Irregularities of the Heart.

There are only two forms of irregularity that need be considered. Irregularities indicating serious mischief will be associated with such diminution of the functional efficiency that the candidate would not seek to recruit—such as the irregularity of auricular fibrillation or of heart-block.

Youthful Type of Irregularity.

The most common irregularity is that which occurs in the healthy heart of the young. It is characterized by a lengthening and shortening of the pauses between the beats; it will often be found to vary with the respiration, the beat increasing in rate during inspiration and decreasing during expiration. When it does not have the characteristic respiratory character it can be made to take on the character by getting the candidate to breathe slowly and deeply for a few minutes. It is frequent in perfectly healthy hearts, and is therefore of no importance, and candidates should not be rejected on account of its presence.

Extra-systoles.

In rare cases the pulse may be found intermitting more or less frequently. If the heart be auscultated, two short sharp sounds rapidly following one on the other may be heard during the pause. If this is the only sign present—that is, if the functional efficiency of the heart be good and the size normal—then these extra-systoles are of no significance and the candidate should not be rejected.

The Effects of Excitement.

Many candidates whose hearts are perfectly healthy suffer from palpitation or excited action of the heart during examination. The beat becomes forcible and rapid and a systolic murmur may be present. If such a candidate be told to lie down and breathe slowly and deeply for a few minutes the heart's action becomes less violent and the rate slows during expiration. With a history of good functional efficiency the candidate may be considered suitable for enlistment.

Memorandum

ON

THE EMPLOYMENT OF BANDAGES FOR THE IRRIGATION OF WOUND-SURFACES WITH THERAPEUTIC SOLUTIONS, AND THE DRAINING OF WOUNDS.

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THE irrigation of wounds has over the application of wet dressings the following advantages.

We can bring our therapeutic solution continuously into application, maintaining its concentration unaltered. I have elsewhere, in my lecture, emphasized that this is, in treatment with saline solutions, of fundamental importance.

We can, given proper arrangements, apply our therapeutic agent to all the internal and external surfaces of the wound, and at the same time obtain ideally effective drainage.

I propose in this Memorandum to describe a series of simple arrangements which, I think, satisfy all requirements.

In the ordinary arrangement in which the irrigating fluid is supplied in the form of a "drip" falling into the wound—and it is the funnel-shaped wound I have in view—the fluid makes its way down along the side of the wound in a runnel, and we thus treat only one small sector of the wound. We have, in fact, the conditions of a rock valley or cave, where a thread of water flows to the bottom in a single channel, leaving all the rest dry.

Let me show you that by an arrangement of bandages the water can be led into the wound where we require it, that it can be distributed so as to wash down all the walls,

and that it can then be carried away without any leakage into the bed.

It will be convenient to begin by considering the properties of bandages and strips of gauze as conduits for carrying water. They may be regarded as conduit pipes

Fig. 1.

Fig. 2.

with porous walls—pipes which will convey water uphill by capillary attraction, downhill by gravity, and first up and then down hill when arranged as siphons.

We may, as a matter of fact, confine our consideration to bandages, for the ordinary bandage is, as comparative experiments bring out, a more effective water carrier than a strip of gauze cut to the same width.

The first point which comes up in connexion with the employment of bandages in suppurating wounds is their liability to be obstructed by the lodgment of particles in the meshes. The method which is employed when the dependent opening of a wound is plugged with a strip of gauze would seem specially designed for the purpose of compassing such obstruction. Here gravity carries the undiluted pus directly down into the wick, and we obtain instead of a drain an impermeable bung which effectually confines the discharges.

