

THE TREATMENT OF WAR WOUNDS

BY

SERUM THERAPY.

By *Dr. Lydia M. Henry*

*Thesis presented for the degree
of M. D. in 1920*

For 13 months after qualifying, the writer acted as Medical Officer at the Royal Infirmary, Sheffield. In each department, it was remarkable what a vast amount of material there was for investigation and research, but the pressure of work during war time prevented any other than the ordinary routine of hospital life. Certain cases, however, remained in her mind, especially three cases of Septicaemia, where the original focus was undiagnosed and which in consequence did not re-act to treatment. Notes were kept of these cases, hoping that some solution to the problem should be arrived at in the near future. Enclosed see charts of:-

S. Case No. 1. aged 19, Admitted as Acute Arthritis.

T. Case No. 2. aged 3, Admitted as Acute Meningitis.

C. Case No. 3. aged 22, Admitted as Acute Rheumatism.

All three were cases of Septicaemia, each of which developed Pneumonia, Endocarditis, Panophthalmitis. (Page 43.)

Leaving the Royal Infirmary, Sheffield, in July 1917, she proceeded to France to work under Miss Ivens M.S. Médecin - Chef of a French Military Hospital, situated between Creil and Senlis - two of the biggest French evacuating centres. In this hospital of 400 beds, afterwards increased to 600, there were cases of every type, cases which were too urgent to be sent into the Interior, and according to pressure of beds, and the Military situation of the day, these were retained for periods varying from a few days to months, i.e. to convalescence and cure.

A month afterwards, a Casualty Clearing Station was built

by the French on the Aisne - in a triangle, bounded by the forest of Villers Cotterets, the main road to Soissons, and the main rail road to Compiègne; in which hospital active work continued until the retreat of May 30th 1918. Here cases were admitted immediately after wounding, before any first aid dressing had been applied; there was therefore ample opportunity of seeing wounds, at every stage, the writer acting as Medical Officer at each hospital alternately.

Owing to their positions, the hospitals were attached to different divisions of the Army; the base receiving the wounded from Mangin's Army, i.e. Foch's Reserves, and the other drawing the wounded from whichever Army was in that section of the line at the time.

Patients were of varied nationality, notwithstanding the fact that the hospital was a French one; there were Americans, Italians, Russians from the foreign legion, Senegalese, Arabs, Germans and an occasional Austrian; British and Canadians were admitted during a British Retreat. Mention is made of these, as it was interesting to note the different effects of national temperament on the individual recuperative powers; if one may say so, the French had become accustomed to being wounded and knew how to grin and bear it; on the other hand, the Americans were new at the game and took it badly. Arabs and Senegalese were like children and, once their confidence was gained, half the battle was won, and they got on well.

As far as possible this Thesis will be dealt with from a strictly medical standpoint; however, it must be forgiven, if occasionally surgical and bacteriological technique and detail creep in, such references being unavoidable. The writer's interest was stimulated by an Article, written by the Chief in Command of the hospital, which appeared in the Proceedings of the Royal Society of Medicine in 1917, dealing with Anaerobic Wound Infection. Full details were taken of a complete series of similar cases passing through the hospital, an open mind being kept on the question of Serumtherapy, which was as yet in its infancy.

In so far as this Treatise is concerned, its main object is to show that it is possible, with co-operation between the various branches of the medical profession, - namely the Physician, Surgeon and Bacteriologist - to combat successfully wound infections and septicaemias, by means of sera; and to suggest that the knowledge is applicable to Civil practice in the treatment of like infections.

At the Base, the patients were brought into a receiving ward, where a certain number of beds were allotted to each Medical Officer. Case sheets were attached to each patient, their temperature and pulse charted. Clothes were removed or speedily cut off, wounds were cleaned, and according to their clinical appearance a list was drawn up for the theatre, dealing with cases in their urgency. A smear from each wound was sent to the Bacteriological Laboratory for immediate examination. Those swabs containing Gram Positive Bacilli, suspicious of Anaerobic infection were immediately reported on. Each case in turn was quickly passed through the X Ray Room

for photograph and localization, and thereafter passed into the theatre. The question of X Rays will not be dealt with here, apart from stating, that it proved extremely useful from a diagnostic point of view in wound infections, the presence of a deep seated Gas abscess was often visible before the signs were of much evidence in the patient. Each Medical Officer took it in turn to work with the Radiologist whilst a convoy was passing through, so that an intimate knowledge might be gained of the appearance of Gas Gangrene infections under the screen.

In the receiving ward, Serum therapy treatment was begun in those cases:-

1. Where Gas Gangrene was evident in an influx of cases, and a patient had to wait his turn for the theatre.
2. Where cases were too far gone to stand immediate operation, and it was thought the serum would act as a dis-intoxicating agent, and so the better prepare the patient for operation. (Patients noticeably improved after an initial dose of serum and before any other treatment was given.)
3. Where there was a sufficient quantity of serum in the hospital to meet other demands. Then prophylactic doses were given. The result of this was so convincing that it was given as often as possible.

With regard to the clinical signs and symptoms of Gas Gangrene, a most noticeable feature was the fact that there was often no temperature on admission, the frequency of the pulse being of far greater diagnostic value; usually there was acceleration and irregularity which remained even after convalescence was established.

In cases where Gas Gangrene was advanced, the patient showed signs of collapse, with a small irregular pulse, and it was often difficult to tell if such a state were due to shock, haemorrhage, or to the existing intoxication. In the incipient stage, the mental state of the patient was striking, there being an absolute disregard or unconsciousness of the severity of his condition, often there was abnormal cheeriness. This reminds one of the mental state which obtains in a systemic intoxication occurring in cases of Pulmonary Tuberculosis, or advanced Tuberculosis of other regions. Both in Anaerobic Infections and in Tuberculosis, there exist localized and systemic infections, and the question naturally arises, may not tubercle be treated by the method to be discussed in this paper.?

The severity of wound infection varied with many conditions, e.g.:- the agent causing the wound, the type and situation of the wound, the atmospheric conditions prevailing at the time, the presence of complications which might lower the resistance of the patient, and the organism which produced the infection.

1. A shell wound was usually accompanied by more serious manifestations than a bullet wound. This was naturally accounted for by the fact that the irregular metal caused more damage to the protective surface and underlying tissues. Again, - a piece of shell usually carried in pieces of contaminated clothing, and even though the wound were a perforating one the cloth was usually left in the muscle, where it found itself in ideal ground for bacterial reproduction; minute infected pieces of such shell might easily be overlooked in the tissues by the Radiologist and the Surgeon, and its presence only suspected by a repeated positive bacteriological report. In the series of cases discussed in this paper - of infected wounds occurring amongst fractures of Tibia and Fibula in 1918, - 73% were due to shell and 27% to bullet. In 1915-1917, amongst the same type of wounds, 80% were caused by shell.

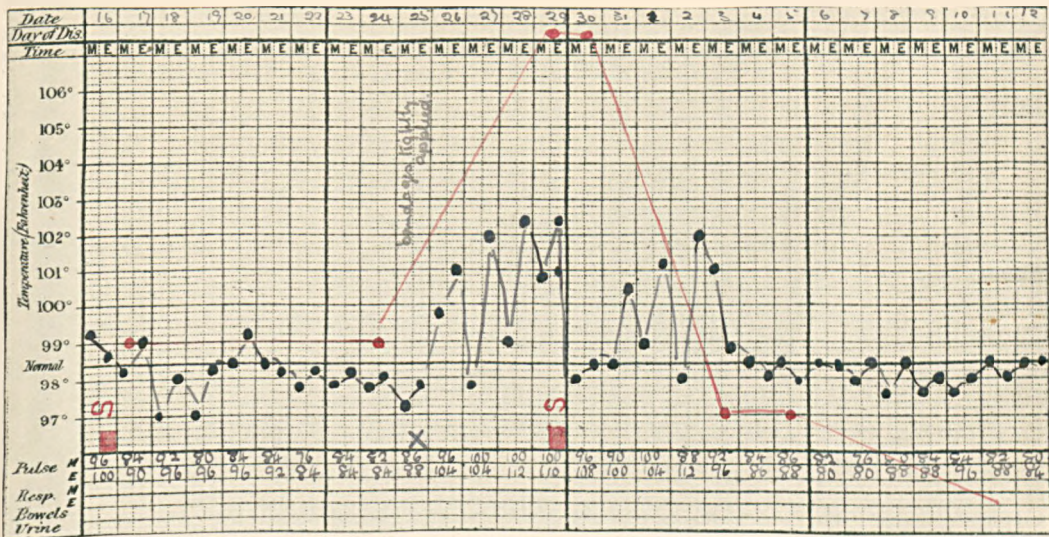
2. Penetrating wounds were more infected because of their imperfect drainage - 75% of the Anaerobic Infections of Tibia and Fibula were due to this. This may be accounted for by the fact that the presence of the bone checked the through passage of the agent.

3. It was a noticeable fact that wounds occurring in the thick fleshy parts of the body were of a more serious nature, as compared with others; the buttock, calf, biceps, furnished good ground for the growth of anaerobes, owing to their good vascular supply. Anaerobic infection was of rare occurrence in scalp wounds.

4. Atmospheric conditions played a very important part in wound infections, when the soil was wet and muddy there was more risk of contamination, transport was made more difficult, so causing delay in treatment.

Amongst Medical Orders issued by the French Army, regarding the official report of Gas Gangrene, special questions were directed to the condition of the soil at the time of wounding, and the period during which the patient remained on the ground before receiving first aid.

5. Haemorrhage, shock, cold and fatigue were all factors which either separately or conjointly brought about a lowering of the general resistance, and the resulting acidosis was difficult to attribute specially to any one of them, since the symptoms due to these were so closely associated. There were also cases where the growth of the organism was aided by artificial means, while the patient was en route for the hospital, e.g. a tourniquet, applied by a comrade on the field, often resulted in increasing the pressure, and in producing a local anaemic condition in the distal end of the limb. Bandages, under which the swollen muscles had no room to expand, constricted the circulation. An example of this was afforded in a case of the writer's, when Soldier P-- was transferred to the Evacuation ward ready for transport. A sister, new to war wounds, tightened the outer covering to make the limb look neater, when infection lit up again and in a few hours counter incisions and active treatment were necessary. A few cases of a similar



The above chart refers to the case mentioned and shows the acceleration of pulse, the rise of temperature, and the increase of micro-organisms per field of the microscope (in red)

nature resulted in a rule that no bandaging be applied to these infected limbs.

During the first half of the war, plaster was used to protect the limb in transport. In looking up cases entering the hospital 1915-17, five out of the twelve amputations of the lower limb with fractured Tibia and Fibula were Gas Gangrenes admitted in plaster. (Nos. 4. 5. 7. 10. 14. on Chart D.)

In all cases where swelling of the tissues followed injury - any outlet to the flow of serum was prevented and suitable conditions were thereby provided for the growth of anaerobic organisms.

The presence of blood clot - in which the organism could multiply - was an important factor in these wound infections; and in the writer's opinion the accumulation of such in the depth of a wound may have accounted for the latent infection which was so puzzling amongst the cases.

6. Lastly - infection depended on the causative organism and those most commonly met with were:-

Bacillus Perfringens or Bacillus Welchii
Bacillus Oedematiens
Vibrio Septique
Streptococcus

and of less frequent occurrence:-

Bacillus Histolyticus
Bacillus Sporogenes
Bacillus Tertius
Bacillus Aerofetidus
Bacillus Tetanus

Each type of organism chose different tissues - this was specially striking in cases of mixed Gas Gangrene and Streptococcal infection; the latter must be included with anaerobic infections because a type of streptococcus was frequently met with in anaerobic cultures.

In each theatre an équipe was formed, consisting of Surgeon, Assistant, Anaesthetist, with Sister and Orderly, and the cases were dealt with in different theatres according to their infection - as far as it was possible to diagnose at this early stage e.g. severe gas gangrenes in one; less severe cases in another; suspicious cases in the third.

By this means it was hoped that, where a large number of cases had to be dealt with at the rate of 50-100 in 24 hours, a suspicious case should not run any risks of being infected by following a definitely diagnosed gas gangrene. It may also be added here that as far as possible the same arrangements were carried out in the wards - less badly infected cases were not placed amongst known severe streptococcal and gas gangrene infections, from their first entry into the hospital. Naturally it was not always possible to tell by the clinical signs and first bacteriological report, exactly which organism was going to predominate, until the organisms were cultured and isolated.

