

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.

It is, of course, a well-known fact that, without any antiseptic appliances at all, wounds, more especially about the face, heal frequently by first intention. How can this take place if blood or lymph, exposed to the air, putrefies as the result of the access of organisms? For, during the operation, organisms enter the wound both as dust from the air and surrounding objects, and also from the water in which the sponges are soaked. There is also between the cut surfaces a layer of blood or lymph (which, however, must as a rule be very small in amount, otherwise healing by first intention does not occur) which, if it were exposed between two plates of glass, would probably putrefy in a short time. How is it that union by first intention can occur under these circumstances? How is it that the blood does not putrefy between the cut surfaces of a wound?

Well, to use Mr. Lister's forcible arguments, the *fact* is that a thin layer of blood, although containing numerous causes of putrefaction, does not as a rule putrefy if it be placed between two healthy living cut surfaces. Or, to state the fact in another way, these organisms, which are certainly present, cannot develop in a thin layer of blood or lymph placed between two healthy living freshly cut surfaces. Or, to state the same fact differently (taking into consideration the different results when the same layer of blood or lymph is placed between two plates of glass), the *living tissues, when in a healthy state*, have the power of preventing the development of organisms in their immediate vicinity.

I have already had occasion, in a former part of this work (p. 252), to point out that if into a *healthy* living animal a small quantity of ordinary bacterial fluid be injected, the bacteria lose their vitality and disappear. I have shown how organisms cannot be found in the living healthy body (I except here of course specific pathogenic organisms, such as bacillus anthracis), unless a considerable amount of their products be introduced along with them. On the other hand I demonstrated how, if the animal were out of health, organisms could live in their blood and tissues much more easily. The same is the case in union by first intention. If the part be of high vital power, and in a healthy state, and if there be an

extremely small amount of blood or lymph between the cut surfaces, union by first intention will almost certainly occur. If the part become inflamed, or if the patient be in a weak state of health, union by first intention, without aseptic means, becomes a matter of great uncertainty.

Traube and Gscheidlen¹ have likewise found that blood taken with precautions from a healthy living rabbit into which, 24 or 48 hours previously, 1½ c.cm. of bacterial fluid had been injected, could be kept for months without undergoing putrefaction.

And, further, the facts which I have already mentioned, that the blood and tissues of healthy living animals do not contain living organisms, shew sufficiently that they have the power of destroying them, for otherwise there are frequent opportunities for the entrance of these into the circulation.

This same principle was made use of by Mr. Lister in his experiments for obtaining unboiled urine (see p. 36). He simply washed the glans penis, and the meatus urinarius. He did not wash out the urethra at all. The urine passed in this way remained absolutely pure, showing that no organisms were present in the urethra. And yet the urethra contains mucus, putrescible outside the body, and there is sufficient time between the acts of micturition for bacteria to spread quite up to the bladder (this was experimentally determined by Mr. Lister); nevertheless they do not penetrate any distance into the urethra. In other words, they cannot develop in this putrescible mucus, when it lies between two healthy living surfaces. Or, to state the fact otherwise, the healthy living tissues have somehow or other the power of preventing the development of organisms in their immediate vicinity.

Now blood clot itself may be looked on as a tissue, though one which is of very low vitality. That it is a tissue is well shown by Mr. Lister's experiments on coagulation of blood; for he found that a tube or cup of blood clot acted in the same way as regards the prevention of coagulation as the living walls of the vessels. He further found that movement of the clot leading to its laceration destroyed its vital power as a tissue.

In the 'Dublin Medical Journal' for August 1879, Mr. Lister, after referring to this subject, mentions the following facts:—

¹ *Loc. cit.*

'I have found, in experiments not yet published, that you may put into such purified glasses' (containing pure blood) 'drops of water of considerable size; and although every hundredth of a minim probably contains a septic organism, and although the blood that flows into each glass is mixed with this septic water, yet the clot there formed, if protected from any other source of disturbance afterwards, remains sweet and pure for weeks together, proving that even outside the body the blood clot has the power in itself of resisting the development of septic organisms—a most important truth.' After applying this principle to union by first intention in cases of amputation, he says: 'But suppose such a stump attacked by muscular spasm churning up the blood clot, then the septic particles would develop, and then you would have putrefaction and septic suppurations, so that without antiseptic treatment in this kind of case, you are at the mercy of perfect immobility; and, as I have said before, even with the best means, you cannot secure this.'

