"THE USE OF NORMAL HORSE SERUM INOCULATION IN THE TREATMENT OF SEPSIS."

BY E. EMRYS-ROBERTS, M.D.

In 1906 Paton [1] strongly advocated the use of anti-diphtheritic serum in septic conditions generally. Later he affirmed that normal horse serum was equally effective. He further claimed that normal horse serum was also valuable in the treatment of tuberculosis, arthritis deformans, broncho-pneumonia, dysmenorrhea, nephritis, cerebro-spinal meningitis, epilepsy, Graves' disease, traumatism, and other conditions, a list which drew forth caustic criticism from Bosanquet and Eyre [2].

In 1911 Horder [3], in the course of a discussion, said that normal horse serum was of service in most acute infections, and that he used it commonly in such states pending the result of bacteriological investigations, being convinced that it exercised at times a powerful stimulation to increased resistance in some infective processes. Curiously, he considered it probable that the non-specific action of N.H.S. in inhibiting the growth of bacteria, or in neutralizing their toxins in infective processes, was bound up in the metabolic disturbances set up about the ninth day of its administration. In the course of the same discussion Hort [4] stated that he was satisfied that N.H.S. inoculation was of value in cases of severe haemorrhage, in which a toxic basis might be held responsible. He also stated that the anti-toxic properties of N.H.S. were very noticeable, especially in inhibiting the toxic action of extracts of normal tissues which, when injected without the serum, were intensely toxic.

My first experience in the use of N.H.S. inoculation in the treatment of sepsis occurred in September, 1916, when I was asked by Captain John Fraser, M.C., R.A.M.C., to see a man suffering from extensive wounds, with gas gangrene infection and a possible septicemia, with a view to obtaining a blood culture. On my arrival, however, at the casualty clearing station the condition of the man was such that it was impossible to obtain the requisite amount of blood, so the syringe and media were left in order that a specimen of the heart’s blood might be obtained, there being every reason to suppose that death was merely a matter of a few hours. Before leaving I was asked if I could suggest any possible form of treatment. I proposed the inoculation of 50 cubic centimetres N.H.S. subcutaneously, which Captain Fraser consented to give. The following day, the specimen of blood not having arrived, I rang up to find that the man was still alive, so a dose of 100 cubic centimetres was suggested. This was followed up by 150 cubic centimetres the next day, and 200 cubic centimetres the day following, and it was satisfactory to learn that, in the course of a fortnight, the man was well enough to be sent down the line.
The next case—also one under the care of Captain Fraser—was in November, 1916, and I am indebted to Captain Fraser for the notes he kindly sent me. Pte. A. H. was admitted to the casualty clearing station with severe compound fracture of the right leg, involving the knee-joint and, at a lower level, both bones of the leg. There was an acutely-spreading gas-gangrene infection. Immediate operation was performed—an amputation in the mid-thigh area. Owing to the presence of infection the flaps could not be closed. A number of dry leather-like sloughs formed over the greater part of the area of the stump, and well beneath these sloughs there was considerable suppuration. On the third day after admission the temperature, which had remained high (103°F.) began to swing. On the sixth day, November 16, the patient’s general condition became much worse, the pulse greatly increased in rate, there was sickness, and at times he became almost comatose. The breathing curiously altered, and there were intervals of deep sighing respiration. On this day Captain Fraser asked me to see the patient, primarily to discuss the advisability of giving him antistreptococcal serum. I persuaded him to rely on N.H.S. alone, so he first gave 1 cubic centimetre intradermically as a desensitizing dose; and two hours later, in the absence of local reaction, followed it up by 25 cubic centimetres subcutaneously. On November 17, 50 cubic centimetres was given, on the 18th 100 cubic centimetres, on the 19th 150 cubic centimetres, on the 20th 50 cubic centimetres, and on the 21st a further 100 cubic centimetres. It was recognized that, within a few hours of the first massive injection, there was an improvement in the man’s condition; he became distinctly more conscious, and the pulse rate began to fall. From this point there was a steady improvement, both in the general and the local condition, the flaps rapidly cleaned up and the temperature and pulse became settled. The improvement was maintained, and the patient was evacuated on the 25th, nine days after the first inoculation.

