An Address

ON

MODERN ANTISEPTICS.

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BY

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THE great conceptions of the early workers with antiseptics were: (1) That all wound diseases are due to infection with living organisms—at first always spoken of as "germs," the "germs of disease." (2) That these "germs" gain access to a wound from without, and chiefly through the air. (3) That these "germs" can be killed by treatment with sufficiently powerful antiseptics, and if and when this is done, healing of a wound proceeds without interruption. The aim of these early antiseptic surgeons was to prevent infection of wounds, and the early triumphs of antiseptic surgery were gained in the prevention of those terrible complications which had up to that time been the bane of surgery.

This prevention of wound infection marked, of course, an enormous advance in surgical knowledge and practice. By careful antiseptic measures—and the same is true of "aseptic surgery"—the healing of wounds in civil practice has for years proceeded with almost unbroken uniformity. Secondary haemorrhage has become a surgical rarity, and wounds have healed without complications under conditions which demonstrated the futility of attributing the previously frequent disasters to "reaction," or to "hospitalism."

The demonstration that wound complications are the result of infection from without and can be prevented by appropriate germicidal measures was, then, the first great contribution of antiseptic surgery, and a splendid contribution it has been!

Since the war, however, surgeons have been called upon to treat, in unprecedented numbers, wounds already gravely infected, and they have been faced, as never before, with the problem of the cure of infected wounds. It is not surprising that the dressings employed as part of the preventive treatment of surgical and recent wounds have proved ineffectual in dealing with wounds already deeply infected. Surgeons experiencing this and yet convinced of the value of antiseptic treatment and of the accuracy of the observations upon which it rests, have sought to add to the efficiency of their antiseptic measures by using in the first place more powerful germicides, and then by using these germicides in a more efficient manner. To this they have added in certain cases the use of serums and vaccines.

But the mere recovery of the patient and the healing of the wound that has been infected is only part of the aim of the surgeon. Knowing as he does that by the use of antiseptics in such a way as to prevent the development of pathogenic organisms in a wound he can ensure rapid and unchecked healing of wounds, he necessarily has asked himself whether antiseptics cannot eradicate these same organisms from tissues in which they are already growing, and leave the tissues free to heal in the same painless, feverless, and rapid way as when no infection has occurred. This is the problem presented to-day to the antiseptic surgeon.

THE CURE OF INFECTED WOUNDS.

Just as the early antiseptic surgical work followed and was based upon certain laboratory experiments, especially those of Pasteur on fermentation, so we have demonstrations—experiments if you like—that have a very direct bearing upon the modern antiseptic problem, which is the cure of already infected wounds. The experiments cannot be a matter of test tubes or flasks, they must be carried out in living animal tissues already the seat of infection. An acute abscess allowed to burst, or merely opened by the surgeon, and not "treated" in any other way, is such an experiment. Up to the moment of letting out the pus, a bacterial invasion runs riot in the tissues forming the so-called "abscess wall," and it is this area of the entire lesion that is the source of the patient's pain, fever and danger. Immediately the pus is evacuated the whole picture changes—the infection is arrested, the invaded tissues are sterilized, and, given certain favourable con-

ditions, the damage that has been done is quickly and completely repaired. This result is brought about by the application to the infected tissue of a highly cellular fluid, locally produced, which has a germicidal effect—what I would for the present purpose call an "autogenous antiseptic"—aided by the evacuation of the mass of liquefied tissue, dead leucocytes, and living, moribund, and dead bacteria, which we call pus. Whenever we see an acute abscess burst and heal very rapidly, we are sure that certain particular agents have contributed to that result: (1) the application to every part of the invaded tissue of a potent autogenous germicide; (2) the preservation of the living tissues from all injury, and (3) the evacuation of all dead matter—the pus. There are, of course, many similar experiments performed for us, bearing upon the problem of the cure of infected tissues, but the life-history of an acute abscess is as instructive as any, and is very familiar.

"THE AUTOGENOUS ANTISEPTIC."

