head of the tibia the horizontally shaded portion represents the extent to which the upper and posterior portion of the head of the tibia is covered. The dotted line running from the top of the capsule from before backwards (through the vertically shaded portion) shows the extent to which the outer side of the shaft is overlapped.

Fig. 3 is from a skiagram taken with the knee in semi-flexion, but otherwise in the same position as in Fig. 2. This brings out the covering over the head of the tibia more forcibly in relation to the inner and posterior portion;

FIG. 2.

it shows also the little tongue of projection under the ligamentum patellae just where this overrides the head of the tibia; the most outstanding feature, however, is the marked extension of the capsule posteriorly, forming a large cushion-like pad more than filling the intercondylar notch, and even bulging out so far behind as to leave the posterior border of the outer condyle of the femur well in the background. This pad, however, is in relation with the inner aspect and not the outer.

The skiagrams were obtained by injection of the right knee-joint immediately after death, through the interosseous

space to the outer side of and about 1 inch above the insertion of the ligamentum patellae. No difficulty was experienced in introducing the emulsion with a 1 oz. glass serum syringe. The pressure required was no more than that to emit such an emulsion from the nozzle of the syringe, and as soon as the capsule was just tense no attempt was made to risk distortion by overdistension; none of the emulsion escaped.

A dilute bismuth emulsion was used of the consistency of ordinary cream. It was carefully prepared by rubbing

FIG. 3.

up in a mortar, the following proportions being employed: Bismuth carbonate 3 iv, aq. dest. (slowly added) to 3 vi, compound tragacanth powder gr. xx. Great care was taken to ensure that the central ray was in the middle of the field in each case.

I am indebted to Captain Claude Horton, R.A.M.C., surgical specialist, for kindly carrying out the injection, also to Lieutenant P. W. Hampden, R.A.M.C., surgical specialist, for his collaboration in this report.

REFERENCE.

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THE ABUSE OF DRAINAGE TUBES.

BY

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SINCE I returned from France I have often been asked, even by intelligent members of our own profession, "What use is your experience of war surgery going to be in civil surgery?" These short notes are the answer, and are the experience of six months' civil surgery since my return from France.

War surgery, as is well known, is a very different thing now from what it was at the beginning of the war.

Now wounds of the head, chest, abdomen (even with faecal contamination), and knee and other joints are sewn up with impunity after early and complete operation, and the results are excellent.

These results are largely due to Colonel H. M. W. Gray, Consulting Surgeon, — Army, and to his devoted band of young and brilliant surgeons. One day the surgical world will realize what an enormous debt of gratitude it owes to Colonel Gray, and he will get the reward he deserves. It was he who first opened my eyes to the "abuse of drainage tubes," and it is his teaching I have applied to civil surgery.

He tells the story of a wounded man arriving at the base with over thirty separate wounds, into each of which a

drainage tube had been placed. What a waste of labour—to say nothing of rubber! The first and most important result of the war in the surgical world will be the abandonment once and for all of the drainage tube. Its day is past, and soon it will only be seen, where it should be, in a museum. When one seriously sits down to think, it is incredible that we have for years deliberately placed into the soft and pliable tissues of the human body a more or less rigid drainage tube with an open passage for secondary infection to creep down. They are well termed, for they are an open "drain in" for infection from outside, and an open "drain out" for the strongly antimicrobial fluids poured out around any infection.

Sir George Lenthal Cheatle grasped this fundamental fact when he introduced his solid drainage tube with flanges; but he still kept to the rigid design. For years it has always been taught that if there is the least infection in any part of the body "put in a drainage tube." This is a mistake.

If surgeons will take their courage in both hands and will not be frightened by a little infection, leaving it to be dealt with by the natural resistance of the tissues to infection, and will give up the use of drainage tubes, they will not only find their results very much better, but they will find their outlook on surgery totally changed. I have proved this for myself, and a complete revolution has taken place in my surgical work.

The first question is, "What is to replace a drainage

tube?" All that is necessary is to put something into the tissues which will keep a "passage" open but which does not leave an open "drain." If a passage is required to be kept open I put in a piece of soft folded rubber—for instance, in an appendix abscess. This allows pus to come away, but will not leave an open "drain" by which secondary infection of staphylococci, from the skin, or other organisms can gain entrance.

