A Lecture ON WOUND INFECTIONS AND THEIR TREATMENT.

DELIVERED (WITH DEMONSTRATIONS) AT THE OPENING OF
AN EXHIBITION OF SURGICAL APPLIANCES FOR THE
TREATMENT OF THE WOUNDED HELD AT THE
ROYAL SOCIETY OF MEDICINE FROM
OCTOBER 8TH TO 14TH.

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(Continued from p. 676.)

PART III.

[Physiological Action of Strong Salt Solutions.]

In connexion with the physiological action of strong salt solutions—and when speaking of strong salt solutions I have in view those containing about 5 per cent. of salt—we have to consider primarily the effect produced upon leucocytes. And we have to distinguish between the case where the strong salt comes into direct application, and the case where it comes into operation from a distance.

In the former case—both in pus and blood—the leucocytes are broken down; and, in pus, evidence is obtained of a setting free of trypsin. In other words, strong salt solutions acting on a medium containing leucocytes will promote auto-digestion, and provide a nutrient substratum which will, as soon as the excess of salt is removed, favour the growth of microbes.

To study the effect of strong salt solutions acting from a distance we centrifuge blood in an emigration tube or cell;¹ let it clot; superpose our 5 per cent. salt solution; allow time for the salt to diffuse; and then incubate at 37° C.

Fig. 12.—We have represented in A and B the lower portion of the white and the upper portion of the red clot obtained by centrifuging blood in one of Emery's cells. The white corpuscles only are shown in the figure. In A strong solution has been imposed upon the free surface of the white clot. In B physiological salt solution has been imposed. The appearances are described in the text.

Fig. 12, A, shows the picture that we then get; and I add for comparison Fig. 12, B, showing the picture obtained when we impose upon the blood, instead of 5 per cent., 0.85 per cent. salt solution. In each case we have: below, the red corpuscles; and above these, the layer of leucocytes; and above these again, the white clot. In A, where the 5 per cent. salt solution has been imposed, we have practically no wandering out of the leucocytes into the white clot. We have instead a tightly packed and sharply margined band of leucocytes intervening between the red and white clots. Below this we see a good many leucocytes which have, as it seems, travelled back from the leucocytic layer into the red clot. In other words, we have here, instead of positive chemiotaxis as in B, paralysis, and presumably also negative chemiotaxis. There would seem to be little doubt about the negative chemiotaxis; for in companion tubes or cells, treated in every other respect than the salt solution as exactly alike, the white corpuscles have all been by the centrifugalization separated out from the red. It will be appreciated in connexion with Fig. 12, A, that the elements of the blood

have, first by the mechanical force of the centrifuge, and secondly by the chemical stimulus of the strong salt solution, been disposed in what I have called the "kakotropic" arrangement—that is, the blood fluids are in front, and the leucocytes behind. The import of this in connexion with the conduct of the wound will presently appear. For the moment let us merely put it down upon our tablets that it would seem to follow from what we see in Fig. 12, A, that we have in strong salt solution an agent which would be capable of arresting all suppurative processes.

Effect of Strong Salt Solution on the Condition of the Wound and the Microbic Infection.

The effect of strong salt solution on the wound will, of course, be the resultant of its physical and physiological effects; and there will be in addition an effect exerted directly upon the microbes.

This last may very quickly be dealt with and disposed of. Percentages of 2 per cent. will begin to inhibit, and 5 per cent. solutions will completely arrest, the growth of pyogenic microbes. In other words, undiluted 5 per cent. salt solution will by itself—and this is to be borne in mind in connexion with proposals to combine this with carbolic acid—prevent any growth of microbes in the wound.

Let us, however, turn—for this is of more moment—to the effect exerted by the hypertonic salt solution on the condition of the wounds. And we may take the case of hypertonic solution applied to a sloughing or indurated wound. Now coming, as it will here, into direct application upon leucocytes, the strong salt solution will break these up, and set free trypsin and favour auto-digestion; and, coming into operation at the same time on the walls, it will promote an outflow of fluid. The effect of this will be to loosen and separate the sloughs, to disperse the induration, and finally to give us—always provided that the concentration of the salt is maintained—a wound in which muscles and connective tissue lie before us as bare and clean, and as free from pus, as meat exposed on a slab at the butchers'. Moreover, impression preparations will show that the surface lymph is practically free from leucocytes, and that the sero-saprophytic microbes have disappeared, leaving behind only a few staphylococci or streptococci. This complete result is, as a matter of fact, only rarely seen—for applied in the ordinary way on a pad of lint or gauze, the hypertonic solution is by the outflow of lymph very rapidly diluted.

