which the amount of work a muscle was asked to do was usually in excess of cell recovery; the resumption of work should be gradual—that is, presumably with cell recovery. The treatment of the muscle is all-essential in the disease. Instead of waiting for a chance recovery in the corneal cells and treating in a perfunctory way the muscles with massage and electricity, we recognize that every affected muscle will work, provided that a commencement be made from zero. It is recognized that an affected limb will retain its heat and show little waste provided that it be rested and worked within physiological limitations. Work must not be done for the muscle, it must itself work.

In conclusion, I would like to mention certain references that to me stand as landmarks—namely, Hunter's lectures on muscular motion, perhaps the master's greatest work; Hughlings Jackson, who taught us the application of Darwin's work to the nervous system; and Owen Thomas, who pointed out the significance of surgical rest. It is to the credit of this great man that he placed his back against the tide that unfortunately the antiseptic system loosened, and Australia owes a no small debt to my teacher, Dr. Peter Bennie of this city, for his unswerving support during the last thirty years of Thomas's work.

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A FIELD HOSPITAL IN BELGIUM.

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THE opportunity of a surgeon in war depends more upon the rapidity with which the wounded reach him than upon any other circumstance. The downward progress of a man gravely wounded is so rapid that a few hours' delay may mean the loss of a life or a limb. For the past three months we have worked in a hospital which has always been within a few miles of the firing line, and we hope that our experience of surgery under these conditions may not be without interest.

The British Field Hospital for Belgium began its work in Antwerp with a well-equipped hospital of 150 beds and a staff of 8 doctors, 20 nurses, and 5 dressers. In five weeks 500 Belgians and 70 British were admitted to its wards, in addition to a large number of slighter cases treated and sent on to other hospitals. On October 8th, 1914, in view of the German occupation, the hospital had to leave Antwerp. We retired, however, in good order, bringing with us, on seven motor buses, all our wounded (73 Belgian and 40 British), all our staff of 40, and practically our entire equipment.

After a week in London to refit, a fresh start was made at Furnes on October 19th, and there the hospital is still at work, acting as the official field hospital of the Belgian army. Furnes is at the centre of the curve formed by the river Yser, and at a distance from the trenches varying from five to eight miles at different points (December, 1914). It is an old Flemish town of about 6,000 inhabitants, and the hospital is established in the large Episcopal College of St. Joseph. It has accommodation for about 100 patients, although by the use of straw wards we have housed as many as 150 on more than one occasion. Every day the military authorities visit the wards and transfer to base hospitals at Calais and Dunkirk every patient who can be moved. The turnover is therefore very large, and has reached as many as 100 in one day. These evacuation arrangements enable the hospital to deal with a very large number of patients, though they make it somewhat difficult to follow any but a few special cases throughout their course.

It will thus be seen that the hospital has enjoyed all the advantages, and some of the dangers, of a well-equipped establishment close behind the fighting line. It has also the immense advantage of a fleet of motor ambulances to bring the wounded direct from the trenches. Dr. Munro's

Ambulance Corps works in conjunction with the hospital, and brings the wounded in with the least possible delay. Most of our cases are received within the first twenty-four hours and in some cases they have reached us in less than an hour from the time of injury. There can be few hospitals so fortunately placed.

Before proceeding to discuss the various injuries which we have been called upon to treat, we must consider for a moment certain general features common to all cases admitted to the hospital. All have been living in the trenches for some weeks, their clothes are sodden and caked with dirt, exposure and insecure sleep will have left some traces on the men themselves. In most cases they must have lain in the trenches for at least some hours after being wounded, for as a rule it is impossible to remove wounded during daylight. When fighting is at all severe they may lie for many hours before they can receive any attention at all. On one occasion we took in five Germans who had lain wounded in the trenches for five days with absolutely no attention at all, two of them with compound fractures of the femur. To physical exposure must be added the mental effect of the terrific bombardment at close range which has been such a prominent feature of the fighting in this neighbourhood. The men seem dazed, stupefied, and apathetic to a degree with which we were not familiar in the less strenuous conditions of the fighting around Antwerp.

