was possible, each time with success. In no case was the wound dressed in less than forty-eight hours. In only one case did sterilization of the track of the projectile as far as the dura mater fail; in this case the sepsis was mild, and was limited to the track, the flap uniting by first intention. There was one death, from meningitis and cerebral abscess, one week after operation; outside the cranial cavity there was no sepsis in this case. In only one patient was there any suggestion of a hernia cerebri. This was in a case with most extensive injury, a large lacerated scalp wound, with marked comminution and depression of skull and extensive laceration and discharge of brain substance. There was also considerable intracranial haemorrhage with pressure symptoms and paralysis of the left arm and face. A large clot was removed at the time of the operation, and subsequently a small protrusion of brain occurred. The protrusion gradually diminished and the face and arm steadily improved. No untoward symptom developed.

NOTES ON WAR SURGERY.

BY

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ALTHOUGH I cannot speak with any great authority on the subject of the treatment of wounds seen in this war, because the contingent of which I am a member remained on Salisbury Plain until early in 1915, and their medical units were the last to be established in France, yet five months of active surgical service in that country has enabled me to make certain observations which will, I trust, be at least suggestive to some who, like the writer, are placed on "the lines of communication," where atypical rather than typical methods of treatment are necessitated.

In dealing with wounds in hospitals on the lines of communication, the first aim of the surgeon is to save the soldier's life, and the second aim is to save the part affected, the two greatest dangers to both being infection and secondary haemorrhage.

In considering the first it must be realized that the great majority of wounds seen in the hospitals of the lines of communication are infected. Of these infections one sees principally three varieties, which should be considered in order of their ordinary seriousness.

I. Infection by Tetanus.

This fortunately is rare because of the faithful use of antitetanic serum at the front, yet because prophylactic treatment is efficacious, whilst treatment of the incident infection is more rarely so, it is wiser to assume that all our wounded have been infected by tetanus, and that all have not been treated with a prophylactic dose of serum at the front. It may be argued that those who have received antitetanic serum are usually tagged, with an inscription giving the dose administered, when they are received at the hospitals of the lines of communication, but the importance of the wounded being protected against tetanus and the fact that the immunity conferred is probably only temporary makes it wise to consider the administration of a second dose in these hospitals. There is but one danger in this practice, namely, that of anaphylaxis, but this danger may be disregarded, and a dose of 1,500 units of antitetanic serum administered subcutaneously on admission, provided always that the patient has not been so treated at a date earlier than one week previously. In this latter case the antitetanic serum must be administered in a different manner; thus, the dose of this serum must be divided into two parts. The first part, containing 1 c.cm., should be given intravenously. The remaining part should be administered subcutaneously half an hour to an hour later.

Two weeks after this administration of antitetanic serum in the hospitals of the lines of communication the administration of another dose should be considered, and if found necessary it should be given in a divided dose, both intravenously and subcutaneously, as already directed.

II. Infection by Gas-producing Organisms.

These are of the anaërobic variety. Of these, the bacillus of malignant oedema is the most common. More rarely found is the *Bacillus aerogenes capsulatus* (Welch). Infections by these are characterized by their virulency. It is necessary, therefore, to recognize them early, because at first the infection is local, although usually of a deep wound, and practically always of the lower extremity.

A wound so infected is dirty in appearance. It contains pus, or pseudo-pus, with a faecal-like odour, which is similar to liquid faeces in colour and consistency. The parts about it are swollen and congested, but at this stage no characteristic crackling may be elicited by palpating the surrounding tissues; thus it may be difficult to differentiate it from an infection by the colon bacillus. Later there may be localized gangrene around the wound about which crackling can be elicited on careful palpation. In some cases this latter may be noticed without a suggestion of gangrene. The condition at first is really one of cellulitis. The patient's general condition, which is due to toxæmia, is often far worse than is suggested by the local lesion. In those cases where crackling is found on palpation there can be no doubt as to either diagnosis or treatment. In the earliest stages, where there is doubt as to the diagnosis, open freely and drain. Where crackling is found, treat at once as one would a fulminating cellulitis, when the freest incisions and drainage are indicated. At the same time hydrogen dioxide may be injected into the surrounding subcutaneous tissues in an attempt to limit the infection. The infected area must be kept under constant surveillance, always remembering that to save life amputation, in the case of a limb, may be necessitated at any time. When gangrene has appeared, amputation is necessary. This may be done through the emphysematous tissues if the open methods to be described later are employed.