In the theatre, - serum treatment was started as soon as the patient was under the anaesthetic. It was given intramuscularly or subcutan^eously - usually into both axilla and always accompanied by saline varying in amount from a half to 2 pints. The saline was quickly prepared and easily given, and if the effect was only temporary it tided over the period of shock, and enabled the patient to stand operation. Cardiac stimulants, e.g. camphorated oil, given hypodermically, was much used at this stage of the proceedings.

The agent was removed as quickly as possible by surgical means; the wounds being freely opened up and drainage established. All loose pieces of bone, diseased muscle and blood clot were removed - and in every case specimens were sent up for bacteriological examination and culture, e.g. foreign bodies, muscle, splinters of bone and exudations from the tissues. The hospital was fortunate in having a well equipped laboratory, where it was possible to examine stained films and cultures of cases in which one was interested, and to watch their pathogenicity in laboratory animals. It was also fortunate in having as consultant Professor Weinberg of the Pasteur Institute; much of the material for the research into the causation and treatment of those virulent infections being obtained at the above hospital; so that in addition to the hospital bacteriological reports there were frequently those of the Pasteur Institute, in suspicious cases.

Between attacks, permission was granted for the writer to attend inter allied conferences at the Ecole de Médecin, where discussions on this interesting subject were taking place. She was also permitted to attend the Pasteur Institute to see the method of preparation of the different sera. Professor Weinberg very kindly took her to several of the Paris Hospitals where Doctors Delbet, Broca, and Chutro and others were using the sera, with wonderfully convincing results.

During the first three years of the war, there was much difficulty in differentiating individual organisms from the flora of war wounds. This was due to the fact that bacilli were met with, which were new to the bacteriologists researching on this

subject. There was much discrepancy regarding pure cultures and similar organisms were given different names, this led to much confusion. Once the flora of wound infections ~~were~~^{was} placed on a workable basis the next step was the manufacture of specific antisera.

Four different varieties of sera were used:-

1. Anti Tetanic.
2. Anti Gas Gangrene.
3. Polyvalent Serum of M. Leclainche & Vallée.
4. Anti Streptococcal (Pasteur).

1. With regard to the first mentioned no further reference will be made as only one case of Tetanus appeared in the hospital during the last two years.

2. Anti Gas Gangrene Serum was prepared in a mixed form by M. Weinberg & Séguin of the Pasteur Institute and hereafter will be referred to as "Mélange Serum". It contained antisera for the three anaerobic organisms most commonly met with in war wounds namely:-

Anti Perfringens.)	
Anti Oedematiens.)	
Anti Vibrion Septique.))	in equal quantities.

3. The Polyvalent Serum of M. Leclainche & Vallée contained:-

Anti Streptococcal Serum.
Anti Perfringens Serum.
Anti Vibrion Septique Serum.

and was much used in those cases of mixed infection for its anti streptococcal properties.

4. The stock anti streptococcal serum was only used when the above polyvalent was not obtainable.

The Anti Gas Gangrene Serum was prepared in the following way:-

Pure cultures of the different organisms were isolated and grown for 48 hours in a meat broth known as "bouillon Martin "glucose". These were then filtered, pulped and candled and the resulting toxin tested for sterility; after which the toxic value on white mice was determined. A horse was then inoculated subcutaneously by repeated doses; his serum in three months time protecting a guinea-pig, inoculated intra muscularly with the original culture. The horse was then bled from the jugular vein into sterile bottles with double parchment caps and containing potassium oxalate. This was allowed to settle over night at room temperature. The plasma was syphoned off into sterile bottles and placed in a warm water bath for 10 minutes, calcium chloride being added to aid clotting. After vigorous shaking the serum was easily separated from the clot. This resulting anti serum was found to protect laboratory animals inoculated with small doses of the original culture, and so the titre was standardized. This serum therefore, which protected laboratory animals against Gas Gangrene, had still to prove its efficiency in human infections of a similar nature.

(Serum therapy treatment was undertaken as an adjuvant to surgical treatment - it was never intended to replace it.)

When given prophylactically it was hoped that the serum would prevent the onset of Gas Gangrene by immunising the patient. It was felt, that in cases to be evacuated into the Interior a few hours after operation, a prophylactic dose of Anti Gas Gangrene Serum, given before the journey, would in some way protect the patient - the effects of trauma on transport, as a causative factor, in the lighting up of any mild existing infection being noticeable.

If given when Anaerobic Infection already existed with the specific anaerobe as yet undiagnosed, it was hoped, that by a fairly large initial dose of this mixed Anti Gas Gangrene Serum, the toxin would be diluted and further growth and spread of the organisms be inhibited. Where any special organism was found to predominate, by pushing the specific anti sera, still more was it hoped to check the spread of infection.

By continuing the injections of the sera in after treatment, in varying amounts according to the bacteriological report, it was hoped that the acquired immunity of the patient should be retained.

(The Anti Gas Gangrene Serum did not profess to deal with Streptococcal Infections).

The object of the Polyvalent Serum of Leclainche & Vallée was to neutralize the toxins of the following organisms:-

Streptococcus.
B. Perfringens.
Vibrion Septique.

and on account of its anti streptococcal properties it was much used in dealing with streptococcal and mixed infections.

There was a local preparation of the serum, which was much used in this hospital. Many of the cases were treated by its direct application to the wound. The case of Soldier S--(page 58) with Streptococcal Infection of the knee joint offers a good example of the beneficial help of this local preparation. Full details are enclosed amongst the joint cases.

In prophylactic treatment, an initial dose was given as follows:-

1. 10cc - 30cc of the mixed Anti Gas Gangrene Serum.
- or 2. Anti Gas Gangrene Serum plus Leclainche & Vallée Serum.
- or 3. Leclainche & Vallée Serum only.

From a curative point of view, serum was given according to the existing infection, in amounts varying with the severity and the desired effect, e.g. in mixed Gas Gangrene, the mixed Anti Gas Gangrene Serum was used; in cases where one organism predominated its specific anti serum was pushed. As an example, suppose a case admitted to hospital shows signs of Gas Gangrene, it is immediately given 30cc of the mixed serum; 24 to 48 hours later if *Bacillus Oedematiens* predominates, then 30cc of Anti *Oedematiens* Serum is given, at repeated intervals until the Bacteriologist reports its absence. Again, supposing a patient is admitted, showing signs of a mixed infection, the fascial and muscular tissues being infiltrated, Anti Gas Gangrene Serum and Leclainche & Vallée Serum are immediately given. Later if the *Streptococcus* is in predominance Leclainche & Vallée Serum only is given, in repeated doses until the infection is controlled.

Serum was also given before secondary operations, as it was feared that the primary Gas Gangrene or Streptococcal Infection would re-occur. This was especially considered before operation for re-amputation. Instances of this may be seen in many of the cases here detailed, for example, Sergt.C. No. 3. Chart B, whose right leg was amputated above the knee for secondary haemorrhage. Although there was a generalized streptococcal infection, re-amputat
-ion and

suturing was performed a month afterwards - Leclainche & Vallée Serum being administered at the same time - primary union occurred, Again in the case of B. No. 24 Chart B, originally the infection was a mixed anaerobic and streptococcal one, with streptococcal infection of the blood. Anti Streptococcal Serum was repeated before re-amputation and the wound healed by first intention.

. In this paper full clinical details are given of :-

1. Cases of Septicaemia with recovery after serum treatment as compared with similar cases with fatal results receiving no such treatment.
2. A complete tabulated list of fractured Tibias and Fibulas with Anaerobic and Streptococcal Infection 1915-18 with results of serum therapy treatment.
3. A series of joint cases showing the results of subcutaneous and local serum treatment.

Anaerobic infections fall naturally into types according to the two cardinal symptoms produced, namely oedema and emphysema.

1. The pure emphysematous type, where the presence of gas is the predominating feature.

2. The oedematous type, where the presence of a spreading oedema is the prominent clinical sign.

3. Mixed forms, where oedema and emphysema are co-existent.

4. Localized infections, with abscess formation.

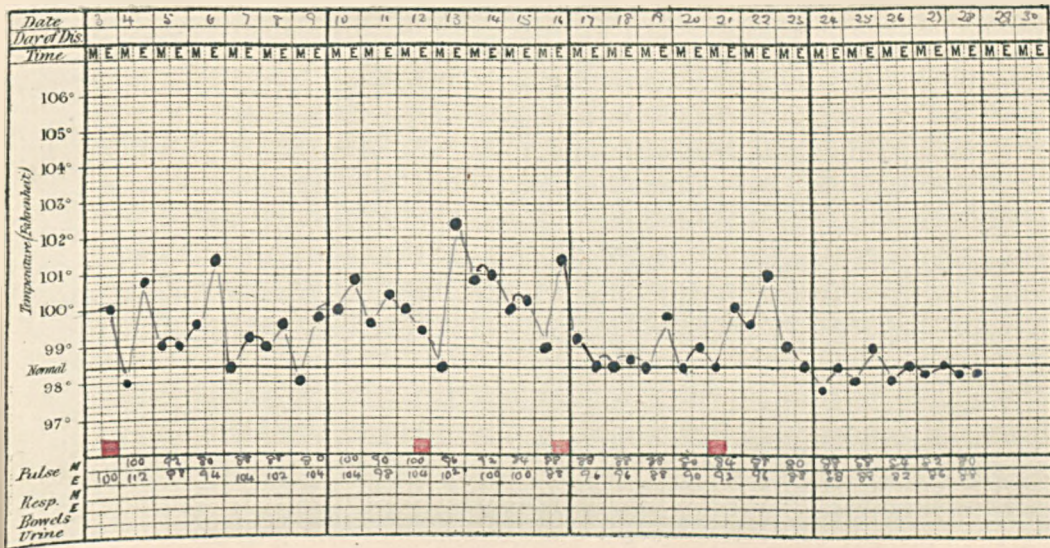
Emphysematous type

On admission there may be no sign or symptom of Anaerobic infection, apart from the bacteriological report. Later, when emphysema appears, its rapid spread reminded one very much of cases of surgical emphysema, following injury to the chest, which in pre war times were not infrequently admitted to hospitals near steel works. Again, there may be on admission, discolouration of the skin and slight bronzing of the tissues, with here and there haemorrhagic blebs, appearing on the surface. The muscular tissue is soon infiltrated with gas, and crepitus is felt. If the condition advances, the general aspect becomes more serious, the pulse accelerates, and in severe cases dyspnoea is present. The mental faculties remain unchanged, a feature which is characteristic

The following are cases where emphysematous gangrene was reported on admission and which responded quickly to surgical and serum therapy treatment. The organisms isolated, the serum used, and the result obtained are tabulated herewith.

	<u>Bacteriology</u>	<u>Serum</u>	<u>Result.</u>
B.	Bacillus Perfringens Vibrion Septique	Leclainche & Vallée 40cc	Recovery
B.	Bacillus Perfringens Vibrion Septique	Mélange 30cc Anti Perfringens 25cc	Recovery
F.	Bacillus Perfringens Other Gram Positive Bacilli.	Mélange 30cc Anti Perfringens 40cc Leclainche & Vallée 10cc	Recovery
D.	Bacillus Perfringens Vibrion Septique	Anti Vibrion Septique 60cc Anti Perfringens 20cc Leclainche & Vallée 10cc	Recovery
A.	Bacillus Perfringens Vibrion Septique	Mélange 30cc	Recovery
R.	Bacillus Perfringens Vibrion Septique Bacillus Putrificus	Mélange 30cc Anti Perfringens 10cc	Recovery

Each case is detailed in the following pages, and where possible, the number of organisms per field of the microscope is charted along with the pulse and temperature.