The arrangements shown in the models (Figs. 1 and 2) show how these difficulties can be circumvented and the wick be kept free from obstruction. We have in these—we may call them "mud-funnel" experiments—funnels filled in with a glutinous mixture of flour and water and in each case a bandage arranged as a siphon. In the first model (Fig. 1) the siphon is a simple loop of bandage carried over the rim of the funnel. We have in addition in this model a wick carried up into the stalk of the funnel. In the second model (Fig. 2) we have a rubber tube introduced through the stalk of the funnel and standing out above the surface of the fluid. This rubber tube is threaded with a bandage, and its end has been cut into two strips which hang down into the muddy fluid. The siphons are here, as you will appreciate, working in what would correspond to wounds standing full of pus, and they have, as you see, in each case carried over a very considerable volume of muddy fluid. And if they were continually refilled they would—for only the distal ends of the ascending limbs of the siphon bandages can here be obstructed and put out of functioning—continue to siphon over indefinitely through the upper segment of each ascending limb. You will also note that the wick in Model

Fig. 3.

No. 1 has become obstructed and has carried out only very little fluid. Finally, in connexion with Model No. 2, I would like, in passing, to call your attention to the principle that we can always, as occasion may require, reinforce the one or the other limb of the siphon; and that in this model we have in the two strands of bandage which compose the ascending limb of the siphon two streams of fluid which are tributary to the descending stream.

I pass on to certain further points having also a general application. You will appreciate that though water will, when it has a clear fall, run down a bandage without leakage, it will, as soon as contact is made with any surface, flow away over that surface. Again, it will leak out at any point when we constrict the bandage, or at any point where we loop up the bandage. For water refuses to run quickly uphill.

To prevent trouble from these sources we must, where our irrigating fluid has to be carried through obstructions

Fig. 4.

Fig. 5.

in the wound, or uphill, substitute rubber tubing for bandage. If, however, we have to resort to a siphon arrangement for drawing off our irrigating fluid from the reservoir, it will be of advantage to thread a bandage into the ascending limb of the siphon, and to carry it sufficiently far in to pass down some little way into the descending limb. It will also be advisable to leave in position the wire which we have used for threading in the bandage, and to bend it round into the form of a narrow U, so as to prevent the end of the rubber tube kicking itself out of the water. The great advantage we get from the use of a wick in our delivery tube is that we cut down the delivery from what the rubber tube would carry (which would be excessive) to what the wick will carry (which will be amply sufficient). Moreover, the siphon, when furnished with a wick, will start itself automatically, and also restart itself when the reservoir comes to be refilled.

I pass on to consider the factors upon which the efficacy of bandage siphons depends. The volume of fluid delivered is determined (a) by the height to be climbed in the ascending limb; (b) by the length of, and weight of water in, the descending limb; and (c) any obstacle to delivery encountered at the distal end of the descending limb.

In addition to these the rate of delivery will be affected (d) by the nipping of the bandage when it rests upon a knife-edge, this factor coming seriously into account in experiments with a long length of descending limb heavily weighted with water.

The experiment here set up (Fig. 3) shows the influence of factors (b) and (c); these being the factors we have to take special note of in connexion with the drainage of wounds. It will be seen that where other conditions are the same it is always the siphon with the longer descending limb which gives the more efficient drainage. Again, it will be seen that, other conditions being the same, a larger volume of water is delivered from a bandage whose end is immersed in water than from a bandage suspended in air. In the case of water dripping off from a bandage into air, consideration will show that the bandage will, just before the drop falls, be overfull of water, and that the inflow into it will for that moment be suspended, to be accelerated as soon as the drop has fallen off. As a result, we have in the bandage which is dripping off into air a cyclically interrupted flow. In contrast to this we have, where the descending limb of the bandage goes down into water, a continuous unobstructed delivery.

The practical application of this in connexion with wounds is that the siphon bandages which carry off the washings from wounds ought to pass down from the patients' beds into water in vessels placed on the floor. And if any bandage happens to be too short to dip into

Fig. 6.

the water the drip from it will be accelerated if it is torn into tails.

Where only little water is flowing off through bandages draining a wound evaporation must be guarded against, for this will, by diminishing the load of water, retard the outflow into the descending limb.

Up to the present we have considered only siphons formed from a single loop of bandage—that is, drainage carried out through conduit-pipes very much smaller in calibre than the vessel they are draining.

