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AN ADDRESS

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ON

The Treatment of Wounds in War

Delivered before the Medical Society of London on November 16, 1914

BY

SIR W. WATSON CHEYNE, BART.,

C.B., F.R.S., LL.D. EDIN.,

President of the Royal College of Surgeons of England

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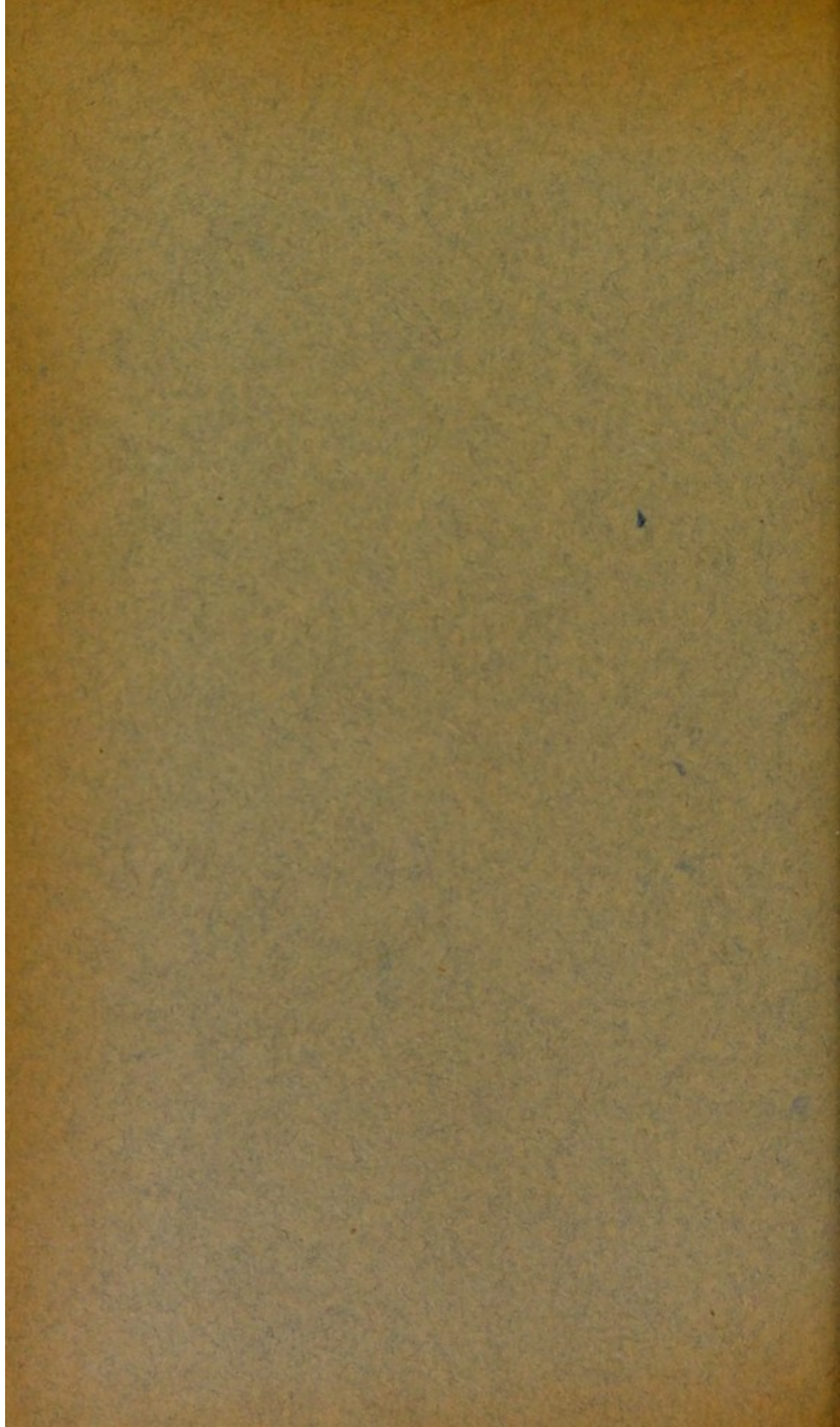


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The Treatment of Wounds in War.

BY SIR W. WATSON CHEYNE, BART., C.B., F.R.S.,
LL.D. EDIN.

President of the Royal College of Surgeons of England.

MR. PRESIDENT AND GENTLEMEN,—I propose to-night to limit my share in the discussion on “Surgical Experiences in the present War” to the treatment of wounds sustained from missiles. The treatment of these injuries naturally falls under two headings: (1) The treatment of the wound itself, and (2) the treatment of the various injuries which may be done to the structures or organs through which the missile passes.

It seems to me that at this stage of the war the most urgent and profitable heading to discuss is the first—viz., the treatment of the wound as a wound, apart from the other injuries which may be present. As regards the latter, we can as yet only speak of individual cases, which, however interesting to the surgeon himself, are not sufficiently numerous or advanced to enable us to make any fresh generalizations apart from those which have already been made in connection with other wars.

THE CHARACTER OF WOUNDS IN WAR.

Naval wounds are practically entirely caused by fragments of shell or portions of the ship itself, broken up by the shells, and these produce large, ragged, lacerated wounds which cannot scab over, and, where bones are injured,

they are very much broken up. We have not had from our ships a single instance of a bullet wound, but we had some bullet and also some shrapnel wounds among the marines from Antwerp. A considerable number of the wounds have also been complicated with burns, while in many cases there have been burns without any wound, as the result of the explosion of the enemy's shells or of our own.

In the case of the Army a large proportion of the wounds are due to the sharp-pointed, narrow bullets, many of which pass through the tissues and leave only small apertures of entrance and exit, which scab over and seldom require any treatment for the wound itself. Occasionally, however, for various reasons, the wound of exit may be large, in which case sepsis may occur there. The round shrapnel bullets make larger orifices of entrance and exit than the rifle bullets and do not so often scab over, while if they fracture bones the injuries are much more severe. The wounds with portions of shell resemble those met with in naval warfare.

Now, the first thing which strikes everyone who is actively engaged at the present time in the treatment of the wounded, whether on land or sea, is the great prevalence of sepsis. Giving my own experience of naval cases, *all the wounds which I have yet come across have been septic*, some of them very badly so. I hear also that those who are working at the Army base hospitals are having a large amount of sepsis in shell and shrapnel wounds, and in addition, at first at any rate, while our Army was located towards the centre of the line, were having a good many cases of tetanus and acute spreading gangrene. So far we have not had tetanus in the naval wounded, and that is of course natural, for, seeing that the tetanus bacillus reaches wounds from the soil, it is only those wounded on land who would get their wounds contaminated with this organism. And, probably for the same reason, I have not met with a case of acute spreading gangrene.