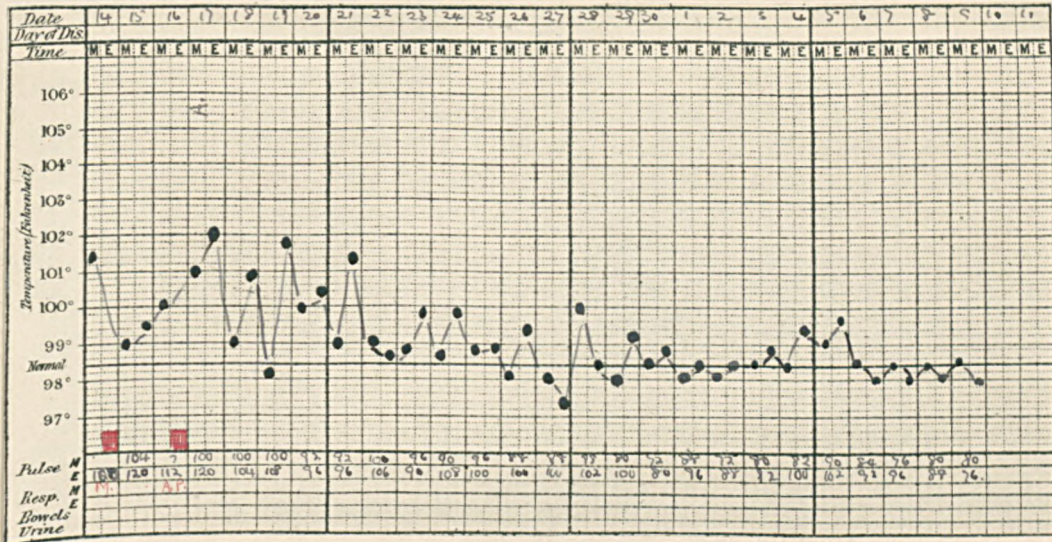
No. 16. Chart A.

B

Wounded June 2nd 1918

Admitted June 3rd with a perforating wound below the knee and fracture of Tibia. The wound was extremely dirty and the medullary cavity was exposed. The infection was a severe Streptococcal and Gas Gangrene one - 20cc of Leclainche & Vallée Serum was given during surgical procedure. During the next week - Bacillus Perfringens, Vibriion Septique and Streptococci were repated ly isolated, and serum treatment was continued. On evacuation six weeks later the wounds were healing satisfactorily.

Case. No. 19. Charl A.

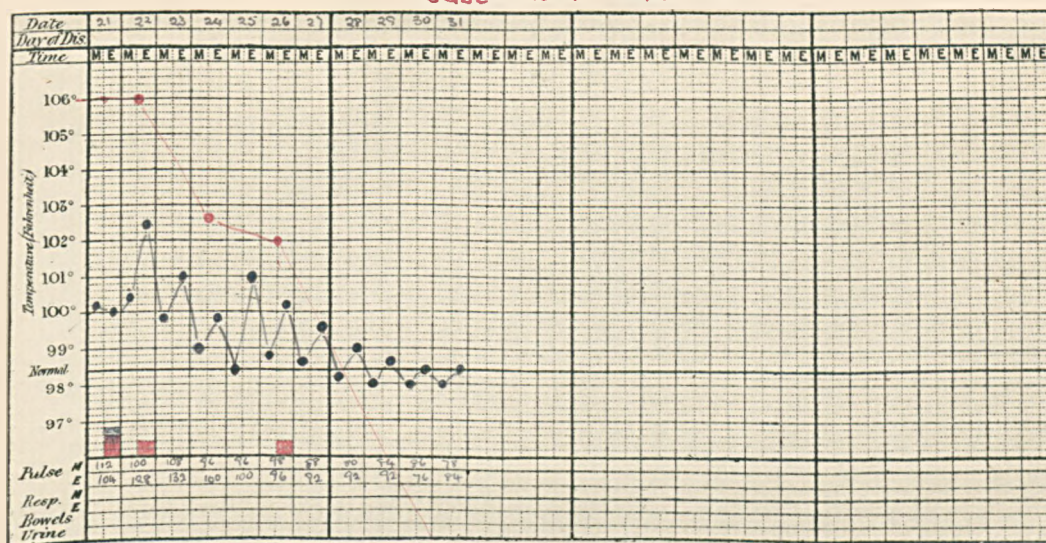


B

Wounded 14th June 1918 - admitted the same afternoon.

- multiple wounds of buttocks, thighs, legs and arms; the sciatic nerve was exposed. The pulse was 120 and the general condition was poor. 30cc of Melange Serum was given at once. Incisions were made for crepitus and infected tissue excised. Bacillus Perfringens and Virbion Septique were isolated - the former predominating. 25cc of Anti Pefringens serum was given and amputation was performed. In spite of his multiple wounds the patient went on satisfactorily.

Case No. 2. Chart A.



F

Wounded 18th August 1918

Admitted 21st August - with perforating wound of the right leg, haemorrhage and gas gangrene of the calf. The wound smelt foul and the muscle was soft and discoloured. 30cc Mélange and 10cc Leclainche & Vallée Serum was given on admission.

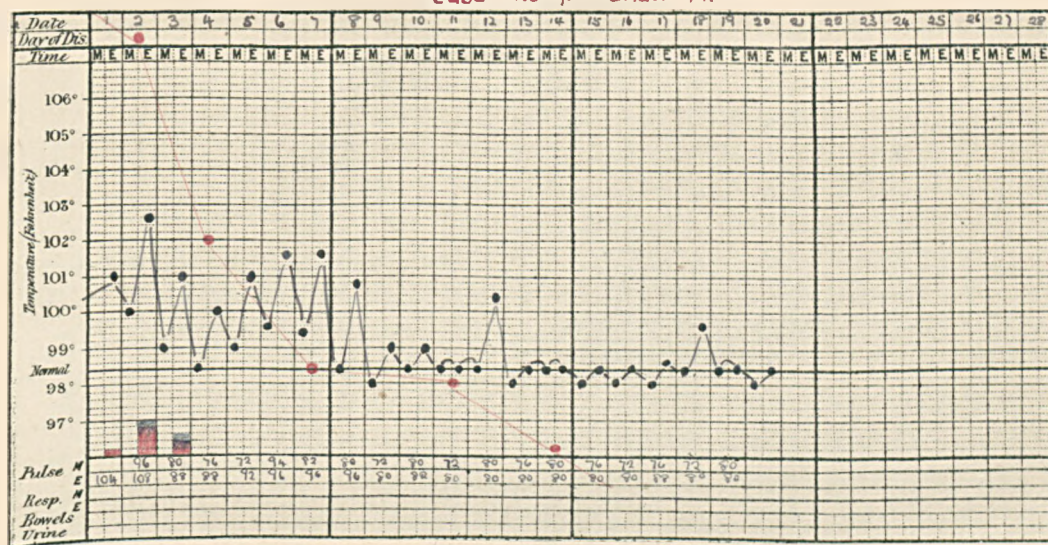
Bacillus Perfringens, Streptococci and Vibrio Septique were isolated from the wound. Patient was nursed as far as possible on his face to prevent any pressure on the posterior aspect of the leg.

August 22nd and

August 26th - Anti Perfringens Serum was given, after which date neither of the above organisms were isolated from the wound and the patient was evacuated on the 31st August.

(The red line shows the number of organisms per field of the microscope)

Case No. 7. Chart A.



D

Wounded 30th May 1918

Admitted 1st June - penetrating wound of calf with fracture of Tibia; much destruction of calf muscle; swelling of the leg and crepitus. There had been much haemorrhage and the smell of the wound was foul. 10cc Leclainche & Vallée Serum was given - operation - gangrenous muscles excised and others divided transversely for the relief of tension; there was much haemorrhage. Vibrion Septique in large numbers and Bacillus Perfringens - were isolated.

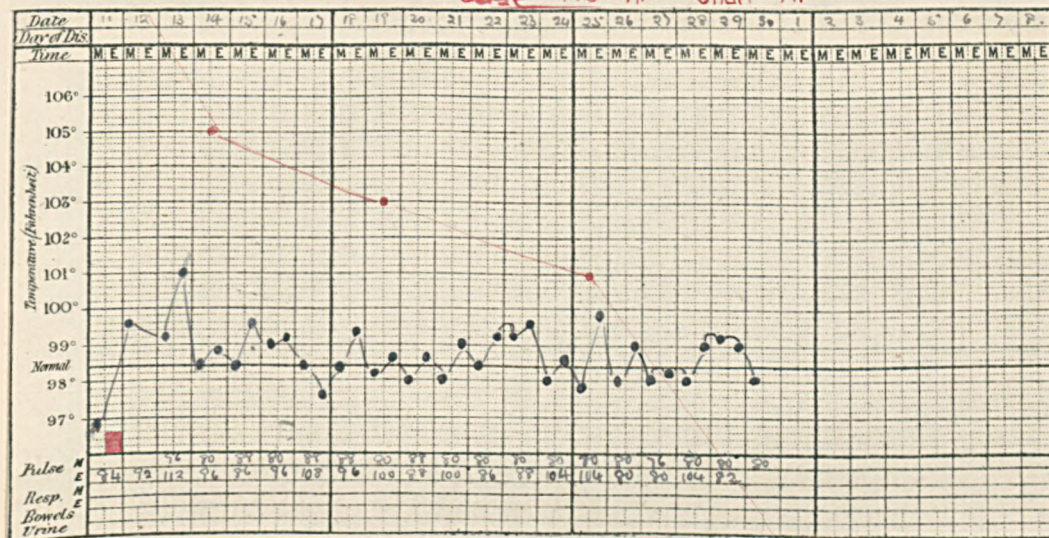
June 2nd the smell of the wound was foul and the tissues looked gangrenous. 40cc of Anti Vibrion Septique Serum and) were given
10cc of Anti Perfringens Serum) subcutaneously

June 3rd - 20cc Anti Vibrion Septique Serum and
10cc Anti Perfringens were repeated and from June 7th the wound was dressed daily with Leclainche & Vallée Serum.

The infection remained quiescent and his recovery was straight forward.

(The red line on the chart represents the number of organisms per (field of the microscope).

Case No 11. Chart A.



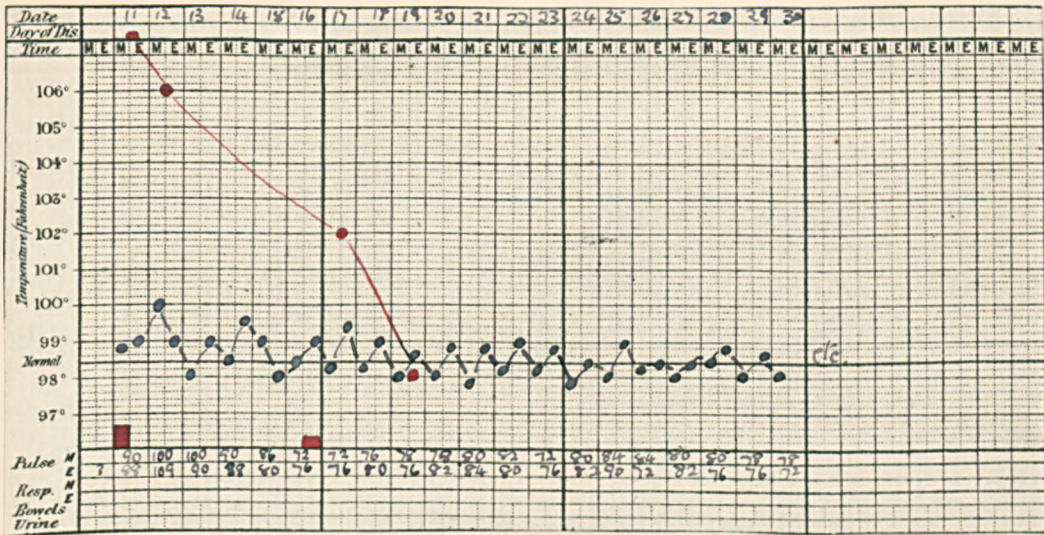
A

Wounded 10th June 1918

Admitted 11th June multiple wounds of the scapular region; penetrating wound of left leg with fracture of both bones. The leg wound was filthy and there was gas in the tissues. 30cc M \acute{e} lange Serum was given on admission before operation. Operation - wounds excised, shell removed and incisions made in the muscles for tension. Gram Positive Bacilli resembling ^(few) Perfringens, Vibrion Septique, and Streptococci were isolated.

June 16th - 20cc Anti Vibrion Septique Serum and 20cc Anti Perfringens Serum were given.

By June 28th no anaerobic Bacilli were found in the wound and he was evacuated a few days later.



Case No. 4. Chart C.