In dealing with infections by gas-forming organisms it is necessary to keep in mind that the patient's life is endangered from the very beginning, and, although very free incisions may relieve the patient even at this date, in cases where we are dealing with a cellulitis alone, in a great number amputation with free drainage will have to be resorted to in the end, in order to save the patient's life.

III. Infections by *Staphylococcus*, *Streptococcus*, and Mixed Infections.

These are the more ordinary conditions met with—indeed, are seen in the majority of wounds. They are combated by drainage; often drainage of the most thorough character is necessary, consequently this subject will deserve special study.

It is generally known that, of all wounds, shell wounds require the greatest care. Where there is any possibility of portions of clothing being retained in the wound, cleansing and free drainage must be instituted. If these wounds are superficial, they may often be laid open with advantage. If the wound, on the other hand, is deep and filled with blood clot, this must be cleaned out and care must be taken to tie any bleeding point, but, if none is discovered, such wound will demand special care, as in such not only is secondary haemorrhage to be feared, but concealed haemorrhage may be followed by clot formation and infection. In dealing with all these wounds, primary suture must never be considered, but rather suture to maintain the patency of the wound is often of great advantage. The excision of superficial wounds is advised with the closing of new surfaces, but no wound in which suppuration can be expected is ever closed.

The method of laying open infected wounds by means of sutures, already suggested, is worthy of consideration. Suppose, for instance, a piece of shell is projected under the skin and, more or less, superficial tissues for a distance of some inches. Its track is probably infected, and its surfaces necrosed. It is often found to be wisest to lay such track open, thus converting a tunnel into an open gutter; further, the cleansing of the wound can be hastened by invaginating its edges and sewing them perhaps even several inches from the wound. If this be done it will be found easy to remove these stitches and to bring the edges together when the wound is clean. The same principle is made use of in amputations. In the hospitals of the lines of communication amputations are recommended usually

only when they are necessary to save lives threatened by infection. In the majority of such cases it is unsafe to perform the ordinary classical operations because flaps may harbour infective organisms. Indeed it seems impossible in the majority of cases to procure an aseptic field; thus, often it has seemed wisest to perform simply a circular amputation, cutting through skin, muscle and bone all at the same level, and to leave the wound entirely open. Patients on whom this procedure is adopted are sent to England as soon as possible, where a second operation for the preparation of flaps and the closing of the wound is performed.

These circular amputations are, however, too wasteful, and if it is possible to save flaps, even if they cannot be used at once, it is wisest to do so. Here, then, the method described as "the laying open by means of sutures" is employed. It is my custom to save every portion of skin, fascia, and muscle which it is safe to keep; with these I make flaps at a later date, but at the time of the operation, to save infection, we invaginate them in the same way as a child having torn into vertical strips part of the stem of a dandelion will invaginate these to form a rosette. When invaginated the soft parts are sewn back, as suggested in wounds of muscle and skin. In this way we make a cone-shaped stump instead of a crater-shaped stump, as it appears before invagination. The bone in this amputation should be left as long as possible, because as soon as our cut surfaces are clean we stretch by traction towards the sawn extremity of the bone by means of tape fastened into these soft parts and secured to the distal extremity of the bone. By means of this traction, begun after the flaps are clean, we prevent the contraction of the soft tissues at a time when it is not yet safe to perform the necessary secondary operation of sewing the flaps in their final position.