The problem of modern antiseptics is first of all how best to sterilize an already deeply invaded tissue, and I submit that the solution of that problem will probably be found in a close imitation of nature's method of effecting this object. But before referring to some of the features of "natural antiseptics," we must notice two points: the first is, that nature plays her healing part in every case of tissue infection, and that whatever additional means the surgeon may use, he is always backed up by nature, and must never think that success depends wholly upon his efforts. In these cases the *vis medicatrix naturae* is very real, it can never be dispensed with, and happily cannot be put out of action, even if the surgeon wished it.

Then we have to ask the question whether this "autogenous antiseptic" is enough for our purpose, and whether having cleansed a wound and possibly provided means of drainage, it will suffice to accomplish all else that is needed to sterilize an infected wound. I think the answer to that question should be in the negative. Great and beneficent as is nature's germicidal power, experience shows that it is often slow and laborious, and is incapable of effecting that rapid repair of wounds which is most urgently desirable. I say this because there are surgeons who treat gravely infected wounds by so-called "boric fomentations," made by soaking boric lint in boiling water and wringing out the fluid. By this means the acid is dissolved out of the lint, and a dressing which at its best is possessed of but feeble antiseptic powers has its germicide carefully removed, and the wet "boric lint" is merely a hot and moist aseptic application. As such it may be of value in stimulating the flow of the natural antiseptic, and in soothing the irritated nerves, but it must not be regarded as an external or heterogenous antiseptic dressing.

Taking the natural method of sterilizing infected wounds as our model, we learn that the surgeon should—

1. Use an efficient germicide; of these he has several from which to choose.

2. He should use an antiseptic which is innocuous to living tissues. It is opposed to "natural antiseptics" to use a caustic antiseptic such as pure carbolic acid, or a substance poisonous when absorbed into the blood stream, like the various salts of mercury. No doubt we have all seen good results in cases in which either of these classes of antiseptics has been used, but such treatment is certainly opposed to the antiseptic process employed by nature, and requires some special condition to justify it.

3. Next the efficient but harmless antiseptic should be applied continuously to the entire infected surface or tissue. How often surgeons have done little more than mix some antiseptic with the discharge after it has escaped from a wound, or have applied an efficient antiseptic for a few minutes once or twice in twenty-four hours! We need to visualize as far as we can in every case the actually invaded tissues, and to secure that our antiseptic finds its way to every spot in the germ-laden tissues.

4. Another lesson is the necessity for the rapid removal from the wound of all dead and dying tissue, all used-up antiseptic, dead bacteria, and tissue debris. This, too, should be effected early, and should be neither intermittent nor dependent upon such violent measures as strong irrigation or firm pressure.

5. If the surgeon does all this, he will, I fear, fall short of the natural process in one important particular, in which

so far as I know we have at present no means of imitating it. Nature applies her antiseptic to an invaded tissue from within out; she assails first and with most vigour the van of the invading host—the most vigorous and active of the rapidly multiplying bacteria. The surgeon, on the other hand, seems to be tied down to attacking the invading host from the rear, in the hope that his antiseptic will soak in so far as to overtake the advanced lines of the invaders.

MODERN ANTISEPTICS.

If these are the lessons we learn from nature's method of curing an infected tissue, what is the practical application of them in our modern antiseptic treatments? I think these treatments may be conveniently put into three categories. There is, first of all, the use of an antiseptic which is at once very highly germicidal and innocuous to human tissues; of these flavine may be regarded as an excellent example. There is, secondly, the frequent gentle application of a potent germicide to the whole surface of a wound until the discharge from the wound is clinically sterile, and then the surgical closure of the wound. And, lastly, the immediate closure of the wound with a sufficient amount of reliable germicide within it to sterilize the whole of the infected area of tissue.

The first—the use of such antiseptic as brilliant green and flavine—calls for no special comment just now. These drugs are certainly good antiseptics, and are a valuable addition to the surgeon's armamentarium, but their use, so far as I can see, does not introduce any new method or new principle of treatment; it is merely alleged to be attended with more success than is commonly met with when other antiseptics are used in the same way.

