SURGICAL NOTES FROM A TEMPORARY CLEARING HOSPITAL AT THE FRONT.*

BY

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DURING the recent fighting in France the clearing hospital has taken its place as a definite unit in the medical organizations. For obvious reasons the clearing hospital could not fulfil its destiny during the retreat of our army from Belgium to the south-east of Paris. When our army took the offensive and drove the Germans over the Marne and across country to the Aisne, it was possible to make use of clearing hospitals. The clearing hospital belongs to the line of communication. It stands between the field ambulances and dressing stations at its front and railhead and its hospital train behind. Its function is to receive all the wounded from the fighting line and transmit them to the hospital train *en route* to the base. Motor ambulances in many cases to-d y convey wounded direct from the regimental dressing station to the clearing hospital without leaving them at the field ambulance dressing stations. Whether the clearing hospital will remain as at present constituted or will be modified or abolished, I am unable to say. It is at present in swaddling clothes, and may require some careful nursing. In addition to being a "rest house" on the *via dolorosa* of the wounded, it is also a sieve. It has to sift the lightly wounded from the seriously wounded and the serious case from the desperate case. In this process of sifting a large collection of wounded men it discriminates between those who are fit to be sent to the base at once and those who must remain for a longer or a shorter period. Many claim that the clearing hospital is not a hospital *per se*, but holds a purely administrative position. I feel sure that it will become more and more a hospital as time goes on, and its surgical and medical equipment will necessarily undergo a complete reorganization. To-day its equipment is little more than that of a field ambulance. It is not equipped to deal with extensive and serious operations, and yet serious operations have been performed and will necessarily continue to be performed at the clearing hospital.

The transportation of the wounded from the front is now being magnificently carried out by the motor ambulances. The motor ambulances during this war can go to any place that a horse ambulance can. All the transportation is carried out on roads behind our front to-day, and also during the fighting on the Marne and Aisne. During the Marne and Aisne, and latterly in Northern France and Belgium, I was attached to a field ambulance, and not at any time was there any occasion to bring the horse ambulance of this unit across a field or through open country. They steadily kept to the roads, and the motor ambulances can do this also.

It appears to me, therefore, that owing to the presence of motor ambulances the field ambulance of the future will be concerned entirely with the evacuation of the wounded of their respective brigades to the clearing hospital. The clearing hospital will therefore become a more important unit, and need not be moved any nearer to the front than it is now. Tuffier in his report on the French clearing hospitals advised that the personnel should be carefully chosen, and that each unit should have a good surgeon of ripe judgement ready to meet with any surgical emergency. The same advice applies to the British clearing hospital. The brief review of a series of cases under treatment at one "temporary" clearing hospital will serve to illustrate my contention that the clearing hospital should at any moment be prepared to handle serious cases requiring dangerous and immediate surgical interference.

It has been said that to-day we are treating wounds of an eighteenth century character with twentieth century technique. The eighteenth century battle wounds were inflicted at close range, so are many of the wounds inflicted to-day.

At Cressy and Agincourt both sides used arrows; our aviators to-day carry sharp arrows, which they spin down on the enemy below. Bombards were used at Cressy, and bombards are used in the trenches to-day. Hand grenades were employed in the Peninsular war, and are employed to-day in the War of the Nations. Our men attack the enemy and the enemy attack us with bayonets, as in the days of the Crimea and the Peninsula. Our riflemen pick off the enemy by long distance fire, and also fire at close range into solid masses of them.

The hardships of the Crimean trenches—cold and frost-bite—are repeated on the Yser. Gangrene was rampant at one time in the Peninsula amongst the French and British wounded, and it has startlingly reappeared to-day. Historians of that day refer to it as hospital gangrene, or the gangrene so common after any surgical operation or wound of that time. It may, on the other hand, have been the same gas gangrene that has ominously complicated so many wounds in France.

FIELD AMBULANCE AND CLEARING HOSPITAL.

In the second week of October the field ambulance to which I was attached arrived at a certain town in the North of France. The brigade which this ambulance served was very soon in touch with the enemy. The fighting rapidly developed, and assumed a most sanguinary and stubborn character. In twenty-four hours we had a very large number of wounded on our hands. The head quarters of the ambulance occupied a large chateau behind the brigade, and within reach of enemy shell fire. A section of the ambulance, consisting of three medical officers and the equipment of one section, was sent to the town four miles further back with orders to prepare a building to act as a temporary hospital, or temporary clearing hospital, or a temporary dressing station. This section took over a large school, cleaned and prepared the rooms, which were large and lofty, and covered the floors with straw. No beds were then available. This temporary hospital had not to await events; the events were there at once in the guise of crowds of recently wounded men. Motor ambulance after motor ambulance dashed up with its load of wounded. These were rapidly lifted out and conveyed into the building; then away went the ambulance to bring in more wounded. Many and large as were the schoolrooms, they were quickly filled to overflowing. The corridors and porches were covered with straw, and this straw was soon covered with rows of wounded men. The paved courtyard under the verandahs was covered with straw, and again covered with wounded. Those densely-packed rooms during that long night were a lurid and impressive picture of the devastation of war. As more and more wounded arrived we had to pack them closer and closer, gently push one this way, lift another there, edge a third one closer still. So it went on. We took in a number of French wounded, and put them alongside our own men. All the wounded were glad to get in out of the pouring rain and be comfortably installed on dry, clean straw, and covered with blankets.

All these wounded arrived with the first field dressing applied. Some were applied by the surgeon with the regiment, some by orderlies, some by field ambulance officers, and some by the comrades of the wounded man. At first we were busy "packing" our wounded as comfortably as we could. Then as soon as possible we performed the dressings where necessary, differentiated our seriously wounded from those lightly wounded, and carried on any immediate surgery required in a small room kept for the purpose. All these wounded had to be fed, blankets had to be provided, and when we began to get things in better running order more wounded arrived. Our wounded behaved like brave men, and took their gruelling like good sportsmen. Next day the pressure was relieved by the opportune arrival of a hospital train, and we were enabled to evacuate 250 of the cases fit for transport. More doctors and some dressers were sent to help, and the vacant places of the 250 sent away were soon occupied by 250 fresh cases.

