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(5) The tub system requires at least eight times as much fuel for the same number of men.

(6) A great saving in soap.

(7) A great reduction in labour and in staff required to look after the baths.

Suggestions.—(1) The material of which the cistern, boiler and furnace are made should be a little thicker, to withstand wear and tear of use, also of frequent taking down and fitting up.

(2) The use of iron, lead, tin, zinc, and brass at the junctions of the pipes with the cistern is a bad combination and forms a weakness in construction.

(3) A three-quarter-inch T with a plug at the base of the flow pipe where this is connected to the boiler is very necessary to enable the boiler to be washed out.

(4) A stop-cock is required on the cross-piece of the spray delivery pipe to enable the sprays on one side to be cut out when four men or under are having baths.

(5) A light cover is required for the cistern to keep out soot from the chimney and other debris.

(6) Three such spray baths should be provided for each Division and worked by P.B. men.

OBSERVATIONS ON THE DRAINAGE OF GUNSHOT WOUNDS.

By Captain C. Max Page.
Royal Army Medical Corps (S.R.).

One of the features of the surgery of the present War has been the necessity for the use of some form of drainage in a large proportion of the wounds.

It must at once be admitted that the practice is undesirable. Any drain inserted into the tissues has the irritant effect of a foreign body, and in the cases in point an infective one. However, no means has yet been devised by which the evacuation of discharges and the prevention of the spread of infection can otherwise be secured. This being so, till the ideal method of treatment comes to light, one must employ the type of drain which most efficiently serves its purpose.

In civil practice, when drainage is necessary, standard rubber tubing has been commonly adopted, and in general the same material has been applied in the treatment of gunshot wounds. In this work I do not think that simple rubber tubes, either perforated or split, have proved entirely satisfactory, and I propose to describe a type of drain which, when it is a question of maintaining a wound track open in its whole
extent, appears to have certain advantages over these. It is difficult to form a judgment of such an appliance, as the standard of effectiveness does not admit of exact measurement. I will therefore merely attempt to present the reasons which suggested its design.

Principles controlling Wound Drainage.—The first action of any drain is to prevent obliteration of the cavity by adhesion or apposition of its walls. The introduction of any foreign body effects this purpose, and it is the second action, namely, the evacuation of discharges from the wound track, which determines the surgical value of any particular pattern. Supposing that no outside hydrostatic or pneumatic force be brought to bear, the movement of wound discharges is effected by two forces:

1. Gravity.
2. Capillary tension.

1. The action and value of gravity in wound drainage is so well accepted, that it need not be enlarged upon here.
2. Capillary tension is the only force effecting drainage in the reverse direction. Its activity is directly proportionate to the capillary surface in action, and is affected by the viscosity of the fluids in question.

The co-efficient of capillarity is higher for water than for any other fluid; it becomes lower in proportion to the albuminous material added.

The condition and nature of the surface dressing also control the movement of fluids in the subjacent wound—thus when the dressing is completely saturated no further movement of fluid along the capillary column abutting upon the dressing will occur.

The value of the above forces will vary in respect of different types of wound, of which three may be recognized, viz.:

1. A cavity, e.g., an empyema or a definitely localized abscess.
2. A potential cavity, e.g., the track of the wound caused by a missile which has lodged.
3. A potential tubular space, e.g., the track formed by the passage of a missile through the substance of a limb.

The method by which drainage is effected in these three types may now be considered.

1. In the case of a cavity, the volume of fluid to be removed will be relatively large, and the drainage of the track from the surface will be usually of little importance. Under these circumstances a simple tube placed so as to reach the inner surface of the cavity will, if acting in the direction of gravity, give ideal results.
2. In the case of a blind track there may be a foreign body or dead material at the end which cannot be completely removed, and as far as the drainage of this part is concerned the above considerations hold good. Drainage of the track however is also probably necessary and the observations made below on the third type of wound will then apply.

(3) The track formed by the passage of a missile will contain blood clots and debris, the collapse of its walls will in most cases obliterate the cavity. The injury will have opened up a series of connective tissue planes, and the aim of drainage is to prevent the spread of infection along them. As the exact position of the openings of these places cannot be determined, the ideal drain should evacuate discharges from the entire inner surface of the wound track. Thus a simple tube lying in the track will permit discharge in the capillary space between its outer surface and that of the wound track; but when, as rapidly occurs, this space becomes clogged by clots or the viscosity of the discharge, the movement will cease. In this instance the action of gravity is acting at a disadvantage in the small capillary surface.

