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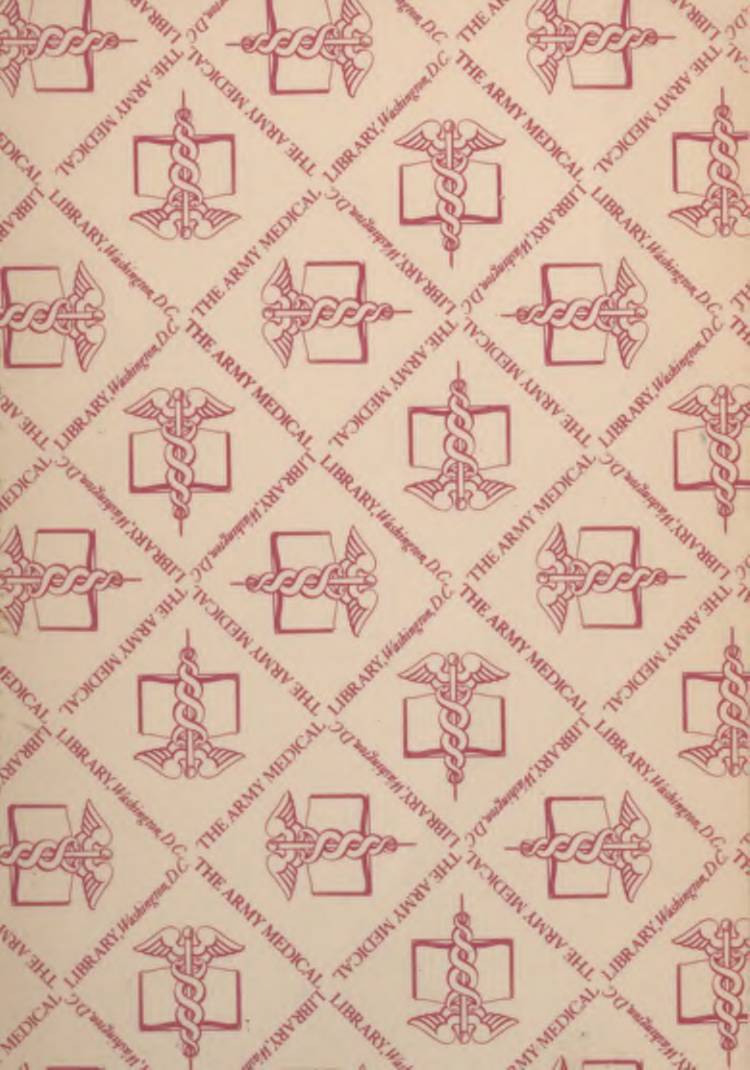
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ANTISEPTIC METHODS AS APPLIED IN ACTIVE MILITARY FIELD OPERATIONS

FROM THE FRENCH OF

E. FORGUE

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SURGICAL ANTISEPTICS

IN

SANITARY ORGANIZATIONS ON THE FIELD.

REGIMENTAL SERVICE, AMBULANCES, FIELD HOSPITALS.

PREFACE.

It would be a mistake to imagine that the complete methods of asepsis, as practiced in the clinics, can be applied to surgery in time of war, or, on the other hand, that the ordinary rules are entirely sufficient to meet the exigencies of the battlefield.

In the sanitary organizations at the front, the surgeon will have to meet difficult and critical situations. The changes in the line of battle, losses in the medical staff—for bullets fly wild and do not always respect the Red Cross—medical supplies exhausted, the sudden influx of wounded after a hot fray, the necessity for swift action: all these conditions peculiar to surgery of the battlefield cannot be compared to the quiet and thoroughly organized methods of hospital service.

Regimental surgeons, surgeons in charge of ambulances or of field hospitals, will have to act not only with decision and firmness, but they must be ready to improvise with intelligence. Of course, it is impossible

for us to foresee all the hazards of war. The case changes according to the fierceness of the action, the number of wounded, the topography of the country and the results of the fight. However, it is useful and wise to consider in advance the general conditions of these organizations under different circumstances; to determine the ordinary difficulties and how to overcome them; to map out a program, with ample room for changes or additions, according to events. This is the purpose of these pages. We wish to give a course of technical and practical instruction. As asepsis is so firmly established, we need no theoretical preamble.

Following the concise style of the Rules and Regulations, we intend to give a set of formulae, avoiding doctrinal arguments and impracticabilities. We very well conceive that in modern warfare a program meets with unexpected obstacles: our organizations on the front line will often be thrown out of order by the rapid firing of the infantry and by the long shots of the artillery. Even when the staff of an emergency post believe themselves out of gun range, they will present to the enemy the appearance of a confused mass and will soon become an excellent target. In spite of all, however, a plan is useful, as it prevents false moves and delays in organization. Finally, the best condition for a well regulated assistance is Victory.

I.

REGIMENTAL SERVICE.

FROM THE LINE OF BATTLE TO THE EMERGENCY POST.

Section 1. *The wounded must be picked up and carried off as soon as possible; transfer must precede dressing of wounds.*

One cannot repeat it too often, said Percy: the first aid and the first comfort given to the wounded is to carry him off promptly and comfortably. To carry off the wounded man is the important duty of the stretcher-bearer; to dress the wounds will be more specially the duty of the more competent and well organized staff at the emergency post.