As the pressure for beds showed no sign of diminution a search was made for another building to hold wounded. This was found at the Hôpital Civil et Militaire, a permanent hospital of the town of X———. The basement floors were full of French wounded. There were two very large empty rooms or halls on the top floor of the hospital. Each room was capable of holding 70 patients at least. A good lift was available, by which a man on a stretcher could be

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conveyed from the basement to the top story. The French authorities offered me the use of these rooms for our wounded men, and also gave me the use of three side rooms for wounded officers. But, greatest boon of all, I was allowed the use of the two operating theatres of the hospital. Both of these theatres were modern and beautifully equipped, with good lighting, natural light and gas, glass tables, a complete set of instruments, sterilizers, towels, aprons, and modern washing basins with foot taps. It was presided over by Sister Ferdinand, a trained nurse with rigid antiseptic and aseptic principles. The nursing at this hospital was performed by Sisters of Mercy, all trained and skilful nurses, and the gentlest and most helpful people one could meet. The Reverend Mother of the Order was the Matron of the hospital, and was also a trained anaesthetist, being able to administer chloroform or open ether. In addition two of the nursing sisters were Irish nuns who belonged to this French Order. The matron detailed these two Irish sisters to work with the British wounded. The women of the city came eagerly also to our assistance, and in a *coup d'œil* had made 180 straw mattresses, provided blankets, hot water bottles, and other adjuncts to sick rooms. I reported all this to Surgeon-General Porter, and that able officer quickly grasped the possibilities of this hospital. He decided that all the very seriously wounded should be sent here, and also those cases requiring immediate major surgical operations. A real clearing hospital now arrived in this town and took over a large college for a hospital. Up to this time, be it noted, one section of a field ambulance with its personnel and equipment, and assisted by five or six medical men detailed by Surgeon-General Porter, had carried out all the duties of a clearing hospital. This is a proof, if any were needed, of the wonderful elasticity and adaptability of the medical service at the front.

The heavy list of casualties was not expected, but at once efficient means were arranged to meet it. All the wounded were housed in a comfortable building with clean straw. All were dressed, all were fed, many were operated upon. This first building was not found sufficient, so another building, the French hospital, was requisitioned, and then the clearing hospital proper with its equipment arrived. Difficulties had only to be recognized to be at once overcome. All three buildings were quickly filled, and between 6,000 and 7,000 wounded and sick were passed through these three clearing hospitals in three weeks.

Sir Anthony Bowlby constantly visited the hospital and saw the patients. I am indebted to him for much valuable advice and help, and also for his cheery encouragement at all times. To this hospital very many cases of the formidable gas gangrene were sent. Having the modern operating rooms, trained nurses, and all necessary surgical equipment, one was enabled to treat and observe the cases in excellent surroundings. The military situation had constantly to be borne in mind, and all the cases were evacuated as quickly as was consistent with safety. One would have liked to have kept many of the men much longer, but the fighting front must be kept as clear of wounded as possible. At this hospital many of the operations were performed under conduction anaesthesia and infiltration anaesthesia. In all the work one was loyally helped by the Reverend Mother and the nursing Sisters, also by the Abbé Bouchondhomme, a French priest, the *aumônier* to the hospital. This splendid priest spoke English and German as well as his own native tongue, and was of great assistance not only to our British wounded but also to the wounded German prisoners in the wards. I am glad to know that the work of the Reverend Mother and the Sisters has been brought to the notice of Her Majesty Queen Alexandra and of the President of the French Republic.

The wounded on arrival were speedily placed on the straw mattresses, quickly undressed by the Sisters, and covered with warm sheets and blankets and surrounded with hot bottles. Basins of hot water and soap were brought round and the wounded were washed and cleaned. Their lice-infected shirts and drawers were sterilized by dry heat. It was the finest example of *l'entente cordiale* to see the French nuns taking off the muddy boots and putties, cutting off blood-stained clothing, washing and cleaning the wounded, slipping on warm, dry shirts, and tucking the blankets and pillows comfortably. Others appeared with hot soup, hot coffee, red wine, and hot gruel. We occupied this hospital for some weeks. One day a German aeroplane dropped a bomb into our courtyard, and another day one on to a house near the gate of the hospital, and several into the central square in the town. One night a "Black Maria" burst between the hospital and the big church in the town, and it was then considered advisable to evacuate all our wounded and establish a clearing hospital further back. This was done, and shortly afterwards the town was freely bombarded by the German artillery beyond X——.

Gas Gangrene.

Gas gangrene was a formidable complication with many of the wounded admitted at this time. If the case reached us soon after the onset of gangrene a cure could almost certainly be promised from the gangrene. If the case arrived late, when the limbs were dead, amputation was the only "conservative treatment" that one could adopt. Many of the cases sent to me were beyond any hope of recovery and soon died. On one day I saw in one clearing hospital in the town 4 cases dying from gas gangrene, in the other clearing hospital 2 cases *in articulo mortis* from the same trouble, and in my own one other case. Seven cases dying in one day from gas gangrene! None of these had been operated upon. This will give some idea of the formidable character of this complication.

In these notes it must be remembered that none but the very serious cases were sent to me. Many cases of gas gangrene were evacuated early and sent to the base hospitals. Most of my cases came from one or other of the clearing hospitals in this town. Some arrived direct from the field ambulances. In every amputation for gas gangrene performed at this hospital the limb was absolutely dead and beyond the possibility of any treatment short of amputation. All the patients were in an extremely grave state. Their general condition was in every case very bad. I cannot picture any worse surgical subject than these men with gas gangrene. Numbers of them were in too low a state to admit of a general anaesthetic, and here the necessary operations were performed under conduction anaesthesia.

Dr. F——, an eminent French surgeon in charge of the French wounded in this town, saw many of my cases before, during, and after operation. I had the privilege also of seeing his gangrene cases at this time. He had amongst the French wounded the same experience as mine. Both of us had German wounded to treat, and here also we met dead limbs from gas gangrene. We were both of the opinion that the Germans at this place were also up against a very virulent "culture" here, that of the anaërobe. Some wounded French refugees were brought into this hospital at this period and some of these had gas gangrene. The serious character of gas gangrene at this time could only be recognized at the front. The serious cases were retained here for operation. I am of the opinion that all cases of gangrene should be treated at the front at the nearest clearing hospital, and that no case should be sent to the base till the gangrene has disappeared, subject, of course, as always, to the military situation. All the wounded admitted to this town—French, British and German—came from the same area of the battle front.