It is a very serious matter that all the larger wounds which arrive at the base are septic. It is true that in some the sepsis is not so severe as to threaten the life of the patient, but it is no light thing for a wound to become septic. Once get sepsis into a wound, especially a compound fracture or a wound of a joint, and you have no certainty as to what the result may be. The patient may lose his life from one or other of the septic diseases, or his limb may have to be removed in order to save his life. His convalescence will be prolonged and may be interrupted by the occurrence of fresh abscesses, while he will suffer much pain. He may be left with serious deformities from the difficulty of replacing parts or of keeping them in proper position on account of the septic wound; and, as the result of the extension of the inflammation and suppuration to the various parts in the neighbourhood, structures become matted together and great disability may ensue.

REASONS FOR SEPTIC CONDITIONS OF WOUNDS.

It is now exactly fifty years ago since Lister formed the opinion that the cause of septic wound troubles was the entrance of bacteria into the wounds, and since he first put that idea to the test in a case of compound fracture. And in that case he saw for the first time in his experience a compound fracture following the course of a simple fracture and not undergoing suppuration. His earliest communication on the subject of the treatment of wounds dealt with compound fractures, most of them severe cases and much soiled, and he was able to record a number of aseptic results and to observe various phenomena, such as the organization of blood clot, which only occur in an aseptic wound. During the rest of his active life he had to treat many compound fractures and other serious injuries, and with some exceptions, to which I shall presently refer, he obtained aseptic results.

You may well ask then, Why are we not having the same experience here to-day? Why are all the large

wounds which reach us from the front in a septic condition? For this there are several reasons.

One very important point which affects this question of asepticity in these wounds is the length of time which may elapse after the injury before the patient comes under treatment. The conditions in the Army and the Navy are very different from those in civilian practice. In the latter the patient can generally be attended to within a very short time after the infliction of the injury, and can be transported quickly to his own home or to a public or private hospital, where the immediate and subsequent treatment can be at once carried out under the most favourable circumstances and without any further movement of the patient.

The Wounded in Army and Navy.

In the case of the Army the wounded must lie where they fall, and cannot be attended to perhaps for many hours. Formerly, where there was not such a terrific hail of missiles over the field of battle, and where, perhaps, a greater feeling of humanity existed, and where also the distances between the combatants were not so great, the Army Medical Corps went out with ambulance wagons and were engaged during the progress of the battle in ministering to the wounded, and in picking them up and removing them to a region of comparative safety at a short distance away. The ambulance wagons and depots for first aid were respected as far as possible by the combatants, and, though the members of the Army Medical Corps exposed themselves to great dangers, it was possible in many cases to commence the treatment of the wounded comparatively soon after the infliction of the wound; and, further, battles were over usually in a few hours. At the present time the condition of matters is quite different. In many instances it would be madness to attempt to pick up the wounded while the engagement is going on, not only on account of the tornado of missiles, but also because the combatants are often too far apart

for the Red Cross badge on the arms of the men, or even on the wagon, to be recognizable, even if it were respected. Besides, the presence of the wagons and men wandering about the field might give important information as to the position of the combatants. The result is that the wounded often cannot be attended to for a long time; sometimes, indeed, we hear of forty-eight hours or longer having elapsed before they are collected, and in the meantime the wounds are becoming more and more infected. It is true that where a medical officer is present in the trenches he may be able to do a little, but only very little, in the way of treatment.

Again, when the wounded have been collected, they must nowadays be removed for a considerable distance, sometimes a good many miles, to the field or temporary hospital, and naturally, with enormous numbers of wounded, this transport cannot be carried out in a particularly expeditious or comfortable manner. Even at this field hospital the patient is not at rest; he can only remain there while those parts of the treatment that are most essential are carried out, and then he is sent on to the base. At the field hospital, however, the treatment of the wound itself can be carried out, at any rate in the more serious cases, but in a good many it is not till the patient reaches the base that full attention can be paid to the injuries caused by the missiles.

In the case of the Navy the conditions are also very unfavourable. In the old days the wounded were carried down from the deck to the surgeon's quarters as soon as they fell, or very soon afterwards; nowadays the surgeons and non-combatants on a battleship are all kept below, and only those actively engaged in the fight are on deck, and consequently the wounded must lie where they fall till the battle is over, or at any rate till a lull in the fighting occurs. From the battleship the wounded are transhipped as soon as possible to the carrier or hospital ship, from which again they are transferred to the hospital at the base, but the treatment of the wounds can be com-

menced as soon as they get on board the carrier or hospital ship. So far the wounded have been sent back to the base in a destroyer or other quick war vessel, but this is very unfortunate for them, as a doctor is not, as a rule, carried on board a destroyer, and little or nothing can be done for them during the transit—at any rate, in the way of remedying sepsis. It seems to me that, wherever possible, a hospital ship should be in the neighbourhood of the action, and the badly wounded should be taken on board it as soon as possible, or, if this is not advisable, doctors, orderlies, and dressing materials should be transferred to the destroyer so that the treatment of the wounds may be commenced at once. The position of the hospital ship and the transference of the wounded are, of course, matters dependent on the military necessities of the case, but the commander should always have present in his mind the supreme importance of the immediate treatment of the wounds and the inadvisability of allowing several hours to elapse before they can be attended to. The point is not the speed with which the wounded can be got ashore ; it is the earliest time that treatment can be commenced, and this, of course can be begun at once on board ship if the necessary means are at hand, however slowly the vessel proceeds to the base. The naval wounded have therefore an advantage over the Army, in that the wound is not so much soiled and can, as a rule, be attended to sooner ; they have the disadvantage that the wounds as a whole are more severe.

Now, as I shall presently point out, the chances of rendering a wound aseptic are comparatively small after twenty-four hours, and practically *nil* after forty-eight hours ; indeed, after that time I should not make any attempt to disinfect the wound. If, therefore, the case does not come under treatment within twenty-four hours I do not think that we can blame any surgeon or any system of treatment for the septicity of the wound. In spite, however, of the above disadvantages, a considerable

number of cases do come under suitable conditions for treatment within the period of time that I have laid down, and that being the case, a certain proportion of these patients should reach the base with aseptic wounds.

Disinfection of Wounds.