The precept of Volkmann must be observed with the greatest care: *the first dressing decides the fate of the patient and determines the subsequent course of the wound.* How many infections are caused by a hasty temporary dressing (in spite of all subsequent antisepsis). Immediate cleanliness is worth more than all secondary cleaning. On the battlefield, can true antisepsis be

practiced? Let us admit that material contained in the air and water-tight dressing-truss may, after being opened and taken out of its wrappings, remain in a satisfactory condition of cleanliness. Let us take for granted that, due to its superior make and its perfect wrapping, the individual package remains, even after many contacts of campaigning and of camps, protected against rain, dust and unclean soakings. There will always be lacking to that antisepsis of the first hour the essential condition: asepsis of the hands. It is one of the most difficult principles to drive into the heads of half-instructed people—among whom the majority of our stretcher-bearers are recruited—that manual disinfection is of the utmost importance. These aids, therefore, must be particularly well taught on this point. But, however well instructed, you cannot expect from them the impossible: can a stretcher-bearer lift a wounded man, touch his clothes, cut or unbutton them, strip him of his arms and of his equipment, sometimes of his shoes, and still keep his hands in a sterilized condition? Disinfection on the very spot is practically out of the question; everything is lacking, water first and time as well.

In serious cases, such as comminuted fractures with large openings of egress, wounds caused by fragments of heavy projectiles, and lesions of the abdomen or of the thorax, it is better to avoid possible contamination

from an imperfect first dressing. In these cases it is more to the interest of the wounded to ask of the bearers a service of rapid transfer, rather than of kindly nursing. Through awkward and hurried manipulations, the patient runs many risks. A badly regulated exploration or an inopportune displacement can be followed by most damaging consequences, such as inoculation carried into the inner depths; complete separation of splinters still attached by periosteal attachments; production of irreducible overriding; vascular ruptures or breaking off of clots that have realized spontaneous haemostasis.

That our bearers should have the moral energy and the physical strength to insure transportation at full speed of the wounded towards the emergency post, will be their best antiseptic work. They should, furthermore, be trained to handle, take hold of and carry with the most careful precautions the seriously wounded, especially cases of fracture. The emergency apparatus spoken of in the regulations are simple ways to insure the immobility of fractured limbs, especially the lower limbs, which, for the reasons mentioned above, is an important factor in antisepsis. But it takes time, and as dressings applied by inexperienced hands will have to be inspected at the emergency post, one might wonder if this time and this care ought not to be given up to the rapid transportation of the other

wounded. A large sling under the back made of sacking, looped strings, and elastic suspenders for binding the lower limbs together and attached to the stretcher itself, will afford a means of rendering the limb immovable, and will insure a fair condition of the injured man until the relief post is reached. Bichloride compresses placed at the openings of ingress and egress, and retained by a sling knotted or by a few rolls of bandage, will be far better and safer than the direct contact with the garments; but it must be done quickly, without shaking the limb and without any contact between the fingers and the wound itself, the haemostatic forceps being used to push in and block the compress.

Sec. 2. *Directions in the case if severe hemorrhage.*

One fact is established by numerous experiences, and that is the frequency of hemorrhages in wounds caused by modern bullets of small caliber and great speed. We must, therefore, teach our bearers a few simple and rapid methods of accomplishing immediate haemostasis. It is greatly to be feared, however, that these first haemostatic dressings will prove to be the source of serious contamination to the wound. This has been noticed even in ordinary surgery, and is easily explained. Copious hemorrhage always makes a startling impression on inexperienced persons: at

the sight of blood gushing freely, our bearer may become frightened and act against all the rules of antiseptic dressing. Indeed, one must have a long surgical experience to acquire precision and coolness in a case of serious hemorrhage. We cannot hope to teach our regimental assistants the course of the blood vessels and the principles of direct haemostasis, but we can teach him to swiftly bind a limb at its head by an improvised tourniquet, making compression either by means of a knotted string or of an elastic suspender. Do not expect him to attempt arterial haemostasis with the only haemostatic forceps contained in his truss, forceps sterilized on the spot in the flame of a match or of a twist of lighted paper. Instruct him to use it to push up into and pack the wound with a compress of bichloride gauze; to strengthen this packing with the solid pressure of several windings of bandage, and thus produce an antiseptic haemostasis. This is especially useful in wounds of the head, the neck, the arm pit, the groin, the hand and the foot. Well trained to this, our bearers may accomplish fine work. "One of my soldier-nurses," says Lustreman, "named Verdun, whom I had promoted to first private, twice was able to stop, by good compression, a very profuse hemorrhage of the femoral artery, giving me time to come and tie the vessel."

Sec. 3. *Slight wounds and light dressing.*

To dress the wounds of the soft parts, superficial sword cuts and the slight wounds caused by side arms, is, primarily, the work of the bearer, the work more congenial and natural for him. In these cases, immediate antisepsis is less important, contamination less dreaded and dressing more rapid, being reduced to the mere closing of the wounds. Powder lightly the wound with iodoform, or other dusting powder, cover it with a folded compress and a layer of wadding or oakum, then fasten all with a few turns of bandage. This can be very quickly done, and constitutes for these traumatisms sufficient antiseptic protection. But one must never forget that the first care is to the seriously wounded: humanity calls for it and surgical therapeutics demand it. It would be unpardonable to dilly-dally with minor dressings, when wounded men would soon die if their speedy transfer were delayed.