The third case—again one of Captain Fraser’s—was that of Pte. R. admitted to the casualty clearing station with a severe wound of the right
shoulder, and almost complete division of the arm from the body. As the limb was already showing signs of gas-gangrene, amputation was performed at the shoulder-joint. The flaps, which were left open, were soon covered with brown leathery sloughs; the temperature became hectic in type. N.H.S. was given, exactly as in the previous case, with a single desensitizing dose and similarly succeeding massive injections. Subsequent improvement was marked and progressive.

These results, and others equally encouraging obtained by Captain E. M. Cowell, R.A.M.C., led me to believe that something more than mere coincidence lay behind the inoculation of N.H.S. in massive doses in the treatment of grave conditions arising from wound sepsis.

An opportunity presented itself when, in the autumn of 1918, I was stationed at Queen Mary's Military Hospital, Whalley, Lancs, to endeavour to establish the inference that any striking improvement in the condition of the patient might justly be attributed to the action of the serum. To this end, therefore, were chosen seriously wounded cases, with swinging temperatures, where every form of treatment had been tried without apparent success—cases which were considered to be at a standstill, or were actually going down hill. Neither septicemia nor secondary hemorrhage were held to be contra-indications, but cases presenting pocketing or sequestrum formation were excluded as far as possible, in order not to introduce disturbing factors.

The method of procedure evolved was as follows: If the man were, at the time, receiving spaced doses of A.T.S. there was no necessity to give a desensitizing dose, if not, this was always done, as before described. Fifty cubic centimetres N.H.S. was next inoculated, either subcutaneously or intramuscularly. The following day, if the man had passed a good night, 75 cubic centimetres or 100 cubic centimetres was given in the same way otherwise this second dose was delayed until the next day. Similarly the third dose, either 100 cubic centimetres or 150 cubic centimetres, at the discretion of the surgeon, was given the day following or the next day but one. Should the improvement in the patient's condition be sufficiently pronounced, there might not be any occasion for the inoculation of the third dose. On the other hand it might be necessary to give a fourth or a fifth dose, increasing each by 50 cubic centimetres as the surgeon might decide.

Every facility was offered and given, and it is with gratitude that I record the generous co-operation of the surgical staff, especially that of Captain J. A. Mackenzie, R.A.M.C., and Captain W. J. D. Bromley, R.A.M.C.

In cases uncomplicated by pocketing or sequestrum formation the results were consistently good, and, in the opinion of the surgeons concerned, who had had a very large experience in the treatment of chronic sepsis, were sufficiently traceable to the use of the serum to exclude the long arm of co-incidence. Time and again were noted the same stages of improve-
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ment, both in the local and the general condition—not only did the wound take on a healthy look, but the patient himself began to sleep well, eat well, and altogether feel a different being. In certain instances, after treatment with serum had been started, the occurrence of pocketing and abscess formation necessitated operative interference, but even in these cases there was ample evidence of the effect of the serum treatment. Later it was decided to estimate the value of the serum when used prophylactically, and a case was chosen (see Pte. H., accompanying reports) where a previous operation had been followed by severe "flaring up" of the wound, where even the application of a soak preparatory to a further operation was followed by oedema of the part. On the preceding day, therefore, 50 cubic centimetres N.H.S. was given, and the operation resulted well—there was no flaring up, and the temperature never rose above 98° F., or the pulse above 96. Fears for the patient from the possible development of serum sickness were found to be groundless, as, in the few cases in which it did develop, the improvement was such that the attack was easily weathered.

Acomb and myself, while engaged in 1913 in the study of the complement content of various sera, attempted to induce increased complement production, since it was thought that an artificial method of increasing complement production might serve a useful purpose in the treatment of infective processes.