After the primary operation, when the flaps are sewn back there can be no concealed pockets of pus. In the second stage, whilst the flaps, after cleansing, are being stretched on the bony shaft as a fulcrum, the tissues are under perfect control. It is only in the third stage, when the tissues being clean enough, the soft parts stretched enough, and we attempt the final operation of sawing off the excess of bone and uniting the flaps, that we are called upon to exercise special care for the protection of the limb.

For severe infections of the extremities the bath, or "constant drip," seems the most efficient form of treatment after free incisions have been made.

In the cranium we may have difficulty with infections. Our rule is to excise all wounds perforating the soft parts and before uniting the cut edges to make a careful examination of the skull in order to get some idea of the extent of the injury. Further procedures are only considered in a most conservative way. In a few cases we have endeavoured to prevent infection of an exposed and uninfected dura by placing a thin layer of absorbent cotton over the exposed area and sealing the opening with Horsley's wax. In one patient sterilized paraffin was used. Either dressing may be changed daily.

The laying open of infected wounds has been spoken of not only as a means of preventing collections of pus but of allowing the cleansing of infected surfaces. This latter is often difficult, and yet of the greatest importance in order to minimize the toxin absorbing areas. Recent suggestions point to the use of hypertonic salt solutions in order to secure lymph lavage. Some surgeons still employ the old antiseptic solutions. Possibly the hypertonic solutions show the best results within the first twenty-four to forty-eight hours after operative procedures. The milder antiseptics may have their place in the later days. Undoubtedly, however, the mechanical cleaning of the parts is of greater importance than either. With scissors much can be cleaned. The cautery also is valuable. At the time of Ambroise Paré this was the most reputed surgical instrument. The lapse of time has not detracted from its efficiency. It is not only a decided mechanical antiseptic, but it also causes lymph lavage, without pain subsequent to the actual operation—a point decidedly in its favour.

The saving of limbs in which there are compound fractures with coincident infections demands not only the employment of the means suggested but the most careful immobilization by appliances of such character that it is

possible not only to dress the wounds, but, if necessary, to syringe or irrigate the infected channels. For such in many patients in my service plaster-of-Paris has been used. This dressing, when properly applied, is most satisfactory, especially if it be fenestrated, for drainage, lavage, and dressings. The windows for such purposes, cut in a plaster cast, are carefully swabbed with melted paraffin before each dressing. This is applied over absorbent cotton and fills the interstices between the plaster and skin as well as between the layers of plaster.

Besides all these methods for the treatment of infections, the local as well as the general effect of the sun's rays are often most marked. If it were possible to treat all infected wounds in the open air results would be better than at present, but, unfortunately, this principle, while recognized, has not yet been sufficiently recognized in military hospitals.

Local Treatment.

The local application of general principles is of sufficient importance to suggest the mention of some methods of local treatment which are used in this service.

Fractures about the Shoulder-joint and Upper Third of the Humerus.

For obvious reasons patients reaching a base hospital with compound fractures of these regions rarely show either wound of entrance or exit to be in the outer wall of the axilla, thus the axillary surface is usually most suitable for splinting when there is a fracture of the upper third of the bone. In these fractures, then, we have sometimes employed a triangular splint which can be fashioned in wood by a carpenter in fifteen minutes. One side of this triangle runs from the apex of the axilla to the great trochanter of the femur of the same side; the second side of the triangle supports the patient's extended arm in a position at right angles to the body; the third side simply unites the other two sides of the triangle. Any degree of traction can be used with this splint by the use of adhesive plaster ("stickers") if the supporting arm of the triangular splint has been made long enough. Most wounds can be dressed without disturbing the splint. The position of the third or uniting side of the triangular splint can be changed easily, thus allowing of adduction of the patient's arm when this assures better reposition of the fragments.

Compound Fractures of the Middle and Lower Thirds of the Humerus.