Sec. 4. *Cases when immediate transfer is impossible.*

In these cases there is no absolute formula, for the battle does not take place according to rules of tactics, nor the strict lines drawn in sham battles. The conditions of the battle may be such that both as bearer and as nurse the assistant's capacities will be taxed to the utmost. During the preparation for battle, the

troops march to the front, utilizing all the natural protections of the ground—the hillocks, hollows, etc. Under such circumstances, the following cases are very probable:

A group of wounded are gathered and placed under shelter by one or two squads of bearers; they cannot be transferred to the relief post, for the intervening space is open here and there and is being fired on by the enemy.

Or it may happen that the conflict has been so fierce that large numbers of wounded have accumulated at several points; to carry them off takes time, and immediate relief is absolutely necessary.

A dressing shelter must be improvised on the spot, and the stretcher-bearers are compelled to make the first antiseptic dressing. If this dressing is a sufficient one, the soldier-nurses will deserve the greatest praise.

The first requisite is to select a place behind a raise of ground out of danger from the enemy's fire.

Cans of water are put to boil over fires made of any handy material.

The wounded are placed in as comfortable a position as possible, the garments slit up and the wound uncovered.

Having sterilized the hands in as hot water as can be borne, the helper proceeds to wash the wound, sprinkle moderately with dusting iodoform powder,

pile on bichloride compresses; on top of this several layers of oakum, and finally wrap up with absorbent cotton fastened by several turns of bandage. What has already been said of the treatment of hemorrhage is sufficient. In case of fracture, the limb can be rendered rigid by means of any emergency apparatus, or when such is lacking, by the use of guns, bayonets, etc.

Remember that when there is time, the irrigation of all wounds with water (at a temperature of 125 deg. or 135 deg.) that has been boiled for half an hour is the very best antiseptic treatment.

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AT THE EMERGENCY POST.

Summary.

I. General disposition.
II. Organization of the post.
    (*a*) Rapid getting up of a field stove.
    (*b*) Necessity of strict distribution of the work.
    (*c*) Improvising of a dressing table for immediate surgery.
    (*d*) Classification of material.
III. Asepsis of the surgeon and his aids.

IV. Asepsis of the materials.
V. Surgical functions:
(*a*) Slight wounds.
(*b*) Fractures without complications.
(*c*) Operations of immediate urgency.

I. GENERAL DISPOSITIONS.

According to the rules, emergency posts are not far behind the reserves of the regiment—that is, about 3,000 feet behind the front line, or 6,600 feet or so from the artillery of the enemy. These distances are not absolute, but they are the average, and serve to point out under what dangerous circumstances the sanitary service is called to serve.

It must be understood, once for all, that to do good work, not of surgery, but of simple dressing, the emergency post must have a certain fixity in its settings. To observe antisepsis, even in its simplest form, means that materials and personnel cannot be constantly on the go. When in a good place a dressing-station is once established, it is to the interest of the wounded, and essential to proper antisepsis, that it remain fixed and not following the changes in the line of fire. Of course, the battle will not be as rapid as the sham battles; with the smokeless powder and the strength of the guns, the preparation for attack will be slow, and there will be pauses and intermis-

sions, which will allow us to go and come more quietly.

First, the chief surgeon of the regiment must not hasten to locate the emergency post; otherwise he will deprive himself of a part of his resources. It would result in false moves, useless unpacking, danger of loss of materials, loss of time and possible disorder when the real attack begins. During the preliminary contests it is wiser to utilize the trusses of the bearers and the kits of the soldiers.

Next in order, the chief surgeon groups his staff and materials; he has at hand all the doctors and all the nurses of the regiment to insure the proper workings of the emergency post. Unity of action is the indispensable condition of discipline and method required by antisepsis. "The scattering" in vogue among the combatants is most perilous in sanitary tactics. The chief surgeon will assign places according to aptitude and functions, will appoint the dressing-squad, will prescribe the unpacking of materials, the fixing up of the post. Thus organized, under one direction, the personnel and the materials constitute a regular sanitary corps, able to divide itself according to the phases of the battle, able to separate into three posts, well linked, corresponding to the three kinds of material of the battalion, and to follow the battle front without moving the first post or disturbing their work.

II. ARRANGEMENT OF THE POST.

An emergency post is to be prepared. The shelter is rather scanty, but the volleys will not reach it; it may be near a wall, but better behind a slope or high embankment, so as to be protected from bullets and long shots of artillery.

The personnel and wagons are grouped in order at that place, marked by two pennons. Each squad of bearers has taken its stretchers and cans. The chief surgeon gives the order for unloading baskets, cans and kegs, which must be constantly filled. As water is used freely, a man must be sent to find out the possible means of fresh supply. If wagons cannot come near, then the materials are to be brought on stretchers.

Rapid getting up of a field stove—its usefulness for the asepsis of the materials.