Assuming complement production to result from leucocytic activity, the inoculum chosen was an extract of leucocytes (sheep's). It was found that the serum complement content rose, more or less regularly, up to the twentieth day, to a considerable height, thereafter falling steadily until it almost reached the original standard, when estimations were discontinued.

Our attention was next drawn to the favourable experimental and clinical results obtained in infective processes with inoculations of leucocytic extract by Hiss and Zinsser (1908-09-10) [5], Alexander, Nauss and Williams (1911) [6], Manwaring (1912) [7], and several other observers. Discussing the mode of action of leucocytic extracts, Hiss and Zinsser first considered that complement was supplied to the infected animal, but they were not able to prove the presence of complement in their extracts. They therefore concluded that the beneficial effects were due to the action of digestive substances, not usually liberated from the leucocytes, of the nature of poison-neutralizing or destroying substances, which acted on the endotoxins and thus relieved the leucocytes of the animal from the effects of the poison and protected the higher cells, so that their functions were not destroyed.

Manwaring held that, under certain conditions, the leucocytic endolysins might be given off into the surrounding medium in sufficient quantity to play an important extracellular rôle. Alexander, Nauss and Williams contended that the bactericidal power possessed by the endolysins was not sufficient to explain the results obtained. They showed also that, in the case of the inoculation of living leucocytes, the results were not due to phagocytosis. They noted that the inoculations were followed by polymorphonuclear leucocytosis.
Alexander (1913), in a written communication, informed me that he and Williams found that whenever there was a leucocytosis, the serum complement content showed a corresponding rise.

Nolf (1919) [8], in a paper on the intravenous injection of peptone in infectious diseases, illustrates the value of this form of therapy, not only in the treatment of typhoid fever, rheumatic fever, gonorrhreal rheumatism and coecal septicemias, but also in the treatment of wounds, both where septicemia has supervened, and also in those conditions where the sepsis is localized. He points out that the action of peptone is shared by a number of other inocula, such as non-specific sera (including N.H.S.), fresh serum from the patient himself, vaccines prepared from saprophytic organisms, distilled water and water to which has been added one or other antiseptic, such as chloramine, hypochlorite of soda, etc. Furthermore, he states that the reaction obtained by the subcutaneous or intramuscular method of inoculation is essentially the same as that obtained by the intravenous route, though attenuated in comparison. Here he refers especially to the shock which invariably accompanies the intravenous inoculation of every such substance, "in fact," as he says, "it is easier to produce shock than it is to avoid it." But he lays stress on the diminution of shock, so far as is possible, by the regulation of the dose, showing that the main object of the intravenous inoculation should be to produce the maximum therapeutic effect with the minimum amount of shock.

If he holds that the reaction is attenuated as regards the therapeutic effect obtained by the subcutaneous inoculation of, say, N.H.S., then one cannot agree with him, since the results obtained by this mode of procedure compare at least as favourably with those obtained by him following the intravenous inoculation of peptone, with the added advantage that no shock is produced.

Regarding the mode of action of peptone and, presumably, of other like inocula, he is, pending animal experiments which he proposes to undertake, unable to say more than to suggest that some action is exerted upon the leucocytes and plasma, whereby the defensive powers of the patient are stimulated. He also notes the same clinical phenomena following the intravenous injection of peptone as were described above as the result of the subcutaneous inoculation of N.H.S.; how that the patient feels better, becomes less excitable, and more inclined to sleep, the temperature is reduced, the prostration is lessened and disappears, and the appetite returns.

When one contemplates the results obtained by the exhibition of non-specific vaccines, one cannot help recalling the cruder, but probably identical, results obtained by the use of setons. It is easy to scoff at and hold in derision some of the ancient procedures adopted by our predecessors, but it should not be forgotten that in many cases they represent the survival of numerous trials and experiments, and that, underlying their use,
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are to be found fundamental considerations, which we should not neglect merely because the old have been superseded by more modern methods.