It will be noticed, when using a soft rubber "passage tube," that the exuding fluid completely fills the spaces left, leaving no open "drain." I find that, unless it is absolutely necessary, it is advisable to use even a "passage tube" as little as possible, but, whenever it is possible, to completely sew up the infected wound. The results are excellent. War surgery has therefore taught us what should be the two main principles of civil surgery:

1. Early and complete operation.
2. That secondary or mixed infection is worse than primary infection.

While the tissues of the body can, if given a fair chance, deal with one infection only, if that infection becomes a mixed one by entrance of organisms from outside, then the last state is worse than the first.

After all, it is only the application of our old methods of dealing with tuberculous infections to all other infections, and treating them on exactly similar lines—namely, free incision, evacuation of contents, cleansing by mechanical means, or by the use of an antiseptic, and primary suture.

It breaks my heart to see surgeons using fomentations and weak antiseptic baths in the treatment of wounds, for they simply encourage the staphylococci to come out of the pores of the skin and secondarily infect the wound.

It is interesting to note the steps by which I gave up the use of "drainage tubes" once for all. I came back from France with a dislike to them, and have only used them since on three occasions, once for a general peritonitis following appendix abscess and twice for empyemata. Always in other cases I have used "passage tubes" of folded rubber. Now I use the latter as seldom as I can, and completely close cases of empyema.

Applying my experience of modern war surgery I started sewing up ordinary staphylococcal abscesses of the subcutaneous tissues, after incision and wiping out with bipp, and found they healed by first intention. I next went a step further. I saw a case of perforated gastric ulcer two hours after perforation, and operated within four hours. I sewed up the perforation, and, as it was near the pylorus and tended to close it, did a gastro-enterostomy. I mechanically cleansed the peritoneum of food, washed out with flavine, and completely sutured. The result was healing by first intention and an uninterrupted recovery, better than I have experienced with the use of a drainage tube.

In these cases and others of perforated hollow organs, stomach or bowel, it is difficult to say which is the most important, mechanical or antiseptic cleansing. Personally I think mechanical, because the rubbing of the peritoneum with gauze produces a beneficial hyperaemia and transudation of lymph.

Then I had to treat a bad compound fracture of tibia and fibula with a large external and contused wound, in a boy who had been run over by a motor lorry. I excised well clear of all damaged tissues—wiped out with bipp, and so mechanically cleansed and closed the whole wound by primary suture. The result was healing by first intention without a trace of suppuration.

The next step forward was in a case of gonococcal peritonitis. I found the peritoneum infected and containing a turbid fluid; I removed one Fallopian tube full of thick gonococcal pus, cleansed the peritoneum mechanically, washed out with flavine, and closed without drainage. The result was uninterrupted recovery and healing by first intention.

As to this case, I realize that it is the practice of many surgeons not to drain in gonococcal peritonitis, and that the fluid passed out by the peritoneum is frequently sterile, but I quote it because I myself, before my experience of modern war surgery, would have drained it for fear of infection, and I am sure other surgeons are "putting in a drainage tube to be on the safe side."

Why should we drain an empyema, where, by the putting in of a drainage tube, we not only run the risk of secondary infection but of collapse of the lung with its sequelae?

A case of empyema following a very severe attack of pneumonia occurred in a man very debilitated and ill, so that it was hardly thought he would live. I excised a piece of rib under a local anaesthetic and made a small incision into the pleura. At once he coughed out a large amount of thick fibrinous exudate. When he emptied his pleura I washed out with flavine and injected about a pint of a suspension of iodoform in paraffin, and sewed up from the pleura and then the skin. His general condition at once improved, the pulse and temperature gradually dropped, and I am quite certain he has made a better recovery than with an open "drainage tube."

The only drawback I found, and that was a small one, was that occasionally a small amount of pneumococcal pus and iodoform paraffin collected between the pleura and skin in the dead space left by the removal of a rib, and required evacuation. Only once did his temperature rise to 100°, but the pulse came steadily down from 120 to 74. He is now very well, and my friend Dr. Elgood, the physician who pulled him through his pneumonia, and I are very pleased with him. Four weeks after the operation the lung had expanded well.

By this method of treating empyema the risks of massive collapse of the lung and of secondary infection are both avoided and the convalescence is shortened.