If a rubber tube with side holes be used, its action will not be very different. The perforations are rapidly filled in with granulations and intruded tissue. The discharge which there may be in the direction of gravity from the lumen of the tube will come from these buds of half strangulated tissue, and satisfactory drainage from the connective tissue planes is impossible. The same observation holds in relation to a perforated metal or glass tube.

A gauze wick acts ideally for a time, but it becomes so rapidly saturated and put out of action that it is of no value in practice.

![Fig. 1.—Section of gutter drain.](image1)

![Fig. 2.—Section of gutter drain with a central lumen. Section also shows the cap.](image2)

In general it will be admitted that drainage is rapidly inhibited in all wound tracks, whether a drain is inserted or not, either by the clotting of the discharges or by the obstructive action of the surrounding tissues. The aim must therefore be to overcome this tendency to stagnation. The hypertonic saline advocated by Sir A. Wright induces a fluid discharge which does not clot. Its use therefore facilitates as well as increases wound discharge. But to obtain the best results this solution must be brought into contact with the entire surface of the wound either by continuous irrigation or by frequently repeated lavage.
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The above-mentioned types of drainage tube do not allow this purpose to be fully effected, but I think the form I describe below fulfils this requirement, and also increases the capillary drainage surface in action.

The Gutter Drain.—The tube should be made of rubber. In section it is star or pinion shaped (fig. 1); the outside diameter should be the same as that of a full-sized ordinary drainage tube. For certain cases the drain should be provided with a central lumen (fig. 2).

The tube is passed through the entire length of the wound track, the upper projecting extremity is capped by a piece of thin rubber tubing (e.g., a cut rubber glove finger) which extends just into the entry of the wound (shown in fig. 2).

It will be seen that, as a result, a series of gutters lying against the wound surface extend the length of the track. When fluid is syringed into the cap, it passes down each gutter so as to bring the solution into contact with practically the whole wound surface, and at the same time clearing away from the same area all debris. After lavage the maximum capillary surface in proportion to the size of the drain is in action.

When this type of tube is employed for blind wounds (type 2) the provision of a central lumen (fig. 2) allows the fluid to be syringed to the bottom of the track, whence it will return along the various gutters.

Theoretically it might be expected that this drain would give good results with continuous irrigation, but in practice relatively forceful washing out of the gutters periodically has proved more satisfactory.

It has not been possible to obtain drains quite in the form depicted, but I have for some months used a substitute made from ordinary rubber tubing. The tube is halved longitudinally, three lengths are then lightly sewn together to form the drain. It is capped as described above.

The appearance of a section is shown in (fig. 3).

As stated above, whatever drain is put in the tissues the reactionary
tissue formation round it soon leaves only a capillary space between the wound surface and drain; for this reason, if it is necessary to leave the drain in place for more than a few days, in addition to lavage periodical movement of the drain of the gutter type is desirable.

In conclusion it should be repeated that the above drain has only been used in its extemporized form. It is not suggested that it affords an ideal method of wound treatment, but in two respects it appears to be an improvement on the patterns in common use, viz.:—

(1) The drain forms with the surface of the wound track in proportion to its diameter the maximum capillary space, along which the evacuation of fluids can occur.

(2) It admits of lotions being brought into general contact with the surface of the wound track while the drain is in place.

A CASE OF OESOPHAGOTOMY FOR FOREIGN BODY.

BY CAPTAIN J. H. M. FROBISHER.

Royal Army Medical Corps.

The following case is sufficiently uncommon in the Service to be worth publishing:—

Dr. Y., 1/4th Hants Battery, was admitted to the Station Hospital, Kasauli, from Lahore. His history is as follows: He was wakened one night by a sudden attack of choking, and found that he had partially swallowed an upper broken tooth-plate he was wearing. He could not swallow the plate completely. He was taken to the Station Hospital, where nothing could be found in the pharynx under chloroform. He was therefore transferred to Ambala for X rays. Here a skiagram showed the plate impacted in the gullet at the level of the cricoid cartilage. He was transferred to Kasauli for operation. On arrival here (four days after the accident) he was in great pain, very short of breath, and was coughing up a large quantity of purulent material. Oesophagotomy was decided on after examination, as nothing could be felt by the mouth.

Operation.—The oesophagus was exposed on the left side of the neck through an incision along the anterior border of the sternomastoid. The carotid sheath was exposed, and dissection carried on between it and the thyroid body. The omo-hyoid required division before this could be done. The inferior thyroid artery also required ligaturing. The oesophagus was exposed, and the plate could be felt in it, and was removed through an incision in its wall. The incision in the oesophagus was closed with silk sutures, and a gauze drain put down to it. The remainder of the wound was closed, except at the lower end, where the gauze drain came to the surface.