If we are dealing with compound fractures in these regions we often use a small Thomas knee brace, with extension by means of adhesive plaster, as now generally recommended in war surgery. In addition, in this service, we usually fix the fractured ends by means of a plaster-of-Paris collar applied close to the skin and fenestrated at the seat of the wound for dressings, as already described.

Compound Fractures about the Elbow.

These we usually treat in much the same way, because of the necessity of getting drainage, which is facilitated by extension and immobilization made possible by the knee splint combined with the plaster-of-Paris dressing. In very severe fractures about, and implicating, the elbow-joint, it is often safest to excise the whole joint, after which operation a fairly good arm may be expected.

If at all possible, all arms should be saved, no matter how mutilated they may seem at the time of the patient's entry into hospital. Orthopaedic surgery has so advanced in recent years that an arm whose function on the admission of a patient may seem to be irretrievably destroyed may, if saved, by judicious treatment be made into an instrument far superior to the best artificial arm available. The patient when examined may be unable to move his fingers; there may be no function at the wrist. Neither loss is sufficient to condemn the arm. If consistent with safety, we should persist in an endeavour to keep the injured member.

Compound Fractures of the Femur.

Compound fractures of the upper third of the femur are often most difficult to treat; indeed, past experience teaches that many femora so fractured have eventually to be amputated. With the abduction splint recommended by Mr. Robert Jones of Liverpool many of these may be most efficiently treated, yet there are some in whom it is

impossible to irrigate or even dress without moving the thigh if so treated. For these, because immobilization is as important in clearing up the infection as in securing bony union, greater security is demanded. The most difficult form of treatment is often, in this fracture, the most satisfactory in the end; thus the fenestrated plaster-of-Paris spica is recommended. Such a cast, if carefully applied during strong extension and abduction of the leg, if reaching from the nipple to the toes of the injured side, will assure perfect rest and ample opportunity for cleansing the wound by irrigation or the syringe. In such plaster splint the bed-pan may be used and the patient transported any distance in comparative comfort. Plaster-of-Paris will help to save both life and limb, but it must be properly applied by one who is willing to remove it if necessary, thus sacrificing hours of labour if there is any suggestion that some unknown change or affection is taking place underneath the plaster.

In treating fractures of the middle and lower third of the femur, whilst one may in certain cases prefer the use of plaster-of-Paris, the Thomas knee splint is usually a most efficient form of fixation. With this not only may extension and fixation be secured, but the latter may be rendered doubly sure by the coincident use of one of many forms of splints or splinting.

Compound Fractures Implicating and Injuries Penetrating the Knee-joint.

In dealing with injuries to the knee-joint it must be realized that they present one of the most serious problems of surgery. If this joint is penetrated by infective material, and especially if, added to this, there is an injury to either of the great bones forming the joint, life is endangered. Thus treatment of such wounds demands the greatest care. We should here, whilst endeavouring to save the joint, always bear in mind the fact that it is easier to save the limb than the joint. Nearly all serious injuries to the knee-joint are followed by limitation of movement if not by ankylosis. This latter causes the greatest inconvenience. We may well, then, consider whether it is worth while attempting to save a leg in which ankylosis at the knee is the best we can hope for when this attempt to save is made at the risk of the patient's life, and when we know that amputation in the lower third of the femur allows of the use of an artificial limb with a knee-joint far superior to a natural, though ankylosed, knee.

The danger of suppuration in the knee seems to lie mainly in two things—first, the difficulty of drainage, and secondly, the liability of the infection to spread into the synovial pouches and about the intermuscular septa both in the thigh and in the leg. From a mechanical point of view, then, the head of the bed should be elevated in all such cases, in order to minimize the possibility of the spreading of the infection into the thigh, which often means the loss of our means of retreat by amputation through the lower third of the femur in patients in whom our conservative position of watchful waiting has become plainly untenable.