I must confess to one failure, if it can be called so:

A child was sent into hospital with a diagnosis of appendicitis. I found general peritonitis with much thickened lymph covering the intestine. The appendix was normal, and no other cause was found. A swab taken was found to be sterile, but no doubt it was a case of pneumococcal peritonitis. I found too much exudation and flaky lymph to attempt mechanically to cleanse the whole of the intestines, which were covered in fibrinous deposit. I washed out with flavine and completely closed the abdomen. The child did very well, the abdomen was quite soft, the bowels acted well, and there was no vomiting. Suddenly on the fifth day the child became worse, and Dr. Elgood, who was in the hospital at the time and saw her, diagnosed pneumonia, and she died before I could be found. Unfortunately no *post-mortem* examination was allowed, but I have no doubt that the child died from a lung complication, and not from the abdominal condition.

A method of treatment in bone surgery which I was beginning to employ in France was founded on the idea of eradicating the "dead space" in a bone following the loss of substance by a gunshot wound or by an operation for infection. My idea was that where a dead space or open cavity was left in a bone by destruction it should be filled, not by blood clots, allowing a nidus for primary or secondary infection, but by an antiseptic wax which could be poured in hot, and would gradually cool and fill up any cavity. I did this on three occasions with excellent results, using a compound of thymol, vaseline, and candle-wax, which I found would become semi-solid at normal body temperature.

The first case was a wound of the upper arm with much destruction of the upper end of the humerus. By early and complete operation I removed many fragments and found a large cavity in the bone. This I filled with thymol wax and carried out primary suture. The compound fracture of the humerus healed by first intention and the result was very good, although a certain amount of thymol wax was exuded for a time through the stitches. I also carried out this treatment for a through-and-through gunshot wound of the ankle where the head of the astragalus was completely gone. The wound healed by first intention without, in this case, any exudation of wax.

I used this treatment as a secondary measure in a compound fracture of tibia with a big hole in the bone. As the wound was clean I poured in thymol wax and filled the cavity and performed a secondary suture; the wound at once healed. I have had no opportunity of applying the method in civil surgery, but in osteomyelitis of the tibia, for example, I should completely lay the medullary cavity open, thoroughly scrape away the infected medulla, fill up the "dead space" with thymol wax, and carry out primary suture. I feel sure the result would be better than by laying the bone open and allowing the wound to heal by granulation.

Conclusion.

In order to avoid mixed infectious surgeons must practise primary suture far more than in the past, and completely give up the use of rigid open drainage tubes.

Instead of draining where there is infection I advise going to the opposite extreme, and not to leave a "passage" open unless it is absolutely necessary.

If a secondary abscess or leakage from bowel should occur it will be dealt with by the inherent resistance of the body to infection, or should an abscess form it can be treated by a second operation, after adhesions have formed.

A new epoch in surgery will dawn when surgeons realize, as I have done, that they can leave quite a large amount of infection to be dealt with by the inherent resistance of the body to infection.

These notes are written with the sole object of stimulating my seniors and contemporaries who have more material to carry out the lines I have suggested, and to more and more practise primary suture in their cases, and above all to give up once and for all the use of open rigid drainage tubes.

Sir Bertrand Dawson, G.C.V.O., has kindly added the following note on the treatment of streptococcal empyemata:

With regard to empyemata, my experience is that the pneumococcal ones do well with immediate closure after evacuation, but not the streptococcal. These latter need to be drained for two or three days, with or without Carrel tubes, and then they can be sewn up.

I agree that streptococcal infections must be dealt with on different lines from staphylococcal, pneumococcal, and other infections, but in civil practice it is very rare to meet with streptococcal empyema.

ANOMALOUS MUSCULAR ACTION IN NERVE INJURIES.

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THE precise action of an individual muscle is not always easy to determine in the uninjured limb, since a particular movement is in most cases brought about by the resultant action of many muscles and not by one alone. When a nerve trunk is severed and the muscles supplied by it are put out of action, the muscles supplied by the uninjured nerves of the same region sometimes give rise to surprising movements. It is probable, in fact, that the movement resulting in these cases is such as never occurs in a limb with properly balanced muscles. While this movement is in many cases of mere academic interest, it occasionally happens that it may flatter the surgeon who has performed a nerve suture, giving him the impression that muscular recovery has begun, whereas an attentive examination of the muscles causing the movement may show that his conclusion is premature.

One of the most striking instances of this that have come under my notice is that when the median and ulnar nerves are divided in the upper arm, active flexion of the wrist is often still present, being brought about by the extensor ossis metacarpi pollicis. Another anomaly is seen in posterior interosseous paralysis, namely, the first dorsal interosseous muscle can cause a lifting of the thumb easily confused with commencing recovery of extension of that digit. These two anomalous movements clearly depend upon the difference of the plane in which the metacarpal bone of the thumb lies relatively to the plane of the four remaining metacarpals.