It was on the hypothesis that the beneficial effects, experimentally and clinically obtained by the inoculation of leucocytic extracts, were essentially due to the introduction of protein that I was led to propose the use of N.H.S. as being a convenient and easily administered form of protein. Had leucocytic extracts been available at the time, their employment would have been suggested. I had hoped to increase the complement content of the patient, being persuaded that the condition of affairs in severe wound sepsis was due less to the absence of antibodies than to the absence, or relative absence, of complement.

Whether we agree with Gurd (1912) [9], who postulates a complementogen in the circulating blood, supporting the contention of Gengou (1901) [10], and more recently of Wollman (1913) [11], that complement does not exist as such in the plasma, or with Addis (1912) [12], and many others, including Watanabe (1919) [13], who hold that complement is actually present, we must, I think, agree that an adequate supply of complement, or complementogen, is of value to the individual. As Bosanquet and Eyre point out, "susceptibility to disease may depend on lack of sufficient complement. Some individuals may naturally be ill-supplied and pre-existing disease may exhaust the supply." How far the relative paucity of complement in the sera of children is bound up in their relatively low-resisting powers to infective processes is worth consideration, though, at the same time, one has frequently met with adults whose serum complement content was relatively low, who appeared to be in excellent health, and who did not seem to enjoy any less degree of health on that account. However, after all, the essential point may be not so much the actual normal serum complement content, as the capacity for complement or complementogen production when occasion demands and, bound up in this, the favourable response to a stimulus to such production.

It is interesting to note that Woodhead (1918), in a verbal communication, informed me that the serum of guinea-pigs, which had received numerous inoculations of horse serum, extending over lengthy periods during the course of anti-serum standardization, had been found to possess a greatly increased complement content.

I therefore examined the sera of several of the cases at Whalley undergoing treatment with N.H.S., and although I expected, on a priori grounds, to find a steady increase in the complement content, I did not do so.

What I actually found was a relative stasis. True, the complement was raised in some instances, but the curve I had hoped to demonstrate was conspicuous by its absence. Incidentally, I was able to confirm the statement, in so far as the complement content in cases of hæmorrhage is

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1 See also Moro (1908) [14], who concludes that a capacity for the ready formation of complement is of prognostic value.
concerned, of Bosanquet and Eyre that "the formation of antibodies and complement is stimulated by the occurrence of haemorrhage and fever," a phenomenon possibly accounting for the undoubted value in many cases of the ancient practice of blood-letting. Ill-health at the time precluded me from making the detailed estimations I had mapped out — viz., daily estimations, in selected cases, of total reds, haemoglobin, colour index, total whites, differential count, complement content, clotting time of blood, the relative number and the types of organisms present, and the general clinical state. The results I obtained were rather in the nature of preliminary canners, but, at any rate, they were sufficiently numerous to induce me to come to the conclusion that if the complement or complementogen were increased, then the excess was as quickly used up, almost, as it was produced. If the improved condition of the patient be attributed to the increased production of complement or complementogen, then it is not difficult to assume that it is in reality utilized in the process, and for the present one is obliged to leave it at that.

Whatever, eventually, may, be accepted as the underlying factor, or factors, responsible for the encouraging results following N.H.S. inoculation, there can, I think, be little question as to the value of this form of treatment in grave sepsis, and possibly in other conditions as well.

Appended are a few case-sheets illustrating the action of subcutaneous inoculation of N.H.S., chiefly in cases of grave sepsis.

Pte. W.

September 1, 1918: Gunshot wound right elbow joint, severely lacerated and shattered; excised, fragments removed. Through and through wound of deltoid and acromion of right side; through and through wound face right side, malar bone smashed. 7th: Admitted Queen Mary’s Military Hospital, Whalley. Wounds lying open, all extremely septic; elbow wound covered with grey membranous slough. Temperature up. 16th: Continuous flavine treatment adopted. Temperature swinging. 29th: Temperature, 103° F., still swinging; no improvement in wounds. October 2: Thoroughly septic condition; much emaciation; loss of sleep
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and appetite; all wounds stationary; arm very swollen and oedematous; grey sloughs; "going down hill"; 50 cubic centimetres N.H.S. 3rd: 75 cubic centimetres N.H.S. 6th: 100 cubic centimetres N.H.S. 10th: Sloughs all disappeared; wounds granulating well; swelling going down. Great improvement in general condition; temperature normal; eating like a horse and sleeping well. 16th: Doing extremely well; arm looking well. 24th: Going very strong.