The second method is that introduced by Carrel. The third is associated with the name of Professor Morison. These are new methods of treatment, and as such deserve special notice.

Carrel's Method.

I had the advantage in April last of seeing, along with some other British surgeons, the Carrel treatment of wounds as carried out in his hospital at Compiègne, and by M. Tuffier and M. Chutro in Paris. The results were certainly most striking. I saw whole series of cases of compound fractures—not one or two selected cases—healing well and without a single drop of pus. I was impressed as much as anything with an experience on my first visit to M. Tuffier's military hospital in Paris. Along one whole side of a ward each bed was occupied with a case of chronic empyema, all the cases but two having followed upon gunshot wounds of the chest, and all of them having lasted for many months before coming under M. Tuffier's care. The treatment had consisted in making a free opening in a dependent part of the cavity and then in applying Dakin's fluid by Carrel's method, as far as possible, to the whole surface of the cavity. A daily enumeration of the bacteria in a smear of the discharge was made, and as soon as the number had fallen to one in a field, or less, and had remained at this level for three consecutive days, the skin edges of the wound had been raised from the chest wall and united, quite regardless of the presence or size of any pneumothorax or unobliterated portion of the pleural cavity so shut in. In every case we saw—and we saw all in the ward—the wound was healed and the man was well. The aim of the Carrel treatment is to obtain "clinical sterilization" of the wound and then to close the wound and secure union of the applied surfaces. It is laid down as a canon that no wound that has been infected should be closed until it has been proved to be practically sterile by thrice-repeated bacteriological examination.

I cannot give any better evidence of the confidence of the surgeons in Paris who are carrying out this treatment with scrupulous precision, than to quote the notice placed in a conspicuous position in each of M. Tuffier's military wards. It reads: "Tout blessé qui suppure a le droit d'en demander la raison à son chirurgien." Or I can quote M. Tuffier's own words to me: "I can sterilize any wound by this treatment."

As our report on this method of treatment was published in the BRITISH MEDICAL JOURNAL for November 3rd (p. 597), I need now only say:

1. That the germicidal effect is produced by the two-hourly bathing of the whole area of the wound with a potent antiseptic, such as Dakin's solution or eusol. This

can only be accomplished when the tubes are carefully placed and distributed. It is not enough simply to place one or more tubes in a wound, and to turn a stream of antiseptic through them from time to time. The method of treatment must be carried out exactly and with scrupulous attention to detail, and by the surgeon himself, if the best results are to be obtained. It must not be handed over to a nurse or any unskilled attendant. It is necessary to say this, as I know the treatment has been condemned on the result of its use under conditions other than those insisted on by M. Carrel.

2. The cleansing of the wound is effected largely by the flow of fluid from the deeper parts of the wound towards the outer dressing; this, too, will not be effected unless the antiseptic is distributed over every part of the wound surface.

3. When one has got into the routine, and if provided with a sufficient number of trained nurses, the treatment is not complicated or difficult; indeed, it lessens the nurses' work as compared with that entailed in some other treatments.

4. Closure of the wound is not attended with danger if it is postponed until the discharge from it is demonstrably free from organisms, or very nearly so.

Morison's Method.

The Morison treatment is quite different in method. It consists in first of all removing from the surface of the wound as completely as possible all dead and dying tissue and tissue detritus, all accumulations of discharge and of bacteria as well as of blood clot and all other "foreign" matter. This is done by vigorous friction of every part of the wound, followed by "drying" of the wound by spirit. An antiseptic paste (bipp) is then smeared over the entire wound surface and rubbed in, and then at once the wound is closed with sutures and covered with a dressing that is not disturbed for twelve days or so, when it is expected that the wound will be found healed or healing well.