Other unexpected actions are that the terminal phalanx of the thumb can be actively extended in cases of posterior interosseous paralysis, the extension of course being brought about by the insertion of the abductor pollicis into the dorsal expansion of the extensor tendon; and that in ulnar paralysis the index finger can be slightly abducted by the obliquity of the extensor tendons passing to that digit. In persistent paralysis these movements, aided by use, massage, and electrical stimulation, may acquire some importance.

Some of these unsuspected muscle actions, it is true, may indicate merely that one's memory for anatomical detail requires furbishing, and anatomists could doubtless furnish many more instances. There is no doubt, however, that a partially paralysed limb offers a rich field for the investigation of the essential action of individual muscles.

Another anomaly which may often be observed is due to the general preponderance of the flexor muscles. This is seen in its most marked form in lesions of the upper motor neuron—for example, in a case of hemiplegia. If the wrist of such a patient is passively extended, the fingers curl into the palm and exercise a quite perceptible grip. In a lower motor neuron paralysis—for example, in complete lesion of the median and ulnar nerves in the upper arm—this action is also observable, though it is not so evident, and may give rise to a false notion that

recovery of active flexion of the fingers is in progress. In some cases it certainly indicates that the elasticity, and therefore the nutrition, of the finger-flexors is being maintained, but in others it points to essential fibrosis and shortening of those muscles, and is consequently of grave significance. In the latter case it usually betrays neglect of treatment. If the fingers can be straightened only while the wrist is flexed this condition of fibrosis is present in the flexors of the fingers. In a most helpful paper Professor Langley¹ has shown that the danger of stretching a paralysed muscle has been somewhat overstated. It is questionable, at any rate, whether it is preferable to risk stretching the muscles or to encounter a case of musculospiral paralysis so assiduously treated on a "cock-up" splint that the wrist, by reason of fibrosis of the extensors, could be brought neither up nor down.

It is surprising, again, to find what little muscular disability may result from complete division of the median nerve at the wrist. In a case recently operated upon there was, except for most intractable trophic ulcers over the median distribution in the hand, which was completely anaesthetic, practically no disability, and the lesion might easily have been overlooked. The abductor pollicis was completely paralysed and its situation represented by a fossa on the radial side of the metacarpal bone, but the loss of this muscle seemed not to affect the utility of the thumb. As for the movement of opposition, this was quite efficiently carried out by the adductores pollicis in combination with the long and short flexors, both heads of the latter appearing to be active in spite of the complete division of the nerve an inch above the wrist. It is interesting to note that within a month the trophic ulcers healed for the first time, but there was still complete trophic loss. This may only indicate, however, that the hand had received better protection after the operation than it had previously obtained.

Cases such as this are of interest from the ease with which nerve lesions may be overlooked, as pointed out by Mr. T. E. Hammond² in the case of the internal popliteal. They also illustrate the point that if a nerve is sutured without a previous careful examination of both muscular and sensory loss, the operator may claim results to which he is not entitled. This may account for some cases of atypically early recovery after nerve suture.

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EARLY CARDIAC BREATHLESSNESS AND "BUFFER-SALT" DEFICIENCY IN THE BLOOD.

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THE review in the *JOURNAL* of June 22nd (pp. 702-4) of the report of Dr. Lewis dealing with the causation of breathlessness on exertion in early cardiac cases is most interesting, but may I be allowed to point out that the expression "buffer salts," first coined in Germany for an effect described and measured originally in Britain, conveys an erroneous impression, because the protective action against variations in acidity or alkalinity is due not to the inorganic salts, carbonates, or phosphates, of the plasma, but almost in its entirety to the amphoteric proteins?

This protective action was fully described, and a quantitative method supplied for its estimation, by the writer and his colleagues Roaf, Wilson, and Whitley at the biochemical laboratory of the University of Liverpool over a decade ago, the results being published in the *Proceedings of the Royal Society* and the *Bio-chemical Journal*.¹

The action was described under the title of the "reactivity of the serum," as distinct from the "reaction of the serum" at any given moment, and by estimating the amount of decinormal alkali and acid necessary to titrate from one definite value of hydrogen ion concentration to another, marked by the mid-point or neutral point to two coloured indicators, namely, phenolphthalein and methyl orange, there was assigned a quantitative value to the "reactivity" or protective power of the blood and tissue