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., F.R.S.,
Surgeon Extraordinary to the Queen.*[Continued from page 162.]*

BEFORE proceeding to consider the second division of our subject, the best form of external dressing for the wound, I have a few words to say regarding the course you might adopt in case you were called upon to operate under circumstances where you had no chemical antiseptic at your disposal. First you should have your sponges well boiled, and also the fine silk threads which you will use for securing bleeding points (the ends being cut short). Such instruments as will not be injured by the process may also be purified in the same way; and for washing the sponges during the operation it will be well to use boiled water, although, from the facts before brought under your notice, you may infer that unboiled water, if free from visible floating particles, would not be very likely to cause mischief. Towels dipped in the boiled water and spread about the seat of operation will diminish the chance of contamination of the wound from surrounding objects. Then thorough cleanliness in the ordinary sense, by the free use of soap and water, must be practised for the hands of the surgeon and his assistants and for the skin of the part operated on. For sutures under these imperfect antiseptic arrangements, materials incapable of absorbing putrescible liquids, silver wire, silkworm gut, or horsehair, should be used rather than sterilised silk, in order to avoid suppurative in the stitch tracks.

For dressing the wound in the absence of chemical antiseptics, dry substances such as absorbent cotton wool or old linen (preferably boiled before use) are far better than anything kept permanently moist, like water-dressing. It was shown several years ago by Naegeli of Munich that the more concentrated an organic solution is, the less easily do bacteria develop in it, much in the same sort of way as a cook who makes her jam has to boil it down until the syrup has a sufficient proportion of sugar in it, or else fungi will develop in the preserve. And so the blood and serum oozing into a dry dressing, becoming more or less inspissated by evaporation, are in proportion a less favourable soil for microbial development. If we look back to our old experiences with water dressing, we can only wonder that wounds ever united by first intention at all under such treatment. The water dressing, clean at the moment of application, was invariably stinking when it was taken off in the course of twenty-four hours; and it seems astonishing that septic mischief ever failed to develop in a wound with this putrid mass lying over its outlet. It only serves to illustrate how powerful are the means by which Nature defends herself against the microbes.

But with dry dressing, in conjunction with the care in other respects which I have referred to, you would find that complete primary union, instead of being a rarity as formerly, would be a matter of very frequent occurrence; although you would not be at all able to reckon upon the constancy of aseptic results which may be obtained by the right use of chemical antiseptics.

Iodoform is an agent very much trusted by some surgeons. It is a very peculiar antiseptic, having extremely little influence over the growth of bacteria outside the body. That was illustrated by a very simple experiment I performed a good many years ago. I took two purified stoppered bottles, and put into one of them cotton wool strongly impregnated with iodoform—10 per cent. iodoform wool; and into the other ordinary

absorbent wool. I poured milk from a dairy into each, just sufficient to soak the mass of cotton, and left them at the temperature of the air. In one of these bottles the milk was thus most intimately associated with iodoform, yet it soured like that in the other bottle, though somewhat later, and when I examined a little of the iodoform wool under the microscope, I found the milk which it contained teeming with bacteria of different species. That simple experiment was enough to show how little power iodoform exerts over the growth of microbes outside the body. This conclusion has since been amply confirmed by the observations of others. It has been even ascertained, as a matter of experiment, that if iodoform is dusted over sterilised cultivating jelly in a test tube, growth will take place from organisms that were contained in the iodoform itself.

But though such is the case, it is nevertheless unquestionably true that iodoform exercises a powerful antiseptic influence upon wounds. The most probable explanation of this apparent anomaly is that suggested by Behring, namely, that iodoform produces its beneficial effects, not by acting directly upon the bacteria, but by inducing chemical changes in their toxic products. Behring has ascertained as a matter of fact that some of these toxins are altered chemically by iodoform and at the same time rendered harmless. Two of his experiments, performed in conjunction with De Ruyter, may be quoted in illustration. A ptomaine obtained from a culture of pyogenic micrococci killed a mouse in twelve hours when injected pure into the peritoneal cavity, but proved entirely harmless under similar circumstances when mixed with a little iodoform. Again, a sample of decomposing pus, which had fatal effects when introduced unmixed into the peritoneum of the mouse, had no influence whatever upon the health of the animal if treated with iodoform, which meanwhile left intact the pyogenic microbes.⁴ In the absence of their toxic products, the bacteria could do little harm, and would probably soon be disposed of by phagocytosis.