One may in many cases—in particular in wounds where the bandages may be obstructed by pus—desire to provide an ampler outflow. This can be done by packing the wound full of bandages, but there is here a right and a wrong way.

In this model (Fig. 4) I have packed a test tube in the ordinary method by taking a strip of bandage and coiling it up into the wound, and I have then taken the loose end of the bandage and, leading it out of the test tube, have employed it as the descending limb of my siphon. Side by side with this I have packed a test tube (Fig. 5) by taking a number of loops of bandage, laying them one above the other over the mouth of the tube, and then pushing them down so as to form with the strips outside a sort of rough letter M. We may call this the *multiple loop method of packing*. When I now turn on the water and fill up these companion test tubes you see that while the one which is packed with a single strand of bandage coiled up inside it empties itself only very slowly, the one

which is packed with multiple loops empties itself almost as fast as I can fill it in. You will note in connexion with the first system of packing that it is quite effective, really more effective than the second so far as relates to the conveyance of fluid along the tube. In point of fact, the contiguous coils of bandage fuse together, and give us all that a full calibre wick could. The real fault of the system lies in the out-flow. It is as if we had a large

main running out into a small pipe.

Holding these principles before us, we may now consider how we can in each particular type of wound arrange for feeding in the therapeutic solution, for distribut-

Fig. 7.

ing it all over the walls, and effectively draining the wound.

Wounds may for our purposes be classified into *cylindrical wounds disposed horizontally*; *funnel-shaped wounds with the funnel opening disposed upwards, downwards,*

and laterally; and finally *ascending or descending cul-de-sac wounds*. We may take these in order.

Arrangement for Irrigating a Cylindrical Wound which Perforates a Limb Horizontally.—Here, as shown in the model (Fig. 6), the irrigating fluid is conveyed into the interior of the wound in a narrow rubber tube. The wound is drained by two leashes of loops, which go down on either side into vessels of water. These

Fig. 8.

are pulled into position in each case by a strand of bandage fastened, as shown in the figure, round the bight of the loops.

In actual practice, when we want to verify that the irrigation is working properly, we do so by the following devices.

We test the effluent by drawing a line across one of the bandages with a stylographic pen, and note that the ink is carried down in streaks by the current. We test the inflow by piercing the rubber tube with the needle of a hypodermic syringe and driving in a bubble of air just above the point where the glass union provides an inspection chamber. Then holding the piece of glass tubing horizontally we see the bubble of air carried along. Where we want to test the condition in the interior of the wound, we aspirate into the syringe while pinching the rubber tube proximally to the insertion point of the

Fig. 9.

needle. Where we want to see the effect of the irrigation in conspectu we cut transverse strips from the bandage at different levels, and prepare microscopical preparations from these by streaking them out one by one over the

surface of the microscopic slides. We then, if the wound is getting progressively cleaner, see the microbes falling off, and if the wound were getting dirtier should see the microbes increase, as we travel inwards towards the wound.

Arrangement for Irrigating the Inverted Funnel Wound.—The kind of wound here in view (Fig. 7) is that produced when a projectile entering the thigh from in front fractures the femur and drives it before it, making an extensive wound of exit.

Fig. 10.

A strip of bandage tied loosely round the bight of a leash of bandages is passed up from below through the stalk of the funnel. This is now drawn tight, and then the strips of bandage hanging bunched up in the centre are one by one looped up over a framework fitted just below the mouth of the funnel. The irrigating stream is now carried through the upper bandage into the neck of the funnel, and here divides up into a whole system of separate streams which together irrigate the whole interior face of the funnel. In connexion with the actual wound we should loop up the bandages, not as in the model through a circular framework of wire, but as in Fig. 8, over a light aluminium cradle placed astraddle upon the limb.