In his recent address at Cambridge, Mr. Lister refers to similar facts, but as he has not yet published them, and as the accounts given in the journals are very garbled, I cannot refer to them. It seems however that he confirmed the experiments just mentioned, and found that blood clot, when kept perfectly undisturbed, did not putrefy, even if 4 drops of tap water were placed in the flask before the blood was introduced.

A very interesting experiment bearing on this subject is mentioned by John Hunter in his paper on 'The living principle of the blood.'

After pointing out how fresh and living eggs resist putrefaction, and referring to various facts which he thought were indications of the existence of a living principle in blood, he narrates the following remarkable experiment, showing that the *blood of young persons resists putrefaction longer than that of old people*; in other words, that the blood of young persons has greater vital power.

'June 24th.—Some blood was taken from a woman twenty years of age, and its surface, after coagulation, was covered with an inflammatory crust.

'On the same day some blood was taken from a woman at

sixty, when the crassamentum was also covered with an inflammatory crust.

'These quantities of blood were set by.

'The blood from the old woman putrefied in two days. That from the young woman kept quite sweet till the fifth day, when it began to smell disagreeably; in this state it continued two days more, and then emitted the common odour of putrid blood.

'Several experiments were made in the course of the summer of a similar nature with the last, in all of which it appeared that the blood from young people kept longer sweet than that which was taken from the old.'

That healthy blood clot can resist putrefaction so long as it is kept at rest explains many remarkable cases which would otherwise seem at first sight at variance with antiseptic principles. The following case, showing the contrast between blood clot when kept at rest and when disturbed, is worth narrating.¹

'On September 15, 1870, a young officer whose left upper arm had been broken about its middle by a Chassepot bullet at Noisseville seventeen days previously, arrived with an ambulance train at the Tempelhof military hospital.

'The plaster of Paris apparatus, which had been applied at once on the battle-field, had become soft and broken, and as the patient complained of pain in the arm, probably as the result of the journey, and as it was somewhat swollen, the apparatus was removed, and a careful examination was made of the wound. When I passed my finger into the wound after removal of the crust, I felt numerous fragments of bone, but was, however, astonished to find *no trace of pus, only coagulated blood*.

'After I had removed all the fragments, a plaster apparatus with a window in it was applied; nevertheless, there now resulted a *violent inflammation and suppuration of the wound*, which for a time threatened the young man's life.'

These views sufficiently reconcile the fact of union by first intention in cases not treated aseptically with the germ theory of putrefaction.

Now in order to have tissues in the state in which they are capable of resisting the development of bacteria in their immediate vicinity, they must be as much as possible in a condition

¹ Esmarch, Langenbeck's *Archiv*, vol. xx., p. 169.

of perfect health. To attain this, the health of the patient must be attended to and kept good, and all causes which irritate and cause the wounded part to inflame or become weaker must be avoided. The causes which weaken the part are various forms of unrest, mechanical or chemical.

To carry out this principle two things are required, viz., accurate approximation of the cut surfaces, and absolute immobilisation of the part. Where accurate approximation of the cut surfaces cannot be obtained, the same principle of absolute rest must be carried out as regards the clot filling up the gap, and it may thus resist the development of bacteria in its substance. Were I compelled to treat any case on this principle alone, I should combine with it the open method, leaving the wound freely exposed to the air. The superficial layer of the clot, by drying up, would thus to some extent form an obstacle to the entrance of organisms.

I have mentioned this as an antiseptic method, as the principle is of great importance in explaining certain otherwise puzzling cases, but I should not recommend it for adoption, for it is only in a few cases, such as in face wounds, where the vitality of the part is high, that this vital action of the tissues and blood clot can be sufficiently trusted.

Such are the chief principles on which antiseptic surgery can be carried out. In the class of antiseptic methods to which I have referred in this chapter, the surgeon does not adhere strictly to one or other principle, partly because the principles on which he acts have not as yet been properly understood or appreciated, and partly because better results can be obtained by their combination.