The Morison treatment of wounds is, in my opinion, the highest attainment yet achieved. Deliberately to sew up a wound known to be gravely infected after a single "treatment" and trust to sterilization being effected by the enclosed antiseptic is a bold procedure which when successful—as it is in Professor Morison's hands—well merits the description of "brilliant." I have not been able to see Professor Morison's cases, but I have read of them and heard of them from eye-witnesses, and I can have no doubt of the results—the brilliant results—which are obtained. The technique is very definite and must be carried out with great care. As in Carrel's method, it is twofold. On the one hand the dead and dying material is most thoroughly removed by vigorous friction. Then a potent antiseptic (bipp) is most carefully applied to every part of the infected surface in sufficient but not excessive quantity.

Professor Morison's treatment cannot be summed up in the one word "bipp" any more than Carrel's can in the one word "tube." Each method of treatment depends for success upon a very careful technique, and it must be carried out in every detail with scrupulous care. Let me repeat that the aim of each is the same—the sterilization of the previously infected wound and its closure so as to secure rapid union with the minimum of scar tissue. Carrel proceeds in stages—first the sterilization, and only after that has been attained does he suture the wound. Morison combines them in one "treatment" with far less labour and less cost in dressings.

It is not for me to pass judgement upon these methods; I would merely express my belief that if the task of modern antiseptics is to "cure" and quickly heal infected wounds, there is good reason to believe that we are now possessed of means by which that task can be accomplished. If we look back with just pride upon the triumph of Lister and his associates in rendering possible and commonplace the prevention of wound complications, we are entitled to be just as proud of the further surgical triumph by which infected wounds can be sterilized and healed as if no infection had ever occurred. Those of us who remember the opposition to Lister's early teaching and practice recognize that it sprang not from jealousy or indifference, but from a failure to entertain and aim at a higher standard of surgical success than his critics were

already familiar with. The surgeon's "works" were limited and conditioned by his "faith." It was because Lister "dreamed dreams" that he worked away with carbolic putty. And so it will be to-day. We have all been familiar with the slow healing by granulation of these sorely infected wounds and with the resulting extensive scarring. The teaching of "modern antiseptics" demands not only the practice of new technique, it calls perhaps even more for the raising of a new standard of surgical work; for new faith, for the visualizing of new possibilities, and success will only come to those who have an enlarged and brighter hope.

FURTHER OBSERVATIONS ON THE RESULTS OF BLOOD TRANSFUSION IN WAR SURGERY,

WITH SPECIAL REFERENCE TO THE RESULTS IN
PRIMARY HAEMORRHAGE.

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IN a previous paper¹ the results of blood transfusion in a few cases of secondary haemorrhage were given, with a description of the Lindeman syringe-cannula method.² Since that time opportunity has arisen of extending its application to cases of severe primary haemorrhage (accompanied by shock). The results of these cases are presented in this paper. In four cases of this series the citrate method was used; one case was done with the Unger two-way stopcock, the remainder by the Lindeman syringe-cannula method. The results have shown:

1. That certain cases heretofore considered as inoperable, and others as exceedingly bad surgical risks, may often be revived to a degree which not only permits of radical operative measures, but ensures a good prospect of ultimate recovery.

2. That in other cases in which the post-operative condition is one of progressively increasing shock, due to the initial loss of blood and to the severity of the operative measures required, blood transfusion is a permanent resuscitative measure of extreme value.

It has been the unhappy lot of every surgeon in a casualty clearing station to have cases admitted under his care which required immediate operative attention, but were in such a collapsed and exsanguine condition that operation was out of the question. In certain of these cases a short operation (frequently amputation) is all the operative treatment immediately necessary, but the patient is unfit to withstand any operation owing to loss of blood and shock. Case 10 is typical of this class.

The Time for Blood Transfusion.

If the bleeding point can be controlled, as in the case of a shattered leg or thigh, the ideal time is as soon as the patient is seen. If operative interference is necessary before the bleeding can be controlled—for example, in intra-abdominal haemorrhage—blood transfusion may be carried out before the patient leaves the operating table. Usually, however, one is tempted to employ the ordinary resuscitative measures before resorting to blood transfusion, but it is unwise to wait too long.

