

of a wound from which organisms are not from the first excluded is therefore of the utmost importance. I have already described the use of india-rubber tubes, and I have referred to catgut and horse-hair. Since, in a wound not treated aseptically, fermentation, most probably followed by suppuration, generally occurs in the track of the drain, we must provide such a drain as shall permit the free escape of pus. Now, neither horse-hair nor catgut can drain pus, and, therefore, a tube of some kind or other must be used. This may be an india-rubber one, or it may be made of various kinds of metal, perforated at its sides, and cut flush with the surface. The tube, of whatever material, must be removed from the wound at each dressing and washed with a strong antiseptic lotion, say 1-20 carbolic lotion. If this be not done, portions of decomposing tissue, &c., remain inside the wound, and become more and more putrid till very soon they become caustic.

Where the wound is not treated aseptically, the principle of having the most dependent opening possible must be carried out to the full.

### III. Irrigation and Immersion.

The principle of free drainage is never of course used alone, other principles act along with it. Of these, one of the most satisfactory is that in which the discharge is not merely allowed to flow away, but is washed away, and the further addition to this principle of adding an antiseptic to the water used for the irrigation and of thus keeping the wound constantly bathed in an antiseptic fluid. The latter is the form in which irrigation and the water bath are now always employed, viz., by the use of an antiseptic solution.

Irrigation is, as a rule, only practicable on the extremities, though it may be carried out on the trunk. For the latter, however, the continuous water bath is the most convenient.

The wounded part having been arranged at perfect rest, a sheet of mackintosh is fastened to the limb, and so arranged that the fluid flowing from the wound shall be conducted to a tub; the vessel containing the fluid is fixed at a considerably higher level than the patient. The form of irrigator most

generally used at the present time is Esmarch's. This consists of a cylindrical leaden or zinc vessel, which has a ring at its upper part to enable it to be affixed to the wall. From the side of this vessel, close to its bottom, a tube passes, and to the end of this tube is fastened a long piece of india-rubber tubing with a nozzle at its end. This nozzle is arranged so as to direct the fluid into the deeper parts of the wound. The fluid used is generally some weak antiseptic solution, such as chlorinated soda or sulphurous acid, or boracic acid.

A very good apparatus can be made in an emergency (according to Thiersch) by knocking the bottom out of a champagne bottle, and having the tube for conveying away the fluid passed through the cork. The bottle is inverted, filled with the solution, and fastened to the wall. The fluid used may be tepid or cold, as we shall see later. There is no advantage in using it very cold, as recommended by some.

Where the fluid is dropped on to the wound, it is well to place a piece of lint over the part where the drop falls, to prevent the constant irritation caused by the concussion. The skin in the neighbourhood of the wound ought to be coated with palm oil, in order to prevent maceration.

The continuous bath is either a bath in which the whole patient can be immersed, or one in which the wounded part alone is placed. There are numerous methods of doing this, and the references to these will be given in the history of the subject.

The advantages of the treatment by constant irrigation are, that the discharges are removed as fast as they form, and at the same time, where an antiseptic is employed, the part is kept constantly sweet. Thus, where the cavity is small and uncomplicated, there may be a truly aseptic state of affairs.

At the same time, where tepid water is used granulation is favoured, while pain and nervous irritation are very much

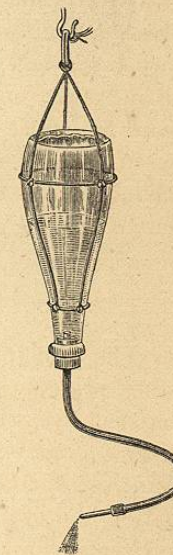


FIG. 73.—THIERSCH'S CHAMPAGNE BOTTLE IRRIGATOR.



diminished. Further, the parts are kept at absolute rest, the necessity of moving them in order to change dressings, &c., being avoided.

As an antiseptic means, I should think that satisfactory irrigation is better than the continuous water bath, for in the latter there is not the same constant change of fluid, nor the same washing away of the discharge.