But whether we have before us the complete, or only the incomplete, result, we have a wonderful improvement upon the state of the wound before treatment. None the less, the prospect for the future is not quite reassuring. In point of fact, we have here lying open and naked before us all the lymph spaces; and, moreover, the elements of the lymph are disposed in the "kakotropic arrangement"—the fluid elements which furnish a favourable culture medium in front, and the leucocytes which would be capable of combating the streptococci behind; and at any rate, so far as the superficial lymph spaces are concerned, there would now seem to be nothing to prevent microbial invasion save only that we have here an outflowing current.

But if the salt which has been absorbed into the tissues were no longer carried away, or if the saline solution outside were now to be diluted, the tide might easily turn and flow inward. In short, we see that we have made a successful advance, but that we must, before we can congratulate ourselves, advance a great deal more.

Our experiments in connexion with the bactericidal power of the whole blood tell us what our next step must be. If we want to keep the streptococci at bay, and destroy them, we must get the elements of our lymph into the agathotropic order; in other words, we must now bring forward our leucocytes. Our studies on emigration tell us how this is to be done. We shall have to substitute for our 5 per cent. 0.85 per cent. saline solution.

Effect of Physiological Salt Solution.

It will in connexion with physiological salt solution be unnecessary to go much into detail with respect to its physical and physiological action. All that requires to be emphasized is that 0.85 per cent. salt solution, which we call normal or physiological, is normal and physiological

¹ The cell referred to is a special form of cell devised by my fellow-worker, Captain d'Este Emery, and made by luting together two pieces of glass slide with paraffin wax.

only with respect to its tonicity. It has, of course, a much higher content in sodium chloride than the blood fluids, and will, when placed in contact with these, send into them sodium chloride, exchanging this against other salts. It is to this different salt content that we have to ascribe the physiological action which 0.85 per cent. salt solutions exert when superimposed upon centrifuged blood. Fig. 12, n, has shown us what then invariably happens. The white corpuscles—and in particular the polynuclear white corpuscles—are carried forward by a chemiotactic movement in the direction of the free surface upon which the physiological solution has been imposed. And precisely the same occurs in the wound. After the lapse of a few hours the perfectly bare wounds which are obtained by treatment with strong salt solution begin to clothe themselves with a grey film. And when we make impression preparations we find on the surface of our cover-glasses a layer of beautifully well-preserved polynuclear white corpuscles. In other words, the elements of the lymph are now in the agathotropic arrangement; and microbes if found at all are only very few in number.

This marks another great step in advance. It is, however, as we shall presently see, one that falls very far short of a final conquest over the infection. But for the moment let us turn aside and see what will happen when hypertonic salt solution is applied to a clean, or, as the case may be, a suppurating wound, and is then diluted. We shall see our new data dovetailing perfectly with the old.

To study the sequence of events where a hypertonic salt solution is spontaneously diluted with outflowing lymph, we carefully clean the surface of a granulating wound. We then bring down upon it—and I owe this piece of technique to my fellow worker, Lieutenant H. H. Tanner—a *lymph cup* such as is shown in Fig. 13, fastening it

Fig. 13.

down securely upon the skin by strips of adhesive plaster. We now introduce a measured quantity of hypertonic solution into our lymph cup, and then from time to time remeasure and sample the fluid. During the first hour or more only a *lymphagogenic effect* is produced. The fluid in the cup increases in quantity—in an experiment I have in mind the original 3 c.cm. of 5 per cent. salt solution increased in three hours to 5 c.cm.—but the fluid remains quite limpid. After that a *leucocytagogic effect* begins to manifest itself. First a few, and then more and more leucocytes emigrate into the fluid in the lymph cup; and the streptococci, which in the first phase of the experiment may have been fairly numerous, gradually decrease until it is difficult to find them.

