AN ADDRESS

ON THE

ANTISEPTIC MANAGEMENT OF WOUNDS.

*Delivered at King's College Hospital in the London Post-Graduate Course, January 18th, 1893.*BY SIR JOSEPH LISTER, BART., M.B., F.R.S.,
Surgeon Extraordinary to the Queen.

THIS day five weeks the patient before you was operated on for a badly united fracture of the patella. He had been kicked on the knee by a horse twelve months previously. In spite of the care of excellent surgeons his limb was in a very useless condition. He could not raise it at all in the extended position, and, in short, he was a complete cripple. When we operated both the upper and lower fragments were firmly adherent to the bone beneath, and separated by a considerable interval. The operation was difficult and protracted, but at length we succeeded in getting the fragments together and fixing them by means of two stout silver sutures. The patient, as you see, can now walk without a stick; he can raise the limb freely in the extended position, and bend it through a limited angle. A useful limb is already assured to him, and he will no doubt acquire in course of time a much greater degree of movement than there is at present. I bring this case before you as an illustration of what may be done by antiseptic measures. In my opinion, such an operation would be unjustifiable unless the surgeon could say to himself with a good conscience that he was practically sure of avoiding septic contamination of the wound. If you consider how terrible the disaster would probably be if septic suppuration occurred after such an operation, I think you will see that I am warranted in this view.

I propose, therefore, now to offer a few remarks as to the means we adopt and the principles on which we proceed in order to attain constancy of aseptic results in our wounds. The matter divides itself into two heads: first, during the operation to avoid the introduction into the wound of material capable of inducing septic changes in it; and, secondly, to dress the wound in such a manner as to prevent the subsequent entrance of septic mischief.

As regards the former of these heads, advancing knowledge has enabled us greatly to simplify our procedure. When I first entered upon this subject—knowing as we did that our wounds, with rare exceptions, underwent putrid suppuration—it was natural to suppose that they were very favourable soils for the development of septic organisms. We knew from the experiments of Pasteur that the air of every inhabited place teemed with microbes of various kinds. We had not then learned to discriminate amongst the various micro-organisms, and there was no reason then to doubt that any one of them getting into a wound would produce serious mischief. Happily, however, we now know the case to be really extremely different, and this from two circumstances. In the first place, we have learned that normal blood-serum is by no means a very favourable soil for the growth of bacteria, provided that they are in an attenuated condition—not in too strong a dose. I may illustrate what I mean by a simple experiment. If we draw blood, with antiseptic precautions, say from a horse or from an ox, into purified stoppered bottles, and simply place them in a stove at the temperature of the human body, the blood remains permanently unaltered. If I dip the point of the finest needle into already putrefied blood and touch the blood in one of those bottles with the needle so contaminated, and replace the bottle in the stove, to an absolute certainty within twenty-four hours the blood is foul and putrid throughout. But if instead of applying the putrid blood in substance I mix it with an abundance of sterilised water, so as to diffuse the bacteria widely, at the same time

washing them of their products, I find that a small drop of this diluted putrid blood, though it contains abundance of bacteria, fails for days together to induce putrefaction. The grossly putrid material—if I may so speak—inevitably causes putrefaction in the blood, but the washed and widely diffused bacteria are unable to do so.¹

Then there is another even more important point, and that is that the living animal body has the power of defending itself against microbes introduced into it, chiefly, as it appears, by the process of phagocytosis, which Metchnikoff has revealed; so that if the micro-organisms are not introduced in too large a dose they are consumed by the wandering cells. These two great truths, then, have been taught us by advancing science: that normal serum is not a good soil for the development of attenuated microbes, and that bacteria introduced among the tissues, if in not too concentrated a form, are disposed of by phagocytosis. The result is that microbes in the form in which they are present in the air are unable to develop in our wounds; and thus we are able to disregard in our operations the once dreaded atmospheric dust.

Hence we may dispense entirely with irrigation, whether in the form of the spray, which was a kind of irrigation, or in any other; in fact, our operations may be performed with just the same simplicity as in former years. What we have to attend to is to prevent the entrance into our wounds during operations of the grosser forms of septic mischief, such, for instance, as exist in impure sponges, on dirty instruments, or in any unclean material upon our hands or on the skin of the patient. Then, again, the *entourage* of the seat of the operation must be considered. To speak first of this last point, we cover the region round about the field of operation with towels soaked in a trustworthy antiseptic solution, and then we are quite sure that if we touch any neighbouring object there can be no chance of our contaminating the wound as the result of this contact.