This is imperative: hot water for the antiseptic washing, for grogs and stimulating drinks; boiling water for sterilizing metal instruments, plugs, compresses, draining-tubes, suture and ligature threads. Without delay, two men will build a field stove, with three or four fireplaces. It would be wise to always carry, on each battalion wagon, a provision of dry wood, dead branches, etc., and not to wait until the last moment to hunt up wood.

Now, the fire is lit in the stove. The plates or dishes are found in the camping materials. There are always enough sacks available: to have the utensils clean, and to do away with greasy cans, the chief surgeon can easily make up the necessary set, which will not add much to the load of the wagon. In one or two large kettles several quarts of water are kept boiling, for following purposes: 1st, for washing hands and immediate surroundings of the wound; 2d, for compresses; 3d, for antiseptic liquids; 4th, for irrigation of contaminated wounds. Add to this water a handful of salt to the quart: according to the experiments of Tavel, salted water boiled for fifteen minutes is sterilized, whilst ordinary water must boil thirty to sixty minutes to attain the same condition. The doctor must have taken a provision of salt: under ordinary circumstances it is easy to take in a good supply beforehand. In another kettle a dozen or two linen compresses should be boiling; they are to serve as an antiseptic protection for the operated parts, and will be slipped under the limbs or the wounded region; they can be used as aseptic cloths, on which can be placed the unpacked materials of dressing and for urgent operations. Plenty of medium and small linen and gauze compresses should be boiled; there are never enough of them; they are the best sponges to wipe the bleeding parts; they will protect the flesh,

keep in place the viscera, cover all the epidermis, except the spot where the surgeon works, are useful for haemostasis, and even serve temporarily as iodoform compresses by rapid and light sprinkling of the drug over them

The assistant surgeon, having asepticised his hands, must begin at once the preparation of wads of absorbent cotton for use as sponges. These wads are dipped into some antiseptic solution, pressed together and tied with a few strings, then thrown into a basin of boiling water. The same basin may be used for sterilized threads and drainage tubes. The cover of a kettle will serve to hold metal instruments that have been sterilized in the salt solution.

Strict distribution of the work is absolutely necessary. The various duties should be assigned in advance, and as far as possible the same helpers should always perform the same functions. Give orders clearly and distinctly, order silence and set a personal example for coolness. By strict discipline and by the co-operation of the various squads all preparations will be made without confusion or loss of time.

Improvising a dressing table for emergency work.

It is fatiguing to dress a wound bending over or squatting down by the side of a stretcher. The results are less satisfactory and there is more danger of

sepsis, particularly if the ground has been recently ploughed over by cavalry or artillery. There are several ways of converting a stretcher into a temporary table. First, if a ditch is near by, the stretcher can be placed across it. If the post is behind a slope, a step may be dug out with a pickax or bayonet, the head of the stretcher placed on it and the feet supported by forked branches planted in the ground.

A light folding frame of steel tubing built specially for supporting stretchers would be exceedingly useful. When the stretcher is in place it should be covered with a waterproof cloth, which can be easily cleaned with a cloth after each dressing.

Classifying of material.

Antisepsis requires that all materials and instruments should be placed in separate groups according to different surgical needs; otherwise there is loss of time, with consequent confusion and impatience.

In the emergency post there is no table upon which to spread out materials, but the tail-board of a wagon, or a stretcher laid across two empty baskets will answer the purpose. Upon this improvised table the following articles are to be laid in order:

First, beside the usual enameled dish for instruments, kettle covers can be used, after purifying them by burning a little alcohol in them.

Keep the enameled dish for haemostatic forceps, a lid for other instruments, and a third for suture implements, threads and needles.

Second, a basin of small compresses and another of sponges; a reserve basin of sponges, of which there can never be too many.

Third, the dressing basin of carbolized or bichloride solution. There should also be an extra dish of antiseptic solution and a basin of warm boiled water.

Fourth, a large platter containing large boiled compresses lying upon sheets of cotton, packages of oakum and rolled bandages, in the order of their intended application.

All this should pass directly from the aseptic hands of the helper to the hands of the surgeon.

III. ASEPSIS OF THE SURGEON AND OF HIS ASSISTANTS.

If the regiment wagon contains but one operating apron, it will be found necessary to supplement it by a towel tied around the neck.

The sleeves must be rolled at least half-way up the forearm; with our uniforms, it is all one can do. Perhaps it would be more advantageous for the surgeon to have sleeves open on the side, or at least buttoned on the cuff.

In the basket are two cakes of antiseptic soap, and two nail brushes. Two basins are required for asepsis of the hands. In the first one, brush thoroughly with soap the nails, which must be kept short, the subunguial space and the articular folds; three to five minutes are needed for this most important cleaning in order to dissolve thoroughly the greasy substances rich in bacteria. Brushing in alcohol to complete the scouring of the skin, rubbing on permanganate, followed by discoloration in oxalic acid, etc., are practicable in clinics, but not in field surgery. The hand, after a thorough soaping, is to be rubbed for two or three minutes in the second basin, filled with the antiseptic solution; carbolic acid seems to us better than bichloride, and we agree with Lister when he claims for carbolic acid an affinity for the epidermis, a more thorough permeating action and a power of combination with fatty substances. Once aseptic, the hands must preserve their purity and avoid all doubtful contact. This detail should be carefully carried out, and it would be well to continually inspect the hands of nurses.