R

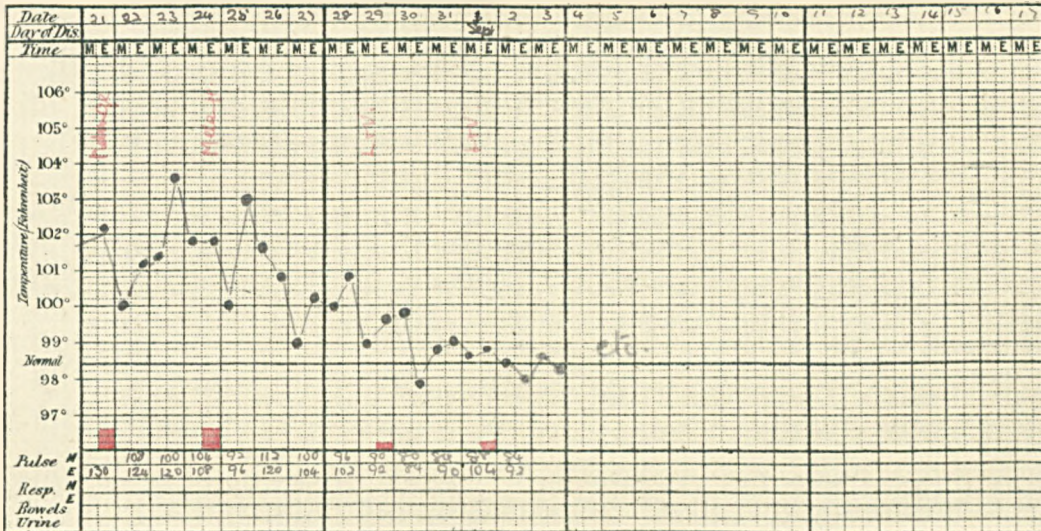
Wounded 10th June 1918

Admitted 12th June with a foul smelling perforating wound of the calf with gas in the tissues. 30cc M₂lange was given in the receiving ward. Operation - wound was freely excised.

Gram Positive Bacilli with spores of various types were isolated. During the next few days there was an increase in the number of Bacillus Perfringens and on June 16th Anti Perfringens Serum was given. The patient was evacuated a fortnight later and the condition of the wound was satisfactory.

Oedematous type

Locally - the superficial veins stand out in a pale skin, there is swelling of the limb; no gas or crepitus; the muscles are pale and anaemic and remind one of "cold ham". There is oedema which steadily extends; there is no apparent gangrene. The face is pale and the patient looks toxic; the pulse is small and quickened. The organisms isolated from the wounds in these cases are:- Bacillus Perfringens and Bacillus Oedematiens but frequently it is extremely difficult to get these in pure culture. In one case - of Soldier X, it was only too apparent that the patient was suffering from this special type of anaerobic infection, yet it was extremely difficult to get a pure culture from any one of the tissues, which were sent for investigation. Three times he was operated upon - large incisions being made to relieve tension, and the muscles incised transversely. The X Ray showed nothing abnormal; there was no fracture to complicate matters - the patient said he felt well and he was in the best of spirits, but the pulse was poor and rapid - the tissues looked exactly as if they had been bled - the muscles white, anaemic and bloated - it was only at the fourth operation that the cause was discovered - a small piece of cloth being found, lying between the fibres of one of the flexor muscles of the forearm and which on culture produced Bacillus Oedematiens. By repeated administration of the expectant anti serum the toxins were neutralized and the infection kept localized. Examples of this type are to be seen in the following cases:-



Case No 3. Charl A.

La V

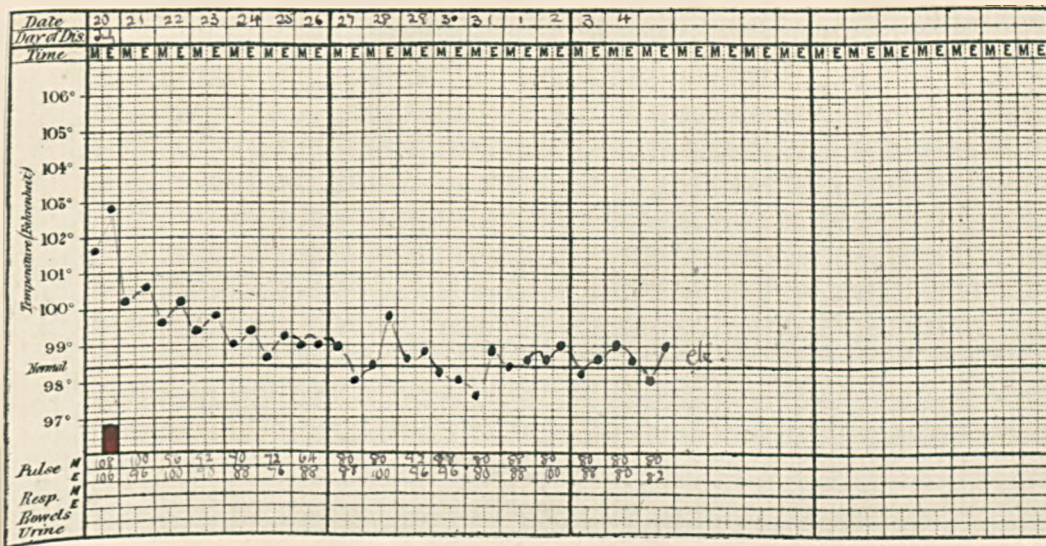
Wounded 20th August 1918

Admitted 21st August - with a large dirty wound of the left leg, fragments of both bones protruding. The muscles were swollen and gangrenous and the tissues were oedematous. There had been much haemorrhage and the general condition was poor - temperature was 102.2 pulse 130. 30cc Mélange Serum was given while the wound was being excised and freely drained. The patient was very ill during the following three days. Streptococci and varied Gram Positive Bacilli were isolated - mainly of the B. Perfringens and B. Oedematiens type.

August 24th - 20cc Anti Perfringens and Anti Oedematiens Serum was given.

On August 29th - 10cc of Leclainche & Vallée Serum was given.

Bacilli Perfringens were still reported in smears from the wound. On September 1st - 10cc Anti Perfringens Serum was given. There was no spread of the gangrene and the wounds healed up without further trouble. A month later, on evacuation, the patient could walk without difficulty.

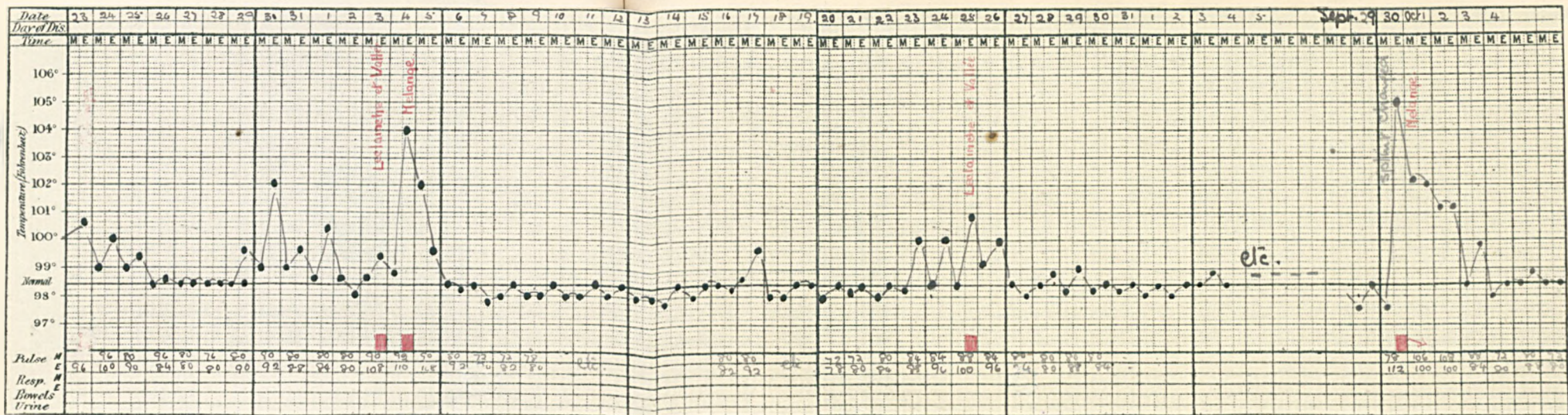


Case No. 21 Chart A.

E

Wounded 17th July 1918

Admitted 20th July suffering from exhaustion - temperature 101.6, pulse uncountable. Right leg was quite gangrenous, cold and pulseless. Oedema was spreading up the thigh; 30cc M^{elange} Serum and 10cc Leclairche & Vall^{ee} Serum were immediately given. Amputation was performed below the knee and pockets of pus were found under the cellular tissue. It was feared that surgical treatment had been too rational and that amputation would have to be performed higher up. From the gangrenous tissue B. Putrificus, B. Perfringens and B. Oedematiens were isolated. The infection quietened down and patient was evacuated in a satisfactory condition. He reported at Xmas 1919 that the stump had healed up a few weeks after evacuation and that he remained in excellent health.



Case No. 67 Chart C.

H

Wounded 20th July 1918

Admitted 23rd July with a filthy penetrating wound through the Tibia below the knee joint. Shell and cloth were removed from the midst of the fracture and the wound well drained - serum was not given.

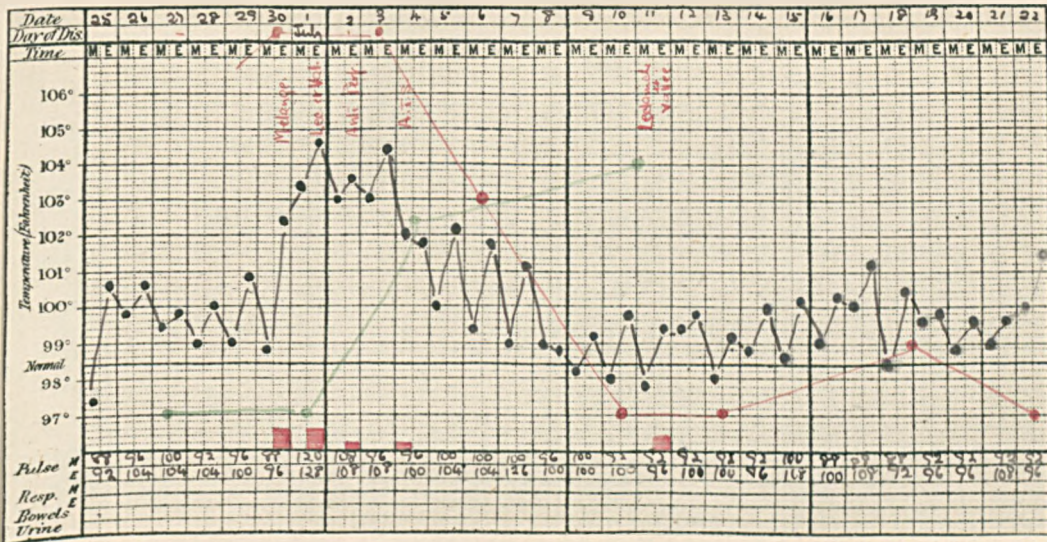
On August 3rd - condition of the wound was unsatisfactory and 30cc of Leclainche & Vallée Serum was given. The bacteriologist reported Bacillus Oedematiens, Bacillus Perfringens and a few Bacilli Putrificus with numerous Streptococci and next day 30cc of Mélange Serum was given - pus was evacuated from the wound. The progress of the case was quite satisfactory during the next few weeks - but numerous Streptococci were isolated on the 2nd August. 30 cc Leclainche & Vallée Serum was given next day.

On September 30th, when the wound was almost healed the splint was changed and a few hours afterwards there was a recrudescence of the infection, with swelling of the limb and much oedema of the foot. The smell from the wound was distinctly offensive, the temperature rose suddenly to 104.8 and the pulse to 112. Incisions were made into the oedematous tissue and 30cc Mélange Serum was given. The patient responded to this treatment and the infection calmed down.

In the so called mixed forms, oedema and gas formation co-exist, locally there is a foul smelling wound with much swelling and discolouration of the skin. The muscles are stained and gas and oedema tend to spread rapidly. The general condition is serious, the pulse is markedly increased, there is often a rise of temperature, and the patient shows toxic symptoms. Of the causative organisms the anaerobes Bacillus Perfringens, Bacillus Oedematiens, Vibriion Septique and occasionally others may be found in the tissues.

Examples of these cases are to be seen in the following, tabulated as previously:-

	<u>Bacteriology</u>	<u>Serum</u>	<u>Result.</u>
L.	Varied Gram Positive Bacilli with spores Bacillus Perfringens Bacillus Oedematiens Anaerobic Streptococcus	Mélange 30cc Anti Perfringens 10cc Leclainche & Vallée 70cc	Recovery
G.	Bacillus Perfringens Vibriion Septique Bacillus Futrificus Bacillus Histolyticus Bacillus Tetanus?	Anti Perfringens 45cc Anti Vibriion Septique 30cc Leclainche & Vallée 50cc	Recovery
B.	Bacillus Perfringens Vibriion Septique Bacillus Futrificus Streptococci & Others	Mélange 60cc Anti Perfringens 30cc Leclainche & Vallée 40cc	Recovery



Red line = Gram. positive Bacilli + Green line = Streptococci per Micros. field.
Case No. 17. Chart A.