Arrangement for Irrigating the Upright Funnel Wound.—The wound here in view (Fig. 9) is that seen in connexion with a compound fracture of the femur with wound of entrance behind and the wound of exit in front. Instead of dividing after entering the wound the irrigating stream must here

divide outside the wound and enter in a number of separate streams. We can get this by dividing up the end of a bandage into a number of tails and planting these about the wound.

The arrangement shown in the model embodies improvements suggested by my fellow worker, Lieutenant H. H. Tanner. It will be seen that we have here fitted to the delivery tube which conveys the fluid into the wound the upper end of a test tube. This serves as a receptacle for the bandage. Fitted to the mouth of the test tube we have a rubber cap traversed by a number of small rubber tubes. Into each of these is inserted one of the tails of the bandage. Finally, each of the rubber tubes is stiffened with wire. This enables us to direct its stream in any direction and to ensure the tubes maintaining any position which we give them in the wound.

Fig. 11.

Fig. 12.

Arrangement for Irrigating a Funnel Wound which is Disposed Horizontally.—Except only in the detail of the disposition of the irrigating tubes and the provision for carrying off the washings the arrangement is the same as in the upright funnel wound.

Arrangement for Irrigating an Ascending or Descending cul-de-sac Wound.—Both these wounds are irrigated by the arrangement shown in Fig. 5. In other words, the irrigating fluid is conveyed in a fine rubber tube upwards or downwards to the blind end of the wound, and the washings are carried away by multiple loops of bandage.

Method of Preventing the Irrigating Fluid running away over the Patient's Skin or Clothing and Soaking into the Bed.—It has already been emphasized that bandages resemble tubes with porous walls and that fluid leaks out whenever on entering or leaving a wound they make contact, as they inevitably must, with the external surface of the body.

We need not here concern ourselves with leaking from the inflowing stream. We have already provided against that by feeding the irrigating fluid into the wound through rubber tubes. There remains the leakage from the bandages which carry the outflowing stream. It is a form of leakage which is always liable to occur except where the wound of exit occupies, as the patient lies in bed, the most dependent portion of his body surface. The only method of dealing with this very serious inconvenience is by damming back the water which escapes. We can do this by means of what I may call *irrigation flanges*. Where we are dealing with a wound situated on a limb, what we require is a *ring-flange* above or below the wound (Fig. 11); or, better, irrigation flanges both above and below. Where we are dealing with a wound opening on the outer aspect of the trunk or limb, with, for instance, a wound on the lateral aspect of the shoulder, we require a *horseshoe flange* (Fig. 12) round the opening of the wound.

Such flanges are built up upon the patient's skin in a very simple manner. We first prepare some formalin gelatin. We do this by dissolving 20 grams of gelatin in 100 c.cm. of water—or better, so as to have plenty, twice that quantity in double as much water.

We now, pouring the gelatin solution out into a bowl, add to it one-tenth of its volume of the ordinary 40 per cent. formalin. Then taking a number of short lengths of bandage, previously laid ready to hand, we immerse these in the formalin gelatin. This done we take a roll of cotton-wool and encircle the limb with it, or, as the case may be, bend this round in the form of a horseshoe and then apply it, with the opening of the horseshoe disposed upwards, to the skin round the wound. Going back then to our strips of bandage lying in formalin gelatin, we take them one by one from the bowl, paste one end down on the skin, carry the middle over the ridge formed by the roll of cotton-wool, and then paste down the other end on the far side, taking care always to overlap one strip of bandage by another. When we have covered in our roll of cotton-wool we have completed our task, and we have now, as soon as the formalin gelatin sets—and it sets in a few minutes—a light stiff watertight confining dam firmly fixed down upon the patient's skin.

Let me say in conclusion that I am indebted to my fellow-worker, Lieutenant H. H. Tanner, for setting up and drawing the models, and also for valuable assistance in elaborating the above system of irrigation and drainage.

Memoranda:

MEDICAL, SURGICAL, OBSTETRICAL.

THE PREVENTION OF DEFORMITIES DUE TO ADHESION OF TENDONS AND MUSCLES.