IV. ASEPSIS OF MATERIALS.

We will briefly consider this paragraph, not having to study it theoretically, nor to describe the methods in vogue in hospital surgery. Here, we must be satis-

fied with swift and simple methods: work well with small means and work quickly.

Disinfection through boiling seems the most normal method for a relief post. To have boiling water is possible under all circumstances and in all places; we have already outlined the organization of that service. On our stove can boil: 1st, several quarts of salt water; 2d, a lot of large and small compresses; 3d, wads of absorbent cotton for sponging wounds; 3d, silk-wormgut and spools of braided silk; 5th, the metal instruments. In all, four to five basins: one kettle for salt water, one or two for the compresses, a large basin for the sponges, gathered in a knotted compress, and for the threads and drainage-tubes; lastly, a cover of a large kettle for the instruments. All this to be on the stove as soon as the post is organized, so that when the surgeon begins work every article will have been boiled thoroughly. Our dressing materials, if carefully prepared and well packed, do not need long sterilization.

Compresses and sponges.

Bichloride gauze and sponges remain aseptic and do not need sterilizing, but linen compresses and ordinary cotton sponges must positively be sterilized if they are to come in contact with open wounds.

Instruments.

When pressed by circumstances, metal instruments can be disinfected by alcohol; pour in the enameled basin some alcohol, put in the instruments, and let it blaze for a few minutes. When there is time, it is safer to boil them, adding to the water bicarbonate of soda in the proportion of 1 to 100; this salt should be kept in a tin box. Asepsis of instruments is most important. We will consider it at length in the ambulance section: at the emergency post, operating is not so extensive and the instruments are limited. A difficulty arises in attempting to render aseptic such instruments as are provided with wooden handles, as well as those whose blades are set in fusible cement; heating or boiling is out of the question. With such instruments, there is only one way of guarding against contamination: keep the handles and blades extremely clean; before and after using wipe carefully the blade in a sterilized compress, moistened with a strong solution of carbolic acid, and wrap the handle with aseptic gauze.

V. SURGICAL ORGANIZATION OF THE POST.

The surgeon highest in rank will distribute the cases and specify each man's duties.

(*a*) LIGHT WOUNDS—A squad should be detailed to care for minor injuries. If, however, the staff of the emergency post is too small to handle the number of wounded, one or several squads of nurses and musicians, according to the arrival of the wounded, can be employed for the simple dressing, such as bullet wounds in the soft parts, shallow wounds without fractures of the limbs or without visceral injuries.

(*b*) UNCOMPLICATED FRACTURES—Another group would attend to fractures uncomplicated by hemorrhage, requiring but antiseptic dressing and immobility, this squad to be under the immediate direction and the constant control of an assistant surgeon. In these two groups, use antiseptic washings with great care: first, to save water, the supply being limited; secondly, because a bullet does not carry septic germs, excepting when dragging in fragments of clothing; thirdly, because, according to Schimmelbusch, there is no better irrigation for cleaning the wound than the aseptic blood gushing from the inner parts; and lastly, because a badly regulated irrigation could bring to the wound some diluted dirt from neighboring integuments. When the soiling by mud or detritus calls for cleaning, the nurses should keep the wound covered with a compress or a large sponge while the neighboring skin is scoured. The dry dressing is the best in these cases. The wound should be

sprinkled with iodoform, covered with an aseptic compress and a layer of cotton or oakum.

(*c*) OPERATIONS OF IMMEDIATE URGENCY —Serious cases requiring immediate surgical interference are to be turned over to a squad consisting of a surgeon and three or more of the best nurses. One will directly assist the surgeon; this helper, if possible, should be an assistant surgeon; a second helper will have charge of the sponges and compresses, another will hand the instruments, and toward the end of the operation, the drainage-tubes and the threads: thus we count at least three helpers, to which add a bearer, whose duty is to hand the basin filled with warm antiseptic solution for washing the hands, to fill the irrigator and to receive the parts cut off. In very few cases, during a battle, will the surgeon be able to do anything save a rapid cleaning of the wound; if a bony fragment shows itself free, or if a strip is visible, it must be excised, but time and facilities will be wanting for a splinter operation, according to rules. What is absolutely required is a dressing as aseptic as possible and then perfect immobilisation. Hemorrhage will demand instant attention. Many die on the field from hemorrhage of a main artery. Others reach the emergency post, either because the external tunic being stretched or torn, has produced spontaneous haemostasis or because compression has been applied

in time to stop the loss of blood. The circular bandage or tourniquet has frequently to be applied at the extremity of the limb and over the clothes. The rules of antisepsis and the ischaemia resulting from the compression together with the fact that possible fracture must be looked for, render it imperative that the circular pressure be done away with as soon as possible.