Le I

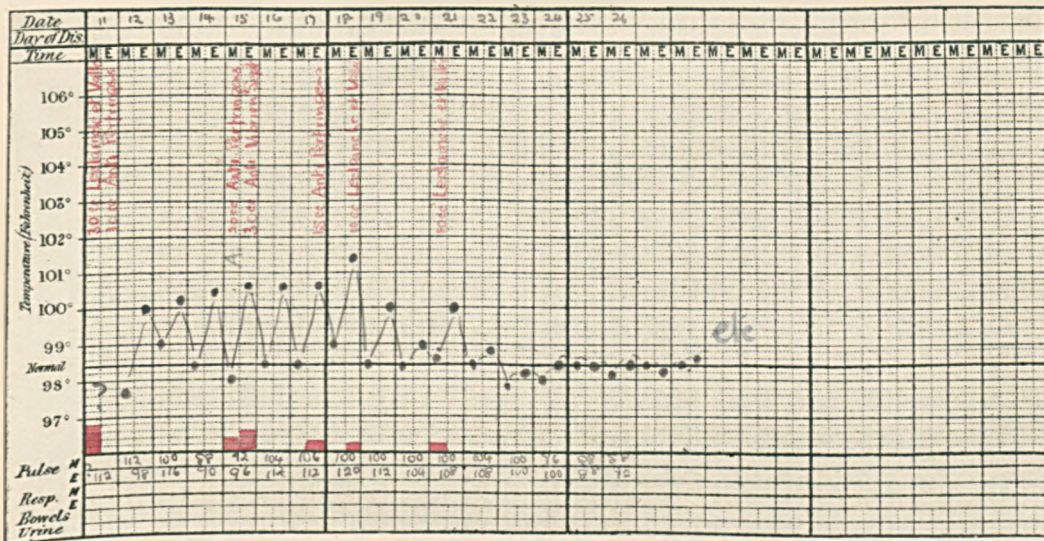
Wounded 2nd June 1918 - admitted same day, with a large ragged perforating wound of the left calf and a piece of shell in the medullary cavity of the Tibia. Gram Positive Bacilli of various types and Streptococci (less numerous) were reported. The soleus and gastrocnemius muscles were divided for tension.

July 30th - the local and general condition suddenly became serious; temperature was 102.4 pulse 100 and weak. The leg was very swollen and gas bubbled from the wound. It was agreed to push serum treatment before amputating. 30cc Mélange Serum was given. Free sporing anaerobes were isolated - B. Perfringens and B. Oedematiens and others unidentified. Next day the temperature remained high and pulse was 128 but the local condition was no worse. A blood culture was taken and reported negative. 30cc Leclainche & Vallée Serum

was given. On the following day there was slight improvement and amputation was deferred. 10cc of Anti Perfringens Serum was given. During the next few days the temperature gradually came down and there was a decrease in the number of Gram Positive Bacilli per field of the microscope.

August 11th - pus was evacuated from an abscess on the anterior surface of the Tibia and Streptococci only were isolated.

20cc Leclainche & Vallée Serum was given the same day. The wound gave no further trouble and healed up quickly. This was certainly a case which benefitted greatly by serum treatment.



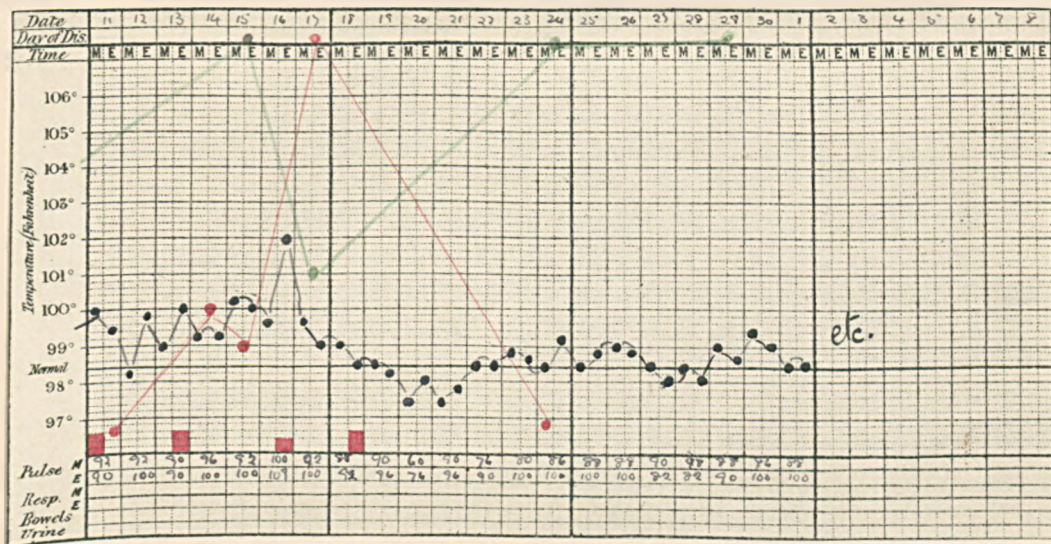
Case No. 9. Chart C.

G.

Wounded 11th June 1918 - admitted the same day with penetrating wounds of the leg and comminuted fracture of the Tibia. There was swelling of the limb and gas in the tissues, the odour was foul. The general condition was very poor and on admission the pulse was uncountable. Intravenous saline was given immediately and 30cc Leclainche & Vallée with 10cc Anti Perfringens Serum was injected. Next day the general condition had improved but on the 15th the oedema was spreading rapidly, the odour from the wound was putrid and the patient showed signs of generalized toxæmia. 20cc Anti Perfringens Serum plus 30cc Anti Vibrion Septique Serum was given and amputation was performed in the lower third of the femur - oedema was found to be spreading along the vessels and the subcutaneous tissues varied in colour. From the infected

muscle:- B. Ferfringens)
 B.Putrificus) were
 B.Histolyticus)
 B.Vibrion Septique) isolated
 Streptococci)
 ? B.Tetanus)

On two more occasions serum was given. The pulse became regular and the general condition showed great improvement. He was evacuated four weeks later, in excellent health.



Case 18. Chart A.

Red line denotes Gram positive Bacilli per Microsc. field.
Green " " Streptococci

B.

Wounded 10th June 1918

Admitted 11th June - with penetrating wound of the leg and fracture of both bones. The tissues were oedematous and there was a spreading gas infection. Amputation was considered and 30cc Mèlange Serum was given at once. The bacteriologist reported numerous Gram Positive Bacilli of various types with free spores - the majority resembling Bacillus Perfringens. A large piece of shell was removed and free drainage established. During the next few days the smell from the wound was foul, the muscles were swollen and anaemic looking and there was gas in the tissues. On the 13th June - 30cc Leclainche & Vallée Serum was given. On the 15th June - The skin was much discoloured; there was no crepitus but a red infiltration of the tissues and oedema were

present - the wound smelt putrid. 20cc Anti Perfringens Serum was given. A culture made from the exudate produced :-

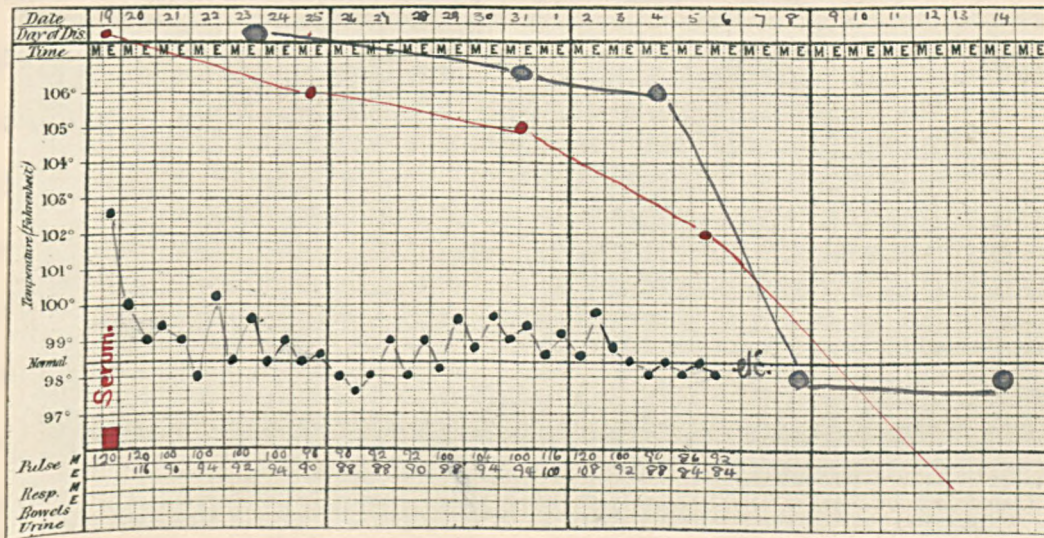
Bacillus Perfringens)
Vibrion Septique)
Bacillus Putrificus)
Streptococci)

Amputation was again considered but 30cc Melange Serum was given and the leg carefully watched for spread of the gangrene. The tissues began to look healthier but convalescence was slow. Five months later it was necessary to remove a small sequestrum and 10cc Leclainche & Vallée Serum was given before operation. From cultures made from the bone all the original gas producing organism were recovered. In spite of this there was no re-infection of the limb.

News was received from him Xmas 1919, when he boasted of his powers of locomotion.

Abscess formation occurs very commonly round the foreign body, and re-acts well to serum treatment, if given sufficiently early. It is often seen in a penetrating wound of the deep tissues, where the agent has almost traversed the limb and comes to lie fairly superficially on the opposite surface. The wound of inlet may be fairly free from infection, but on making a counter incision over the foreign body, it is found to be embedded in a well of pus, which may contain any of these organisms. Untreated, this local infection may attain one of the above types, the pus may burrow along the muscular planes causing a generalized infection. If one of the pyogenic organisms be present e.g. Streptococcus, the growth of this organism is accelerated, and the resulting mixed infection is a most virulent one.

A case of this type is seen in the following:-



Case No. 6. Chart A.

Red line denotes Gram positive Bacilli & blue line Streptococci per Mic. field.

B.

Wounded 18th July 1918

Admitted 19th July - in a state of exhaustion. There was a large lacerated wound over the left Tibia with a badly comminuted fracture of that bone. The leg was very swollen and the tissues much discoloured; the odour was putrid. There was also a penetrating wound of the left antecubital fossa - with much swelling and oedema - a serous discharge flowed from the lesion. The pulse was 120 and the temperature 102.6. The presence of gas could be seen in the tissues under the X Rays. 30cc M \acute{e} lange Serum was given in the receiving ward. Operation - a large piece of shell was found in the Brachialis anticus muscle, lying in a well of greyish pus.

The wound of the leg was excised and several pieces of shell and cloth removed from the midst of the fracture. The patient was nursed in open air and the wounds were partly exposed to sunlight. Each day these were dressed with Leclainche & Vallée Serum. They responded remarkably to treatment and both wounds cleaned up quickly. In a few days all Gram Positive Bacilli had decreased leaving Streptococci in possession. The serum was applied locally until smears were reported negative. On evacuation the wounds had healed, there was good union of the Tibia and the patient could get about. From news received at Xmas 1919, patient had returned to College and was taking part in all his old sports.

The following are the Septicaemias already referred to, occurring in Civil practice, which induced the writer to collect similar cases amongst war wounds and charts of these are enclosed:-

S. Case No.1. aet 19 - admitted as acute arthritis of the right elbow, probably of gonorrhoeal origin, developed Pneumonia, Pericarditis, Endocarditis, and Left Panophthalmitis.

Intravenous eusol was given.

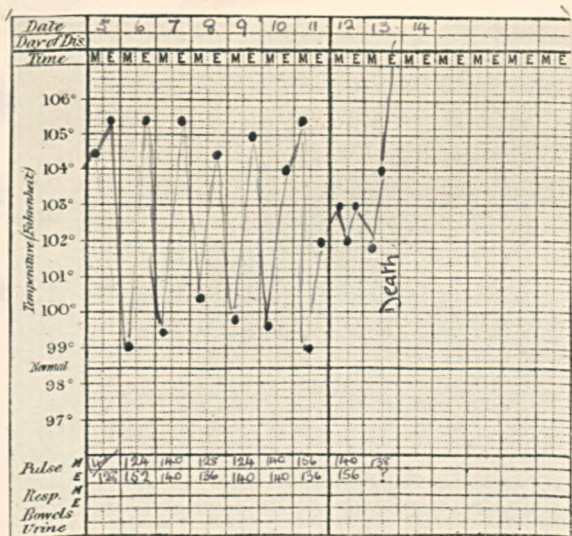
T. Case No.2. aet 3 - admitted as acute meningitis, no signs of increased pressure in the cerebral spinal fluid which was clear and contained nothing abnormal, developed Pneumonia and Panophthalmitis.