To study what will happen when 5 per cent. salt solution is brought into operation upon a suppurating surface and is afterwards diluted, we take a sample of pus, mix it with 5 per cent. salt solution, and then place it in the incubator. We then dilute with sterile water until we have brought down the content in salt to 0.85 per cent., and then we incubate for a further period of hours. After the expiration of that period we find—and we may put this down to the setting free of trypsin from the cells broken down by the strong salt solution—a much more luxuriant growth of microbes than in a control sample incubated for the whole period with physiological salt solution.

Reverting now to our wound which was treated with physiological salt solution, you will remember that we had there a position won but not consolidated; and, if events were now allowed to take their course, the leucocytes which had been drawn up to the surface, and in particular, perhaps, those which had done service in the destruction of microbes, would not long maintain their vitality, for

the conditions which prevail on denuded surfaces are, as we have seen, uncongenial to leucocytes. Now just as soon as the first leucocytes die and break up and set free their trypsin, all those in the neighbourhood become involved in the same ruin, and this provides for any microbes that have survived or come in from outside in an eminently favourable culture medium. After this we have very soon upon our wound surface in the place of an almost extinguished infection a luxuriant culture of microbes; and though no doubt it might be possible, by instituting continuous irrigation with physiological salt solution, still to hold on, our position cannot really be consolidated by anything except the restriction of the infected surface and the final closure of the wound. In other words, that as soon as we have practically conquered the infection surface we ought, as I said in an earlier section of this lecture, to proceed immediately to secondary suture of the wound.

TREATMENT BY VACCINES.

Treatment by vaccines would have hardly any meaning in connexion with antiseptic treatment; but it is, as a moment's consideration will make plain, very intimately linked up with phylacagogic treatment. For, once we have made up our minds that an infection will have to be fought by the protective powers of the organism, it will be reasonable to look round and see whether the protective powers of the organism generally cannot be reinforced. And it will also occur to the mind that not only the blood fluids could be reinforced in protective substances but also chemiotactic sensibility of the leucocytes could be so altered as to give a more vigorous emigration response. If this were secured, the leucocytes would not only come more rapidly and more effectively into action, but they would come into action in the whole theatre of infection, instead of, as in the case where salt solutions are applied, only in those regions into which the salt is conveyed by diffusion.

Having seen where vaccine therapy fits in, we have next to consider how and upon what principle we shall select from the bacterial flora of the wound those microbes which ought to be combated by vaccines. The principle here is quite clear: we ought to direct our attention to those microbes which are least easily killed by the protective elements of the blood. That will mean that we ought to put into our vaccine primarily the streptococcus and the staphylococcus, for these belong to the class of serophytes; and in the second instance the bacillus of Welch and the *Bacillus proteus*, for these belong to the class of imperfect serophytes, microbes which will, provided we make a sufficiently heavy implantation, establish themselves and then grow luxuriantly in the blood. Let me explain that whenever in the following I speak of a vaccine for bacterial infections of wounds I shall have in view either (a) a vaccine containing streptococci and staphylococci obtained from wounds, or (b) a vaccine which contains in addition to these the bacillus of Welch.

The question of the vaccine settled, the next question is at what stages in the wound infection we can find specially favourable opportunities for the use of vaccines. The first of these specially favourable opportunities will present itself immediately after the wound has been received. The patient is here just entering upon his incubation period; and it may quite well make all the difference to him if he is now, before the microbes which have been carried into his tissues grow out, enabled to kill them. I hold very strongly—and there would be no difficulty at all in arranging for this—that every wounded man should be inoculated as soon as he reaches the first-aid post. A second, and also very favourable, opportunity of achieving definite good by inoculation would present itself at a later stage, in those cases where the streptococcus, or the bacillus of Welch, or the two acting in conjunction, establish a footing in the tissues, and begin to spread there. I am thinking, of course, of the early stage of erysipelas, cellulitis, or gaseous emphysema, where we have, as the case may be, the beginnings of an inflam-

² Both varieties of vaccine are available in all military hospitals, the first under the designation "antiseptis vaccine," the other under that of "antigangrene" vaccine. If an autogenous vaccine were to be made for a particular patient one would determine the microbes which menaced him by taking a sample of his pus and making, as described in the first portion of this lecture, progressively smaller implantations of this into his serum or blood by the method of pyosero-culture, or pvo-haemo-culture, and then using for the vaccine those microbes which grew most readily in the blood.

matory blush on the skin, or the beginnings of induration, or it may be that purplish mottling of the skin which heralds gaseous gangrene.