We have had a fair number of cases of deformity due to adherent tendons and muscles at the Cliff Hospital, Felixstowe. Most of the scars were situated on the forearm, but some were on the arm or thigh.

The worst feature of cases of old forearm scars is the inability to flex or to extend the fingers and wrist. Flexion is greatly diminished in cases of scars involving the extensor surface of the forearm, and extension is similarly diminished in cases of scars on the flexor surface. In addition to this loss of movement, the soldiers complain

a great deal of a sensation of inconvenience due to the pulling on the scar by the muscles involved. A similar complaint is made in cases of scars on the arm and thigh.

The cases we have had have resisted all attempts for their improvement by massage and movements, and on operation it has been found that in the majority the condition has been due to the failure of the surgeon to sew up the deep fascia after making an incision for the removal of the bullet. The exposed muscles or tendons become adherent to the skin. The condition can easily be cured by suturing the deep fascia after separating the adhesions, putting up the forearm on a splint in a suitable position, and having recourse to movements and massage some twenty-four hours after the operation. The success attending these steps has been very great. The condition can be still more easily avoided by suture of the deep fascia in every case in which it is opened, following this up by early massage and movements.

Other cases are due to the tendons and muscles becoming adherent in the scar following a wound. The adhesion is, as in the last class, to the skin, and is due to the division of the deep fascia. These contractions can be avoided by early massage and movements, and when the contractions have already taken place, can be cured by similar measures. Too much stress cannot be laid on the importance of suturing the deep fascia in every case in which it is opened by the surgeon.

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THREE-PLY WOOD FOR SPLINTS.

IN these times of scarcity of skilled labour any device which will enable comparatively unskilled persons to make efficient surgical appliances is worthy of record, and I therefore offer no apology for drawing the attention of surgeons to the advantages of three-ply wood as a material for splints.

This substance consists of three very thin layers of tough wood which are superimposed, so that the grain of the middle layer runs at right angles to that of the two outer ones. The three layers are then cemented together under pressure. The resulting material is very strong for its weight, has no tendency to warp, and can only be split with great difficulty. It is made of various thicknesses, of which I have hitherto used three, namely: $\frac{1}{16}$, $\frac{1}{8}$, and $\frac{1}{4}$ of an inch. Owing to the absence of any tendency to split, windows may safely be cut in the splints to allow access to wounds. After softening the wood by soaking it in hot water, it can be bent into any moderate curve, but naturally it is easier to mould the thinner varieties than the thicker. It must be held in the desired shape during drying by bandaging or other means, after which the curve becomes fixed, and there is no tendency to spring back.

For many of the smaller splints, such as those for the forearm, even when windows are cut, no reinforcement is necessary if they are made of the $\frac{1}{8}$ in. stuff, but when using the more easily bent thinner material, or making longer splints, it is wiser to strengthen them by nailing a strip of wood, $\frac{1}{2}$ by $\frac{3}{8}$ or $\frac{3}{4}$ by $\frac{1}{4}$ in., along either edge, or wherever it may seem to be needed. Small $\frac{1}{2}$ in. brass tacks, which do not rust and can be easily clinched, are very suitable for this purpose.

A number of these splints have been and are in use at the Royal National Orthopaedic Hospital in the treatment of wounded soldiers, and have given satisfaction on account of their strength and lightness. This latter quality makes them acceptable to patients and also less likely to shift their position. The cost of a square yard of three-ply wood is about half a crown. Out of this twenty-four forearm splints can be cut, costing for materials, including nails and strengthening strips, not more than 1½d. each. Adjustable jointed splints are made of the same material, with the addition of metallic hinges of various kinds, such as will readily occur to any one of a mechanical turn of mind.

Of course these splints cannot be sterilized by boiling, but if they are given a coat of shellac varnish they will not absorb discharges, and they can easily be cleaned with cold water and soap.

London, W.

E. MUIRHEAD LITTLE.