As to the best means of purifying the sponges, etc., it appears that there is, after all, nothing better than the agent which I happened to employ first—carbolic acid. There was a time when, in consequence of Koch's publications on the subject of corrosive sublimate, it to a large extent displaced carbolic acid in the practice of surgeons. It turns out, however, that Koch, able as he is, was misled on a certain point which led him greatly to exaggerate the germicidal power of corrosive sublimate, and that in truth it is for surgical purposes very inferior to a solution of carbolic acid in water. It is a happy thing for us as surgeons that those organisms which have the most resisting spores do not trouble us in surgical work. For instance, the hay bacillus, which is sure to grow in an infusion of hay left exposed for a while, has spores of an exceedingly resisting kind; but supposing the hay bacillus to get into a wound it would do no harm whatever. Again, the anthrax bacillus has very resisting spores, but if we take good care that the catgut which we use has been treated with an antiseptic that will certainly kill any spores of anthrax with which the sheep might have been affected that furnished the intestines for the catgut, we shall never have any chance of anthrax getting into our wounds. What we have to deal with as our surgical enemies in the shape of microbes are almost exclusively sporeless micrococci. Some of these, however, are much more resisting than others. The staphylococcus pyogenes aureus—a very common cause of suppuration—is very resisting. Now it has been shown that in such solutions as would be used in surgery carbolic acid destroys this organism much more rapidly than bichloride of mercury does.²

There is, however, one spore-bearing bacillus with which we have to deal but too often as surgeons, namely, the tubercle bacillus. Some experiments were made a few years ago by M. Yersin, at the Institut Pasteur, on the germicidal action of various agents upon tubercle bacilli grown in pure culture on glycerine jelly. I will not enter into the details of his experiments, but if you refer to his paper³ you will see that they are very beautiful and very trustworthy. He found

¹ See *Transactions of the International Medical Congress*, 1891, vol. ii. p. 372.

² See Behring, Ueber Desinfection, etc., *Zeitschrift für Hygiene*, Neunter Band, 1892, p. 417.

³ See *Annales de l'Institut Pasteur*. Tome deuxième, 1888, p. 60.

that a water solution of carbolic acid 1 in 20 killed the bacilli in thirty seconds; carbolic acid 1 in 100 killed them in a minute; while corrosive sublimate 1 in 1,000 required ten minutes for their complete destruction.

But though the bacilli of tubercle, as grown in this way, seem really to have had spores, yet those spores are in a less resisting form than we meet with in our surgical work as they grow in the living body. In sputum, for example, they are much more resisting. Accordingly I lately asked my colleague, Professor Crookshank, to make some experiments for me with reference to the tubercle bacilli as they exist in phthisical sputum, and he has been good enough to do so. I may refer in detail to the method of procedure. On December 13th, 1892, three guinea-pigs were inoculated under the skin of the thigh with a little of the sputum treated with carbolic lotion. Some of the liquid sputum was introduced into a test tube; to this was added the solution of carbolic acid 1 in 20, about five times the volume of the sputum. This was shaken up freely, and after a certain time the supernatant liquid was poured off from the precipitate. Sterilised water was then poured in in abundance, and shaken up with the precipitate to wash out the carbolic acid; and of the precipitate which again formed a little was introduced by means of a sterilised pipette under the skin of the animal's thigh. If the bacilli were destroyed, no harm would result to the animal; if, on the other hand, they remained alive the fact would declare itself in due time by enlargement of the inguinal glands affected by the tubercle. One portion of the sputum was subjected to the action of the carbolic lotion for one minute; another portion for an hour; and a third portion for four hours. Three control experiments were performed, that is to say, three guinea-pigs were inoculated with sputum which had not been acted on by carbolic acid at all, but treated in a similar manner with sterilised water. I saw those guinea-pigs yesterday. The three which were inoculated with the sputum on which carbolic acid had not acted all had great enlargement of the inguinal glands of that side, showing that tubercle had developed there. The one that had received sputum acted upon by the 1 in 20 carbolic solution for one minute had indeed enlargement, but exceedingly trifling compared with that in the other three. The two inoculated with sputum on which the carbolic acid had acted longer, in one case for one hour and in the other for four hours, appeared to have absolutely sound groins, showing that the tubercle bacilli, in this most resisting form in which we can find them, had been perfectly destroyed by the carbolic acid solution, 1 in 20, acting upon them for those periods of time; while even one minute had been sufficient very materially to affect them.