In many of the cases of gas gangrene bones were badly shattered and pulverized, splinters of bone were lying in surrounding muscles, or had been driven out through the skin. Important nerves were injured, torn, or compressed in many of them. Important blood vessels were frequently, but not invariably, injured. In some, big vessels had been torn through, in others arteries and nerves were compressed by displaced fragments of bone. The wounds were dirty in most cases. The skin was black and lacerated, and muscles were extruded and covered with coagulated blood clots. Wound full of blood clots, and containing at times pieces of khaki cloth, shrapnel fragments, nickel casing of bullets, gravel, and, in two cases, bits of rock. There were, however, cases in which the bullet had drilled an apparently clean hole through a joint, like the wrist or ankle, without much apparent destruction to bone. In such cases one would not expect gas gangrene; yet it sometimes occurred. One eminent surgeon stated that he had not seen gas gangrene anywhere save in the extremities. This observation was not confirmed either by myself or by Dr. F——. I had amongst my patients two cases of gangrene of the thoracic wall. In one there was a bad

shrapnel wound of the axilla. One rib was badly shattered, and the muscles of the side of the chest extensively torn; gas gangrene was present over the shoulder, and extended across the thorax as far as the sternum, and well over the clavicle. In the second case a rib was grazed by shrapnel, and the superjacent tissues badly torn. Gas gangrene had spread up and down from this wound. In another case a wound (shrapnel) above the crest of the ilium exposing the bone was admitted with gangrene of the abdominal wall and back. A shell wound exposing and injuring the mastoid process was followed by gangrene of the scalp and side of neck.

Gas gangrene is encouraged by tight bandaging and many of the cases had a bandage applied all too firmly. When a man is wounded in a trench his mate frequently applies the first aid dressing, and fixes it like a tourniquet. This could perhaps be obviated by making the bandage of the first field dressing a little wider than at present. A narrow bandage tends to become cord like.

All the cases of gas gangrene had a very penetrating putrefactive smell, which is quite characteristic. The area of advancing gangrene is preceded by an oedematous zone which fades in one direction to the area of healthy skin and in the direction towards the wound to a dullish injected area which crackles on palpation. Nearer the wound the skin is purplish and dark. Around the edges of the usually jagged wound the tissues were black or greenish-black. Extravasated blood undermined the skin all round the wound. The wound itself was full of blood clots. The limb distal to the wound was swollen, greenish-black, covered with green blebs, cold, anaesthetic, and pulseless in the "dead" limbs. Frequently toes and fingers were quite black. In other serious cases there might be a little warmth, or a slight pulse. If any case showed either of these two favourable signs, an attempt was made to save the limb, and was in many cases successful. The gangrene did not spread up a limb in an even circle. For example, it might reach anteriorly to the lower third of the thigh, and posteriorly be at or well above the fold of the buttock. This was due to the extravasated blood lying more towards the dependent parts and to hypostasis. In the upper arm the gangrene travelled rapidly up the inner side along the course of the big blood vessels. The invasion spread upwards; very little crepitation was felt below the site of the wound. The circulation below seemed to be rapidly cut off, and that portion of the limb underwent the changes associated with a complete circulatory block. The emphysema travelled always towards the healthy living tissues. Wounds of the thigh with shattering of the femur, wounds of the elbow-joint and of the metatarsus were very prone to develop this gangrene. Some of the cases were admitted within thirty-six hours after receipt of the wound, with well-marked gangrene.

The flaps in all the amputations performed were not closely coapted. Two or three stitches were employed to hold them loosely together. Drainage had to be free and easy, for many of the flaps were made from tissues already crepitating but not gangrenous. In two of my cases the flaps sloughed. This was due to conservatism in attempting to preserve as much as possible of an upper arm in one case and of a forearm in another, and to employing devitalized flaps. Every attempt was made to secure strict antiseptic treatment. Gloves were changed after the amputation had been performed and before the stump had been treated. Hot antiseptic lotions, principally carbolic lotion (1 to 60), were applied to all exposed surfaces. Iodine catgut was employed for ligating the vessels. In spite of all precautions many of the wounds became septic, and this could only be expected of tissues so gravely involved, and with men who were so obviously ill. Every case before operation was given antitetanic serum. As a matter of fact, every wounded man at these hospitals, no matter how slight his wound, was inoculated with antitetanic serum. All the drained amputation wounds were dressed at the end of twelve to eighteen hours with carbolic dressings (1 to 60), and cotton-wool was freely employed to cover the whole area of the wound and the regions well beyond.

All of the cases were treated with hydrogen peroxide injections. I could not obtain any hydrogen peroxide from British sources during the first week at this place, but obtained a supply from French sources. How I obtained it I will not proclaim from the housetops. At this time hydrogen peroxide was worth untold gold. Hydrogen peroxide is acid in reaction, and it was made neutral or slightly alkaline by adding some sodium bicarbonate. It was tested with litmus paper before being used. Some of the peroxide we had was in the form of "perhydrol," and this being twice the strength of the usual *B.P.* strength, was diluted. I had at this time no information about the correct method of employing the peroxide or the dosage to use in injecting. The method I employed was as follows: The needle of the large syringe—already full of the peroxide—was inserted about two fingerbreadths above the line already indicated. Multiple punctures were made to surround the limb or affected area with this zone of hydrogen peroxide. Next, the needle was inserted through the crepitating area and into the subjacent muscles and fascia. Next, the long infiltrating needle (for infiltration anaesthesia), with a blunt point, was passed in till it met the bone. By manipulating this needle one could inject all the tissues surrounding the periosteum. I am of opinion that this is necessary, for from the observation made on many cases of amputation, a greenish mucoid lymph was observed about the bony attachments of the muscles. I did not know whether this was of an infective nature or not, so treated it as if it were. A dissection of the bone at the upper part of a removed limb showed this zone surrounding the periosteum in every instance. This course was carried out in all the "saved" limbs at this hospital.

The wounds in every case received very careful attention. All blood clots were carefully swabbed away. All splinters of bone were removed where possible. In many cases splinters with high attachments had to be left alone for fear of lacerating healthy tissues and opening new parts for infection. Some of the cases sent down would therefore require future operations for the repair of the broken bone. The aim was to cleanse the wound, establish a free drainage, and stop the spreading gangrene. The after-treatment of these cases was for a base hospital, and not for a clearing hospital so near the front. The edges of the wound were as a rule torn and fragmented, and were carefully cleansed or rawed. Free drainage was most important, and this was effected with rubber-tubing drains. The majority of the wounds were cleansed first with hot carbolic lotion 1 in 40, then dried with gauze, then packed with gauze wrung out in potassium permanganate lotion. Stitches were rarely used. Most of the wounds were sent down "gaping." In some cases strapping was employed to keep the gauze and tubing in position during the transportation to the base.