Pte. D., R.E.

September 10, 1918: Gunshot wound right leg with fracture of femur above the internal condyle, involving the joint; foreign body removed, wound drained; did well. October 1: Admitted Queen Mary's Military Hospital, Whalley. Condition pretty good; wound discharging. 6th: Wound started to discharge profusely, x-ray showed no bone necrosis, tube put in; temperature started to swing and continued swinging till the 14th when the temperature came down, but a profuse discharge persisted. 15th: Temperature again began to rise, temperature 101.2° F; anorexia. 16th: Temperature 102° F.; feeling very rotten. 17th: Temperature 101.8° F. 18th: 50 cubic centimetres N.H.S. 19th: Temperature down, returning to normal. 20th: 75 cubic centimetres N.H.S.; much less discharge, feeling much better; has a huge appetite. Progress maintained.

Pte. F.

September 28, 1918: Gunshot wound right upper arm, with compound fracture of humerus, a through and through wound; excision and removal of bone fragments at Casualty Clearing Station. October 10: Wounds dirty and septic. 12th: Admitted Queen Mary's Military Hospital, Whalley; wounds very septic; condition low and toxic, temperature 102° F.; condition continued with swinging temperature. 29th: 50 cubic centimetres N.H.S. 31st: Wound cleaning; appearance of red granulations; eats and sleeps well. November 1: 100 cubic centimetres N.H.S.; increasing red granulations; general condition good. 3rd: 100 cubic
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centimetres N.H.S.; healthy granulations. 5th: Continued improvement, especially marked in general condition; eats and sleeps extremely well. 7th: Going strong; uninterrupted recovery.

Pte. D., W.R.

October 12, 1918: Gunshot wound left arm, head of radius and ulna badly shattered, joint opened, excised and bipped. 23rd: Admitted Queen Mary's Military Hospital, Whalley; condition poor; wound very septic and oedematous. 25th: Temperature 102°8'; much pain; wound sloughy and oedematous. 27th: Tube inserted; temperature swinging. 28th: Temperature, 103° F. 29th: Temperature, 101° F.  November 1: Temperature, 103°6 F.; wound discharging foul pus. 2nd: Second tube inserted; condition getting much worse; temperature, 103° F.; pulse 100-120. 4th: Diarrhoea. 5th: 50 cubic centimetres N.H.S. 6th: Feeling better; temperature, 101°6 F.; pulse 96. 7th: 75 cubic centimetres N.H.S.; temperature, morning, 100° F., pulse 96; evening, 101° F., pulse 100. Much better; wounds very clean; pink granulations; sloughs all gone; little discharge. 9th: 100 cubic centimetres N.H.S.; going very strong. 11th: Feels himself again; wound quickly closing up; minute red granulations; temperature normal. 12th: "Cannot get enough to eat"; feeling very fit.

Pte. W., N.H.

October 23, 1918: Gunshot wounds severe both legs; badly spattered with shell fragments; no injury to bones, vessels or nerves; many small foreign bodies removed. November 4: Admitted Whalley; very septic condition; all wounds sloughing; colour of face yellow and unhealthy; swinging temperature. 17th: 50 cubic centimetres N.H.S. 19th: 75 cubic centimetres N.H.S. 21st: 100 cubic centimetres N.H.S. Rapid
improvement; wounds granulating well; appetite good; sleeps well; 
colour returning to face; feels very well; uninterrupted recovery.

Pte. G.

