

an incubating apparatus, and kept permanently at a high temperature. This method, though much lauded for a time, really seems to have favoured considerably the development of septic diseases.

IV. *Concentration of the Fluids, and their Admixture with Oxygen.*

The method of treatment which has been the greatest stumbling-block in the way of the acceptance of the principles of antiseptic surgery is the open method, for surgeons have been unable to see how the success of this method could be reconciled with the germ theory of putrefaction. They have looked on it as the antithesis of aseptic treatment, as acting on the very opposite principle to that on which the aseptic method is based. And yet, when we come to consider the matter in the light of the true principles of antiseptic surgery, we find that the open method is an advanced method of antiseptic treatment. Of course other principles, such as that of perfect rest and free drainage, also tell markedly in this case.

I have stated that this open method acts antiseptically in two ways, and these I must now briefly consider.

1. It acts antiseptically in that the discharges dry up, and become more concentrated, and thus become unfit soil for the growth of bacteria.

That concentrated fluids are not suited for rapid development of organisms is well known. Thus Pasteur pointed out that organisms could not grow in sugary solutions which had become concentrated. This fact is made use of in the arts, in the preservation of fruits. Sugar is added in large quantities, and then the fruits can be kept for an indefinite length of time. It is not that the sugar is an antiseptic killing the organisms, it is merely that by its presence in large amount the fluid is rendered unsuitable for development.

The same principle is made use of in preserving milk. The milk is evaporated to one-third of its original volume, and a considerable quantity of sugar is added to it. Without the addition of the sugar, the condensed milk may be kept for a

considerable length of time without the appearance of organisms in it; with sugar it may be kept indefinitely.

The same is the case with other albuminous fluids such as the discharge from wounds. Concentrate pus, and it will be found that organisms develop in it only with difficulty.

Then we know the contrast between cases of dry and moist gangrene; how in the latter putrefaction rapidly occurs, or, in other words, organisms rapidly develop, while in dry gangrene putrefaction does not occur, i.e. organisms cannot develop.

The same was seen in Cazeneuve and Livon's experiments on urinary bladders, mentioned before at p. 37. In that case organisms could not develop in the wall of the bladder, because the fluid was constantly evaporating.

2. In the open method another antiseptic advantage is gained by the free admission of oxygen to the discharge.

Some very remarkable effects of oxygen in retarding putrefactive and other fermentations were published long ago by Pasteur. He pointed out that if a sugary solution were freely exposed to air in a thin layer, the yeast plant, though it grew luxuriantly, caused very little fermentation. On the other hand, if oxygen were excluded, only a small development of the yeast cells was necessary for fermentation. And he has shewn that other plants besides the yeast plant can cause alcoholic fermentation, if only they are deprived of free oxygen.

With regard to putrefaction he has brought forward similar evidence. The organisms which cause putrefaction are, according to him, incapable of living in the presence of oxygen. If a putrescible fluid be freely exposed to the air in a thin layer, putrefaction does not occur, at least not for a very considerable time. Just as in the butyric fermentation, oxygen not only interferes with the fermentative process, but actually destroys the bacteria which cause it. Hence the free exposure of a putrescible fluid to the air results in comparative freedom from putrefaction, partly because the oxygen interferes with the development of fermentative changes, and partly because the oxygen directly kills the putrefactive bacteria.

There are two methods of wound treatment which act on the principles alluded to above. The first is that introduced by Bartscher and Vezin, and carried out in the following manner: 'After

all bleeding vessels have been tied, and after the stump has been cleansed from blood clots by means of a sponge and cold water, the patient, for whom two beds are provided close to each other, is put to bed, the stump is laid on a soft pillow, and over it a piece of gauze or linen is loosely placed in order to keep out the flies, the whole stump being freely exposed to the air.⁷ At the morning visit, the surgeon pushes his hand under the stump, raises it, removes the pillow and applies a new one, or lifts the patient on to the other bed, without further cleansing of the wound. In this method all attempts at union by first intention are given up.

Burow of Königsberg published his method in 1859. He attempted to obtain primary union as far as possible. This he did by bringing the surfaces of the wound into contact after a few hours by means of strips of plaster applied over part of the surface, all other dressings being avoided.

Rose, whose results of open treatment have been specially published by Krönlein, adheres to Bartscher and Vezin's method, with this exception, that he daily washes out the wound with some antiseptic lotion. Crusts are removed, as they are never complete enough to prevent putrefaction, and only cause tension by their presence, and indeed protect the discharge underneath from the action of the air, or of the antiseptic lotion. Rose farther ventilates very freely, so as to have a plentiful supply of air to the stump. He employs this method in all wounds, except those on the face, where union by the first intention is desirable.

The open method pure and simple is that introduced by Bartscher and Vezin; for here, while the discharges are allowed to flow away freely, they are left to the unaided action of the air. The antiseptic effect of this method is no doubt increased by the addition of intermittent antiseptic irrigation.

Burow's method cannot act nearly so perfectly, for in it discharges must accumulate in various parts of the wound, and they are therefore not so conveniently placed for thorough action of the air.