And the employment of vaccine would also be specially opportune when we address ourselves to the partial or complete secondary suture of the wound. For the conditions are here analogous to those which obtained when the original wound was received—analogue in the respect that we have in both an implantation of microbes into the depth; and analogous also in the respect that success or failure will hinge upon the rapidity and effectiveness with which the protective elements of the blood are brought to bear upon the implanted microbes.

But to all this it may be objected that we have here merely plausible theoretical considerations; and that what is required is direct evidence establishing the utility of inoculation.

Let me therefore consider with you how far it would be possible here to procure probative evidence; and for the sake of those who attach superior authority to clinical evidence, let us begin with this.

A comparison of what would be procurable in connexion with antiseptics inoculation with what has been procured in connexion with antityphoid inoculation will here clear up certain points for us. The first of these is, that once a man has been inoculated against typhoid, events will take their course unaffected by outside interference. In other words, if an inoculated man comes into contact with infection, and the typhoid bacillus effects a local lodgement in him, nobody comes and interferes between the organism of the patient and the invading microbe. Moreover, when the invading microbes are successfully disposed of, there will not remain open any door to after-infection. The exact reverse will hold of antiseptics inoculation.

Here there will be all sorts of interference, useful or, as the case may be, harmful, at the point where the microbes have effected a lodgement; and the wound will remain open to further infection from outside, and in particular it may readily be reinfected in the course of operative interference. By reason of this it will, if the wound becomes septic, be impossible to tell whether the responsibility lies with the microbes originally implanted, or whether these were killed off, and we are in presence of an after-infection. Enough will have been said to show that it will be quite out of question to procure in the case of antiseptics inoculation trustworthy statistical data such as are available in connexion with typhoid.

Precisely the same will hold true in the case of antiseptics inoculation undertaken as a preliminary to secondary suture of the wound. For here everything will depend on the operative skill of the surgeon and on the scientific preparation of the cases. And the only judgement which will have value will be that of the surgeon who has actually followed the cases; and, again, his opinion will have value only if he have experience also of cases of secondary suture undertaken without inoculation.

There remains the third class of case, that where vaccine is employed to abort an incipient infection of tissues. Here, again, statistical proof will be unattainable. When, however, a sufficient number of separate observers shall have experimented with the vaccine, using control, and shall have formed each his own experimental judgement, we shall have evidence which will really have probative value. But experimental judgements of that kind are not yet available in sufficient number.

For the present, therefore, there is not—nor will there ever be, except only in connexion with the last class of case—anything to carry conviction to that type of man who puts aside what he calls "theory" and demands everywhere proof and certainty.

But, while we have in these matters no certainty—and let us not regret it overmuch, for certainty is like the stick without the dog to the blind man who wants "to get a move on"—we have here all that an exacting mind could require in the way of inferential evidence of the value of immunizing response in wound infections. Such evidence is furnished by the fact that patients who make only very indifferent immunizing response suffer from long-continued pyrexia, and their wounds heal slowly, and they not infrequently develop serious complications, in particular in the form of spreading infections and metastatic infections of joints. The direct reverse holds of patients who are making satisfactory immunizing

response. Their wounds heal rapidly; and they never give cause for a moment's anxiety. Now, such immunizing response as we see here safeguarding the patient is, in the case of healthy men—and I reckon as healthy men all who are not suffering from autoinoculations and fever—readily obtainable by the inoculation of vaccines.

I have now completed what I have to say about the different ways of treating wound infections; and you will have appreciated that, while antiseptic treatment stands apart, the three other methods are closely interlinked—forming together a complete system of phylacagogic treatment. Let me now draw the threads together, and put before you in outline a scheme which might serve as a basis for the treatment of wound infections.