When we add to these general conditions the loss of blood and the actual shock which must be associated with any severe injury, it will be seen that the first efforts of the surgeon must be directed to the treatment not of the injury itself, but of the general condition of the patient. He must be got warm, his circulation must be restored, he must be saved from pain and protected from further shock. In other words, saline infusion and morphine form the starting point in every serious case. Bleeding rarely requires immediate attention. Unless it had been dealt with effectively on the field, the patient could not have reached hospital. But the means adopted were probably very primitive, and with improvement in the circulation bleeding may recur. This is a very real and serious danger which must on no account be overlooked.

We cannot urge too strongly the necessity for deferring any serious surgical procedure until all that is possible has been done for the general condition of the patient. It need not take long. Hot-water bottles, an enema of coffee and brandy, a quarter of a grain of morphine, and a pair of subcutaneous needles delivering really hot saline, will carry through a serious operation a patient who half an hour before was cold and pulseless. We are dealing with absolutely healthy individuals, and their rate of recovery is amazing.

Two features are common to practically all wounds produced by projectiles in the present war. All are septic and in all there is great destruction of tissue. These two facts are correlated, for the infection is certainly not due to the organisms with which one is familiar in ordinary surgical work in England, but in a large degree, at any rate, to saprophytes. The patients never show the phenomena of acute sepsis as seen in civil practice, but rather a condition of almost pure sapraemia. The wound may be a black and gangrenous crater, such as would under ordinary circumstances be incompatible with life, but its edges show no spread of infection, the patient is comfortable, and has no rise of temperature, and with suitable treatment the wound will become covered by healthy granulations and rapidly heal. In bad cases, it is true, ordinary sepsis may develop, but this occurs very late and is obviously due to a secondary infection bearing no relation to the original bacteriology of the wound. The recognition of this fact is of extreme importance, for all wounds must be treated with full surgical asepsis, whilst a liberal use of hydrogen peroxide will destroy most of the organisms primarily present. We do not here refer to the special infections of gas gangrene and tetanus.

The destruction of tissue is so great that each side has repeatedly accused the other of using dum-dum bullets. This is based on an entirely mistaken reading of the evidence. Our opponents do not use such bullets, for the very good reason that they have discovered something far more deadly at long range. Their pointed bullet is carefully constructed so that its centre of mass is far back. On striking any tissue, soft or hard, it at once turns over and

passes through backwards, the uncovered base mushrooming as it advances. The point of the bullet is under these circumstances unaltered. In the course of operations we have repeatedly met with specimens demonstrating the correctness of this view. The minute wound of entrance, the great internal destruction, the position of the bullet, and its mushroomed base, admit of no other explanation.

The injuries with which we have had to deal may be divided into those of the head, chest, abdomen, and limbs. The treatment required and its results in these four regions are in striking contrast. In the first two immediate operative treatment should be minimal, since the recovery of the head cases depends as a rule on factors beyond the surgeon's control, whilst the recovery of the chest cases depends on non-interference. In the other two regions we hope to show that the most radical forms of operative treatment are those which offer the greatest prospect of success.

INJURIES OF THE HEAD.

The head cases with which one has to deal in a field hospital are certainly the most hopeless, for all the simpler cases will have been sent to the base. In most of the injuries to the skull by projectiles which we saw at Furnes the damage to the brain was so extensive as to be incompatible with life for any length of time. We saw no cases of clean-cut perforation of the skull. In all those in which the projectile had pierced the skull large areas of the cranium had been broken in, whilst the laceration of the brain itself was terrific. Even where the projectile has not entered the skull but merely cut a groove in its surface we found large fragments of bone at a distance of an inch or more below the surface of the brain. It was most unusual to find them in contact with the skull. In such cases we cannot expect from trephining results at all comparable with those of civil practice, and when we add the sepsis which universally prevails the hopelessness of these cases becomes apparent. These are, of course, very different from the more moderate cases which reach the base hospitals, where quite good results may be expected from skilful surgery. We had a number of these in Antwerp, and they did excellently. We conclude that it would be better to send all head injuries through to the base hospital rather than occupy the beds of a field hospital with cases for which immediate surgery can do so little.