This leads us to the question of the disinfection of the wound, a branch of wound treatment which I fear is but little taught in the schools. Lister's experience and practice in this matter are forgotten, if, indeed, they are now known. The omission really arises from the want of precision and the carelessness which are creeping into the treatment of wounds at the present time. I do not make this as a universal charge by any means. There are many surgeons who take the very greatest care, whose operations it is a pleasure to watch, and whose results are excellent. But there are many others who do not seem to have got a proper grip of the matter, and whose results leave much to be desired. They follow the fashion in having a well-finished operating theatre, in dressing themselves up in the most approved and elaborate fashion, and in having instruments and dressings sterilized; but they end there. They forget the ubiquity of bacteria, and that their instruments, gloves, &c., may lose their sterility during the course of the operation; they deride antiseptics. If suppuration occurs in the wound afterwards they ascribe it to all sorts of causes, such as the silk, catgut, migration of bacteria, gout, influenza, &c., rather than the real cause—viz., their own faulty manipulations, and their example is naturally followed by those whom they teach.

Asepsis and Sterilization.

In one of my books I placed at the beginning as a motto the following sentence: "Suppuration in a wound made by a surgeon through unbroken skin is due to some error on the part of the surgeon." This gave great offence, but it is absolutely true, and unless a man takes that view and searches his own procedures when things go wrong in

order to see where the error was, I quite despair of his ever being a trustworthy aseptic surgeon. To exemplify the carelessness which is not uncommon in the treatment of wounds, I could entertain you for the rest of this meeting by telling you the quaint things which are done by those engaged in operations, and the constant opportunities which are afforded for the entrance of bacteria during an operation, and the crude ideas which are abroad as to "asepsis" and "sterilization." Watch the course of one of these so-called aseptic operations from a bacteriological point of view and you will see all sorts of errors and omissions which pass unnoticed, and these have led to a large literature on stitch abscesses, bad catgut, migration of bacteria, and so on.

I saw an operation the other day ; everything had been sterilized, a dry sterilized towel was spread out on a table, the boiled instruments were turned out on this towel, and were then arranged by a nurse who did not wear a mask. Something excited her attention, two other nurses came up, also unmasked, and the three became agitated, all bending over the instruments and talking at the same time ; people were coming and going, and at least twenty minutes elapsed between the time that the instruments were turned out and the commencement of the operation. Were they still aseptic ? And yet the surgeon comes in completely booted and spurred, innocently picks up a knife and goes on with the operation. Is it any wonder that that surgeon has a good deal to say about catgut, silk, and so-called stitch abscesses ?

I am always very suspicious of so-called sterilized towels and swabs, especially in work in private. They are often placed in a sort of potato steamer for a few minutes, an apparatus which would take hours to cook a potato, and therefore if I do not know the nurses I always order the towels to be boiled in a pan for half an hour and not touched before I arrive. Well, in one case, nurses were sent out from a large aseptic hospital who were said to be fully trained and most excellent. They received my

instructions about the towels, and on my arrival I found a very small, poky room with very few dishes in it (not the palatial apartments in which some of my more fortunate *confrères* are accustomed to operate). I looked about for my towels, but could see no trace of them. I therefore called the nurse and asked her for them. She lifted the lid of the commode and there were my aseptic towels reposing at the bottom of the nightstool—another source of *Bacillus coli* infection of wounds which is worth remembering.

A fresh instrument is wanted during an operation, or an instrument falls on the floor. It is popped into some boiling water and presented to the surgeon "sterilized" within a minute! A surgeon is doing an intestinal anastomosis, clips away mucous membrane, rinses his scissors in some salt solution, leaving the tags of mucous membrane and portions of fæces in the basin, and when his hands become sticky rinses them in the basin repeatedly during the course of the operation. When an abscess containing *B. coli* forms he is much interested and refers to the remarkable habit that coli bacilli have of wandering through the coats of the intestine in cases of intestinal anastomosis, separation of adhesions, &c. This pernicious habit of the *B. coli* seems to be particularly common in operations in the pelvis. It never seems to occur to the surgeon that he has introduced the sepsis during his operation and that migration of bacteria, if it occurs at all, only takes place through the inflamed wall of the intestine.

I think the man who annoys me most is the boiled water man! Some surgeons seem to take a particular pride in emphasizing their contempt for antiseptics and the extreme simplicity of their methods. A surgeon comes to an operation and finds a dish containing some fluid. He asks what that is, and the nurse, who has been carefully trained in real aseptic work, says, in fear and trembling: "That is carbolic lotion for your instruments." It is most instructive to see the look of contempt on the

surgeon's face as he says: "Carbolic lotion! Who on earth uses antiseptics nowadays? I thought that no one out of an asylum ever thought of them. Take it away and give me a bowl of boiled water." He does not disinfect his hands, but trusts to the protection of boiled gloves, which, however, are soiled at the very beginning by being put on with unsterilized hands. He thinks that he is no end of a great man, and the unfortunate thing is that the nurses and students think so too and follow his fatal example. I wonder whether, if such a man had a son at the front at the present time, he would feel happy in the thought that the only thing which the surgeon had at hand for the treatment of wounds in war was a basin of boiled water. Faugh! The futility and littleness of it all make me sick.

Importance of the Bacteriological Problem.

The result of this slackness is that a good many men are being sent out from the schools every year who are not impressed with the bacteriological problem involved in the treatment of wounds, or who have come to believe that no such problem is involved, while they have become thoroughly impregnated with the idea that the use of antiseptics is an abomination, and that no surgeon who has any self-respect left or who is not in his dotage would ever think of using them. When they are confronted with soiled wounds, such as occur on the field of battle, they do not know what to do or how to proceed beyond painting the skin with iodine and covering the wound with a piece of gauze. The consequence is that the bacteria get a firm hold on the tissues before any means which might have been efficient in the first instance can be adopted. Hence the results which Lister obtained with compound fractures at the very beginning of his work fifty years ago, and which he continued to obtain subsequently, are not being met with in the present war.

The answer then to the question, why do practically all

wounds in the present war become septic? is threefold: (1) Because there is often long and unavoidable delay in collecting the wounded and commencing treatment; (2) because the wounds may be very large and complicated and almost impossible to disinfect thoroughly; and (3) because in a good many cases no attempt is made to disinfect these wounds, or if it is made it is utterly inefficient.

How, then, should the large open wounds which occur in warfare be treated? The treatment of these wounds may be considered under two headings according to the time at which they come under the notice of the surgeon—viz., (1) those which can be treated during the first twenty-four hours after their infliction; and (2) those which are only met with at a later period, when sepsis and suppuration are already established.

(1) TREATMENT OF WOUNDS WHICH COME UNDER THE SURGEON'S CARE WITHIN THE FIRST TWENTY-FOUR HOURS AFTER THEIR INFLICTION.