Clinical observation appears to show that some degenerative changes take place in the organism when the exsanguinated condition persists for more than a few hours. If the patient is allowed to reach this stage he does not receive the same amount of benefit from the transfusion as when given earlier. For this reason it is advisable to give the blood as soon as possible after admission if circumstances permit.

Other great factors besides loss of blood in the production of shock are loss of body heat and physical exhaustion. After blood transfusion these other factors may be combated by providing warmth and rest for a few hours before operation. Acidosis incident to the shocked condition may be treated by the administration of sodium

bicarbonate. It is obvious that in severely wounded and exsanguinated patients there is a greater liability to the development of severe infection during their subsequent progress than if the anaemia were decreased by the addition of fresh blood.

The benefit of blood transfusion has its limitations, and it should not be used indiscriminately. It is, for example, of more limited value where gas gangrene has already developed, and should not be done unless the infected area can be either brought under control by excision or free drainage, or eliminated by amputation.

Amount of Blood to be Transfused.

This depends largely upon the giving capacity of the donor and the receiving capacity of the patient. A small patient will require proportionately less blood than a large heavily-built patient to produce the same effect on pulse and blood pressure. In severe primary haemorrhage 700 to 1,000 c.cm. may be regarded as an average amount, and will usually tide the patient over his crisis. Smaller amounts have been given with some success, but the most immediate and lasting improvement has been obtained with the large amounts. Cardiac dilatation in these exsanguinated recipients has not been observed even with the larger amounts. In transfusing 1,000 or 1,200 c.cm. the intervals between the injections of the blood-filled syringes should be longer towards the later part than at the beginning of the procedure, and the minimum amount of saline should be introduced into the recipient's vein between the injections of the blood-filled syringes.

The effects of loss of blood will show themselves at different times in the donor according to his size and robustness, the amount of blood, the rate at which it is removed, and the particular method employed. An impressionable donor will exhibit symptoms earlier than one of phlegmatic temperament. In none of the donors has anything more than temporary disturbance been observed. This coincides with the observations made by Colonel Fullerton,³ who had the opportunity of keeping donors under observation for some considerable time after they had given blood to patients.

The advisability of transfusing blood in the following cases was determined by the general condition of the patient, the pulse, and evidence of severe haemorrhage, the prospect of recovery after transfusion and operation, and in the later cases the blood pressure. A wounded man who has lost much blood and has a blood pressure below 90 mm. Hg is not a good subject for operation; with a blood pressure below 70 mm. Hg he is in a precarious condition. Loss of blood intensifies to a very great degree the amount of shock produced by traumatism, and in the majority of such cases the immediate issue depends upon control or elimination of the effects of haemorrhage.

Immediate Results.

In the cases of severe primary haemorrhage accompanied by shock, blood transfusion frequently produces an immediate and almost incredible improvement. The change from a pallid, sometimes semi-conscious patient with a rapid flickering pulse to a comparatively healthy-looking, conscious and comfortable patient with a slower and fuller pulse is dramatic evidence of the value of the transfused blood. The blood-pressure readings before and after show the remarkable change produced by the new blood. In those cases in which readings were taken during the subsequent forty-eight hours it was shown that this rise in blood pressure was well maintained. This is in marked contrast to the transient effect on the blood pressure of normal saline injections. The chart illustrates the gradual fall in pulse rate and rise in blood pressure during the blood transfusion. The immediate result of the transfusion is that it places the patient more on a footing with a man similarly wounded who has not lost more than a moderate amount of blood.

REPORTS OF CASES.

CASE 1.—G.S.W. Femur and Femoral Vessels: Amputation:

Death.

Rfn. T. M. Admitted November 23rd, 1916, in extreme collapse. Compound fracture of left femur; femoral vessels severed. Intravenous saline was followed by temporary improvement for some hours, but condition was still inoperable. Blood transfusion (800 c.cm. by Unger two-way stopcock) was followed by immediate improvement. Amputation above fracture. Death in thirty-six hours from gas gangrene.