WOUNDS OF THE CHEST.

Wounds of the chest almost invariably do well, provided they are left to themselves. There is, of course, the immediate danger of death from haemorrhage into the pleural cavity, but in a patient who has been successfully conveyed from the battlefield this can be combated. With morphine and saline infusion most cases will cause little anxiety, though care must be taken not to raise the blood pressure by the latter method beyond what is absolutely necessary. Later on a haemothorax or an empyema may develop. The former should only be opened if it is accompanied by an effusion so extensive as to cause dangerous pressure, or if it becomes septic. An empyema must be opened in the usual way.

ABDOMINAL WOUNDS.

The chief interest of our work at Furnes centres, however, round the treatment of abdominal wounds and of compound fractures of the humerus and femur. In these cases our opinion and our practice have been in direct antagonism to the views generally held—and, indeed, held previously by ourselves. After a very considerable experience of these conditions in circumstances where our opportunities were exceptional we are convinced that in every case where a wound of the intestines is suspected an immediate laparotomy is imperative.

In the South African war it was found that in bullet wounds of the abdomen the intestines frequently escaped injury, and that even when they were wounded the injury was often limited to minute punctures. Provided the intestine was not too full at the moment of injury, these punctures were rapidly covered with lymph and sealed off. In addition, the conditions of the country and the absence of water made abdominal surgery difficult, and it was, in fact, found that the chance of recovery was far greater if the patient was left alone, kept quiet with morphine, and starved. That experience has cost the lives of many patients in the present war. Here the conditions are

utterly different. The bullets for the most part in use are really, as we have already explained, an ingenious advance on the dum-dum. They are so balanced that on impinging on soft tissues they turn over and pass through backwards, mushrooming as they go. The result is extensive laceration of all the tissues through which they pass, and the abdomen is no exception to this rule. In our experience it has been the exception to find punctures. In most cases the intestine was cut almost or completely across, and even where this was not the case the punctures were large, ragged holes, the closure of which by natural means would have been a mere surgical curiosity. The close range at which fighting has taken place is no doubt another factor, and that this is so was borne out by the much graver nature of the rifle wounds seen by us at Furnes as compared with those at Antwerp. In fact the only case of puncture we saw at Furnes was the result of shrapnel.

If these observations are correct it necessarily follows that very few cases of intestinal injury can recover spontaneously. On the other hand, in the present war it is an easy matter in a properly equipped hospital to carry out an abdominal operation with almost the safety of a London theatre. The difficulty at present is that, from a want of recognition of the above facts, the hospitals have for the most part been placed so far behind the lines as to be useless for the purpose. Unless abdominal cases can be brought in within six hours of the time of injury it would be much better to leave them in the trenches and to use the available transport for more practical purposes. It is our absolute conviction that to carry abdominal cases back to base hospitals is, to put it in the mildest terms, a grave mistake.

We do not propose to discuss in detail in the present paper the cases on which the above views are based. We would merely describe the general routine treatment which we adopted. In every case the preliminary treatment to which we have already referred occupied a very prominent place. Most of these patients came in suffering from severe shock, cold, and loss of blood. Many were icy cold and pulseless, yet with morphine, saline infusion, and coffee and brandy injections they always improved rapidly.