As far as possible one endeavoured to treat the wound gently and to avoid traumatizing the tissues and encouraging shock. The after-treatment of these patients was very important. Every means had to be taken to prevent and to combat shock. Salines were given by the rectum. Saline was infused into the axillae and abdominal wall. The onset of pain and restlessness was treated with morphine. Heat was applied in the form of hot water bags to the back of the neck, the top of the head, to the epigastrium, and to the limbs. Fall in blood pressure was treated by pituitary extract and caffeine injections, and by position—elevating foot of bed, etc. Conduction anaesthesia is mentioned again in this connexion to emphasize its value as opposed to general anasthesia. These cases of gas gangrene were all bad surgical subjects, for in addition to the gangrene, loss of blood, privation, and exposure subsequent to being wounded, their wounds were dangerous and mutilating, and the transportation to the hospital was, sometimes, necessarily an agonizing ordeal. This will show that our clearing hospitals at the front should be well and thoroughly equipped with all modern appliances for the treatment of shock and a staff fully alive to this clamant necessity. A clearing hospital cannot to-day remain as an administrative unit only.

CASE I.

Private B., sent from clearing hospital for amputation of arm. Humerus badly smashed at lower third, large gaping shell wound, full of foul blood clots and exuding sanguineous serum, forearm and elbow-joint black and gangrenous and quite dead. Crepitation present to middle of deltoid and into axilla, extended higher up axillary side than outer side. Amputated about level of deltoid, flaps cut through crepitating tissues, which were sodden and very slightly vascular. Flaps loosely approximated with three silk gut stitches. Injected hydrogen peroxide beyond infected area and alongside shaft of bone and into

muscles. Watched case for seven days, then evacuated, gangrene cleared, flaps healthy, wound suppurating; shock present after operation.

Examination of the removed limb showed that the brachial artery and veins were crushed above elbow-joint.

CASE II.

Private M. (Wilts). Shattered elbow-joint by shrapnel; wound received seventy-two hours previous to admission. Crepitating to upper third of upper arm. Hand and forearm completely gangrened. Wound very foul. Amputated at lower third of upper arm. After-history to eighth day uneventful, was then evacuated. (Hydrogen peroxide carried out in this and all the cited cases of gangrene.)

In the arm removed the vessels and nerves at the elbow-joint were badly crushed. General condition of this patient very bad on arrival. Bad pulse, cold, restless. In spite of general bad state was operated on one hour after arrival.

CASE III.

Captain X. (Devons). Shrapnel wound left elbow-joint. Gas gangrene well up the upper arm and well down the forearm. Crepitation over deltoid and into the axilla, also extending across chest and round to the back. Opened the wound up freely and removed splintered bones from lower end of humerus and upper part of radius and ulna. Cleaned out all clots, drained through and through with rubber tube. Peroxide freely injected above and below wounded joint.

The circulation was present in the forearm, but was very feeble. He had lost sensation in hand and fingers, and could not move the parts voluntarily. He will probably get a good arm with a somewhat stiff joint. Owing to the escape of the important vessels, this limb was saved, in spite of the extensive area of gangrene. He was doing well twelve days after operation, but was septic.

CASE IV.

Private J. R. (Royal Fusiliers). Shrapnel wound, right lower jaw, three days before. Jaw smashed badly from angle of jaw to canines. Gas gangrene present over side of neck and over clavicle. Smell very bad. Drained freely. Injected hydrogen peroxide freely into various fascial planes of neck and submaxillary regions.

This case was doing fairly well when sent to the base six days afterwards. The crepitating gangrene had disappeared, but a deep incision had to be made on the fourth day into the tissue at the angle of the jaw for suppuration. He, of course, will require plastic surgery for repair of the jaw later on.

CASE V.

Private P. (Northumberland Fusiliers). Wounded forty-eight hours previously in right foot and ankle; metatarsus pulverized. Wound full of dirty and foul-smelling blood clots. Toes and forepart of foot quite dead. Gas gangrene to about mid-leg. Crackles felt over popliteal space. Amputated at upper one-third of leg. Injected hydrogen peroxide freely round popliteal space, and into posterior flap, and all round knee-joint.

Examination of the removed foot showed extensive destruction of vessels and nerves round the ankle-joint.

CASE VI.

Private I. (Royal Fusiliers). Left hand shattered by shrapnel three days before. Hand and fingers dead. Wound foul smelling. Gas gangrene present at wrist, and crepitations present to middle of forearm. Amputated through middle of forearm; the flaps looked very doubtful. Injected with peroxide about site of amputation.

CASE VII.

Private E. Bullet wound of right upper arm; entrance wound through deltoid posteriorly, exit middle of upper arm anteriorly. Humerus badly shattered; wound accidentally inflicted by a French bullet seventy-three hours before admission. The gangrene here had extended considerably; the whole axilla was crepitant, and crepitations were present on the whole of the right side of the chest wall, front and back, and well over the acromion process and clavicle into the cervical region. The man's condition was very grave. He was very cold, and was vomiting, had a very feeble pulse, and was wandering a little. An attempt was made to improve his general condition before operation by giving salines hypodermically and rectal injections of coffee, brandy, etc. The arm was removed at shoulder-joint, only flap possible was one from back. Deep incisions were made through the infected area over chest and neck, back, and hydrogen peroxide pumped in. His condition was very serious all night, but improved towards morning and rapidly during next day. Was able to take champagne and other stimulants. On dressing the wound, one flap was found to be quite dead; it had not been stitched at all, only bandaged over. This flap was then cut off, the part being quite insensitive. Great improvement from this till the seventh day. All signs of gangrene had disappeared. Wound, although quite uncovered by any flap, was looking clean and healthy. He developed septic pneumonia on the seventh day, and died on the tenth day.

This case was interesting but unfortunate. The patient made a magnificent rally from the serious operation performed, when he was being smothered with a rapidly spreading gangrene, which of itself would have killed him shortly. It also shows that in some circumstances one may be unable to get a flap to cover an exposed disarticulated joint. Had he not developed the pneumonia, he would have probably recovered from a very extensive and formidable gangrene. In this case deep incisions were made in the crepitating area, and the wound naturally provided also a very free drainage.

CASE VIII.

Private P. (Northumberland Fusiliers). Shell wound, foot and ankle, received forty-four hours previously. Gangrene to knee-joint; crepitations to middle of thigh; amputated at lower one-third of femur; loosely coapted flap. After-history good.

Ankle and foot absolutely smashed. All vessels destroyed. Wound very foul.

CASE IX.

