonitis than in the case of the small intestine, although the escaping fecal contents are more likely to cause sepsis.

Even without the additional strain of operation, abdominal injuries produce severe shock. Due to

this and the hemorrhage which so frequently occurs, the *white face, quick breathing*, and *rapid small pulse* which always mean trouble, will be present even with no great amount of pain or tenderness. These symptoms alone may present themselves but they call for constant watchfulness. They are sometimes due to a marked degree of the *rigidity* of abdominal walls which is Nature's defensive attitude when the muscles are protecting a wounded organ. If the same symptoms exist, however, *without* pain and tenderness or rigidity, they more definitely suggest *hemorrhage*, and in a majority of fatal endings from abdominal wounds, hemorrhage is the cause of death. If, after some days local pain and tenderness appear—with a rise of temperature—look out for peritonitis and again, perhaps with hemorrhage. This inflammation or peritonitis accompanied with jaundice, suggests a lesion of the liver and bile ducts and the escape of bile into the peritoneal cavity.

If the kidneys or the bladder are wounded blood will be discovered in the urine and probably severe pain will accompany micturition. Since it has been decided that patients with abdominal injuries have a much better chance for recovery with early operation, special measures have been instituted to ensure the possibility of this proceeding and an operating room will be in constant readiness.

The multitudinous duties of the operating nurse

are well defined and have been already briefly outlined. Each class of cases requires its own procedures and each surgeon has his own method; all will be quickly learned in the emergencies of the circumstances, and they can be learned in no other way.

Various kinds of missiles may be lodged in the abdomen without causing symptoms but discoverable only by the use of the X-ray. Bullets will probably not be removed under those circumstances, but fragments of shell or of shrapnel are not safely left as they may cause abscess, or erosion of the blood-vessels, with their consequences.

After-care of Operative Cases.—The patient is to be placed comfortably in a half-sitting position, with the knees somewhat flexed, the tension of the abdominal muscles being thus relaxed. This will direct the spread of the peritonitis, if it occurs, to the lower part of the abdomen away from the movable organs. No solid food should be given, but water if there is great thirst, is granted in tablespoonful doses every ten or fifteen minutes, even if perforation of the bowel is suspected, as it is rapidly absorbed in the upper part of the alimentary tract. Even with hemorrhage, water may be given in this way, because the ready absorption will meet the demand of the system for fluid which could not be safely given by saline transfusion or hypodermoclysis. Liquid food may be given at once if the wound is only that

of a solid organ or if it is known to be in the lower part of the bowel. Pituitary extract will probably be ordered to overcome shock and prevent distention of the bowel.

No laxative will be ordered for five or six days nor the administration of an enema, as even a low enema will cause peristaltic movements of the bowel, extending far above the rectum. When the time arrives a safe proceeding is the injection of a small amount of glycerine in the rectum *preceded by* an injection of *pituitary extract.* The surgeon may consider it necessary, later, to order calomel in ¼ gr. doses every hour up to five grains. Milk is not advised as food in these cases, except in very small quantities, on account of the flatulence sometimes caused by it, and the bulky stool. Benger's food made without milk, meat juice, or meat essences are more suitable, eggs are quite allowable, being digested in the stomach and duodenum and almost entirely absorbed before reaching the bowel. Solid food never—until after the expiration of a week; perforation and hemorrhage have been caused here as in typhoid fever by too early use of solid food.

The patient is to be absolutely at rest—no exertion allowed for any purpose; he is not to raise his head while lying supine or while half sitting because involuntary action of the abdominal muscles

is unavoidable even in so slight an exertion as lifting the head from the pillow. Lift it for him, by a hand slipped underneath the pillow; treat him as though he already had a hemorrhage; perhaps he has and the symptoms are not showing. Watch unceasingly for blanching of the face, increasing pulse rate, or difficulty in breathing. Know the location of organs; instruct assistants, so that they may know the possible dangers and emergencies to be prepared for.

The above directions apply also to those whose desperate condition classes them as non-operable. Such will probably be the nurse's own patient and she will feel a justifiable pride in her work, if happily she should pull him through to safety after all. It has been known that the assiduous care of a nurse has saved the life of a patient with a supposedly fatal wound of the abdomen.

NOTE.—*Abdominal operations* in war time are far more serious than in time of peace.

First, the condition of the man was unfavorable when the wound was received.

Second, in the worst cases time has elapsed before operation is practicable and peritonitis is already present.

Third, the impossibility of knowing just what damage is done necessitates greater risk in the undertaking.