Now this is to me a very satisfactory matter, because it gives experimental demonstration of the truth, of which I have long been convinced by experience, that we need not fear tubercle bacilli in our sponges if we keep them for a considerable time in 1 in 20 carbolic lotion. The way in which our sponges are treated is this: they are washed well with soap and water, and afterwards with soda; then thoroughly washed again with water, and finally, after drying, put to steep in 1 in 20 carbolic solution till they are again required for use. For my own part, I purify my sponges for private operations in a somewhat rough and ready way. I put the sponges after an operation into a tank of water, and let them putrefy there. The fibrin, which clings among the pores of the sponges, becomes liquefied by putrefaction. They can then be washed thoroughly clean of their fibrin, and the washing is continued until they no longer give a red colour to water. They are then put into 1 in 20 carbolic solution and kept there. In my Edinburgh practice I used to proceed in a bolder way. Taking the sponges out of the putrid tank, I washed them in water, and sometimes if I was in a hurry, even before the water which came from them was completely freed from red colour, I dipped them into the 1 in 20 carbolic solution, and took them at once to my operations. I have before now applied a sponge so treated immediately to a wound for the purpose of exercising elastic pressure and absorbing blood and serum from it, and then put on my external antiseptic dressing over it without any bad result. These facts taken together will, I think, be enough to convince you that it is not necessary, as

is sometimes done, to discard these most valuable articles and substitute for them sterilised cotton wool or tissue of one kind or another, incomparably inferior to sponges for the purpose of absorbing blood.

This same 1 in 20 carbolic solution is what we use for purifying our instruments, our hands, and the skin of the patient. For the instruments, it is very much more convenient to be able to purify them by a solution like this than to boil them, as is sometimes the fashion at present. It is all very well in a large hospital where you have conveniences for the purpose of heating to any temperature you please the instrument or whatever it is you wish to sterilise, but for private practice it is a most inconvenient thing to have to boil your instruments; and even when you have boiled them and brought them sterilised to your operation, it often happens that an instrument falls upon the floor or comes in contact with some source of contamination. You cannot boil it again before going on with the operation, but the bath of carbolic lotion at once puts it right.

As to the length of time for which the instruments should be kept in the solution, a good deal depends upon the care with which you wash your instruments before putting them away. Any which have teeth, such as forceps, require special attention. They should always be brushed with a nail-brush before they are dried, so that there may be no crusts of dried blood upon them which the carbolic lotion might require a considerable time to penetrate. If this has been done, a very short period is sufficient for sterilising. In private practice I put the instruments into 1 in 20 carbolic lotion just before the patient is brought into the room. They continue to be kept in it during the administration of the anæsthetic and during our other preparations, and this is quite adequate for the purpose. It is of great importance that we should not make things unnecessarily complicated.

So also with the purifying of the skin of the patient. It is not needful to apply an antiseptic lotion for hours together, as is sometimes done; a few minutes' action of the 1 in 20 carbolic solution is really sufficient. For purifying the eyelids before ophthalmic operations the carbolic lotion would cause serious irritation. In this special case a weak solution of corrosive sublimate, applied in compresses, is probably the best. It must, however, be continued for a lengthened period.

While carbolic acid is more trustworthy as a germicide for surgical purposes than corrosive sublimate, it is in other respects also greatly to be preferred. Carbolic acid has a powerful affinity for the epidermis, penetrating deeply into its substance; and it mingles with fatty materials in any proportion. Corrosive sublimate solution, on the other hand, cannot penetrate in the slightest degree into anything greasy; and therefore, as the skin is greasy, those who use corrosive sublimate require elaborate precautions in the way of cleansing the skin—treating it with oil of turpentine or ether, not to mention soap and water, to remove the grease which they feel it essential to get rid of for the efficient action of the corrosive sublimate. Now all this is unnecessary care if you use carbolic lotion. I can testify to this from very ample experience. For my part I do not even use soap and water. I trust to the carbolic acid, which by its penetrating power and great affinity for organic substances, purifies the integument in a way that inorganic salts, like corrosive sublimate, cannot.

Our sponges during the operation are washed with 1 in 40 carbolic lotion. You will see how important it must be to have your nurses and assistants careful. In truth, it needs no small pains to teach them to take the care, simple as it is, yet all-important, that is requisite for avoiding the contamination of a wound with gross septic material. Finally, because we cannot be always quite certain of our assistants being as careful as we wish, before we close the wound, we wash it with 1 in 40 carbolic lotion. This irritates very much less than the spray, which applied a stronger solution during the whole operation; and in proportion to the diminished irritation there is less serous effusion, and therefore less necessity for drainage.

[To be concluded.]

THE Local Government Board has given its sanction to the new medical arrangements in Limerick Workhouse.