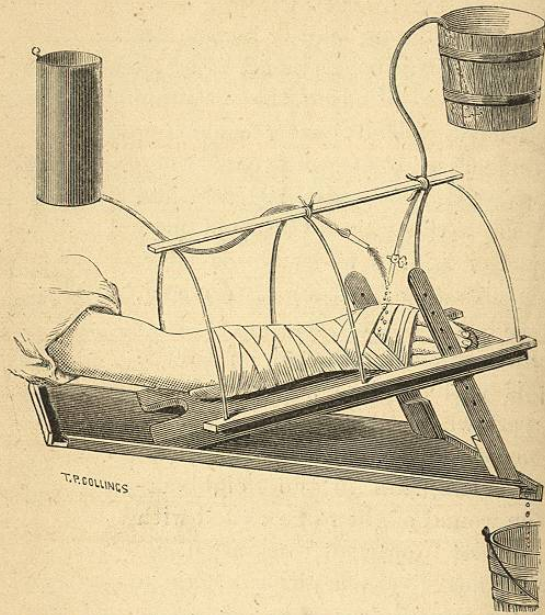


FIG. 74.—ARRANGEMENT FOR IRRIGATION IN THE UPPER LIMB.  
(After Esmarch.)

The favourable results of constant irrigation in preventing septic diseases are very remarkable, and, in this respect, it probably stands next to strict aseptic treatment.

The disadvantages of these methods are for the most part the sodden state of the wound and the consequent œdematous condition of the granulations, the constant state of unrest of the wound and the inconveniences attending the application of the method. For the first reason they are discontinued when granulation is complete and has filled up the deeper parts of the wound, and when the time for blood poisoning has passed.

That the good results of irrigation and immersion are not due to mere maintenance of temperature, as has been

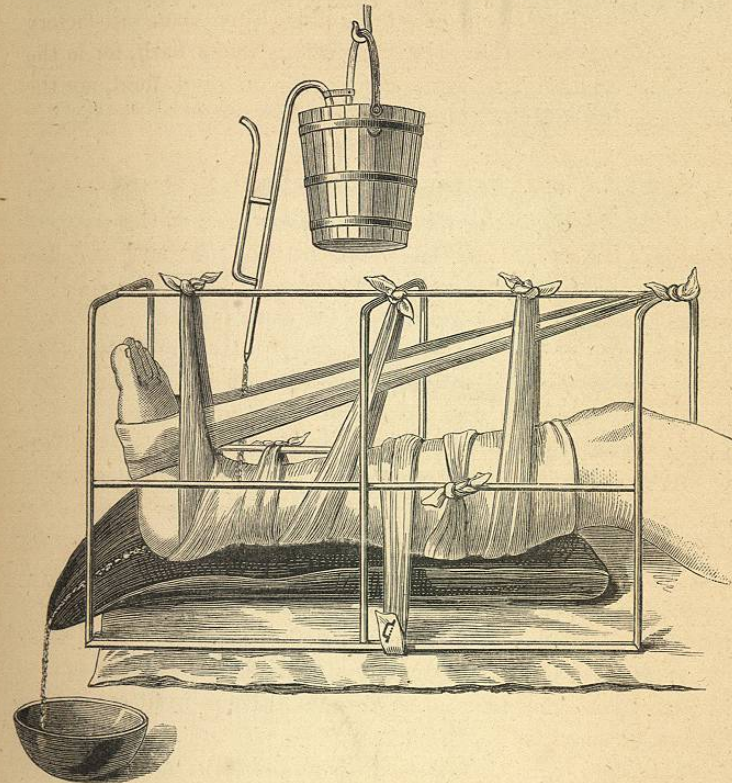


FIG. 75.—ARRANGEMENT FOR IRRIGATION IN THE LOWER LIMB.  
(After Esmarch.)

supposed, is shown by the results of M. Guyot with his incubation method. Here the wounded part was enclosed in

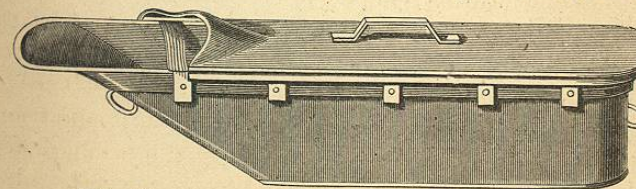


FIG. 76.—APPARATUS FOR CONTINUOUS IMMERSION.  
(After Esmarch.) (For the extremities.)



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