Lieutenant X. Bad lacerated shrapnel or shell wound of left leg. Tibia fragmented at lower third. Fibula fractured, but not comminuted. Large entrance and exit wound. Sent from clearing hospital with note, "Gangrene foot and ankle, probable amputation." This officer was very excited and restless and very upset at the idea of losing his limb. His foot was swollen, livid, and cold. Crepitation was present to the popliteal space, but very little anteriorly. The wound was very foul and full of blood clots. Smell typical. Edges of wound livid. Faint circulation felt round ankle-joint. Wound cleaned, under anaesthetic, with carbolic lotion; peroxide injected in the usual way. Removed splinters of bone. Drained wound with tube and packed with gauze wrung out in potassium permanganate. Wound dressed twelve hours after operation with permanganate gauze. Foot looked livid still, but circulation was better. Sir Anthony Bowlby saw this case with me on this day, and we were both satisfied, but not over-confident, about the progress as regards the limb. Next day the wound was oozing blood fairly freely. The following day Sir Anthony saw the case again. The wound was then very inflamed, but the gangrene had completely disappeared. When the patient was evacuated the wound was suppurating freely and was still in a very bad condition, but one felt very hopeful that the limb would be preserved.

CASE X.

Captain T. Shrapnel wound forearm, received forty-one hours previously. Ulna pulverized from lower part of olecranon to lower end of bone. Radius intact. Wrist and elbow joints intact. Wound of forearm very ragged and torn, muscles extruding; full of blood clots, and commencing to smell. Crepitation present round upper part of wound, edges of wound black and scdden. Under anaesthetic, removed a large number of pieces of splintered bone lying embedded in the muscles. Injected hydrogen peroxide into the tissues round elbow-joint and forearm. Drained wound freely after cleansing well with carbolic lotion.

The gangrene disappeared completely, but the wound became profoundly septic.

CASE XI.

Major X. Bullet wound of left forearm, shattering radius and ulna. Entrance and exit wounds very large. Evidently wound at close range. Shot twenty-six hours previously. Characteristic gangrene smell and gas gangrene present at an early stage round the wound. Veins distended at wrist and hand, and fingers and hand much swollen. Here the wound was freely opened, drained and cleaned, and hydrogen peroxide injected into the tissues all round the wound. All sign of gangrene had vanished next day, but a plastic operation will be required later to unite the widely separated ends of the splintered radius and ulna.

CASE XII.

Lieutenant S., sent from clearing hospital for amputation at hip. Was shot through the right thigh four days previously. Bullet entered in front, about middle of thigh, and emerged posteriorly at gluteal fold, badly smashing the femur in its course. Entrance and exit wounds large; exit wound very jagged. Delirious, restless, pulse very poor; temperature subnormal. Gas gangrene present. Crepitations up to above the crest of ilium, and extending on to lumbar region. Smell almost overpowering. As there was some slight circulation present round the knee and ankle, an attempt was made to save the limb. Usual procedure adopted; free drainage, hydrogen peroxide, etc. The patient's general condition rapidly improved after the operation, and on the second day after the gangrene was disappearing, and there was a free pulsation in the limb. He was then evacuated. Although the gangrene was disappearing, it was still a question whether the limb would be saved, as the wound was an unusually severe one. He was evacuated so early owing to military reasons.

CASE XIII.

Private R. (N. Lancs.). Struck on crest of right ilium by a bullet at short range, two days previously. Large wound of entrance; no exit. Wound ragged and gaping, and full of splintered bone. Crepitations all over gluteal regions; oedema of thigh muscles; foul smell. Opened wound up freely, cleaned with carbolic and permanganate, and made two counter incisions in buttock for drainage. Removed bullet lying at upper part of sciatic notch. Injected hydrogen peroxide freely all round the infected area. Healing rapidly when sent down to base.

The following case illustrates the danger of overlooking tourniquets:

CASE XIV.

Private —— (Wilts). Admitted on October 25th, 1914, with complete gangrene of whole of right arm from shoulder to fingers. Bullet struck upper arm in front where axillary becomes brachial artery, tearing artery. Emerged through

posterior wall of axilla. A strap tourniquet was applied round the axilla and shoulder to stop the sudden haemorrhage, covered over with cotton-wool and arm bandaged to side. This was done at the front. The man was sent back to a field ambulance, where the tourniquet was unfortunately overlooked, and the upper arm and shoulder covered with more wool and bandaged. He was then sent to a clearing hospital and then transferred to me. It was then fifty-four hours after the tourniquet had been applied. The arm was dead, and the condition of the man was so bad that we thought he would die in a few hours. The tourniquet was removed, and the torn vessel was easily reached and ligated. Circulation had ceased, and on removing tourniquet no bleeding occurred. Eight hours afterwards the condition had slightly improved, but was still desperate, and under conduction anaesthesia the arm was disarticulated at the shoulder-joint. For several days following he lay at the point of death. Then he made an astonishing improvement, and, although very weak, was getting hourly stronger when he was evacuated.

This case was not one of gas gangrene, but was due to tearing of the axillary artery and a forgotten tourniquet. Sir Anthony Bowlby saw this case with me before amputation, and also saw him two days afterwards, and on both visits the man's outlook seemed hopeless. His recovery was due to the great attention and skill of the French nursing Sisters who nursed him constantly night and day.

These histories are illustrative of the series of cases of gas gangrene at this clearing hospital at this period. One man had secondary haemorrhage following an amputation below the knee. The flaps necrosed, and sloughing occurred in the deeper structures. The femoral artery was ligatured in a hurry under local anaesthesia, and later the limb was amputated above the knee-joint.

In every case of amputation performed there was nothing else to be done in order to save life. The limbs were dead. In many of these cases important blood vessels were torn, crushed, or compressed, and when the vessels were injured the gangrene developed more quickly and spread more rapidly. It is regrettable that one had to perform so many amputations at this time, but it is a matter for congratulation that so many lives were saved. One of the cases (not above recorded) died suddenly twelve hours after a disarticulation at the shoulder-joint. Another one (not above recorded) died three days after amputation at the hip-joint, from gangrene which progressed steadily on to the perineum and lower abdomen, even after free drainage, incisions and peroxide injections. There were in addition five deaths from gangrene following wounds of the extremities. These five were admitted in a dying condition, and passed away two to four hours after admission. One could do nothing for them surgically. Other cases died at the other clearing hospitals in the town. It was a sad and mournful experience seeing these fine young men die.

HEAD WOUNDS.

Scalp wounds were common, from a simple graze to an extensive tearing. As a rule, all these cases did very well.