Before that, however, let me just pause to express my gratitude and indebtedness to my fellow-workers in these researches on the treatment of wounds, and in particular to Captain S. W. Patterson of the Australian Medical Service, to Captain d'Este Emery, and to Lieutenant A. C. Inman and Lieutenant H. H. Tanner. And I have at the same time to express my grateful acknowledgement to the authorities of the Army Medical Service, and to Colonel W. l'Estrange Eames, C.B., of the Australian Hospital, and, above all, to the Medical Research Committee for placing the services of these officers at my disposal.

SCHEME FOR THE PHYLACAGOGIC TREATMENT OF WOUND INFECTIONS.

It will be convenient for the ordering of this scheme of treatment to follow the wounded man from the "first-aid post" back through the whole system of hospitals.

Treatment in the First-aid Post.—Here, after haemorrhage has been arrested and the wound has been cleaned and bandaged and splints have been fitted, it will be well to give a prophylactic injection of "antigangrene vaccine," this being, as already explained, a vaccine containing the streptococcus, and staphylococcus, and bacillus of Welch. For this injection nothing in the way of apparatus would be required beyond a syringe in a metal case and the vaccine in a rubber-capped bottle. From this last the vaccine would be drawn off as required through the rubber cap sterilized with lysol or other antiseptic. To sterilize the skin at the point inoculated is, in connexion with injection of vaccine, a work of supererogation.

There would follow upon the inoculation a rapid immunizing response which would, one is entitled to anticipate, in a bullet wound perforating only tissues, extinguish the infection, and would in other wounds do the same in those regions where the physiological conditions were not too unfavourable.

Treatment in the Field Ambulance.—I would suggest that the work of the field ambulance, which is—except in the case of the wounded who are too ill to move—restricted to mere washing and sterilizing operations, to the application of clean, dry dressings, and to the injection of tetanus antitoxin, should be extended to the performance of simple operations for the excision of the projectile and foreign bodies, and the procuring of efficient drainage. And I would suggest that all wounds, with the exception of those which promise to get well of themselves, should be treated with hypertonic salt solution. These suggestions are dictated by the consideration that where a wound will, if left to itself, certainly become septic, we ought, at the earliest possible moment, both to remove extraneous substances which contain microbes, and provide for a free outflow of lymph from the whole internal and external surface of the wound.

Concerning the operative procedures for the procuring of drainage it will suffice to say that they ought to give sufficient access to permit of loops of sterile bandage, previously steeped in a solution of 5 per cent. sodium chloride and 0.5 per cent. sodium citrate, being carried down into the wound to serve as wicks.³ The introduction of the bandages ought to be prefaced by a syringing out of the wound with the aforesaid solution, and the free ends of the bandage ought to be carried out from the wound to be inserted between plies of lint well soaked in the same solution, and folded over so as to form a thick pad. Finally, one or two tabloids of salt ought to be

³ Vide here the author's Memorandum on the Employment of Bandages for the Draining of Wounds, BRITISH MEDICAL JOURNAL, October 16th, 1915, p. 554.

planted in between the back layers of the pad, and over the top of all ought to come a layer of impervious protective tissue. This method of dressing ought to be applied also to the open funnel wound. In the case of "goug-out" or "punched-in" wounds of soft tissues the wicks of bandage would, of course, be dispensed with.

This will be the place to elucidate two points which come up for consideration everywhere when hypertonic salt solutions are used as lymphagogic agents. The first has reference to the concentration of the salt, the second to the addition of citrate of soda.