We seem thus able to understand how iodoform dusted over the cut surfaces of a wound may have great antiseptic efficacy, more especially as it remains for a long time unconsumed among the tissues, and is remarkably free from irritating properties. In circumstances where it is impossible to exclude septic agencies, as in operations upon the mouth or the rectum, or when putrid sinuses are present, iodoform is of very high value. Before applying the iodoform in such cases we mop the cut surface with a solution of chloride of zinc, 40 grs. to the ounce of water, which has a remarkable power of retarding septic changes in wounds in the presence of contaminating materials. On the field of battle iodoform is probably the best means at present at our disposal. Again, in compound fractures, while we endeavour to purify the wound with strong carbolic lotion, we cannot be certain of entire success in this respect, and I should be sorry to dispense with iodoform.

But if you operate when the integument is unbroken, with a sufficient space around for the application of a dressing, I would not recommend you to use it. To apply it to the interior of the wound would be then entirely superfluous, provided that you have taken care to avoid its contamination while operating, and have at your disposal some trustworthy material for preventing the subsequent access of septic mischief. This, as we have seen, iodoform cannot be expected to do. A porous material impregnated with it, when soaked through and through with blood or serum, will allow the microbes of external defilement to propagate in its substance, though doubtless more slowly than if the iodoform were absent. It is essentially in the interior of the wound that the virtues of iodoform are displayed; and the original Vienna practice of dusting the cut surface with the powder, and applying simple absorbent cotton externally, gave results which were much extolled at the time, and were probably not far inferior to those obtained by the use of iodoform wool or iodoform gauze. An iodoform dressing affords no security against the penetration of septic microbes to the outlet of the wound. At the same time, it is easy to see that circumstances may often arise in which iodoform dusted over the

⁴ See De Ruyter, zur Iodoformfrage. *Langenbeck's Archiv*, 1887, p. 984. Some bacteria are more affected than others by the direct action of iodoform. In the special case of the cholera microbe it seems to act as a poison. See Neisser, *Centralblatt für Bacteriologie* 1888, p. 387.

cut surfaces may fail to act effectually; as, for example, when those surfaces are separated by extravasated blood.

Any material that is merely aseptic, such as cotton wool or gauze sterilised by heat, having nothing in its substance to check in any degree the development of microbes, will allow the septic evil to spread freely to the wound from the external world, if blood or serum happens to penetrate at any point to the exterior. In addition to this fatal objection such a dressing has other disadvantages. The necessary sterilising apparatus, though it may be provided at a public institution, cannot well be at the disposal of the private practitioner. And, further, the merely aseptic material, having no power to correct any accidental defilement, must require an almost impossible degree of care in its manipulation. I have seen this system in operation in very able hands with results by no means satisfactory.

[To be concluded.]

A LECTURE ON ANTICHOLERAIC INOCULATION

*Delivered, by Invitation, at the Laboratories of the Royal
Colleges, Victoria Embankment.*

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MICROBIC VACCINES.

THE discovery of the mutability of the character of microbes, and of their capacity to be artificially transformed into vaccines of fixed and determinate nature, is certainly the greatest step which has been accomplished in medical science since the first study of pathogenic microbes was made. The task presented to investigators afterwards was that of recovering the germs of contagion which were recognised as being the cause of the disease and to elaborate protective substances from them, and to establish hygienic habits of daily life necessary for the preservation of living beings from the diseases which lie in wait for them.

M. Pasteur, after having discovered the first principles of the method by experiments on "fowl cholera," developed them greatly by his studies on anthrax; he then turned his attention to hydrophobia, which, being a disease common to both man and animals, was an appropriate one for applying to the treatment of human diseases the methods previously used for animals.

ARTIFICIAL INTENSIFICATION OF VIRUS.