After perhaps half an hour of such treatment, the abdomen was opened under spinal anaesthesia, which for these cases offers immense advantages. Open ether was often given at the same time, partly to overcome the patient's nervousness and partly for the sake of its stimulating effect. Only a minute dose was of course required. The abdomen was opened by a rectus incision, right or left according to the side of the wound. In every case in which the intestine had been wounded an amount of blood and faecal material varying between one and three pints was found free in the peritoneal cavity. The injured portion of the intestine was drawn out and rapidly secured in soft clamps, care being taken to bring out no more than was absolutely necessary. The peritoneal cavity was then cleansed as far as possible with coarse marine sponges of moderate size. Gauze is useless for dealing with such a quantity of material. The whole cavity was invariably found to be full of blood and intestinal contents, and the sponges had to be swept widely round it in order to cleanse it properly. The intestine was now more carefully examined and such holes as permitted of simple suture were closed. As a rule, however, a portion had to be excised, usually about 3 ft. The whole injured portion was invariably taken—first, because a double anastomosis appeared to involve greater risk, and, secondly, because in double lacerations the mesentery between had not usually escaped. In one case this involved a resection of 20 ft. Whatever the condition, the operation was completed, for experience showed us that there was no case so desperate that it might not have a chance of recovery. The two edges of the mesentery were carefully brought together and end-to-end anastomosis was invariably used, except in cases involving resection of both small and large intestine. In no case was a Paul's tube used. An end-to-end anastomosis can be completed in ten minutes with absolute security, and is much more satisfactory. The anastomosis completed, a further attempt was made to cleanse the peritoneal cavity. The edges of the wound were held up and hot saline poured in from a jug. This was removed with clean marine sponges swept round the abdomen as

before, and, if necessary, the abdomen was filled again and the operation repeated. Finally, the abdomen was filled with saline and closed without drainage.

It will be noted that we are dealing with a peritoneum already completely involved, and that when its toilet has been completed it is perfectly normal in appearance and has been entirely freed from all visible contamination. We are, in fact, dealing with a case of peritoneal contamination and not of peritonitis in the ordinary sense of the term. In the ordinary case of infective peritonitis we should regard the treatment we have described as the most fatal which could be adopted.

The immediate results of this line of treatment are extraordinarily good. In every case the general condition of the patient on leaving the table has been good, although in almost every case he had reached us in a desperate state. In the ultimate result the one essential factor is the time that has elapsed since the injury. If a true peritonitis has become established the outlook is grave in the extreme, and certainly after twelve hours very few cases will recover. Even at Furnes we only received a limited number of cases in six hours, but in these cases the results were most encouraging. Shortly before we left Furnes we had a remarkable series of 7 cases, all received in a period of thirty-six hours and all wounded by rifle bullets from six to eight hours before admission. Of these, 5 were doing well when we last saw them five days after operation; 1 died fourteen hours after operation (20 foot resection); 1 died on the third day from a gas infection of the abdominal wall (resection of right half of colon). All were treated rigidly on the lines above laid down, with the exception of one, who had a retro-peritoneal injury of the caecum. Of the remaining 4, 3 involved extensive resections of the small intestine, and 1 the suture of a large hole in the caecum. With the one exception mentioned, the peritoneal cavity was in each case flooded with blood and intestinal contents, and it is inconceivable that they could have recovered apart from operation.

This group of cases has specially impressed itself upon our minds as exactly summing up our general experience, that with immediate operation in cases received within six hours there is a reasonable hope of the patient's recovery. Without operation we have never seen a case of undoubted intestinal injury recover.

We would add one word of warning—that it is useless to wait for the ordinary signs of intestinal perforation. We have always taken the passage of a bullet across the abdomen, except in its upper portion, as sufficient evidence that the intestine is wounded, and experience has amply justified this view. We have seen no case in which a bullet has crossed the abdomen without injuring the intestine. These patients often do not exhibit in any marked degree the rigidity and tenderness which are such infallible guides in civil practice, still less the Hippocratic *facies* and the general appearances characteristic of peritonitis. They far more resemble a ruptured ectopic gestation, with the fatal difference that delay means a faecal peritonitis. The risk of a laparotomy is nothing compared with the risk of delay.

In our opinion immediate operation is the only treatment of any case of suspected intestinal injury.

COMPOUND FRACTURES.

Compound fractures of the femur and humerus constitute a problem of a very different order. Here there should be, as a rule, no question of immediate operation, for the general condition of the patient will render such a proceeding dangerous in the extreme.