The surgeon gradually loosens the constriction and applies the haemostatic forceps to the bleeding artery. If possible, he is to ligate the vessel at both ends. If impracticable, allow the forceps to remain in the wound well covered with compresses, but without putting on any pressure or giving any cause for movement. If the forceps are aseptic, they may remain during the time necessary for complete haemostasis: twenty-four hours for average sized arteries, forty-eight hours for main arteries. This method has been frequently applied with success. No so-called preventive incision must be made—only those strictly necessary to catch bleeding vessels or to secure antisepsis. No probing of wounds of the chest, abdomen or skull and no primary amputations—that is to say, no amputations other than the mere trimming of a limb irremediably mutilated, as by the explosion of a large projectile. One saw cut and a few incisions to clean up the ragged stump are all that is permissible.

This surgical work, rather limited in its scope, must

be done dry, as much as possible. The warm stream from an irrigator may be used, however, to cleanse a traumatic focus, to dry up capillary hemorrhage and to disinfect the deeper parts. But these washings should be minimized and wet dressings should be used. Dust with iodoform, cover with several layers of bichlorided gauze and use cotton for wrapping. This dry dressing is the best and can remain a long time in position. There is produced a sort of antiseptic crusty cicatrisation. The deep layers of the dressing agglutinate in an adherent shell when the blood has dried. This we have often observed. If the wound has no bad odor, the dressing need not be changed right away. Frequent changes of dressing are to be avoided; it is a loss of time, causes pain to the patient and only irritates the granular formation, and by exposing the wound allows of the possibility of bacterial infection. Dry dressings; few dressings: this is the motto in military surgery.

THE AMBULANCE.

II.

I. General dispositions.

II. Organization of the ambulance.
   (*a*) Fireplaces.
   (*b*) Water.
   (*c*) Tables.
   (*d*) Organization of the squads. Distribution of the materials.

III. Asepsis of the surgeon and of his assistants.

IV. Asepsis of the materials.
   (*a*) Basins, etc.
   (*b*) Instruments.
   (*c*) Compresses and sponges.
   (*d*) Sponges of absorbent cotton.
   (*e*) Linen compresses.
   (*f*) Silk thread.
   (*g*) Silkworm gut and metallic thread.
   (*h*) Catgut.
   (*i*) Draining-tubes, probes, tourniquets.
   (*j*) Antiseptic solutions.

V. Surgical rules.

I. GENERAL DISPOSITIONS.

The ambulance presents more favorable conditions for thorough antisepsis than the emergency post, and the shelter is better and more permanent.

Usually it has been conceded that the ambulance is located at some 5,400 feet from the line of fire of the enemy and at some 9,000 feet from the artillery. As a rule, yes; but in some cases the ambulance has had to co-operate on the very front; we know several chief surgeons who did not hesitate to go, marching under the cannon and taking their positions with the emergency post. So here again we meet with the same difficulties as in the organization of an emergency post, the only difference being a distance between them of several hundred feet. But the ambulance has the advantage of a superior stock of instruments, and will have the prominence in surgery.

The ambulance must be well located to insure good antisepsis, and must also be so divided as to answer emergency calls during the battle. Antisepsis is not possible with frequent changes and movings about.

II. ORGANIZATION OF THE AMBULANCE.

(*a*) FIREPLACES AND STOVES—If the chief surgeon has chosen a house for the location of the

ambulance, the arrangement is simplified; the kitchen stove can be used for boiling of the surgical materials; the household crockery and kitchen ware will be very handy; water, wood and salt are there. The division of the work proceeds more rapidly. Frequently the ambulance, or at least its second section, is compelled to go to the front, so as to remain in touch with the emergency posts. There is no dwelling in the vicinity, and the work will have to be done in open air, sheltered by some obstacle of height corresponding to the distance of the enemy's batteries. The more distant the batteries, the higher must be the obstacle. The same conditions then are present as for an emergency post, except for the advantage of having more materials and a more thorough organization.

This second condition is half-way between the ordinary post and the sheltered ambulance. Fireplaces must be built immediately, as in the posts.

What has been said regarding the emergency post pertains to this section of the ambulance.

(*b*) SUPPLY OF WATER—The supply of water is of the first importance. Modern surgery, for asepsis and washings, uses it abundantly; the thirst of the wounded is well known, and the condition of shock in which they are necessitates the preparation of hot and tonic drinks. The wagon carries fifty quarts of water, in two reservoirs. That is enough to

begin with, but a continuous supply must be provided for, and when the ambulance is in the field the possibilities of steady supply should be carefully considered. On top of the baskets in the wagon is a ten-quart iron pail and six pails for carrying water. When the ambulance is in a house, of course these difficulties do not exist.

(*c*) OPERATING AND DRESSING TABLES—In the wagon there is an operating table with a back. Cover it with a narrow mattress or a thick sheet and a waterproof cloth. If strong kitchen tables are to be got, so much the better, for they are steadier and enable the surgeon to dispatch his work more swiftly. It will be necessary, however, to arrange temporary tables for the two or three dressing squads. For this purpose stretchers on poles may be used, if out doors, or, if in the house, boxes or an unhinged door will answer.

(*d*) ORGANIZATIONS OF THE GROUPS AND DISTRIBUTION OF THE MATERIALS—"The chief surgeon must direct the service so as to avoid any tumult and confusion, which would hinder good work. He will divide his staff into three squads: the first, for receiving and sorting the wounded and for the ordinary dressing; the second squad, for surgical operations of immediate urgency; the third, for com-

plicated dressings requiring the use of apparatus for immobilizing."