In connexion with the concentration of the salt all strengths from that of sea-water—corresponding to about 2.5 per cent. of sodium chloride—to a saturated solution—corresponding to 30 to 40 per cent. of sodium chloride—have been used in the wound; and the stronger the salt solution the greater the lymphagogic effect. But as the concentration of the salt increases, treatment will be more and more painful until with saturated, and nearly saturated, salt solutions we get escharotic effects with intolerable burning on the wound surfaces; while on the skin there is produced severe irritation followed by bacterial infection. The strength of the salt solution must therefore be kept within limits. Where we have freshly cut edges of skin, and, as in the flapless amputation, nerve fibres exposed in the wound, it will be unjustifiable to employ more than 5 per cent. of salt; and even then it will be well to protect the cut edges of the skin with a thin coating of vaseline. When, on the contrary, we are dealing with comparatively insensitive granulation tissue, or with quite insensitive sloughing surfaces, we may, with a view to achieving more rapid results, employ somewhat stronger solutions. But even with sloughing wounds it will be better not to go beyond 10 per cent. of salt. Again, when we use a wet pack of salt solution, it will be well to protect all the skin in the neighbourhood with a coat of vaseline. And finally, when we use, as suggested above, tabloids of salt to keep our salt solution up to strength, in despite of outflowing lymph, care must be taken to prevent the solid salt coming into contact with the wound surface.

Passing now to the question as to when citrate of soda should be employed in combination with hypertonic salt solutions, it may be explained that the purpose of the citrate is to prevent the lymph coagulating in the siphon bandages and on the walls of the wound. I may point out, in connexion with this, that while 5 per cent. salt solution will, as already Alexander Schmidt showed, prevent clotting, it will not, as my fellow worker, Lieutenant A. C. Inman, has shown, prevent clotting in blood that is mixed with pus. Such blood is, however, prevented from clotting by 5 per cent. salt mixed with 0.5 per cent. of citrate of soda. The practical rule, therefore, will be to add citrate of soda when we are confining the discharge and may be dealing with pus; and to omit the citrate as unnecessary when we are irrigating and washing away any pus.

Treatment at Casualty Clearing Stations.—As the patient is transported farther and farther back from the front, and x-ray and other equipment becomes available, it becomes possible to undertake more extensive operations for the procuring of drainage, and for the removal of the projectile and extraneous substances, as well as for resection of hopelessly infected tissues. But we have always in connexion with operations upon a patient who has to be transported farther, to consider not only the practicability of the operation, but also that of keeping the patient under close observation sufficiently long after we have operated. It must be remembered here that the wound infection is always the important factor to keep in view, and that the period which is occupied in transport will generally represent for the patient a period of retrogression; and the set-back will generally be proportionate to the duration of the journey. During transport drainage will, unless this can be prevented by wet salt packs applied under protection, be interrupted; the wound may become "lymph-bound," and then cellulitis or gas gangrene may supervene. Or, again, if the wound has arrived at the suppurative stage, the discharges will be confined and become tryptic, and corrupt.

This will, of course, apply retrospectively as well as prospectively, so that in every hospital which receives patients from the front its work will consist largely in efforts to regain for the patients ground lost upon their journey. In particular the induration of the walls of the

wound will require to be dispersed, and relief will have to be obtained for the wounds that are lymph-bound.

Treatment at Hospitals at the Base.—Operative work will here be called for in connexion with two classes of cases. First there will be cases of spreading infection in the tissues—cellulitis and gaseous gangrene—which have manifested themselves during transport. These will require treatment by free incision supplemented by hypertonic salt solution. Further, there will be operations postponed from the casualty clearing stations—postponed either because of pressure of work or for the patient's sake, to give him the benefit of special equipment or special operative skill available at the base, and in conjunction with this the longer hospital stay which is there permissible.

The longer hospital stay will, when it can be secured, allow of quite important progress in the conduct of the wound infection. It will then be possible to embark upon, what I may call, the full programme of phylacagogic treatment.

In this programme we first irrigate with a hypertonic salt solution until we have restored the tissues to their natural condition, and are dealing with a mere surface infection, and only with serophytic bacteria. We then irrigate with physiological salt solution till we have extinguished, or all but extinguished, the surface infection. And we then undertake, in one, or in a series of successive operations, secondary suture of the wound.

The essential features of these three linked procedures have already been explained, but the details remain to be worked out. The following practical points may, however, be emphasized.

Lymphagogic Irrigation.—The irrigation and drainage of the wound may with advantage be conducted by the methods which form the subject matter of the demonstrations already referred to (see Footnote 3). The solution which I would suggest for use is a 5 per cent. solution of sodium chloride, boiled, and kept at a temperature of 37° to 40° C. Irrigation with this solution ought to be continued *de die in diem* until the desired result is obtained. If we fail in this we have probably some retention of pus in inaccessible spaces, and these ought to be opened up. Whether irrigation ought to be continuous, or whether it ought to be continued for only a few hours at a time, remains to be determined.