October 20, 1918: Gunshot wound right hip and groin; severe, ex-
tensive and communicating, involving gluteal vessels; also right wrist and 
left arm. 26th: Admitted Queen Mary's Military Hospital, Whalley; all 
wounds septic. 31st: Severe secondary haemorrhage from gluteal vessels; 
wound laid open and vessels ligatured. November 1: Wounds septic; 
tissue very friable. 4th: Further severe secondary haemorrhage; wound 
re-opened; tissue extremely friable; general oozing; no vessels tied; 
packed; skin blanched, lemon yellow tint; 50 cubic centimetres N.H.S., 
beneath fascia lata of thigh. 5th: More comfortable. 6th: Fair night; 
feels better this morning; eating well. 7th: 75 cubic centimetres N.H.S.; 
temperature down. 8th: Condition rapidly improving. 11th: Going on 
steadily; wounds cleaning up nicely; feeling very well; eating and 
sleeping well. 14th: Getting on by leaps and bounds; colour good; eyes 
bright; sleeps well; eats like a horse. 21st: Going strong.

Pte. B., R.E.K.

October 7, 1918: Gunshot wound right leg and left upper arm; lay out. 
Captured by Germans. 9th: Recaptured by British. Right leg amputated 
upper third of thigh for gas gangrene; wound of upper arm excised and 
F. B. removed. 14th: Secondary haemorrhage of femoral artery; 
900 cubic centimetres blood transfused. November 4: Admitted Queen 
Mary's Military Hospital, Whalley; condition extremely poor; emaciated; 
skin a dull yellow tinge; right thigh—flush amputation, the whole 
exposed, no attempt at granulations, surface smooth, light pink, no 
pocketing; no appetite; sleeps badly; mental state depressed. 8th: 
Slight delirium, with rigor. 9th: No change in condition, local or general; 
short streptococci recovered from blood; complement content 15; 50 cubic 
centimetres N.H.S. 11th: Commencing improvement in stump; wound 
looking a little healthier; 100 cubic centimetres N.H.S. 12th: Compl-
ment content 30. 13th: Slight general improvement, feeling a little 
better; complement content 20; 100 cubic centimetres N.H.S. 14th: 
Complement content 15. 15th: Granulations spreading; appetite im-
proving; sleeps fairly well; complement content 5; 125 cubic centimetres 
N.H.S. 16th: Complement content 5. 17th: Steady improvement; 
colour of face returning, but mental condition low, firmly believes his 
lungs are hopelessly diseased; complement content 20; 150 cubic centi-
metres N.H.S. 18th: Wound closing up, granulating round the edges. 
19th: Complement content 5; 150 cubic centimetres N.H.S. 20th: Com-
plement content 20. 22nd: Much better; wound going strong; eating 
and sleeping well. 24th: Still improving; putting on weight. 26th: 
A great deal better; colour much improved, face filling out; enjoys his
food; strong healthy granulations on stump. Convalescence was delayed by an infection of the seat of inoculation in the outer side of the left thigh.

Pte. McA.

September 27, 1918: Gunshot wound right lumbar region; bullet removed inner side of right thigh; wound not touched; gunshot wound thorough and through left forearm, with fracture of radius; track cleaned and loose bone removed. October 3: Admitted Queen Mary's Military Hospital, Whalley; had been bleeding for two to three days from arm wound; very ill; condition low; much blanched; no appetite. 6th: Still oozing blood, very blanched. 12th: Very ill and drowsy; wounds dressed only. 14th: Complement content 80. 15th: 50 cubic centimetres N.H.S. 16th: Very comfortable; slept well. 17th: Feeling better; appetite improved; sleeps well. 18th: Much better; temperature steadily down; eating well. 19th: Condition splendid; uninterrupted recovery; complement content on October 25, 5; on October 26, 10.

Pte. J.