Let us consider the condition of such a wound from a bacteriological point of view, and here I shall only speak of the larger wounds sometimes caused by bullets and wounds caused by fragments of shell or by shrapnel bullets. Wounds due to the modern small bullets, when they pass directly from one side of the body to the other without injuring bone or becoming deflected, are very small and sometimes difficult to find, and usually scab over and close without any further attention than a piece of dry dressing, unless some important internal structure has been injured.

Rapid Growth of Bacteria in Wounds.

With regard to the larger wounds they must, of course, be widely infected with bacteria at the time of their infliction, at any rate to a considerable depth; and not only is the wound infected at the moment of injury by the bacteria

carried in from the skin and clothing by the fragment of shell, but it very rapidly becomes much more seriously infected by dirt from the clothing, or from surrounding objects, and, in the case of land warfare, by the soil of the place in which the wound is inflicted. These large wounds are consequently infected with all kinds of bacteria, not only with naked, easily killed organisms, but also with highly resistant spores, the latter being most common and most dangerous in wounds soiled with earth. These organisms are not only lying free in the cavity of the wound and thus apt to be washed away by the blood, but they are also adherent to the tissues which form the sides of the wound, if indeed they have not been actually driven into them. These bacteria, finding themselves in a highly nutritious soil and at a suitable temperature and with plenty of moisture, at once begin to sprout and multiply with great rapidity. I do not know how long it would take a spore to sprout in the first instance, but I do not suppose it would be any great length of time; but once they have sprouted, they multiply rapidly. Many organisms divide and double their numbers within twenty minutes. At that rate, it does not take long for a wound to be filled with myriads of organisms. Suppose we take it that each organism divides in half an hour; that would mean that each organism gives origin to 15,000,000 at the end of twelve hours. Further, not only do these organisms multiply in the fluids which are free in the wound, but being in contact with weakened or dead tissues, the pathogenic varieties soon penetrate into the tissues and establish themselves there. Within the first twenty-four hours, therefore, we may take it that the state of matters is that the fluids in the wound are already teeming with actively growing bacteria, which have also penetrated into any pieces of dead tissue on the surface of the wound and to a slight extent into the living tissues forming the wall of the wound. Once they have penetrated into the tissues they establish themselves there and are extremely difficult to dislodge.

Eradication of Sepsis.

Now it is evident that the only efficient way of dealing with such a state of matters is to destroy these organisms, which have entered the wound, as soon as possible and before they have had time to grow and establish themselves firmly in the tissues, bearing in mind the fact that every hour that passes they quadruple their numbers at the very least. This will not be done by painting a little iodine over the skin around, or even by pushing it in among the blood, and by covering the wound with a piece of aseptic gauze; very much more careful and vigorous treatment is required than that. And it should be in the mind of every man who deals with these wounds that the ultimate results depend to a large extent on the prevention of sepsis; these results concerning not only the life of the patient, but also the rapidity and smoothness of his convalescence and his later condition.

As to the period of time during which it is advisable to attempt disinfection of the wound, my opinion is that it is only during the first twenty-four hours that it is at all likely that bacteria can be eradicated, and indeed after twelve hours the result is not at all certain. During the first twelve hours, however, the great majority of wounds, unless they are large and irregular or complicated with extensive comminution of bone, can be quite readily and immediately rendered aseptic, and if proper precautions are taken afterwards will remain aseptic, and thus the whole troubles resulting from the primary soiling of the wound will be avoided. Even up to twenty-four hours the infection can be rooted out in a considerable percentage of the cases. In the circumstances under consideration where wounds are soiled with earth, and where therefore there is considerable danger of tetanus and gangrene, I think that the period during which an attempt at disinfection should be made might be prolonged up to forty-eight hours. After that time the disinfection will certainly fail, and the attempt will do more harm than good by injuring the

tissues which are opposing the invasion of the bacteria and thus enabling the infection to spread more easily and rapidly. Hence I would lay it down as an axiom of practice in the class of wounds under consideration that if the treatment can be carried out within the first twenty-four hours (and in the case of wounds soiled with earth forty-eight hours) an attempt should be made to kill the organisms which have entered the wound. These organisms can only be got rid of by means of chemical antiseptics. I fear that, try how you may, you cannot avoid their use.

Two points must be taken into consideration in making this attempt. The first point is, that we have not only to kill actively growing bacteria, but also the spores of bacilli, seeing that some of the latter class of organisms are highly pathogenic. For example, the tetanus bacilli and various other bacteria which cause pathogenic processes, such as some forms of gangrene, are spore bearing, and are thus extremely resistant to all destructive agents. Hence, the agents we use must be sufficiently potent to kill spores under whatever circumstances they are found, whether dry or in albuminous or oily materials. And the second point is that these spores must be killed quickly, because one cannot keep such potent agents for any length of time in contact with the tissues, otherwise they may destroy them, and furthermore, these agents, if absorbed into the system, are all more or less poisonous.

Antiseptic Agents.

There are three potent antiseptics in common use at the present time—viz., carbolic acid, bichloride or biniodide of mercury, and iodine. Of these, we may exclude the mercurial salts, because although they kill microbes quite readily and in very considerable dilutions, if these organisms are free or in a slightly albuminous fluid they are of no use when the organisms are present in albuminous or oily substances. In the case of the former, mercury

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This statement has been disputed ; indeed, it has been stated that 1-20 carbolic lotion is as potent in its action on spores as the undiluted liquid acid. I therefore asked Dr. Bassett Smith to test the matter independently, and he reports that undiluted carbolic acid kills anthrax spores in 20 to 30 minutes, while 1-20 carbolic lotion takes 24 hours to produce the same effect.

W.W.C.

The following has been reported; indeed, it has been
stated that a number of persons in the same
region have been killed. It is not known
whether the deaths are due to the same cause or
whether they are the result of different causes.
It is not known whether the deaths are the result
of a single cause or whether they are the result
of different causes.

W. H. H.

combines immediately with the albumin, forming a compound which possesses very little antiseptic power; and as regards the latter, these salts do not dissolve in oil, and therefore organisms lying in oily material are not reached by the antiseptic. We are therefore left with the two substances, carbolic acid and iodine, and we must now consider these substances and determine which of them is best and most suitable, and in what strength they should be used.