CHAPTER XIII

TRENCH DISEASES AND AVIATOR'S HEADACHE

Trench Frost Bite.—This name is applied to a condition of the lower extremities resembling gangrene. Although it has been termed "frost-bite," the parts are not necessarily frozen, but have been subjected to a prolonged exposure to cold and wet. It has prevailed in the trenches because early in trench warfare the lack of drainage caused the feet and legs of the men to be immersed in water for days and weeks at a time, and *prolonged exposure* rather than the degree of cold, appears to be responsible for the disease. The symptoms are those of inflammation caused by cold; these may be erythema only, or blisters and peeling of the cuticle; sometimes even the superficial death of the skin follows, or gangrene of some portion. *Edema* occurs early and induration of the tissues will damage the muscle fibers. Results of experimental research indicate that *damage to the blood-vessels* is the cause of these symptoms. In some cases the vessels rupture, causing minute hemorrhages into the connective tissues. Usually discoloration of the skin arises

from the great number of these hemorrhages, but although they produce a resemblance to the color of gangrene, they do not constitute evidence of its presence.

Trench frost-bite is favored by the fact that when in the trenches the soldier's boots are almost never removed and he has very little walking exercise, as the men have at times been obliged to remain long in one station with the feet immersed in water. Special care in the treatment of these cases must be exercised to *prevent rapid return* of circulation in the limbs; the application of heat in early cases is therefore contraindicated. It would cause congestion and swelling of the vessels which in their weakened state they would not be able to withstand. The precautions, in other words, are similar to those exercised in the care of frost-bite under any circumstances.

The resemblance between the results of exposure to freezing temperature and those of long exposure without freezing, have led to the use of the same term in both cases.

A somewhat different condition has been called "*trench foot.*" This also occurs oftenest in cold rainy weather. Investigators report a fungus (not named) which invades the feet of those standing long in the water of the trenches, causing peripheral neuritis with numbness, prickling, burning, etc.

Local treatment has usually cured the affection; occasionally some portion of the toes has been lost. Boric acid and camphor solution are used, applied on cotton compresses. Sometimes copper sulphate is applied in addition. It is claimed that amputation has not followed this treatment (further than the loss of part of the toes), although septicæmia has been known and, *rarely*, tetanus. Neither patient nor nurse should be discouraged by the gradual and tedious rate of improvement.

Aviator's headache is of interest although *not surgical.* It is probable that pathologic conditions at present not recognized nor explainable, will develop with the increased number of army aviators. The problem of physiologic adjustment to high altitudes is a rather serious one; as the man ascends he must breathe air which is increasingly rarefied, consequently, he is getting less and less oxygen. This leads to his "aviator's headache," rapid heart action, labored respiration and general discomfort. It is believed by some physiologists, that by a mysterious and fortunate provision of Nature oxygen is extracted from living tissues and delivered to the blood in the lungs, after the needs of the system are so great as to compel it. It is thought that this physiologic process will be developed in response to the demand, and for those who are training for aviator's work a gradual process of adaptation to rarefied atmosphere should be insisted upon.

The treatment of "*aviator's headache*" is in the hands of the patient. More oxygen would seem to be suggested.

More serious conditions and symptoms would be due to suddenness of change in *barometric pressure.* The aviator will encounter these only if he rises *rapidly* to a height of 20,000 feet, which is hardly possible, therefore the headache and loss of breath comprise the ills he has to meet, with the addition of extreme changes of temperature. All these may yet bring him to the hospital.

A number of conditions of ill health among the men in the trenches are of frequent occurrence and sufficiently serious to require hospital care. These are not surgical cases, therefore will not be described at this time. Such are *trench fever*, and various forms of *malaria*, the so-called *trench nephritis*, with the occasional appearance of *typhoid* and *para-typhoid fevers*, although these latter have been largely prevented by the immunizing inoculations which are made obligatory in some armies, notably in that of the United States. Sanitary precautions and modern methods of caring for troops have reduced the number of cases of *dysentery* which in the past has prevailed extensively among them.

The entirely unprecedented methods and conditions of the present war have been accompanied by equally unforeseen affections more or less serious in

their consequences to the health and the life of the soldier. For instance—a form of *nephritis* has existed among the men in the trenches which has been attributed by some investigators to a special infection. A certain organism (a *diplococcus*) has been found in a series of cases under observation. The conditions of trench life are of themselves sufficient to cause congestion of internal organs which would make them peculiarly sensitive with or without the invasion of specially infectious bacteria. Nephritis of such origin is not commonly serious enough to threaten life.

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