September 19, 1918: Gunshot wound upper third right calf with fracture of fibula. 28th: Admitted Queen Mary's Military Hospital, Whalley; wound septic. October 3: Secondary hemorrhage of posterior tibial artery. 10th: Temperature, 103.6°F. 11th: Operation wound opened and packed with bipp for further secondary hemorrhage; 50 cubic centimetres N.H.S. 12th: Condition low; much blanching and emaciation; appetite poor; sleeps badly; 50 cubic centimetres N.H.S. 13th: 60 cubic centimetres N.H.S. 14th: Very restless; no sleep; much pain in wound; no appetite; temperature, 103.8°F. 17th: Packing removed; condition of wound good. 18th: General condition improved; more comfortable, sleep and appetite better. 19th: Going strong; complement content 40; uninterrupted recovery.

Pte. B. M.

October 23, 1918: Gunshot wound left humerus; compound fracture. Gunshot wound through and through left upper arm, and laceration of left forearm. 31st: Admitted Queen Mary's Military Hospital, Whalley; wounds very septic; much sinus and sequestrum formation; wounds discharging freely. November 4: General condition poor; emaciated; considerable suppuration; grey sloughs; no red granulations; sleep and appetite poor; 50 cubic centimetres N.H.S. 5th: A fair day; arm painful. 6th: Much pocketing; operation suggested; much opening up done; pus found tracking up; 50 cubic centimetres N.H.S. 7th: Looks ill; a fair night. 9th: 100 cubic centimetres N.H.S.; sleeps much better; appetite very good. 21st: Going strong; good colour; fatter; eats and sleeps well; uninterrupted recovery.
August 24, 1918: Gunshot wound, abdomen; shrapnel entered left flank between costal margin and anterior superior spine, producing laceration of anterior abdominal wall half way between umbilicus and pubis; some bruising of small gut. 25th: Laparotomy; foreign body removed; abdomen closed in layers; no drainage. September 5: Admitted Queen Mary’s Military Hospital, Whalley; condition fair; some general wasting; no abdominal distension; bowels acting well; wound in back almost healed; 12th: During the past week slight elevation of temperature; slight suppuration near abdominal cicatrix, some tenderness and tympanites; no pain, vomiting or tenderness during the day; after a turpentine enema night sister observed patient in discomfort, on removing bandages found protrusion of small intestine from abdominal wound, which had sprung open. 13th: 3 a.m., operation, partial obstruction of bowel by adhesion to left side of wound reduced; bowel irrigated and replaced; wound sutured and drained; general condition grave. 14th: Bowel contents started to flow from posterior wound. 15th: Discharge from abdominal wound changed two-hourly; natural movement of bowels. 18th: Abdominal wound septic; tube removed, wound now gaping, bowel plainly seen; extreme general wasting; condition precarious. October 18: Small piece of gauze found projecting from posterior wound and removed (apparently present since laparotomy of August 25). 24th: Abdominal wound starting to skin over, but extremely unhealthy looking. 28th: General condition very poor; excessive wasting; sleeplessness, loss of appetite, mental depression; 1 cubic centimetre N.H.S.; no local reaction, at end of two hours 50 cubic centimetres N.H.S. beneath fascia lata. 29th: Complement content 25. 30th: 50 cubic centimetres N.H.S.; feels brighter. November 1: 50 cubic centimetres N.H.S., more cheerful. 3rd: Sleeps well and soundly, no wild dreaming; headache gone; has good appetite; looking much better, eyes brighter. 4th: 50 cubic centimetres N.H.S.; taking more interest in life. 6th: 50 cubic centimetres N.H.S., looking heaps better, feels lively, wants to get up; eating ravenously. 7th: Complement content, 5. 9th: 50 cubic centimetres N.H.S., going very strong; 11th: Complement content, 5. 13th: improvement steadily continuing.

Serjt. F.