Each squad unpacks and assorts in its appointed place the materials pertaining to its function.

On the tables covered with boiled compresses each squad spreads out its materials.

First, the articles for disinfection of the hands: three iron basins, two antiseptic brushes and two antiseptic soaps.

The same basket (one for each squad) contains three enameled dressing basins. In one, place the sponges of sterilized cotton or the gauze compresses for dressing, which may take the place of the sponges if necessary. In the second, place the boiled linen compresses.

In the third, a carbolized or bichloride solution for washing. Put the materials for suture and ligature, catgut, silkworm thread, thread, needles and reels, etc., into a separate dish.

The two dressing squads will not need many instruments: scissors to cut the threads, a couple dressing forceps and a few haemostatic forceps, which are all easily contained in one basin, preferably rectangular. The operating squad will not need more than six enameled basins. The largest of these basins will contain the haemostatic forceps; the second, the scissors, dressing forceps, grooved directors and retractors; the third, the knives and bistouries; the

fourth, the instruments for osteotomy; and the fifth, the rubber bands for haemostasis.

When the ambulance is in or near a house, various pieces of crockery can be added: basins, soup-tureens and platters, which will allow further subdivision of these articles.

III. ASEPSIS OF THE SURGEON AND OF HIS ASSISTANTS.

A basket should contain eight gowns. If these are are wanting or soiled, use an apron (the same basket should contain at least ten aprons) and a napkin or towel tied around the neck; the sleeves rolled up as high as possible. Twenty aprons are reserved for the nurses.

We need not repeat how important is asepsis of the hands. The methods we have already discussed under the rules for the emergency post apply equally to the ambulance.

IV. ASEPSIS OF MATERIALS AND INSTRUMENTS.

(*a*) We must again emphasize the necessity of absolute cleanliness of materials, basins, etc., and instruments, all of which must be continually scrubbed with

soap and hot water and afterward brushed with alcohol and then left in the salt solution.

In cleaning instruments by burning in alcohol care must be taken not to allow the steel to become too hot and thus tarnished.

(*b*) Where a large number of instruments are to be asepticized, the most practical method is that of boiling in a one per cent. bicarbonate of soda solution for about ten minutes.

If bicarbonate of soda is not obtainable, borax will do, or in extreme cases even lye, wood ash, etc., can be used.

After boiling, the solution should be strained off, leaving the instruments dry.

Kitchen utensils that have double bottoms with perforations in the upper bottom, or wire strainers, etc., are very convenient to hold instruments while they are being boiled. Small instruments and needles should be wrapped in a compress before boiling, so that they will not be lost when the liquor is decanted.

The method of overcoming the difficulty of making aseptic such instruments as have wooden handles, or whose blades are set in cement, has already been explained.

(*b*) COMPRESSES SPONGES—The disinfection of sponges is always risky, for they can only be sterilized through chemical process, which is tedious and un-

satisfactory. Gauze compresses are the best artificial substitutes. From a bolt of gauze cut pieces about one yard square; fold them over and over four times and baste quickly. These compress sponges are perfect and easily handled; they fill up bleeding cavities well, and wipe off the surface smoothly; they are superior to absorbent cotton, because no bits of cotton stick in the wound, which is to be feared, particularly when operating in the abdomen or at the contact of bony fragments, upon which the wadding catches; they are absorbent and are well sterilized in half an hour's boiling.

(*d*) ABSORBENT SPONGES—These sponges, prepared as stated in paragraph concerning the emergency post, and tied together in a compress to prevent their scattering, will all be perfectly asepticized by boiling.

(*e*) LINEN COMPRESSES—Linen compresses, which are also sterilized by boiling, have many uses. The large ones surround the operated zone or isolate the limb to be operated. The medium ones are used to push aside strips of flesh, and in amputations they may be folded into other complicated compresses. In resections or removal of long splinters, they will shield the fingers of the assistant who opens the wound and will help to keep open the edges of the wound. They will be very helpful in covering and

separating the haemostatic forceps, which, in a profuse hemorrhage, are numerously employed and are very embarrassing. It is therefore well to have a large supply on hand.

(*f*) SILK THREAD—After thirty minutes boiling, braided silk thread is thoroughly sterilized; and pieces of thread, cut according to need, should pass directly from the sterilizing apparatus to the sterilized hands of the surgeon.

(*g*) SILKWORM GUT AND METALLIC THREADS—Silkworm gut is asepticised by boiling, as well as silver thread. Their advantage over braided threads is their smoothness, which prevents imbibition and consequent carrying of septic material from the surface to deeper parts of the wound. These sutures are the more valuable the more the likelihood of external contamination.

(*h*) CATGUT—Catgut we do not approve for surgery on the battlefield. Its asepsis is obtained only by a long and careful process; its adhesiveness is variable, its absorption irregular. Silk for ligatures, visceral sutures, deep stitches, and operations on the neck; silkworm gut for superficial stitches and silver thread for bony unions are specially recommended.