(a) *Carbolic Acid*.—A saturated watery solution of carbolic acid (1 in 20) will kill naked, actively growing bacteria in a few seconds, but will not kill spores with certainty under from twelve to fifteen hours, and this time will be still further prolonged if these spores are present in albuminous or oily material, because a certain amount of the antiseptic power of the carbolic acid is lost in combining with these substances. It is evident, therefore, that washing out the cavity of the wound with 1 in 20 carbolic lotion will not disinfect it if it contains the spores of pathogenic bacilli. On the other hand, liquefied carbolic acid will kill spores in a very few minutes—as soon, in fact, as it can soak into them. * And therefore, if carbolic acid is to be employed in wounds soiled with material such as earth containing pathogenic spores, it must be used in the form of liquefied carbolic acid. Carbolic acid precipitates and combines with albumin, but the compound is still strongly antiseptic. It also dissolves readily and in large amount in oil, still retaining its antiseptic property, though not so strong as in watery solution. (1 in 10 oily solution is about equal antiseptically to 1 in 20 watery solution.) Hence the presence of oil does not protect the bacteria. This is the chief reason why I prefer carbolic acid for the disinfection of the skin rather than any other antiseptic, because it dissolves in the natural oil of the skin and so can extend its antiseptic action down the hair follicles and the orifices of the sebaceous glands. Further, carbolic acid is an anæsthetic, and its application causes very slight pain, which subsides almost immediately.

(b) *Iodine*.—The antiseptic power of iodine is practically the same as that of carbolic acid, so that the 2 per cent. solution in common use is of about the same value as 1 in 50 carbolic lotion. What the effect of a 5 per cent. solution of iodine or of still stronger iodine would be on the tissues I do not know, but I fancy it would be intensely irritating, to say the least. Even with the 2 per cent. solution the skin must be dry before it is applied, otherwise it is very apt to be blistered, and the antiseptic properties of the iodine solution are said to be diminished. How it could be used in the field with the impossibility of drying the skin and keeping it dry I do not know, and I have been told that there have been several cases of iodine burns of the skin where this antiseptic had been employed.

Further, iodine causes great pain, which lasts for a considerable time, as is well known in connection with the iodine treatment of hydrocele. When I was a student the treatment of hydrocele was the injection of a strong solution of iodine, and the agonies which the patient suffered afterwards, and the pain and the inflammation, which lasted for some days, were in very marked contrast to the painlessness and absence of inflammation which follow the injection of carbolic acid. Hence, although I may be thought not to be up-to-date, I still prefer carbolic acid to iodine, not only for the disinfection of the skin, but also, and more especially in the circumstances with which we are dealing, viz., as a means of destroying the bacteria which have already entered wounds before they come under the care of the surgeon. I am not, however, prepared to say that a sufficiently strong preparation of iodine might not possibly effect the same purpose, but in a few cases which I have seen in which iodine has been applied to the wound, it had not prevented the sepsis. Personally, if I had a wound I should insist on the use of carbolic acid in preference to iodine, both from the point of view of efficiency and of comfort.

Other antiseptics have been suggested, but none of

them are sufficiently potent for the cases under consideration. Of these, peroxide of hydrogen seems to be a favourite abroad, but its antiseptic power is comparatively weak and it would be useless against spores.

Lister's First Work.

Before describing the details of the procedure to be adopted in disinfecting a wound let me recall Lister's first work and our subsequent experience. Lister's first attempt at aseptic work was by the use of a crude solution of carbolic acid called German creosote, so impure that at first he thought that carbolic acid was insoluble in water. For a time his experiments were only made on compound fractures, of which a large number, some of them very serious, occurred in Glasgow, where he was located at that time. His original plan was to introduce a piece of lint soaked in this crude carbolic acid into the wounds and thoroughly rub it into the recesses, and then to put in some more carbolic acid and stir it up with the blood so as to form a sort of paste which filled up the wound. Every day he painted a little carbolic acid over this coagulum, and in order to diminish the evaporation of the acid he covered the clot with a piece of block tin. Ordinary towels were then applied around to catch the discharge which soaked through; no other dressing was employed.

What was the result? All the cases followed an aseptic course so long as he continued the application of the carbolic acid; there was no temperature, no inflammation, no sloughs separating, no poisoning—in fact, none of the dreadful things which students are led to believe will result from the application of carbolic acid. No doubt in some cases where the carbolic acid was in contact for some time with the skin a small superficial slough formed, which, however, was of no consequence. After a time, when he peeled off the superficial layer of the clot he found a healed, or almost healed, wound beneath. And

as showing the absence of any injurious effects, it was in cases so treated that he first observed and demonstrated how blood-clot if aseptic acts as a mould for the penetration of cells and for the formation of new tissue—what is now known as healing by blood-clot. In some of his cases he discontinued the application of the carbolic acid after the deeper part of the wound had healed and when there was only a superficial sore, and as he had not devised any antiseptic dressing then he employed the ordinary dressings which he had previously been in the habit of using. Two or three of these cases showed septic troubles after the carbolic acid was left off, and, indeed, phagedæna occurred at this late stage, thus affording additional proof of the protective effect of his new treatment. I would recommend those who hold up their hands in horror at the idea of applying liquid carbolic acid to infected wounds to read and digest Lister's early papers.

Development of System.

As he developed his system, and found that carbolic acid was soluble and active in oil and water, he modified his plans, and later his method was to wash out compound fractures thoroughly in 1 in 20 carbolic acid lotion, taking measures to see that all recesses of the wound were subjected to its action. With this second plan the majority of compound fractures also remained aseptic, but a certain proportion did not do so, these results differing therefore from those which he obtained in the early days with the crude carbolic acid; these failures chiefly occurred in wounds which were badly soiled. We now know the reason of this, viz., that the dirt may be so ground into the tissues that the carbolic solution does not penetrate it thoroughly, and further that the 1 in 20 solution does not kill pathogenic spores in a short time. This led us to remove all visibly soiled portions of soft tissues or bones and to apply liquid carbolic acid to these surfaces, using the 1 in 20 lotion for the rest of the wound, and this

diminished the number of failures, and this is the plan I adopt in civilian practice. I believe that this plan would be quite satisfactory in the majority of wounds in war, but where they are very badly soiled with earth, as is so often the case at present, we should, I feel sure, revert to Lister's original plan in so far as to paint the whole surface of the wound with liquid carbolic acid; with the exception, perhaps, of narrow tracks in the deeper parts. Certainly this ought to be done in all cases of compound fracture.

In carrying out the disinfection of the interior of the wound not only must it be done methodically and thoroughly, and all the recesses of the wound carefully attended to, but one must not forget that it is most important to disinfect the surrounding skin most carefully. It is useless to disinfect the interior of the wound and to leave bacteria on the skin free to multiply there and spread in and infect the wound again. I also think it is best to *begin* with the disinfection of the skin. Again, one great difficulty in obtaining proper disinfection of a wound is the constant flow of blood from the wound which dilutes and washes away the antiseptic, and steps must be taken as far as possible to arrest or control the hæmorrhage in the first instance; this is a very important point. It may also be necessary to open up the wound, not only in order to arrest the bleeding, but also to reach all the recesses of the wound for the purpose of disinfection. Further, the process is painful, and therefore I should advise that in all cases an anæsthetic should be administered.