The experience acquired in the prevention of hydrophobia by preventive inoculation—the first human disease treated according to the new method—gave observers a perfectly clear plan which they might follow for other human diseases. It was shown that in order to be successful it was necessary to prepare a series of virus, gradually increasing in strength until they reached a fixed degree of virulence greater than that of the ordinary virus, which, when used, should permit the organism to become accustomed to a poison more virulent than that which it has to fight against at the moment when infection takes place. The *traitement intensif* of hydrophobia, based upon virus of a maximum strength, has inaugurated the method, and has shown the true rôle of the virus kept in a fixed state of exaltation by appropriate experiments.

The acquisition of an exalted virus and the establishment of a method suitable to keep it in a fixed state is, then, the starting point and the final aim in the research of a vaccine, for we repeat that it is necessary gradually to accustom the organism under treatment to this fixed virus. It is known that this task may be accomplished by the passing of the infectious organism through a series of animals, and that the microbe acquires the maximum of its contagious power by cultivating it through a long series of living beings.

THE PROBLEM AS APPLIED TO CHOLERA.

In the case of cholera the first attempts towards this end were made by trying to infect animals through the digestive canal. In this way the culture of the microbe took place in a medium occupied by a number of foreign microbes, which from the first rendered the means employed uncertain. The result of the introduction of a microbe into a medium already occupied by other microbes depends upon the nature of the latter, and their presence renders its development sometimes more easy, sometimes, on the contrary, impossible. Besides, the purification of the microbe by artificial culture, made with virus transmitted through two animals, is a source of weakness which counterbalances the exaltation.

PREVIOUS ATTEMPTS AT SOLUTION.

This explains how M. Pfeiffer and Nocht, in seeking to strengthen the cholera microbe by passing it alternately through animals and cultures, have not been able to obtain a microbe capable of overcoming the natural resistance of birds; and this is the reason why M. Roux and myself, in trying to transfer the intestinal contents from one animal directly to another, according to the method used by Gamaleïa, have seen our series interrupted after the third or the fourth transference.

The idea which M. Gamaleïa had in 1888 of cultivating the microbe in the thoracic cavity of animals gave rise to much hope, and at one time the task might be considered as accomplished. Unhappily this method, perfectly applicable to the microbe which M. Gamaleïa called "*vibrio Metschnikovi*," was found defective when it was applied to the Asiatic cholera microbe, as we have seen in a series of trials made in this direction by M. Roux and myself. The idea of M. Hueppe, which dates from the same time, of producing the infection of animals by the introduction of the cholera microbe into the peritoneal cavity, has been since taken up again by M. Pfeiffer, who proved that in the case of the cholera microbe a phenomenon was produced which is analogous to that seen in a series of others, as in diphtheria or of tetanus, which are characterised by a local development of the animal organism without an invasion of the blood or of the parenchymatous organs. This phenomenon consists in that the infectious agent itself disappears in the animal killed by the microbe, and therefore, even were it possible to again find the remains of the culture injected and to transfer them to a second animal, the latter would not retain any further trace of the microbes, and the series would be interrupted.

THE AUTHOR'S METHOD: EXPERIMENTS ON ANIMALS.

In the research that I have done at the Pasteur Institute on vaccination against Asiatic cholera I have chosen for my starting point the inoculation of the animal into the peritoneal cavity. Starting from this point I have worked out a method which permits the culture of the microbe in the animal organism in a state of purity during indefinite generations, the exaltation of it to a well-determined maximum of strength, and keeping it at the same degree of virulence for an unlimited period of time.

This method is illustrated by three series of experiments, which were the subject of our publication in the *Comptes Rendus de la Société de Biologie* of Paris, and which are:

1. Giving the first animal a dose larger than the fatal dose, and killing this animal in a sufficiently short space of time to be able to find the more resisting microbes.
2. To expose the exudation taken from the peritoneal cavity to the air for several hours.
3. Then to transfer this exudation to the next animal, of large or small size, according to the concentration of the exudation.

In the hands of a number of other experimenters this method has given the same results and showed a perfect consistency.

The properties of the virus which is obtained in this manner of cultivation are as follows: Upon intraperitoneal inoculation it kills guinea-pigs regularly in the space of about eight hours, and the fatal dose for this animal is reduced to about twenty times less than that which it would have been necessary to take for the microbe with which I started. The same inoculation kills rabbits and pigeons with a dose which would have been perfectly harmless at the beginning of the experiments. It kills guinea-pigs by intramuscular inoculation.