(*i*) DRAINAGE-TUBES, PROBES AND BANDAGES FOR HAEMOSTASIS—Drainage-tubes and rubber bands for haemostasis can be sterilized by boil-

ing. Boiling spoils quickly the probes made of gum: it is best to clean them by rubbing soundly their surface with a sterilized compress and by injecting into their canal some antiseptic solution.

(*j*) ANTISEPTIC SOLUTIONS—On this subject there is but little to say. Iodoform, carbolic acid and bichloride of mercury are the three best bactericides, and the ambulance has always a large quantity of them. Iodoform remains the same, never varying in its effects; it neutralizes chemical toxines, a most valuable property in the prophylaxis of lockjaw, which if of frequent occurrence in surgery of the army. In quantity, however, it is dangerous, and it will have to be given cautiously. The carbolized and bichloride solutions are easily prepared from concentrated solution or compressed tablets. The water used must first be boiled and poured into purified basins. Carbolic acid is far superior to the bichloride for cleaning the integuments, on account of its biting action on the skin and of its affinity for organic substances. The bichloride exerts, in a very small quantity, a great antiseptic force: diluted to 1.2000, 1.3000, it will destroy at least the ordinary bacteria.

V. SURGICAL OPERATING IN THE AMBULANCE.

(*a*) ORGANIZATION—"Operative intervention," says M. Demmler, "is connected with the examination; the incisions, the removal of splinters, already constitute intervention, and it would be dangerous to interrupt it and let another person continue. It would increase the chances of contamination."

We believe, on the contrary, that division of the work is a guarantee of its good execution. All will depend upon how the wounded are sorted, and for this it is necessary to have an experienced surgeon. This classifying is not absolute, and a patient sent to the group of one operating table may be passed on to the third group. The two groups will operate near each other, in adjoining rooms in the same hall, or in the open air, in the case of flying organization. The transfer of a patient from one group to another causes no trouble, no delay, and, with a few precautions, no risk of infection. On the contrary, if the group in charge of the apparatus of immobilization, being exposed, naturally, to contact with non-sterilized material—metallic cloth to be cut, gutters to be lined, plaster to be manipulated—is compelled to operate also, how much time is lost in bringing about a proper condition of asepsis? And if the operating group must handle

the apparatus of immobilization, there is contamination, and necessarily a new sterilization. It is safer and quicker to pass over to the group of immobilization the patient who has been operated upon, the fractured man after the antiseptic removal of the splinters and the artrotomised patient after the cleaning of the articulation. Through this regular order of work, materials will be saved, confusion of orders avoided and antisepsis preserved.

(*b*) SIMPLE DRESSING—As in the emergency post, the best one is a dry iodoform dressing covered with absorbent cotton.

(*c*) CLEANING OF THE WOUNDED PARTS—At the ambulance, where one has time, and the cases are not very serious, the parts adjoining the wound must be carefully cleaned, otherwise, under an antiseptic covering, there would remain a septic surface, capable of infecting the region. Warm soaping, scouring with alcohol or ether, final brushing with carbolized solution: such is, as for disinfection of the hands, the proper order. An important precaution is to protect the open wound by a large absorbent sponge or a thick sterilized compress to prevent contamination by water during the washing. During the campaign one must expect greasy skins, soiled with blood, perspiration and mud. In such cases turpentine

seems to us the best thing for cleaning the epidermis, and an ample supply of turpentine should be provided.

(*d*) ASEPTIC TREATMENT OF COMPOUND FRACTURES—To the operating squad belongs the duty of maintaining strict asepsis in this division of the work.

Incisions should be as few and as small as possible, and should be always made in the direction of the long axis of the limb. The wound should be explored with the index finger, followed by antiseptic irrigation.

Fragments of clothing are first extracted and floating splinters completely separated from the bone.

If the wound is infected deeply, swab it with a plug of absorbent cotton on the end of a haemostatic forceps, moistened with 1-8 chloride of zinc solution or carbolic acid, one part to ten parts of alcohol. Irrigate thoroughly and insert a drainage-tube or a strip of iodoform gauze at the dependent points.

If asepsis is complete, splinters still partly attached and sufficiently covered with periosteum will reunite with neighboring fragments; the medulla will adhere to the bone from which it has been detached and intramedullary effusion of blood will be reabsorbed.

Recollect the rule: remove only what is crushed and detached, and asepsis is complete with simple early removal of splinters.

(*e*) ANTISEPSIS OF ARTICULAR WOUNDS—Articular wounds caused by firearms are of great surgical interest. In those cases where a bullet has pierced an articulation, grazing or furrowing the head of the bone, simple closing of the wound is sufficient.

As a rule, however, more extensive wounds are encountered. Articulations must be emptied of blood, bony fragments taken out, and if the synovial membrane is infected, touching with chloride of zinc or carbolized alcohol is necessary. After this irrigate with boiled water, 135 deg., insert drainage-tubes or gauze, and dress in the usual manner.

In wounds of the larynx, tracheotomy is indicated more frequently than in ordinary surgical practice. Injuries to the urethra call for the insertion of a permanent catheter to prevent constant dribbling of urine through the wound.

All that has been said of emergency posts and ambulances pertains to field hospitals, with the exception that the latter have a more secure and permanent location, and therefore the ordinary rules of asepsis as practiced in clinics and city hospitals can be applied more thoroughly and satisfactory.