Among the objections to these methods are the following; in all, except Burow's, union by first intention cannot possibly occur, indeed no attempt is made to obtain it; as a conse-

quence of this, a long time is required for healing, while a larger scar is obtained; the frequent formation of scabs and the consequent tension also cause great annoyance.

Closely allied to the open method stands *healing by scabbing*. This may be brought about chiefly in two ways. The crust may either be allowed to form naturally, or its formation may be aided by artificial means.

This healing by scabbing acts in two ways. In the first place, the first principle of the open method of treatment comes into play; the discharge dries up and becomes an unfit soil for the development of organisms. In the second place the fluid underneath it is in such a thin layer that the living tissues in the neighbourhood prevent the development of organisms in it. Of course in many cases no living organisms would be there to develop, for the scab would form an absolute protection against their entrance.

The natural formation of the crust can only take place efficiently in small wounds, and only exceptionally where cavities and recesses are present. For in larger wounds, as we have seen, there is too much discharge for a sufficiently rapid and thorough formation of a crust; and if the crust is not perfect and rapidly formed, putrefaction takes place underneath it, while at the same time, by confining the discharges, tension and ulceration result in place of healing.

But though this natural formation of a crust cannot be trusted to in most cases, yet by artificial means a satisfactory one may be obtained.

The method in which this was done by Bouisson, was by blowing air on to the wound, and thus drying the discharges. This method will be described in the historical part of this work.

The most common modes are by the application of various powders, such as starch, alum, flour, &c., to the discharge, so as to form a paste. The best substance which can be employed in this manner is powdered salicylic acid, as recommended by Neudörfer, and mentioned before under 'Treatment by Antiseptics.' This is sprinkled on till no more fluid exudes, and it combines the advantages of a thorough crust with those of an antiseptic dressing.¹

¹ For details of these various methods, see the historical part.

Other attempts have been made to produce a scab by the application of various caustic substances to the surface of the wound. The crust so formed, containing as it does a strong caustic, is unable to undergo putrefaction; and where the inflammation caused by the application is not too great, and does not lead to accumulation of fluid under the crust, an excellent result is obtained. In this case, as no organisms are present under the crust (they were destroyed by the caustic), and as the firmly adhering crust prevents their entrance, we have the typical aseptic result—healing of an open wound without suppuration or granulation. There are, however, various objections to this method of crust formation, the chief of which is the loss of substance involved in the process, while the same disadvantages are present as in the open method proper, viz., slowness of healing and a large scar.

Closely allied to this method of crust formation is that in which the crust is obtained by the application of the actual cautery.

Crust formation is seldom suitable unless in the case of superficial wounds without recesses or cavities, for, if these are present, an opportunity is given for the occurrence of tension under the crust. It is a method by no means easy or universal in its application. Where it is employed I should recommend the use of Neudörfer's method, viz., the formation of a crust by the aid of salicylic acid powder.

Alphonse Guérin's Cotton-wool Treatment acts partly on the first part of the principle of the open method, but it hardly comes into the category of antiseptic methods.

As originally used, the wound was simply washed with water, and a large mass of cotton-wool applied around it, and firmly bandaged on.

At present the wound is washed with some antiseptic lotion, and layers of cotton-wool, containing camphor powder sprinkled in it, are applied. The deeper layer consists of wool moistened in carbolic lotion.

More details of this method will be found in the historical part; but I may mention here a point which Guérin considers of great importance. The dressing should not be applied or changed in the ward, but in a theatre or side room, and the

packet of cotton-wool should not be opened till the time of application of the dressing. No doubt these precautions may prevent some infective material present in the ward atmosphere from settling on the wound or on the cotton-wool, but it is only a chance that such will be the case.

This method can hardly be called 'antiseptic' in the sense in which we have used the word, for the antiputrescent principles on which it acts are not very powerful. As the result of these dressings, the discharge becomes thick and concentrated, and not a very good medium for development of organisms. Nevertheless this concentration of the discharge cannot occur to anything like the extent which takes place when it is left freely exposed to the air. The second principle on which it acts is that it ensures absolute rest to the wound. By means of this rest the granulations are not lacerated, and neither bacteria nor their products can be admitted into the body. This however is a principle relating to *infective* disease, a subject which we have not mixed up with the true antiseptic principle, which is solely that of preventing putrefaction in the wound.

Guérin's method cannot be recommended except in some exceptional cases of disease of joints with sinuses, and even here the retention of the putrefying discharges, and the consequent irritation, render it of very doubtful value.

I have already described the aseptic applications of pure cotton wool at p. 141.

V. Assist the destroying Action of the healthy living Tissues on Bacteria.

This principle may be aided in two ways, viz., by perfect mechanical rest, and by attention to the general health.

By perfect mechanical rest, when the tissues are in perfect health, and the blood clot is undisturbed, the tissues and clot may be kept in such a state as to resist the development of organisms. This method, though without recognition of the antiseptic principle, has been long practised, and of late has been specially advocated by Sampson Gamgee.¹

¹ *On the Treatment of Wounds*, 1878.