C. Case No. 3. aet 22 - admitted as acute rheumatism, developed Pericarditis, Endocarditis and Panophthalmitis.

All three resulted in death.

Septicaemias. resulting in Death.

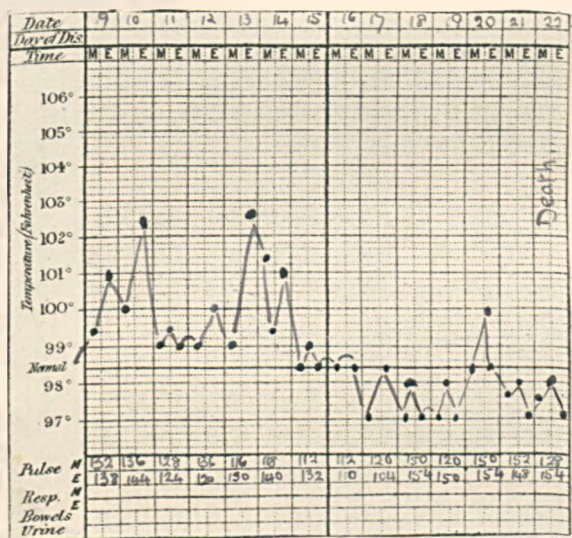
1917.



Case No. 1. S — Oct. 19.

Admitted to Royal Infirmary, Sheffield.
with Acute Arthritis.
developed pneumonia.
pericarditis. + endocarditis.
panophthalmitis.

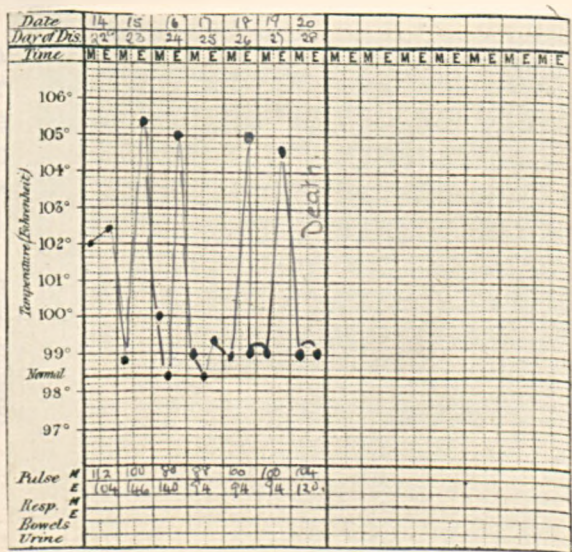
1917.



Case No. 2. T. — Oct. 3.

Admitted to Royal Infirmary, Sheffield.
? Meningitis.
developed pneumonia
panophthalmitis.

1917.



Case No. 3. C. — Oct. 22.

Admitted to Royal Infirmary, Sheffield.
with Acute Rheumatism.
developed pericarditis.
endocarditis.
panophthalmitis.

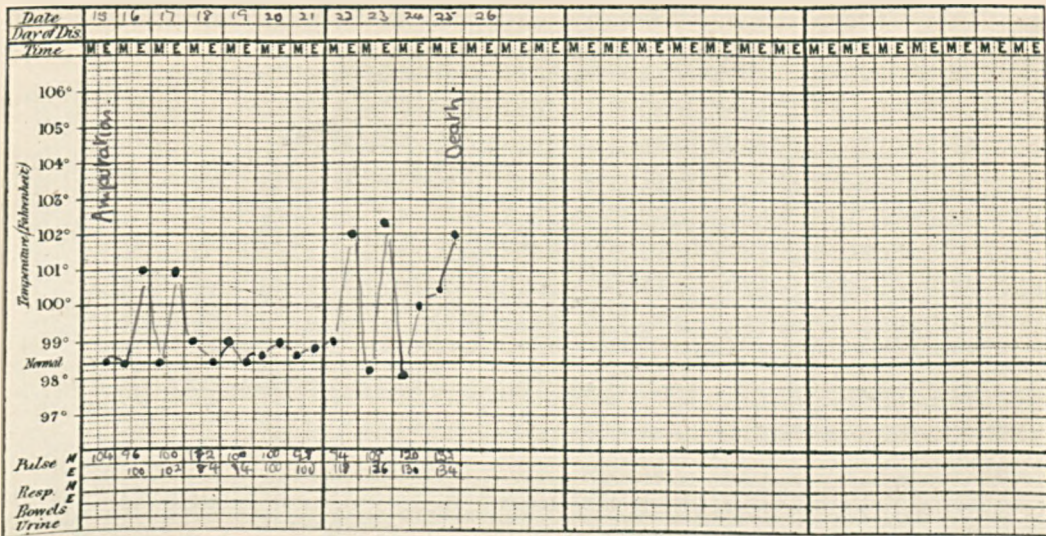
Septicaemias following War wounds

		<u>Serum</u>	<u>Result</u>
C. 1915	Gas Gangrene, Septicaemia	0	Death
F. 1915	Gas Gangrene, Septicaemia	Non specific therefore useless	Death
P. 1915	" " "	" "	Death
H. 1918	" " "	No Anti Gas Gangrene Serum given	Death
G. 1917	Gas Gangrene Myocarditis Septic arthritis Blood Infection B.Perfringens & B.Histoliticus	Anti Gas Gangrene Serum used	Recovery
P. 1918	Anaerobic Infection Localized abscesses Lungs, heart & kidneys implicated Rigors. Femoral Thrombosis	Serum used	Recovery
R. 1918	Wound of hand with Streptococcal Infection of the blood	Serum treatment	Recovery
B. 1918	Anaerobic & Streptococcal Infection Blood Infection	Serum treatment	Recovery
C. 1918	Streptococcal Infection of knee joint Blood Infection	Serum treatment	Recovery
D. 1918	Gas Gangrene right thigh & fractured femur; secondary anaerobic & Strept. Infect. knee joint. Lungs and heart implicated. Blood infection	Serum treatment	Recovery
D. 1918	Streptococcal Infection of Hip joint & fractured femur and pelvis; swelling of knee joint. Blood examination unsatisfactory	Serum treatment	Recovery

From this tabulation it is evident that cases of Septicaemia, receiving no serum treatment, had a fatal issue.

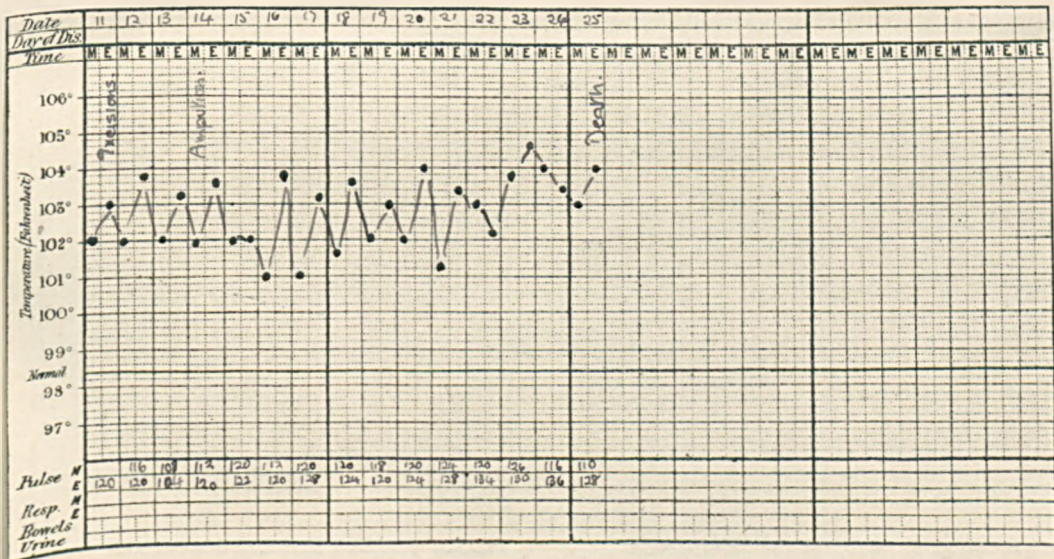
Case C. — No. 1. Charl. D. Gas Gangrene. Septicaemia. Death.

1915.



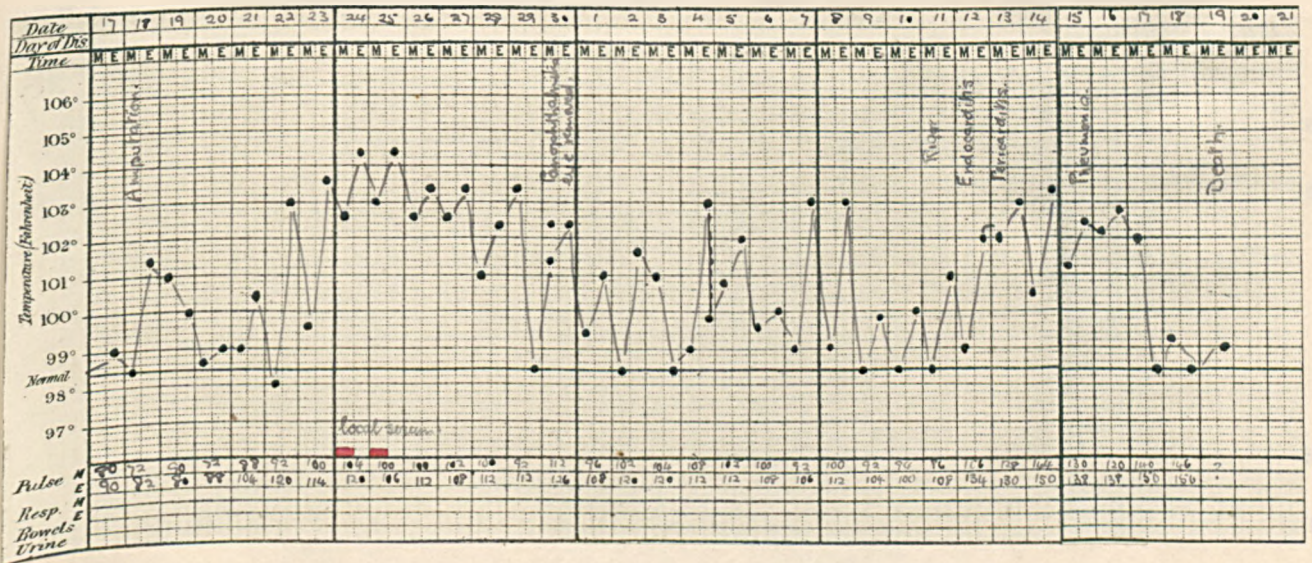
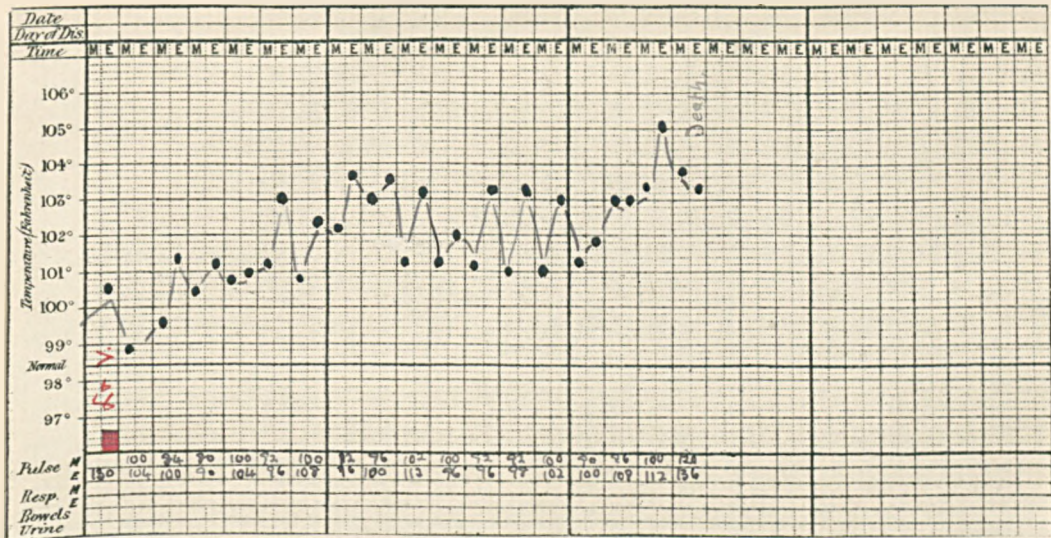
Case F. — No. 11. Charl. D. Gas Gangrene. Septicaemia. Death.