In many minor ways the antiseptic principle may be aided. Thus, by the use of catgut ligatures, we do not have a long septic thread hanging out of the wound, conducting putrefaction into its interior and leading to deep-seated suppurations, &c.

The silver suture acts in the same way as compared with the silk. Silver does not absorb the putrescible materials, and thus putrefaction does not occur in it. On the contrary, silk absorbs blood and serum, which putrefy in it, and the silk which was

at first unirritating, becomes very acrid and causes inflammation in its vicinity.

What are the various means by which the general health and tone are kept up in septic cases, what is the careful selection of healthy individuals for operation, but imperfect attempts at antiseptic surgery?

What is ventilation but an antiseptic means? The air being constantly changed, the foul emanations from wounds containing septic bacteria are diluted and swept away, while at the same time a better state of health is obtained.

And so I might go on enumerating various minute points which have been, in ignorance of their true significance, adopted in the treatment of wounds, all of which, more or less, act on and promote antiseptic principles.

We thus come to the end of our discussion of the Principles and Practice of Antiseptic Surgery. We have seen that antiseptic surgery is simply a struggle with the causes of putrefaction. I have not mentioned the germ theory of infective disease at all. That has no essential bearing on the principles of antiseptic surgery. All that is required of antiseptic surgery is to prevent the occurrence of all kinds of fermentation. The germ theory of infective disease is, I say, an independent view, and not part of those principles at all. It is from mixing up these two theories that the confusion, and much of the difficulty in accepting the principles of antiseptic surgery, have arisen. Thus, for instance, a surgeon who writes a good deal on this subject, after admitting to the full the germ theory of putrefaction, states that he refuses to accept the principles of antiseptic surgery and aseptic surgery in its train! Speaking of the principles of antiseptic surgery, he says: 'Granting that the same germs which would inevitably produce putrefaction in a dead infusion of beef are constantly admitted to wounds, there is not the slightest particle of evidence that they do produce any change whatever upon *living* tissues. still less is there any evidence that the changes which occur in the numerous varieties of what we call blood poisonings, even when they are of an undoubtedly local origin, have the slightest analogy to those seen in a putrefying dead infusion.'

Such a passage simply shows that the author is confusing

together the two germ theories—that of putrefaction with that of infective disease. But, as I have already pointed out, *the germ theory of putrefaction is the only view at the basis of antiseptic surgery*; and the author admits the truth of this theory, and yet rejects aseptic surgery!

But let the germ theory of putrefaction be once admitted, antiseptic surgery and, where possible, aseptic surgery, is the logical, practical outcome. What does it matter for the *principles* of antiseptic surgery what the precise relations are which fermentations in wounds bear to the bad symptoms after wounds? These are points to discuss in connection with the *results* obtained, but they are not the essential points to be considered in determining the adoption or rejection of *antiseptic* methods.

Leaving out of view the question of infective disease, and supposing that we deny its connection with fermentations in wounds, I would ask any surgeon who takes the above line of argument, whether he would view with satisfaction the entrance of causes of putrefaction into the peritoneal cavity? I venture to say that he would not, and that the following would be the result of his calmer cogitations: 'I do not care at all what relations fermentations in wounds bear to infective diseases, but I would rather not have putrefaction present in the abdominal cavity, and I must insist on your taking all possible precautions to prevent the entrance of its causes. In other words, I believe in the germ theory of putrefaction, and I wish the methods of practice which follow logically from such belief to be fully carried out in this case; i.e. I wish the strictest aseptic precautions to be employed. If, at the same time, infective disease is also avoided, I shall be very pleased, but I do not understand the causes of it. I do understand, however, the causes of putrefaction, and I wish no precaution to be spared by which it may be avoided.'

I venture to think that, with the mass of evidence now existing, there will be very few disbelievers in the germ theory of putrefaction; and, as soon as a man accepts that view, he is bound, as a rational man, to put his belief into practice on one or other of the lines indicated here. He must do that, I say, whether he believes in the germ theory of infective disease or

not, were he indeed ignorant of the existence of such a view; though no doubt the precise amount of energy which he will bring to bear in carrying out one or other method will to a certain extent depend on the view which he takes of the dangers which may arise from fermentations in wounds, and these we shall have to consider when we come to speak of the results of the various methods.