Methods of Disinfection of Wounds.

The procedure would be as follows. The patient having been placed under an anæsthetic, the first thing is to control the bleeding. In the case of an extremity a tourniquet is applied, but where the wound is situated on the trunk any visible bleeding points should be

clamped and the wound temporarily stuffed with gauze or large sponges. The next step is to cleanse and disinfect the skin thoroughly. In the first place scrub it thoroughly with 1 in 20 carbolic lotion and ether soap, then shave it, and finally wash it thoroughly again with the carbolic lotion, leaving a cloth saturated with the lotion over the whole area, so as to continue the disinfecting action and protect the skin while the interior of the wound is being attended to. The interior of the wound must now be disinfected, and if it is necessary to gain access to the deeper parts in order to enable one to see what one is doing, which is very important, the wound must be enlarged by incisions made in suitable directions. The blood must be thoroughly swabbed out, the wound made as dry as possible, and the skin or fat or other structures which are visibly soiled with earth or dirt should be cut away. The wound being then held wide open by retractors, a piece of sponge dipped in the liquefied carbolic acid is carefully and thoroughly applied to the whole surface of the wound and to all the recesses, care being taken, by holding a swab in the other hand on the edge of the wound, to prevent the acid running over the skin. It is well to sponge out the wound after the first application, and then to apply the acid a second and even a third time if there is bad soiling. If at the bottom of the wound there is a long narrow track leading to the tissues, it may not be necessary to disinfect it along its whole length, because the probability is that the bullet or fragment of shell does not carry the organisms in to a very great depth. If it is a large wound which has to be soaked with the undiluted carbolic acid, it may be well, after about five to ten minutes, to wash it out first with 1 in 20 carbolic lotion, and then copiously with saline solution, so as to get rid of the excess of carbolic acid and thus reduce the chance of absorption.

Having completed the disinfection of the wound, the tourniquet is relaxed, the vessels tied, and a good-sized drainage tube inserted down to the bottom of the wound,

or even through a counter opening if there is any doubt as to the thoroughness of the disinfection. Any incisions made by the surgeon may be closed by stitches, but no attempt should be made to stitch up the original wound, unless possibly where flaps of skin have been turned to one side, in which case they may be brought roughly into position by two or three stitches. After the disinfection of the wound is complete it is well to give the skin around an additional wash with the carbolic lotion, in case it may have again become soiled from the wound.

In the case of a wound on the trunk or neck where no tourniquet is available, and where therefore the bleeding cannot be thoroughly checked, the disinfection is much more difficult and uncertain, because blood is constantly washing away and diluting the antiseptic. Hence, the first thing to be done under these circumstances is to open up the wound and try to check the bleeding by clamping any bleeding points; these, however, must not be tied at this stage. The wound should then be firmly packed with gauze, so as to check the capillary oozing. Having done this, the skin around is cleansed and disinfected in the manner already described, and attention is then turned to the wound itself. The plug is then taken out and a smaller one substituted, so as to leave the skin and subcutaneous tissue exposed to view. The surfaces so exposed are then dealt with in the manner already described, badly soiled skin and fat being clipped away and the surface thoroughly soaked with the antiseptic. Further portions of the plug are then removed so that the whole surface of the wound may be disinfected bit by bit; in addition it is well to irrigate it thoroughly with 1 in 20 carbolic lotion, and then, if large, with salt solution. Finally, the vessels are tied, and in doing so it is well in the first instance to take off the forceps one by one, daub the vessel with carbolic acid, catch it again with clean forceps, and then tie it. The rationale of this procedure is that the piece of tissue caught by the forceps has not been disinfected, and if it were tied at once a septic point and ligature would result.

In both cases after the disinfection is complete an antiseptic dressing (not merely an aseptic one) should be applied. The reason for using a dressing containing an antiseptic is that in the first place aseptic dressings are seldom available on the field of battle, and in the second place it may not be possible to change the dressing for some time, and if a non-antiseptic dressing is used the discharge passes through it and bacteria rapidly develop in it and reach the wound. On the other hand, a dressing containing an antiseptic which is soluble in the serum may give enough of the antiseptic to the serum to render it an unsuitable medium for the development of organisms, and thus, if the dressing cannot be changed early, an aseptic result may still be obtained. I believe that wool impregnated with salicylic acid is the best for this purpose, but it is well to put a piece of cyanide gauze (which is itself only feebly antiseptic) over the wound, so as to keep the salicylic acid from the skin.

It takes a long time to describe this matter, but it is perfectly simple, and I have adopted this method of dealing with compound fractures and other open wounds for years with a very large measure of success, and I should be very much ashamed if any considerable number of cases which came under my care within twelve hours after the accident did not follow an aseptic course. If iodine is preferred I cannot say what strength should be used, but it certainly ought to be much stronger than the ordinary 2 per cent. solution which is the favourite at present. The procedure would be the same as I have already described. If iodine is used instead of carbolic acid for the disinfection of the skin, it should not be applied directly over the dirty skin, and therefore, here also, the skin must be thoroughly washed and shaved and dried, first with a dry cloth and then with acetone. The trouble is that the skin will soon be wet again with the blood and serum when the wound is taken in hand, and not only is the disinfection imperfect, but the skin painted with iodine, if again wetted, is liable to be much irritated.

I have not the slightest hesitation in saying that the disinfection will be much more thoroughly and satisfactorily done with carbolic acid, with less loss of time and also with less irritation of the skin.

Local Disinfection and other Methods of Treatment.

The proper disinfection of a wound cannot be carried out in a hurry, and unfortunately in the Army it will not be till the patient has arrived at the first field hospital, and in the Navy, till the patient reaches the surgeon's quarters on the battleship or the hospital ship itself, that it can be taken in hand thoroughly. Whether anything can be done in the field or trenches which might help to delay or circumscribe the sepsis is a problem well worth considering. The first dressings with which the soldiers are provided are of no use except to prevent the entrance of further dirt, and the surgeon cannot be expected to carry with him the arrangements necessary for disinfecting the wound, though he might carry some antiseptics which might be introduced into the wound. Thus we have been trying at Chatham to make soluble bougies or suppositories, each containing $1\frac{1}{2}$ gr. of carbolic acid, which might be pushed into a wound before the emergency dressing is applied, or the surgeon might be provided with strong iodine solution, and pieces of gauze soaked in this solution might be pushed into the wound and left there.* No thorough disinfection can, however, be carried out till the patient has reached some place (field hospital or sick bay) where he can rest for some time and where the methodical disinfection of the wound can be undertaken. As soon, however, as the patient has arrived at such a place the wound should be disinfected thoroughly, whether anything has been done previously or not. Even at the field

* Since the above was written, Mr. G. L. Cheatle tells me that he has had a paste containing carbolic acid made and put into paint tubes. This would probably be more conveniently carried than suppositories, which would be apt to melt, and if a long tube were attached to the paint tubes the paste could be very quickly squeezed into the recesses of the wound.

hospital or sick bay it may not be possible to keep the patients long enough for all the wounds to be thoroughly disinfected, but at any rate all compound fractures and wounds of joints which do not require amputation and all wounds badly soiled with earth should be dealt with as far as possible.