Because of the anatomical conformation of the joint, surrounded as it is by muscle and tendon, and formed by the close apposition of two of the largest bony surfaces of the human frame, drainage depends on the position in which bony apposition is least marked and gravity counts most; thus the outer side of the joint is the position of choice for drainage, and the flexed and strongly abducted and everted position of the thigh and knee is the best attitude of this member during any attempt made to save an infected knee-joint. Other means there are of draining this joint, but my firm belief that an artificial leg, as already suggested, is often better than an ankylosed knee impels me to refrain from describing methods which are indicated only in cases of such gravity that an immovable knee is the best result possible.

Compound Comminuted Fractures below the Knee.

Such fractures can be treated with drainage and almost any form of splint; that used by Mr. Robert Jones of Liverpool—the thin sheet-iron splint covered with boiler-felt—is as good as any, but here again my personal predilection is for plaster-of-Paris.

Compound infected fractures of the ankle can be treated by a variety of splints of a right angle in form. If the astragalus is fractured it is best to excise it.

Compound fractures of the tarsal and metatarsal bones are treated in much the same way as similar conditions of the bones forming the ankle-joint. Here conservative surgery again is the most profitable. The injury to a foot must be indeed severe before we are forced to amputate it, and it is only when our line of retreat—in this case a possible amputation through the lower third of the leg—is threatened that we are forced to consider the loss of the foot, provided always life itself is not threatened.

Wounds of the Thorax.

In attending patients with wounds of the thorax we should be willing to "wait and see," interfering only when called upon by the advent of untoward symptoms or conditions.

Wounds of the Abdomen.

For obvious reasons these rarely have to be dealt with on the lines of communication, but in these conservatism should be our motto. Of the few cases we have seen, those in which no operation was performed did best. The hospital nearest the front is the proper place for the treatment of these, and if patients suffering from abdominal injuries are carried there early enough, operations entirely inadvisable in our hospitals further from the firing line can be successfully performed.

In closing this memorandum, based principally on the work of my section in this hospital on the lines of communication, I would accentuate the fact that not only my experience but the experience of others has forged my credo of conservatism as the motto of war surgery.

WORK AT A BASE HOSPITAL.

IMPRESSIONS AFTER SIX MONTHS AS A SURGICAL SPECIALIST.

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Six months spent as a surgical specialist at a base hospital teach one many things—above all, patience. While the variety of cases is infinite in the way of injuries to particular structures, the curious sites from which shrapnel is removed, etc., yet the actual types of operations done are limited, and to one who has had a large experience of emergency work in a busy city such as Glasgow the class of work presents little new or difficult.

Far too little credit has been given to the astonishing healing powers of the fighting man, who, up to the moment of his wounding, is in a state of health much above that of the usual hospital patient, as the result of his open-air life and abundant diet. When this is properly appreciated less will be said about the results of wonderful new antiseptics, and of methods which make the antiseptic era a back number, and of vaccines, etc. Nearly all the cases are septic, and if the work is to be done efficiently, expeditiously, and at a moderate cost, I believe it can best be with a technique in which antiseptics play a large part. A rigorous aseptic technique is a farce in such a type of work, is needlessly expensive, and will not, in my opinion, stand the test of twenty serious operations, packed into twenty-four hours.

Most of my actual operating was done with the assistance of my theatre sister only, though when I required further help I always had willing and able assistants. The procedure in an ordinary case of shrapnel embedded in muscle was as follows: The dressing gowns and towels had been sterilized by steam. The gloves and instruments were boiled, the lotion basin and trays were boiled or flamed out. The gloves were used wet out of sterile water. I scrubbed my hands with soap and water, soaked them for a short time in 1 in 40 carbolic lotion, drew on a pair of gloves, redipped my hands in the lotion basin, and when I had my gown put on I was prepared to start whenever the anaesthetist signified that the patient was ready. I prepared the skin with iodine and fixed the necessary towels with clips. I used the best probe in the world, an index finger, which becomes marvellously educated in seeking out the track of a foreign body through the tissues. I located the piece of shrapnel and removed it with a pair of forceps. I then swabbed out the