1915.

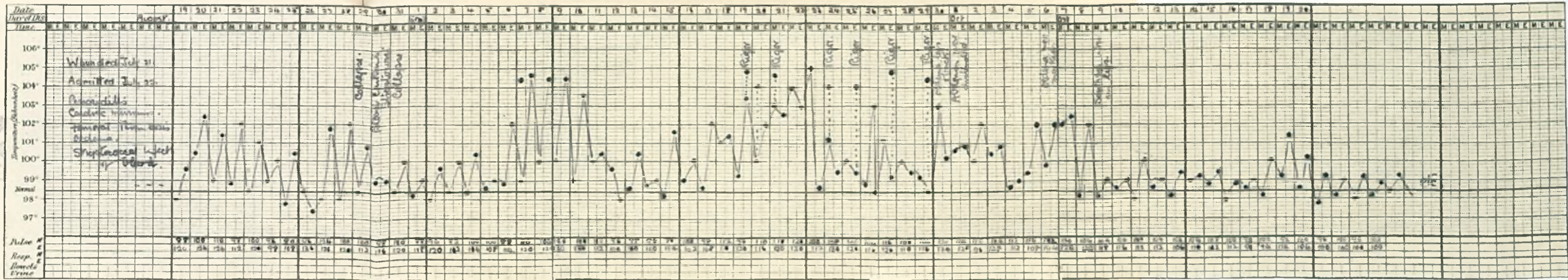


Septicaemias.

Case H. — No 13. chart. C. Death from Gas Gangrene. 170 Anli. Gas Gangrene serum given.



Case P — No 7. chart D.
 1915. Gas Gangrene. + Streptococcal Infection. Septicaemia.
 No Anli. Gas Gangrene Serum given; only local anti-streptococcal given late.
 Death from Gas Gangrene.



Septicaemia : Serum Treatment: Recovery.

P.

Wounded 20th July 1918

Admitted 21st July with a perforating wound of right shoulder joint and fracture of the head and shaft of the humerus. Patient was very anaemic. 30cc of Melange Serum was given at once. The infection was a mild Perfringens and Streptococcal one. He made a splendid recovery, the fracture had united but unfortunately there was a sudden haemorrhage from the wound and amputation had to be performed for an aneurism of the axillary artery on August 26th. For the next few weeks the general condition was very critical. There were repeated rigors, pericarditis, endocarditis, oedema of the legs and back; and thrombosis of both femoral veins. The abdomen was distended and he suffered much from colic. Serum treatment was repeated every few days and there was complete recovery.



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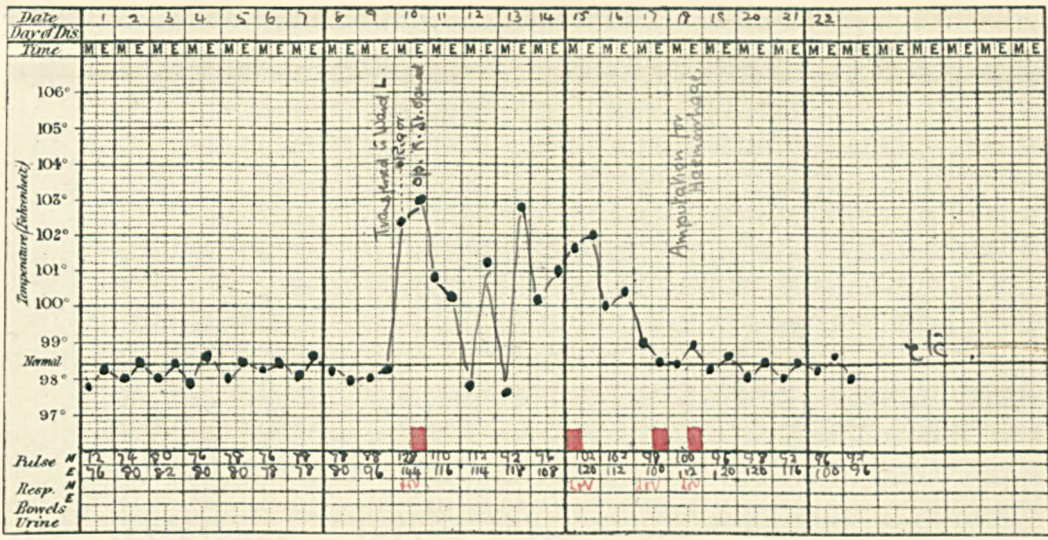
**CONTAINS
PULLOUTS**

R --- was a civilian aet 54, who received a wound of the hand, whilst working in the neighbourhood of the hospital in October 1917. On admission, there was redness and swelling, temperature was 102 and pulse 100. Incisions were made and during the next few days the local condition improved. Numerous Streptococci were isolated. 5 days after the injury the infection began to spread up the arm, which became brawly and oedematous. In spite of repeated surgical interference, the general condition became very critical - the temperature remained high, the patient looked jaundiced, there were occasional rigors; herpes were present on the lips, the tongue was dry, cardiac murmurs were audible and the patient was delirious each night; crepitations were present at the base of both lungs; the urine was diminished and contained albumin in large amounts. Streptococci were present in the blood.

Leclainche & Vallée Serum had been obtained for the case of S ---- (Streptococcal infection of the knee joint) and it was decided to try its effect in this case. Subcutaneous injections were given at repeated intervals and the local application was used in dressing the wounds.

The patient made a complete recovery and is now in excellent health. (Unfortunately the temperature chart of this case has been lost)

streptococcal infection. It is interesting to note with regard to this case that the scalp wound, though infected, gave no trouble.- the skull was trephined and the wound sutured; there was healing by first intention.



Case No. 3 chart B.

Secondary Streptococcal Infection of knee. Blood Infection.
Serum Treatment. Recovery.

C.

Wounded 29th August 1918 - operated on same day at Field Ambulance. Bullet removed; sequestrotomy, drainage established.

6th September admitted to hospital, temp. 100, pulse 100, wounds fairly clean, no anaerobic organisms found on microscopical exam. Condition satisfactory till 8th November, transferred to another ward. 24 hours afterwards, rigor. temp. 102.4. pulse increased from 88 to 128, patient felt very ill and vomited. Locally erythema of the skin. knee joint swollen. patient sallow, quite delirious;-knee joint opened up, pus found.

Direct examination - streptococci. gas produced in anaerobic cultures and streptococci isolated from these.

30cc Leclainche & Vallée Serum given with Saline subcutaneously.

Blood culture contained numerous streptococci.

November 14th - knee joint again washed out. 30cc Leclainche & Vallée Serum. was given.

November 16th - 30cc Leclainche & Vallée Serum - general and local conditions satisfactory.

November 17th - Unfortunately patient had a sudden haemorrhage from the peroneal artery - necessitating immediate amputation. 30cc Leclainche & Vallée Serum again given and intravenous saline, Patient's condition very serious.

November 18th - improvement.

Convalescence uneventful.

December 15th - Stump re-amputated and wound sutured.

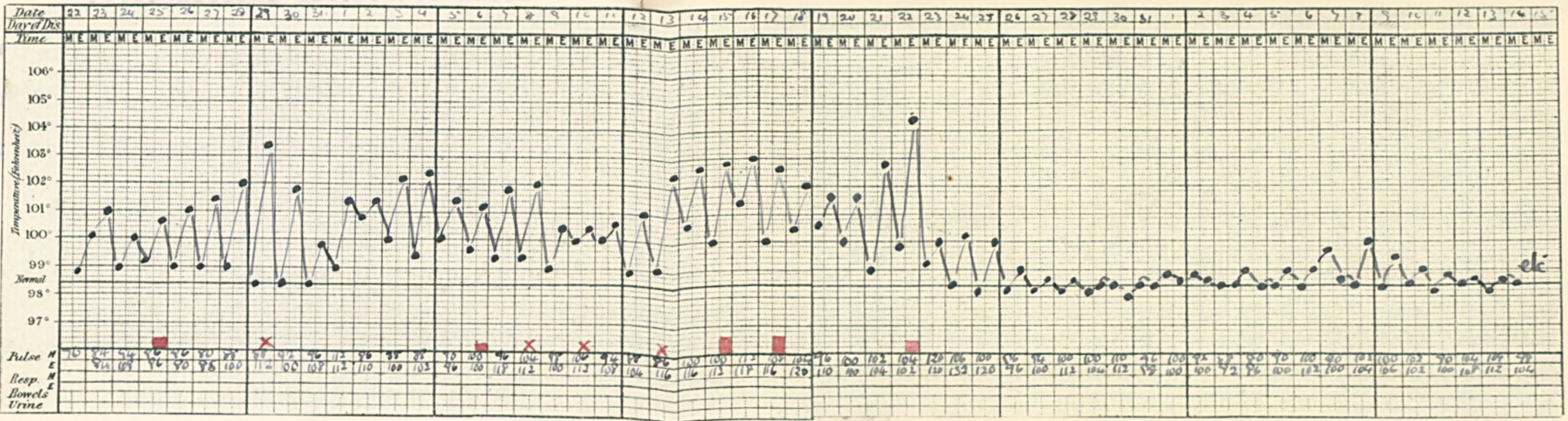
10cc Leclainche & Vallée Serum given.

Wound healed by first intention.

In all - 130cc of Leclainche & Vallée Serum was given.

In this case, had it not been for haemorrhage the patient's leg would in all probability have been saved. On opening up the knee joint after amputation all signs of sepsis had disappeared; the original wound was clean and healthy and the fracture of the Tibia firmly united.

The condition was one of generalized Streptococcal infection which re-acted well to serum treatment.



Severe Streptococcal Infection
 Leclainche + Vallée Serum used locally.

D.
Wounded 21st July 1918

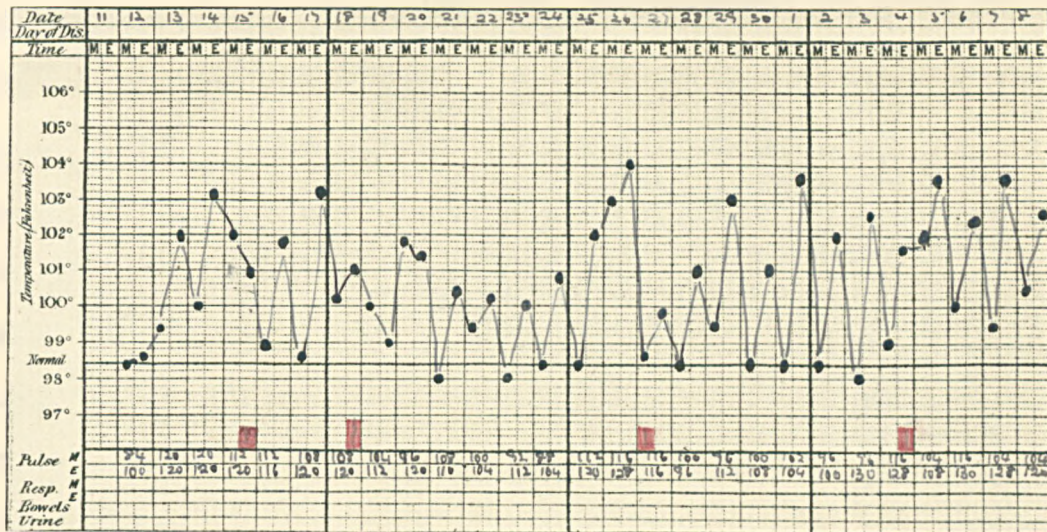
Admitted 24 hours afterwards with a penetrating wound of left hip and fracture of femur into the joint; also fractured pelvis. He was operated upon immediately, a large piece of shell and masses of filthy cloth being removed from the head of the femur. Carrel Dakin tubes were inserted. Numerous streptococci and less numerous gram positive bacilli were reported. No serum was obtainable until the 25th, the wound was foul smelling and pieces of soft spongy bony tissue were constantly removed with the dressing; pus oozed up from the depth of the cavity and the patient's condition was very critical.

On July 31st the wound had a distinctly sweet putrid odour, and from anaerobic cultures abundant streptococci only were isolated.