Wounds involving injury to the bony wall of the brain were also very common. Compound depressed fractures with extradural haemorrhage responded well to treatment by trephining, elevation of fragmented bone, removal of spicules of bone sticking on to brain surface, controlling haemorrhage, and removing blood clots. More extensive wounds with laceration of brain substance, loss of brain tissue, or with fragments of bone deeply embedded in the brain, did very badly.

The head wounds in all these cases were carefully cleaned, fragments of bone removed, and free drainage provided, but the results were very bad. Hernia cerebri and septic meningitis rapidly developed and the symptoms speedily progressed. These brain cases were the most distressing of all. The men died slowly, were very restless, constantly screaming and shouting and struggling, throwing off their blankets and rolling off their mattresses. They required constant attendance for these things, and for retention of urine, etc. Eleven shell wounds of the head were admitted with laceration of brain substance and hernia cerebri; all died. One was admitted for middle meningeal haemorrhage, was operated on, and recovered. One was admitted for a shrapnel wound of vertex; the shrapnel made a gutter fracture over the longitudinal sinus and caused severe haemorrhage. This patient was trephined, and when evacuated was doing well. With one exception, all the operations on the skull were performed under local anaesthesia.

WOUNDS OF ABDOMEN.

Shell and shrapnel wounds of the abdomen frequently lacerated the abdominal wall to such a degree that bowel prolapsed from the wound. Two cases were admitted with large loops of small gut protruding from wounds of the abdominal wall. In one the protruding bowel was plastered with fine gravel stones. In another the loop of the bowel protruding was gangrenous. These cases were cleaned up as well as possible, the gut repaired and returned and the pelvis drained. All died.

In one large shell wound to the left of the umbilicus a mass of omentum protruded. This was cleaned and gently pushed back, and held to the peritoneal edge with two fine catgut sutures. The wound was drained. This man recovered.

CASE XV.

Corporal W., admitted with shell wound of right infracostal region. The liver was exposed in the gaping wound. Shock bad, haemorrhage severe. The wound was packed and an attempt made to rally him, but he died in four hours.

Examination after death showed extensive laceration and bruising of liver. Gall bladder torn and extravasation of bile present.

CASE XVI.

On the same day another man was admitted with a shell wound of same region as Case 15. Liver exposed and also the hepatic and transverse colon. Shock severe. Was operated on at once under infiltration anaesthesia. Omentum seen lying at one corner was carefully pulled up and used to pack off bowel. Drainage tube and gauze inserted under liver. Edges of wound cleaned and loose stitches put through and through the skin and muscles but not tied. Acute jaundice developed in two days but cleared up well. Wound remained clear throughout. Drain removed on fourth day and stitches pulled tight. Recovery normal.

The cases of perforating bullet wounds of abdomen did well. No surgery was attempted. Nothing was allowed by the mouth for three or four days. The question of pelvic drainage was always borne in mind in connexion with these visceral wounds.

Several shrapnel wounds of the colon were admitted. All died.

CASE XVII.

One man who had a faecal fistula from a wound of the ascending colon died in four days. Nothing was done surgically.

CASE XVIII.

Another was admitted two days after having been wounded with a faecal fistula to the left of the umbilicus, involving the descending colon. The area surrounding the wound was very foul and a rapidly spreading infiltration into the abdominal muscles was taking place. The leak through the bowel was a "diarrhoeic" leak — bubbling, frothing, scalding, and constantly welling out. The bowel wound was small, but the injury and laceration to the muscles and skin were extensive.

The bowel was washed out through a catheter with warm olive oil at first, then with boracic lotion, followed by bismuth lotion. He was given bismuth and opium by the mouth. The diarrhoea through the wound did not abate; the wound steadily got worse and the general condition of the patient was not good.

Left alone he would have died from the diarrhoea and from the septic wound. It was therefore decided to operate. Under open ether anaesthesia the abdomen was opened below the umbilicus, through the right rectus muscle sheath at the middle line. A lateral anastomosis was established between ileum and sigmoid colon. The operation was performed three days after entering hospital and the fifth day from receipt of wound. The area round the shrapnel wound was cleaned and drained, and the wound packed with gauze wrung out in potassium permanganate solution. For some hours after the operation the diarrhoea stopped. Then it recurred as violently as ever—this time through the rectum. The shrapnel wound still leaked and bubbled a little, but could be kept fairly dry. The day after operation the patient's condition was worse. The diarrhoea still continued through the rectum, and although the shrapnel wound could be kept almost dry from faeces, the condition of the tissues all round this wound was much worse. He died on the morning of the fourth day after operation.

CASE XIX.

The third case of faecal fistula was sent in by Sir Anthony Bowlby from a field ambulance. This young officer had been lying there for some days. He had had a shell wound of the right groin involving the caecum. The whole abdominal wall was dusky and threatening to slough all round the wound. He was admitted in a moribund state, and nothing was done but to give him morphine.

After death I made a careful examination of the abdomen. The wound had torn the caecum and ascending colon, but the bowel was closely adherent to the abdominal wall. There had been no leak into the peritoneal cavity. The pelvis was clean. The bowel had glued itself well round the injured area. The bowel was, however, badly bruised, and extensive extravasation of blood had occurred into its wall.

The mortality in cases of faecal fistula is very high. My opinion, formed from what I have seen of this class of wound, both in France and also during the Boer war in South Africa, is that all, or nearly all, of them should be operated upon (short-circuiting of bowel and lavage of bowel above and below the wound). The death-rate without surgical interference must be about 90 per cent. at least, and surgical interference might save many. There is always the "thousandth man" who will pull through if given a chance.

The opinion of German surgeons is interesting in connexion with the treatment of abdominal wounds. The words of Professor Payr, of the Saxon army, in the *Muenchener medizinische Wochenschrift*, and already quoted in the BRITISH MEDICAL JOURNAL, are full of interest. "The victims of these wounds (abdominal wounds) seldom receive proper treatment at an *early date* when operative interference would be most beneficial, and at a later date when all the resources of surgery were at the patient's disposal he was already on the high road to recovery or too ill to be benefited by an operation." The rough generalization—that perforating abdominal wounds above the umbilicus do well and should be left alone, and that those below the umbilicus are dangerous and may require operations—is apt, when oft repeated, to be absorbed as a fixed surgical guide. Nothing could be more harmful. It is perfectly true that wounds above the umbilicus do well as a rule and should not be operated upon. It is also very true that some die from peritonitis due to a leak of blood and bowel contents at the time of wound, subsequent collection of this infected material in the pelvis, and then pelvic abscess or spreading peritonitis.