Leucocytagogic Irrigation.—Our therapeutic solution will here normally consist of boiled physiological salt solution. It, however, remains to be determined whether in those cases where secondary suture is for any reason impracticable, it may not be better to substitute for physiological salt solution some such fluid as Ringer's solution or Locke's solution (without the sugar), whose salt content will more nearly resemble that of the blood—such a fluid, though as a leucocytagogue not so good as physiological salt solution, might quite as well prove more favourable to the growth of connective tissue and epithelium.

There remain over now two general questions with regard to which an explanatory word must be said. The first relates to infections of joints and serous cavities which are shut off from the exterior; the second, to the employment of antiseptics and antiseptic precautions in connexion with operative interference and the various manipulations and procedures undertaken in the wound.

Treatment of Infections in Unopened Joints and Serous Cavities.—The complete programme of lymphagogic treatment, leucocytagogic treatment, and secondary suture is, of course, a programme for open wounds. But lymphagogic treatment will be superfluous where we have a purely surface infection in a closed cavity. And the question of secondary suture will not come up, unless we have first opened up widely—a method of treatment which is, at least in infections of the knee-joint, of very doubtful wisdom. There remains accordingly of our programme only the irrigation with physiological salt solution, and in combination with this effective drainage. In the particular case of a knee-joint infection the fluid could be supplied through one needle and be carried off through another. Or the fluid might be carried in through a fine rubber tube inserted in a very small incision. And the fluid might be allowed to find its own way out, or it might be carried out by a siphon of sterile bandage inserted through a small counter opening and carried down to a vessel of water standing on the floor.

Employment of Antiseptics and Resort to Antiseptic Precautions in Connexion with the Wound.—The employment of antiseptics and the taking of antiseptic precautions in connexion with all operations and manipulations in wounds is governed by the consideration that the patient will have made immunizing response only to those microbes which the projectile carried into the wound, and to those contained in the vaccine—these being *ex hypothesi* those present at the outset in every wound. To all other microbes the patient will, except only so far as the increase of his antitryptic power may protect him, be fully susceptible. From this it follows that we shall, if we neglect any antiseptic precaution, be running the risk of superadding to the already subsisting infection another infection; and in hospital we shall be running the risk of transferring infections from patient to patient. Herein, then, lies the justification for prescribing the prophylactic employment of antiseptics and antiseptic precaution, and in particular the use of sterile instruments and sterile gloves in connexion with the dressing of patients, and in association with this the sterilization of all bandages and salt solutions used in the wound:

CONCLUDING REMARKS.

I pass in conclusion—for in the end one's thoughts always take that direction—to the problem as to whether it would not be possible for the researches I have detailed to bear fruit in a wider sphere than that represented by the present audience and those who will perhaps read this discourse.

You see that my mind is here set upon those questions of organization concerning which I ventured to say something when lecturing here some six months ago.⁴ Let me to-day again break ground for you by indicating that there are included in the Army Medical Service in reality three different services—a Service of Administration; a Service of Sanitation; and a Service for the Treatment of the Sick and Wounded. And let me again, in connexion with the last mentioned, ask you to remember that it is staffed almost exclusively by medical practitioners joining for the war; and that the civil profession is by consequence specially responsible for its efficiency. Now, if that is so, it then must be for the civil profession a duty of special obligation to see that whenever, in the practically unexplored field of wound infections, any new knowledge is gained, that new knowledge shall be brought into application in all military hospitals.

At the beginning of the war the outlook, so far as it related to the wounded, was, I think, somewhat as follows:

It was realized that all sorts of surgical operations in which life would be at stake would have to be undertaken; and that these would, under the conditions that existed, fall to new-joined junior medical officers with very little operative experience. There were, therefore, sent out to the theatre of war a certain number of eminent surgeons.

Here at the very outset we see recognition of the fact that the rank and file of new-joined medical officers will require—and, moreover, will very gratefully accept—skilled help and supervision.

There were two alternative ways of supplying help and supervision.