August 31, 1918: Gunshot wound through and through right chest wall; laceration of pectoral muscles; fracture upper edge of 5th rib in nipple line; muscles excised; wound bipped and sutured. September 3: Considerable cough, some emphysema. 4th: Admitted Queen Mary’s Military Hospital, Whalley, following forced evacuation; small wound above right nipple; sutured wound across lower border of pectorals; some dulness and diminished breath sounds right base, no adventitious sound; slight hæmoptysis. 9th: Temperature 102·2° F., respiration 32, pulse 100;
very troublesome cough; breathing distressed; rusty expectoration. 10th: Temperature 102° F.; very restless—morphia; condition remained stationary, with swinging temperature; very troublesome cough, with much expectoration; condition poor; most restless. October 9: 50 cubic centimetres N.H.S. 11th: 50 cubic centimetres N.H.S. 13th: Temperature normal and remained so. 19th: Cough now troublesome at night only. November 4: Expectoration decreasing in amount, less purulent; general condition remarkably improved. Sleeps and eats well and is looking heaps better, having lost cyanosis completely. 21st: Has been up and about for a week, is getting fat.

Pte. B.

September 26, 1915: Gunshot wound (gas shell, was wearing mask at time), abrasion right forearm; cleaned and drained; wound outer-side right thigh, excised and sutured; wound inner side right thigh, incised; foreign body not removed; through and through wound right leg, excised; posterior tibial vessels found divided—ligatured; comminuted oblique fracture of tibia, loose fragments removed; irrigated; Thomas' splint. 28th: Redressed at Casualty Clearing Station. 29th: Sent down by barge; temperature 100°F., to 100·2°F. October 1: Wound of right leg incised and opened; thigh excised and opened and wounds cleaned at General Hospital. 3rd: Admitted Queen Mary's Military Hospital, Whalley; all wounds dirty. 16th: Since admission temperature swinging from 97° to 100°F.; wounds septic. 18th: Temperature 103·8°F. 22nd: Temperature 103·8°. 28th: Wounds continue septic, in spite of constant treatment with flavine, complement content 15°; 50 cubic centimetres N.H.S. prophylactic to op. following morning; collapsed during night; condition grave. 29th: Right leg amputated; condition very low, pulseless; passed a fair day. 30th: Complement content 20—75 cubic centimetres N.H.S. 31st: Much better: eating and sleeping well, complement content 5. November 1: No further dose given as temperature steadily fell and wounds improved; complement content 5. 5th: Going strong. 3rd to 8th: Daily estimations of complement content, each 5.

Pte. H.

April 20, 1915: Gunshot wound left leg, simple wound; gas gangrene set in and leg was amputated. 29th: 15 cubic centimetres A and 20 cubic centimetres B. welchii serum given in France. June 2: Generalized sepsis with local areas of infection—right knee-joint, left buttock and right pectoral region. 4th: Admitted Queen Mary's Military Hospital, Whalley, forced evacuation—air-raids; condition very low; right knee stiff and swollen; right ankle swollen; large wounds in left perineal region, left loin and in each side of the chest; acute diarrhoea. Prognosis very grave. 18th: 20 cubic centimetres anti-streptococcic serum, swinging temperature to 103 F. 21st: Temperature normal for two days, then started swinging.
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28th: 20 cubic centimetres A.S.S., no result; tremendous pain and much swelling, with brawny hardness in right ankle, leg and hip. July 26th: Amputation of leg at thigh, hip not drained; temperature still kept up. August 13: Hip opened; extra-articular abscess drained. 14th: 40 cubic centimetres A.S.S. 15th: Temperature rose slightly then fell to normal. Condition improved daily until September 1, when a piece of dead bone was removed from left stump, the wound flared up very badly. Temperature started to swing and kept up for five days then settled down. Went on quite well till the 2nd, when it was decided to reamputate left leg. A preparatory soak was applied, this was followed by œdema of the stump. Temperature 100° F., pulse 124. Operation postponed. 13th: 50 cubic centimetres N.H.S. given prophylactically. 14th: Reamputation performed, a very good result—no flaring at all; temperature never rose above 98° F., pulse 96. Note also interesting result following inoculation of 40 cubic centimetres A.S.S. on August 14.

REFERENCES.