It is after a few days, when he has recovered from shock and loss of blood, that the best course to pursue will have to be decided on. Unless the problem is given up in despair and the limb amputated some mode of fixation must be adopted which will allow the utmost freedom for dressing, for every wound is septic. The sepsis is not usually of a virulent nature and is largely due to saprophytic organisms, many of them anaerobes. The nature of the wound, however, encourages their development, for as a rule there is a small wound of entrance and a somewhat larger exit, whilst between the two is an amorphous mass of pulped tissue including the indistinguishable remains of perhaps six inches of bone. If left to itself for a few days

the whole will be a seething mass of sepsis and gas will bubble from the bullet holes. The general rule as far as we can gather has been to dress these cases neatly on the field and to amputate them three days later when they have reached a base hospital. We do not wonder. But if from the first they had been treated on other lines in a very large proportion of cases the limb might have been saved.

In dealing with these cases we have to face two facts—first that the wound is septic, and second that a large section of the bone has been pulped. Obviously osteomyelitis must result and loose portions of the bone will finally come away as dead sequestra. The cases should, to our minds, be regarded as cases of osteomyelitis complicated by a fracture. If this complication of the disease could only be got rid of it could be treated on ordinary lines. We got rid of the complication by plating the fracture. It seemed to us that the introduction of a little more dead material in the form of a steel plate could make very little difference, whilst it reduced the nursing and dressing of the case to simplicity itself. But we had always been told that no plate would hold in a septic wound and that at the end of a few days the whole thing would break down. Whether this observation depends on the faulty application of the plates or whether the form of sepsis with which we dealt had other characteristics we do not know. Certainly, we have on no occasion seen a single screw work loose from the bone. Very large and heavy plates were used for the femurs, 10 in. $\times$ $\frac{1}{2}$ in. $\times$ $\frac{3}{8}$ in. being perhaps the most useful, fixed by six screws at each end. These were specially made for us by Messrs. Krohne and Sesemann. By this means the two end fragments were fixed together in their proper relative positions, the intermediate portions being left *in situ* if they appeared to have a blood supply. No external splint of any kind was used. The plate held the bone with absolute security and the fracture could be ignored.

Twice a day the wound was washed out with hydrogen peroxide through tubes introduced for the purpose during the operation. In most cases the wound in a few days showed clean granulations, and only a little discharge would be washed out of the deeper regions. The patient soon learnt to move the limb about for himself, and, in fact, in several cases we had some difficulty in persuading him to stop in bed. Radiographs show that in these cases callus forms in a perfectly normal manner, and that at the end of six weeks the small fragments have fused together into a uniform mass sufficient to ensure the union of the bone. By this time the wound will have closed completely or be reduced to a small sinus, which is washed out daily, and which is obviously closing from below. As to the ultimate fate of the plates it is impossible yet to speak. Their removal would in any case be an easy matter, and would be a small sacrifice to pay for the ease and comfort they have provided. Any one who has attempted to nurse one of these femurs on a splint, and then the same case after plating, can have only one opinion on the subject.

CONCLUSION.

We have written this brief account of our work in the hope that we may be able to save others from some of the difficulties which we ourselves had to face, and from the mistakes into which we fell in our attempts to reach a solution. We have written, above all, in the hope that others may attempt these terrible abdominal cases in hospitals as well equipped as that at Furnes, and as near to the fighting line. It has been said that skilled surgery is of no use at the front. We hope that our humble attempts may at least show that five miles behind the trenches there is room for the highest surgical skill that England can produce. We look forward to the time when the man wounded in the abdomen will reach the surgeon not in six hours but in sixty minutes, and when the results of abdominal surgery in the field will rival those of abdominal surgery at home.

THE tenth annual meeting of the American National Red Cross Society was held at Washington on December 9th and the three following days. The report showed that more than 180 surgeons and nurses had so far been sent to Europe, and it was added that more were urgently needed.