First, the surgeon should be prepared early to drain the pelvis with a tube through a suprapubic opening. If in any doubt of sepsis at all it is inadvisable to wait for strong confirmatory symptoms and signs; a suprapubic drain should be immediately established.

Secondly, the free administration of morphine is open to question. Morphine given at the time of the injury to prevent shock by easing the pain is absolutely necessary. It is equally necessary to keep the patient free from pain for eight or twelve hours afterwards. Then morphine should be withheld in order that the surgeon can faithfully comprehend the patient's state.

Thirdly, these men should, from the time of admission, be treated in the Fowler position, in order to establish a pelvic drain.

Fourthly, they should be kept at the clearing hospital for ten days and then transferred to the base. Early transportation in the lying-down position is surgically improper.

Fifthly, it is seldom necessary in these cases to open the abdomen to search for the wound in the bowel. That can be left to the bowel itself and to the omentum. The pelvis is the point to approach and to drain. Vomiting or retching, hiccough, distension and rigidity of the lower abdomen at the end of thirty-six hours after receipt of the wound, and increasing pulse-rate, are indications to drain the pelvis. The temperature at this stage is no guide, but the pulse is all-important.

Wounds of Scrotum and Testicle.

Four such cases were admitted. In two the right testicle was removed at once, owing to severe laceration of cord and testis proper. In the third case an attempt was made to save the testis, but orchitis and severe suppuration ensued, and it was removed. In the fourth case the cord was torn through and the scrotum bruised. The testicle was left alone here, and the case was evacuated three days later. I do not know what the result was. Wounds of scrotum and testicle are not so common as one might expect. After the battle of the Marne two cases were treated at one ambulance, and at the Aisne three more by the same ambulance.

Gunshot Wounds of Hand.

Wounds of the left hand were extraordinarily common. Many were wounded between the index and middle fingers at the base of the fingers. Some had the tops of fingers blown off, and some the little and ring fingers badly injured. The same holds true of the Indian troops. On visiting a clearing hospital of the Meerut Division, I could not help being struck by the number of men with left hands in slings. All these injuries were very carefully examined, and the conclusion of various surgeons on this subject should be carefully collected at some future date.

Wounds of Orbit.

Wounds here were fairly common. One young Highlander was shot through the temple, the bullet entering at one temple and emerging through the other. He was totally blind, and had proptosis of both eyes.

In another case a bullet entered at the inner canthus of the right eye and emerged in front of the left ear. The left eye was destroyed; it was removed under local anaesthesia. The sight of the right eye remained intact.

Most of the wounds of the orbit were associated with bad tearing of the cheek and malar regions.

Dr. La Personne pointed out at a meeting of the French Academy of Medicine in Paris the frequency and gravity of ocular lesions, and particularly transverse wounds of the orbits, which were followed so frequently by total blindness. He indicated the principles which ought to guide the surgeon when he intervened surgically in these cases.

Wounds of Kidneys.

Only one case of wounded kidney was treated; it was sent by the officer commanding of school clearing hospital for severe haemorrhage.

Case xx.

A shell splinter had torn the lumbar muscles badly over the right kidney posteriorly. Muscles extruded; wound very foul; shock severe. Passing "pure blood" per urethram. During the first twenty-four hours this was very alarming. Infiltrated novocain all round kidney region; opened up wound; cleaned muscles, brought kidney well into muscles. Kidney was lacerated and bruised. Did a partial decapsulation, and stitched capsule by three catgut sutures to muscles. Drained freely with two rubber tubes and packed round with gauze. On third day the urine was only slightly bloodstained, and the condition was good. On the fourth day removed gauze but left tubes. These were removed on the sixth day, when I had to evacuate him owing to hospital being bombarded.

Wounds of Bladder.

Two cases of bladder wounds were received:

Case xxi.

The first man was wounded by a shrapnel bullet. Wound of entrance in hypogastrium; no exit wound. Admitted sixteen hours after injury. He had not passed urine during that time; he says that he thought he was shot three or four hours after he had urinated.

A catheter was passed at once, and about 2 oz. of blood and urine withdrawn. He was put under open ether anaesthesia, and an incision was made in middle of abdomen, to the left of the wound. Blood clot found lying on surface of bladder, which was deep down. Difficult to define source of bleeding at this time. The peritoneum was opened, and omentum was noticed to be well down on brim of pelvis. A considerable quantity of bloody urine was mopped up slowly and carefully. Palpated posterior surface of bladder, but was not sure where the leakage came through. On palpating found the shrapnel bullet. The bullet may have been dislodged from a temporary resting-place somewhere in the pelvis during the process of swabbing. Then made a lateral incision through left side. Passed down two rubber drains behind bladder, and packed omentum deeply down on to tubes. Closed peritoneal wound after first dragging up bladder into incision. Opened bladder; upper surface very bloody and bruised. Shrapnel had grazed upper surface and perforated it at the left side. Leak occurred through this. Shrapnel wound in bladder was not sutured. Stitched bladder to incision by four sutures after drawing it fairly firmly round a rubber drainage tube. Packed all round tube with gauze. Inserted one deep stitch of catgut through muscles and fascia and bladder at the upper part in order to completely close off peritoneum. Dressed shrapnel wound with hydrogen peroxide and gave a dose of antitetanic serum.

This anxious case surprised us by the uneventful after-history. As no sign of peritonitis occurred, and as the suprapubic drain tube in the bladder was acting well and not leaking, one of the tubes in the pelvis was removed in twenty-four hours, and the other alongside in forty-eight hours. The loose stitch left through the incision here was then tightened and the wound completely sealed. The case was evacuated on the twelfth day with a suprapubic fistula.

The case was seen by Surgeon-General Porter and by Sir Anthony Bowlby, and illustrates my previous contention that clearing hospitals should be equipped to meet any such cases. In this case the man owed his life to the excellent modern equipment of the French hospital. Some meed of praise is due also to the kindly omentum which came down to the pelvic brim, and also to the probable

aseptic state of the urine. The operation was performed about sixteen and a half hours from the time the man was hit.

CASE XXII.

The second bladder wound was that of a man shot through the right buttock transversely; also by a shrapnel ball. Admitted with extensive extravasation of blood and urine around the perineum and both buttocks. Opened up area of extravasation by multiple incisions. When incising over the left ischio-rectal fossa found the bullet, which practically dropped into one's hand. Owing to the man's state, which was very bad, no attempt was made to hunt for the wound of the bladder. The bladder was opened suprapubically and drained.

He was kept in hospital six days after operation; the perineum was then dry and doing well.