The one was to associate the eminent surgical experts with the Medical Service of the Army in the capacity of consulting surgeons. To do so, was not to follow the precedent of civil life: for in civil life the operating surgeon is not consultant and adviser to the operating general practitioner. Nor was it to follow the precedent of the army. But, at any rate, that was the course that was adopted.

The other and, I think, the better alternative would have been to have made those who now function as surgical consultants integral elements in the army machine; to have entrusted to them the selection of the operating staff in the hospitals in their administrative unit; and then to have made them directly responsible for all operative treatment in those hospitals.

All this touches, but only indirectly, the particular point in organization I want you to consider.

What seems to me specially required is the organization of all that department of treatment which lies outside the sphere of the operating surgeon, or at any rate the sphere

of the operating theatre. Before the war it was generally held about this department of treatment—let me call it for short “the conduct of the wound infection”—that all that would be required would be: to drain the wound, by making an opening at the most dependent point; then to wash out with antiseptics; and finally, to apply dressings. And it was held—and no doubt correctly—that for the proper carrying out of the antiseptic washings and dressings any doctor who was on the *Medical Register* or any trained nurse would suffice.

Now the wind has swept this all away, and it has come home to everybody that every wound is infected and that the infection is the really serious element in wounds. Coming on the top of this, practically everybody has become aware that the antiseptic system has—so far as the treatment of the wound infection is concerned—completely broken down. So finally it comes to this, that the progress of knowledge has filched away from the ordinary medical officer everything, other than the knife, which he was relying upon for the treatment of bacterial infections of wounds.

And though here and there he may have substituted for the antiseptic hypertonic salt solution, that is, as we have seen, only to take one item out of the programme of bringing the protective elements of the body to bear upon the infection; and what is required is the complete programme. Now to carry out the complete programme it will be necessary to stop every moment and think; and it will be necessary also to verify every step; and to make as occasion requires new departures. Now to stop every moment and think, is not given to everybody; and to verify, and as occasion may require rectify, one's course in combating a bacterial infection involves thinking in terms of microbes and protective substances and autoinoculations and vaccines, and involves also a certain acquaintance with laboratory technique.

So that I have the conviction that a newly-joined medical officer, supposing him left completely without supervision and help, would more easily perform successfully all the surgical operations that might be required of him than conduct satisfactorily the treatment of a wound infection.

If that is so—and it is for you to judge whether it is so—what follows is that it will be necessary to provide in connexion with the conduct of the wound infection the same kind of aid and instruction as is provided in connexion with operative surgery.

And what holds true with respect to the organization of the one, will hold true also with respect to the other. For the conduct of the wound infection, which we are here considering, one would wish to have in each large administrative unit a responsible head disposing of a staff of men with both laboratory and clinical experience, who would be deputed one to each hospital to exercise supervision as “a physician in charge of wounds” over all that department of treatment which lies outside the sphere of operative surgery.

And I would emphasize that it would be just as necessary in the case of the “physician in charge of wounds,” as in the case of the “surgical specialist,” to confer such rank as would make it possible effectively to direct the operations of the medical officers working in the wards.

ACCORDING to the *Boston Medical and Surgical Journal*, Scandinavian immigrants do not survive in the Southern United States, where their former settlements have entirely disappeared, whilst those in the northern States are thriving. Albinism is markedly frequent in the German and Scandinavian races. The Greeks are subject to various forms of infantilism, especially arrested sexual development, and are particularly prone to spinal meningitis. The Armenians and Syrians are susceptible to sporadic typhus and trachoma. Spanish, Portuguese, and Basque shepherds readily contract anthrax. Italians, who age prematurely, have a marked tendency to arterio-sclerosis, while pellagra, hookworm, malaria, rickets, and osteomalacia are common amongst them. Italian emigrants are very liable to tuberculous diseases. Turks suffer badly from parotitis. Tuberculosis is killing out the red Indian. Diabetes is so common among the Jews that its increase in New York keeps pace with the free immigration of European Hebrews. The admixture of Jews with the physically dominant races in the States has produced a fine type relatively free from the recessive characteristics of Aryans and Semites.

⁴ The *Lancet*, May 1st, 1915, p. 898.