At the present moment great stress is being laid on the particular kinds of organisms which may have entered the wounds, but very little is said about disinfecting the wounds. Instructions are being given, as regards the Army, that immediately the patient comes under treatment he should have a subcutaneous injection of antitetanic serum and another of polyvalent antiseptis vaccine. Now I cannot speak with any authority as to the prophylactic value of antitetanic serum when injected into the subcutaneous tissues, but although *subcutaneous* injections of this serum are of no value in the treatment of tetanus once it has developed, those who have worked at the subject state that subcutaneous injection of the serum is of value if used immediately on the occurrence of infection. As regards antiseptis vaccine as a prophylactic, I am very sceptical indeed. It may possibly modify the severity of the impending sepsis, but I feel sure it cannot be depended upon to prevent it. At the same time, we must not disregard any possible safeguard, and for the present I think it is well, in military surgery at any rate, to inject these substances in the manner which has been advised. I should not think that it is necessary in naval surgery to inject antitetanic serum.

I do hope, however, that those who have to treat these wounds will not take it into their heads that after making these injections they have done all, or indeed, anything of any real importance, for the safety of the patient. I am very much afraid that some men will be satisfied with these injections, and will take no further local steps to render the wound aseptic, and will look on these injections as a way of avoiding the use of the much-hated chemical antiseptics. By all means use these injections, but never

lose sight of the fact that the only trustworthy way of avoiding the septic diseases which inevitably follow these wounds is to kill the organisms before they have taken root in the body. Remember also that we have not to do only with one species of organism; we have to do with a great many, and even if the methods suggested were as effective as we could hope it leaves many other organisms untouched.

(2) TREATMENT OF WOUNDS IF MORE THAN TWENTY-FOUR OR POSSIBLY FORTY-EIGHT HOURS HAVE ELAPSED SINCE THE INFLICTION OF THE WOUND.

It may happen that patients cannot be treated within the period above mentioned, and the question arises whether any attempt should then be made to disinfect the wounds in the manner above described. By this time the organisms will, for the most part, have got a firm hold on the tissues, and any attempt to get rid of them by antiseptics will fail, and if the attempt fails at this stage it may cause a great deal of harm by injuring the actively granulating tissues. It may possibly be well still to clip away any visibly soiled tissues and touch the raw surfaces with liquid carbolic acid, but I think that any attempt at general disinfection of the wound would be a very injudicious and harmful procedure, and still more so if suppuration has begun. Indeed, I would go further and say that not only should strong antiseptics be avoided, but also even weaker ones. I usually find that surgeons get busy syringing out these early septic wounds with various antiseptic lotions, and not only on the first occasion but every time the dressing is changed, and I consider this to be very bad practice indeed.

The Relation of Antiseptics to Wounds.

In fact, my views on the relation of antiseptics to wounds are exactly the opposite to those in vogue at the present time. It may be that I am not up to date, but

I fancy that I have perhaps been trained to take the treatment of wounds more seriously than most people, and to think and work a great deal at it. My own view is that if a wound is aseptic, while I do not willingly put antiseptics into it, their entrance will not interfere with healing at all so long as no bacteria have been let in by the surgeon. But, on the other hand, if bacteria are already established in a wound, I think it is the worst treatment possible to meddle with it more than one can help, and more especially to syringe it out with antiseptics and to poke gauze and other things into it. The general practice at present is just the reverse, viz., to avoid antiseptics when the matter is of no consequence and when their use outside the wound may help to prevent the reinfection of instruments and materials used; and, on the other hand, to use them when the wounds are septic, when they cannot kill the bacteria, and when the only effect they can have is to damage the natural defences of the tissues. The chief antiseptic which I would use in septic wounds, and that only in foul-smelling ones, is peroxide of hydrogen, which, although a feeble antiseptic, certainly seems to overcome the fetor and does not irritate the tissues to any marked degree. If it is deemed advisable to wash out a septic wound, use normal saline solution as a rule, though very weak antiseptic lotions may do no noticeable harm, once granulation is fully established.

I believe that the chief reason for the present prejudice against antiseptics was the free use of these lotions formerly by surgeons who deluged their wounds with antiseptics, but took no care as regards disinfection of hands, skin, instruments, &c., and infected their wounds thereby, at the same time damaging the resisting power of the tissues by their antiseptics. The result was that the wounds did badly, but not, as they thought, as the direct effect of the antiseptic, but from the introduction of bacteria into the weakened wounds. They thought they were practising Listerism, and therefore gave it a bad name, but they were not following the master's teaching. I remember in

the old days of the carbolic spray remarking to Lister more than once that while practically all our wounds healed aseptically, yet if a wound did go wrong with us, it went wrong worse than in the hands of septic surgeons. The reason was that the irritation of the spray diminished the local resisting power, and so enabled the organisms introduced to grow more readily; if no organisms were introduced this temporary diminution of local resisting power did not matter. It is curious how difficult it is to make people understand that carbolic acid or other antiseptic is not used as an application to a wound, but as an application to the bacteria outside the wound. The healthy tissues are sterile, as I was the first to demonstrate many years ago, and they need no antiseptic application to them; the enemy, the bacteria, come from without and should be killed outside the wound.

Drainage of Wounds.

As the wounds have come to us at the base hospital they are not only septic but they are often imperfectly drained. It is therefore necessary in most cases of large wounds, and especially where bones or joints are injured, to interfere with them by operative measures on their arrival at the hospital, but this should be done, as far as possible, once and for all. The patient having been put under an anæsthetic, the skin should be cleansed and disinfected in the manner previously described, and if there is any earth or gross dirt still visible about the wound the tissues involved should be cut or clipped away and the raw surface daubed with liquid carbolic acid. Apart from this, which is only occasionally necessary, the important point is to provide the freest possible escape for discharge, and in order to obtain this it is often necessary to enlarge the original openings and to make counter openings. Further, any foreign bodies which are readily accessible, such as clothing or fragments of shell retained in the wound, should be removed, but at this stage it is not advisable to open up fresh wounds in the deeper

tissues in order to hunt for bullets and pieces of shell, for this is only to expose fresh tissues to infection unnecessarily before the body generally has developed its full resisting power.