Perhaps this man should have been operated upon through the perineum by an external urethrotomy high up, but it was thought at the time that the suprapubic drain was the safest.

BAYONET WOUNDS.

Only one bayonet wound was admitted to this hospital. This seems very surprising, as bayonet attacks were reported to be occurring frequently and one would have expected serious wounds.

CASE XXIII.

Private F. (Royal Fusiliers). Brought in urgently by motor ambulance for treatment for severe haemorrhage from mouth and eye. The bayonet had entered at the inner canthus of the left eye and penetrated through the left maxillary antrum. He was bleeding freely from vessel round palatal and maxillary regions. Under ether the antrum was opened through the canine fossa, and the opening was rapidly enlarged. It was found full of blood clot. It was washed out and packed in gauze soaked in hydrogen peroxide. Packing had to be very firm in order to stop the smart bleeding.

The eyeball had escaped injury, evidently pushed aside by the bayonet.

WOUNDS OF THORAX.

A considerable number of officers and men were admitted with perforating wounds of the thorax. Wounds of the upper part of the chest invariably did well; wounds of the lower part were serious and often fatal.

A short history of one case will illustrate the others.

CASE XXIV.

Captain S., R.A.M.C., attached to the —— Regiment, was shot through both lungs by a bullet while gallantly attending to wounded men under a heavy fire. For this act he has been awarded the Military Cross. He was stooping forward at the time with both arms extended away from the body. The bullet struck him about the lower part of the right axilla and emerged about the posterior axillary line of the left side. He was admitted with severe shock and dyspnoea. He had frequent cough, which he tried to prevent owing to the pain it produced. When put to bed and heroin ¼ grain placed under the tongue he became easier and the shock gradually disappeared. The cough eased off and respiratory excursions became more marked; temperature normal, pulse rapid. There was marked dullness over the right lung base. The breath sounds were vesicular but distant. The patient said he felt so well that he wished to get up. In fact he did get up once or twice when the watchful French nursing sister was out of the ward.

At the end of the third day the temperature ran up to 103° F. Dyspnoea became marked, and pain in breathing so severe that a hypodermic of morphine was given; the pain was all over the right base. Briefly, the course of events was: pleurisy of right base, pneumonia over the course of bullet wound through right lung, expectoration of old blood clots, high temperature. The left lung, curiously enough, escaped, although there was dullness due to haemothorax of left base. The after-history was a slow recovery.

All the penetrating bullet wounds—those with entrance and exit wounds—behaved in a similar way. First, a period of dyspnoea, very little haemoptysis, with shock slight or severe. Then a period, usually lasting for two or three days, of comparative quiet, with slightly quickened breathing, no haemoptysis, occasional cough, no rise of temperature. Then a rise of temperature, frequent and painful cough, with expectoration of particles of old blood clot, and thick mucus, and signs of pneumonia round the track of the bullet, and generally pleurisy of base from the haemothorax. The above only refers to the course taken at the time of the wound and for some days afterwards. The after-history of these perforating wounds of the thorax often presents other features.

LOCAL ANAESTHESIA.

Local anaesthesia on active service is a subject that will bear some study. The circumstances in which this form of anaesthesia can be applied are many. The condition of the wounded, owing to shock, haemorrhage, exposure, and gangrene, is often so serious that any operation, however small, entails formidable risks. For the prevention of shock, local anaesthesia has proved to be invaluable. It can abolish pain and so remove a powerful factor producing shock. It enables one to operate on many patients when a general anaesthetic would be hazardous.

The principles of infiltration anaesthesia and of conduction anaesthesia are easily mastered. One need only have a sound knowledge of the anatomy of the nervous system. The surgeon must accustom himself to the needles and apparatus. Conduction and infiltration anaesthesia was carried out in a large number of cases in this hospital. The method was employed in all the trephine cases except one. It was used in amputations of fingers and in cleaning up wounds in the hands and fingers. It was employed in operations on the toes, feet, ankle, leg, fractured thighs, opening a frontal sinus, removing contents of orbits, removing testicles, in shell wounds of limbs.

I hope to record these cases in a special article at a later date. The syringes and needles are not supplied by the army. One must bring one's own outfit. It can be conveniently packed in a light metal box enclosed in a canvas bag with a handle. Barker's infiltration needles are necessary, and also two sets of needles and syringes for the conduction anaesthesia. My outfit included also adrenalin in solution, beta eucaine in powders, and tablets of novocain-suprarenin. These tablets are added to physiologic salt solution, and can be made up to various strengths, as 0.5 per cent., 1 per cent. or 2 per cent. The tablets contain novocain and suprarenal extract. The solution can be boiled after adding a few drops of dilute hydrochloric acid, and so rendered quite sterile.

ACIDOSIS AND THE NITROGEN PARTITION IN PREGNANCY.*

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To Dr. Whitridge Williams is due the institution of a scientific examination of the urine in pregnancy. Recently he has modified to some considerable extent his original view that an ammonia coefficient over 10 to 15 per cent. is an indication for the prompt termination of pregnancy. Most of those working at the subject were more or less prepared for this change, but perhaps not all are yet convinced that his present view is a clear and sound one. It will be of interest, then, and possibly of service, to review the later aspects of the question and to report some recent results in a series of cases.

It appears to me regrettable that investigation, even in toxic cases, in maternity hospitals is so often limited to a quantitative estimation of the albumin, of the urea, and occasionally of the ammonia, and to a qualitative examination for acetone bodies. These elementary tests, while no doubt of distinct service, cannot aspire to rival an investigation which gives with moderate accuracy the percentage of total nitrogen, the fractions of this existing as urea and as ammonia, and the actual amount of acetone-complex bodies present.

Further, when a fuller examination is undertaken, it is usually limited to abnormal cases. No clear comparison, therefore, is obtained between the normal and the abnormal. It will be apparent later in this paper that it is not legitimate to judge of the ammonia percentage in pregnancy, normal or abnormal, from the percentage found in the urine of a non-pregnant individual.

This paper records the results of an investigation of the urine in 80 cases of pregnancy, both normal and toxic, and has as its special endeavour the description of several tests for that purpose. These have the particular merit of being applicable by a relatively inexperienced worker in a clinical, as distinguished from a bio-chemical, laboratory.

Mathison's Method of Ammonia Estimation.

This test is performed as follows:

Shake for two minutes 25 c.cm. of urine with 15 grams (circe) of *neutral* potassium oxalate and 50 c.cm. distilled water. The

*A paper read in the Section of Obstetrics and Gynaecology at the annual meeting of the British Medical Association at Aberdeen.