As to the actual drainage of the wounds, that must be carried out by the use of as large drainage tubes as can be conveniently introduced, with holes of suitable size cut in their sides; where there are counter openings it is well to pass the tube through from one opening to the other. A most extraordinary practice has grown up of late, viz., instead of using open tubes, to introduce masses of gauze into the wound under the idea that they will drain away the pus. Even those who use tubes generally slit them open at one side and fill them with gauze. Now the object of drainage and dependent openings in these cases is to let the pus run away as soon as possible so that the products of bacteria shall not lie in the part and cause local irritation or be absorbed. To push gauze into a sinus is effectually to prevent the pus escaping freely; and the pus soaking into the gauze and lying there undergoes still further changes as the result of bacteric growth, and becomes a highly poisonous and irritating substance. Whoever heard of stuffing a drain-pipe with gauze so as to let water run away, far less thicker material like pus?

I cannot conceive how this method of draining wounds ever arose; I fancy it was some aseptic surgeon who found that when he put a drainage tube into a wound, the wound always suppurated, and the bright idea occurred to him that by using gauze instead he would keep bacteria out. However it arose, I regard it as one of the most foolish and mischievous things that have ever been introduced in connection with the treatment of wounds, and especially of suppurating ones.

I may illustrate this by an anecdote. Some years ago I built a house in the country, and we had some difficulty in getting a proper water supply. At length I found a spring on the top of a hill in the neighbourhood where the earth had been somewhat hollowed out and which

was used by a crofter not only for household purposes but also to water the animals. I got leave from the landlord to make a proper well there and to get the overflow for my own use. This I did, making a nice clean well for the crofter with an overflow to water the animals, and this left ample water for my house. The crofters are very conservative people, though they always vote for the Radical candidate, and this particular old lady had a great affection for the old well and resented very much the new one. To relieve her feelings she put all sorts of things—rotten fish, &c.—into the well. We did not notice this at first, and thought the water was extra good and tasty, but presently the flow of water through our pipe began to fail and ultimately stopped altogether. On examining the well the spring was all right, and there was nothing for it but to dig up the pipe. About a hundred yards from the well I found a piece of dirty linen, evidently a portion of the old lady's chemise, which was very rotten and completely prevented the flow of water. Now this is exactly what you do when you fill a drainage-tube with gauze; you prevent the free exit of the pus, and the gauze becomes very rotten and poisonous.

I do not think one can go too far in preventing the accumulation of septic material in a wound. Two of the very best cases which I have so far had have been cases of fracture of the pelvis with extensive tearing of the rectum. For a few days they were treated by drainage, a large tube through the anus, constant irrigation, &c., without any improvement, but as soon as I performed colotomy and cut off the access of fæces their improvement was immediate and most remarkable, and one of them has already healed, and will soon be in a condition to have his colotomy opening closed.

Dressings—Irrigation.

As regards dressings in these cases, of course aseptic dressings are not only useless but injurious. The septic

discharge soaks into them and decomposes there, and the dressing simply becomes a septic poultice which poisons the wound. Antiseptic dressings are rather better, and in small wounds do well enough, the dressings I use being cyanide gauze next the wound with salicylic wool outside. But in large wounds the pus does not take up enough antiseptic to stop the decomposition entirely, and I am not at all satisfied with large masses of dressings over a wound. I believe that in these bad septic cases the less dressing you apply the better, and my experience is that as regards dressings it is best in these cases only to lay a few layers of antiseptic gauze over the wound to prevent it being soiled by the clothing or blankets, and to apply boracic fomentations and change them frequently. To pile on dressings on septic wounds, whether these dressings do or do not contain antiseptic substances, is only to revert to the old methods of two or three centuries ago which have been long since, and quite rightly, discarded. Wherever it is possible, however, in the case of large wounds and those involving bones or joints, constant irrigation with normal saline solution is by far the best method of treatment where circumstances allow of the employment of this plan. The irrigation is at first continued day and night, but after some time, as the discharge gets less and the wound begins to heal, boracic fomentations may be substituted during the night, but the irrigation should be continued during the day till healing is nearly complete. Where gangrenous processes set in, a water bath, frequently changed, with a little iodine or permanganate of potash in the water, is the best treatment.

Removal of Missiles.

There is just one other point to which I shall refer, viz., the question of the removal of the missile which has done the damage. Of course, if it is present in the main wound, or is doing harm by pressure or otherwise, it should be removed at once; but not uncommonly fragments of

shell or bullets pass into the tissues for a considerable distance from the main wound, and if left alone may become encapsuled and not do any harm and the wound of entrance will heal quite well. Such fragments can be removed by a separate incision later if necessary. I think that there is too great a tendency to hunt for small fragments of shell or bullets at the present time. It is interesting that when they traverse the tissues for some distance they seem to shed the septic material which they have carried in with them. I have one case where a piece of shell passed through the rectum and is embedded deeply in the other thigh and is not causing any irritation. It is well, however, to have a stereoscopic skiagram taken in all these cases as soon as the condition of the patient allows; this will help the surgeon to determine later if he should remove the fragment.

CONCLUSION.

Gentlemen, I am afraid I have taken up far too much of your time, but the question I have been referring to is one of tremendous importance, and I entreat you to give it your most earnest consideration. If you have followed what I have said, it is clear that I only advocate the use of antiseptics at the very commencement of the treatment; but at that time, in order to serve the purpose, they must be sufficiently powerful. I am much opposed to their use in suppurating wounds. Some object to the use of these strong antiseptics on the ground that they may cause a slough. This, however, is a mistake: used as I have advised they may kill a microscopic layer of the surface of the wound, but they cause no visible slough. Even if they did cause a slough, if you have destroyed the bacteria the slough is of no consequence; it will be absorbed like any other piece of dead tissue, and what does a slough matter as compared with the life and future usefulness of the patient? It is very trying for those of

us who are parents to feel that any day we may hear of the death of our boys in battle. If they die on the field of battle, they at least die nobly in fighting for their country and for the safety of those they have left behind. Surely it makes it still harder for us to know that if they escape death on the field of battle they may still, as the result of imperfect disinfection of the wounds, die from sepsis or be maimed for life. I beg of you to consider this matter calmly and logically and without prejudice, and see that every possible means is taken to avoid this great calamity.