The wound was dressed locally with Leclainche & Vallée Serum at various intervals during the next fortnight.

On 15th August - 25cc of Leclainche & Vallée Serum was injected subcutaneously and repeated two days later when the knee joint was observed to be much swollen and there was more suppuration of the head of the femur.

On 23rd August - the hip joint was resected and 20cc Leclainche & Vallée Serum was given at the same time. The patient began to have acute diarrhoea of a dysenteric type; the stools numbering up to 20 a day and very offensive. Cultures from these produced abundant Bacillus Coli and Streptococci in large numbers. He became distinctly sallow and emaciated; the report of the blood cultures was unsatisfactory. Leclainche & Vallée Serum, applied locally to the joint was persevered with, and the tissue lost the grey putrid look and the smell became less offensive. The patient had a long convalescence and was retained in hospital until December 1918 by which time he had regained excellent health and could bear his weight on the limb. News was received from him at Xmas 1919, and his powers of locomotion are increasing.



Mixed B. Perfringens & Streptococcal Infection. Blood Injection.
 Serum Treatment. Recovery.

D.

Wounded 10th June 1918 - operated on same day.

Admitted to hospital 11th June with multiple wounds; comminuted fracture of right femur.

June 15th - numerous Streptococci and Bacilli Perfringens reported. 30cc Leclainche & Vallée Serum - given subcutaneously with saline.

June 18th - 40cc Leclainche & Vallée Serum subcutaneously.

Wounds discharging copiously, thick yellow foul-smelling pus, patient looking very sallow, nauseated, pulse irregular and rapid, cough; increased respiration. Cardiac murmurs audible, swinging temperature, pulse irregular.

June 26th - A large abscess opened in upper thigh, pus evacuated from knee joint containing abundant Streptococci.

20cc Leclainche & Vallée Serum given with saline.

A Blood culture was positive.

July 1th - Knee joint washed out.

30cc Leclainche & Vallée Serum was given.

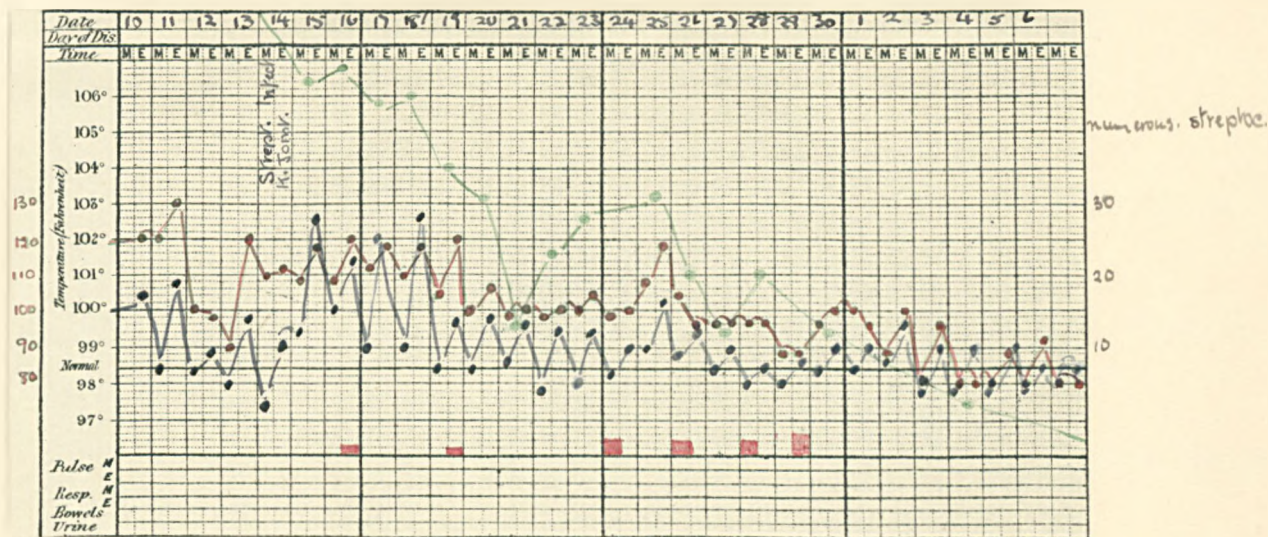
July 10th - Temperature dropped, improvement of general condition, pulse regular-still increased.

August 15th - Patient evacuated. fracture united. wounds healed. movements of knee joint improving with massage.

The general condition of this patient remained critical for several weeks and it was a daily consideration whether to amputate the limb and so increase his chance of recovery, but after each injection of serum an improvement in the general and local condition was quite noticeable.

Joint cases have been tabulated and detailed in a similar manner.

	<u>Infection</u>	<u>Serum used</u>	<u>Result</u>
S. Fractured Femur Knee joint infected	Streptococcal	Leclainche & Vallée locally	Healed
M. Fractured Femur Knee joint infected	Gas Gangrene Streptococcal	Anti Gas Gan. Leclainche & Vallée	Good
R. Fractured Femur into knee joint	Gas Gangrene Streptococcal	Anti Gas Gan. Leclainche & Vallée	Good
B. Fractured Femur Local Abscesses Cystitis Infection of blood?	Gas Gangrene Streptococcal Iyocyneus	Anti Gas Gan. Leclainche & Vallée	Recovery after am- putation
P. Penetrating wound of knee joint	Gram Positive Bacilli of varied types	Anti Gas Gan.	Perfect movement
B. Penetrating wound of knee joint	Streptococcal	Leclainche & Vallée	Good
M. Perforating wound of ankle	Severe Streptococcal	Leclainche & Vallée sub- cutaneous and local	Recovery
F. Penetrating wound of foot	Gas Gangrene Streptococcal	Anti Gas Gan. Leclainche & Vallée sub- cutaneous and local	Recovery
P. Penetrating wound of foot	Severe Gas Gan/grene	Anti Gas Gan. Leclainche & Vallée subcu- taneous and local	Recovery



Secondary Streptococcal Infection of Knee Joint.

effect of local serum treatment. one red square = 1000 serum.

S.

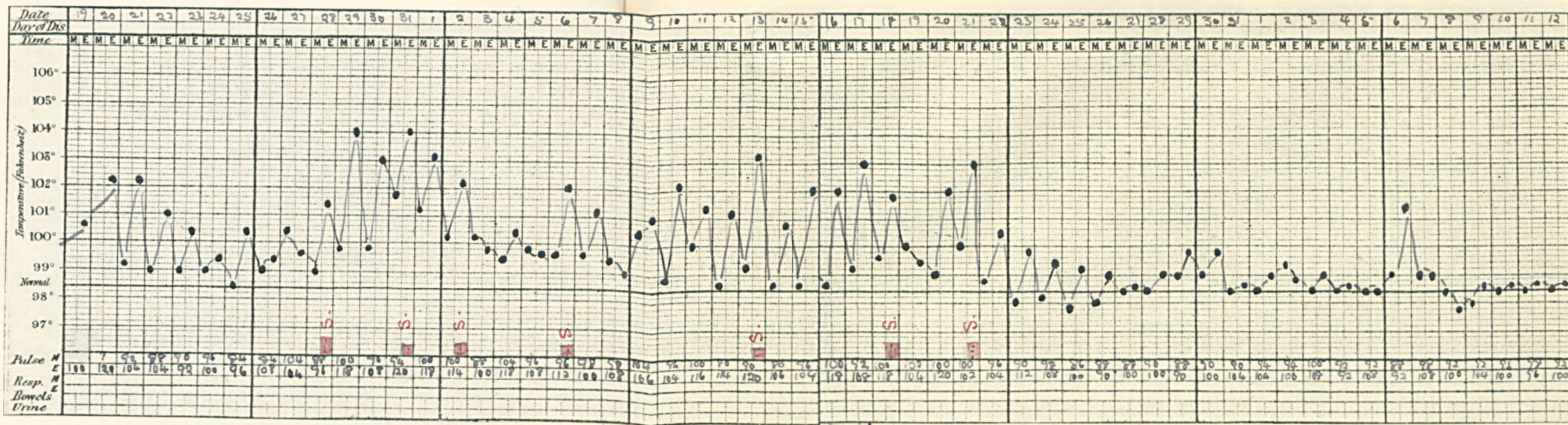
Wounded 27th October 1917 - perforating wound of left lower thigh with fracture of femur - operated on same day at Field Ambulance.

November 10th - Admitted to hospital.

November 14th - Secondary Streptococcal Infection in the knee joint, patient sallow, toxic appearance. Joint opened and washed out.

It was decided to try Leclainche & Vallée Serum. This was applied straight into the joint. The temperature settled - the pulse became regular and the organisms gradually disappeared. Above-see chart with details - the ^{green} ~~red~~ line shows the number of Streptococci per field and their decrease with serum treatment.

Patient was walking well before evacuation.



Mixed Gas Gangrene + Streptococcal Infection of Knee Joint.
 Recovery.

Wounded 19th July 1918 - admitted same day with a penetrating wound of left thigh and a perforating wound of knee joint with comminuted fracture of femur.

He was operated on during the early hours of July 20th - foreign bodies were removed; wounds were excised and cleaned and drainage was established. Numerous Streptococci and Gram Positive Bacilli of various types were reported - there was no serum available.

July 27th - The leg was extremely swollen and the foot oedematous; the wounds were foul; with formation of black sloughs.

Gangrenous tissue was excised and pus was evacuated from the knee joint - a foreign body still remained inside.

30cc M^elange Serum was given in subcutaneous saline.

Various types of Gram Positive Bacilli and Streptococci (the latter predominating) were isolated from the joint exudate. The patient looked extremely ill and emaciated, and complained of continual pain

in the joint - the mentality was unimpaired. Amputation was considered but postponed until serum treatment be well tried.

A blood culture was return negative.

On the 31st July the 2nd August and the 6th August 20cc Leclainche & Vallée Serum were given.

By August 8th the general condition had improved, enabling 2 foreign bodies to be removed from the knee joint under X Rays.

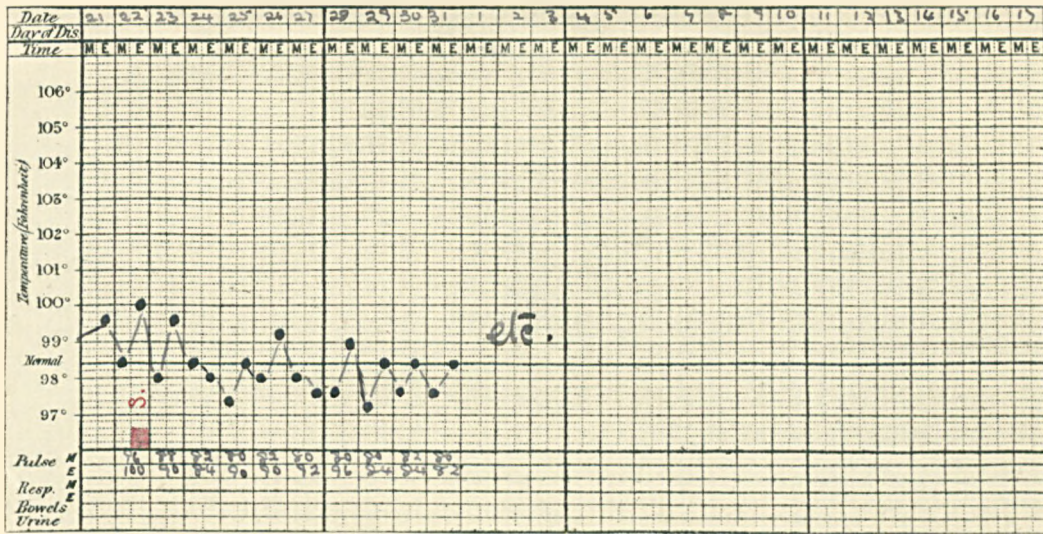
On August 13th the 18th and the 21st 20 cc Leclainche & Vallée Serum were again given subcutaneously in saline.

The temperature dropped; the pulse became regular and the patient's condition began to improve. He remained in the hospital till the final evacuation in December; his wounds were completely healed; the fracture was united and in good line and with massage the use of the limb had returned.

At Xmas 1919, the patient reported that he is in excellent health, and can get about quite well.

In all - the patient had 140cc Leclainche & Vallée Serum and
30cc Mélange Serum.

This was undoubtedly a case which benefited from both sera.



Penetrating Wound of Knee Joint. Anaerobes present

Complete Recovery of Joint Movements.

F.

Wounded 20th August 1918

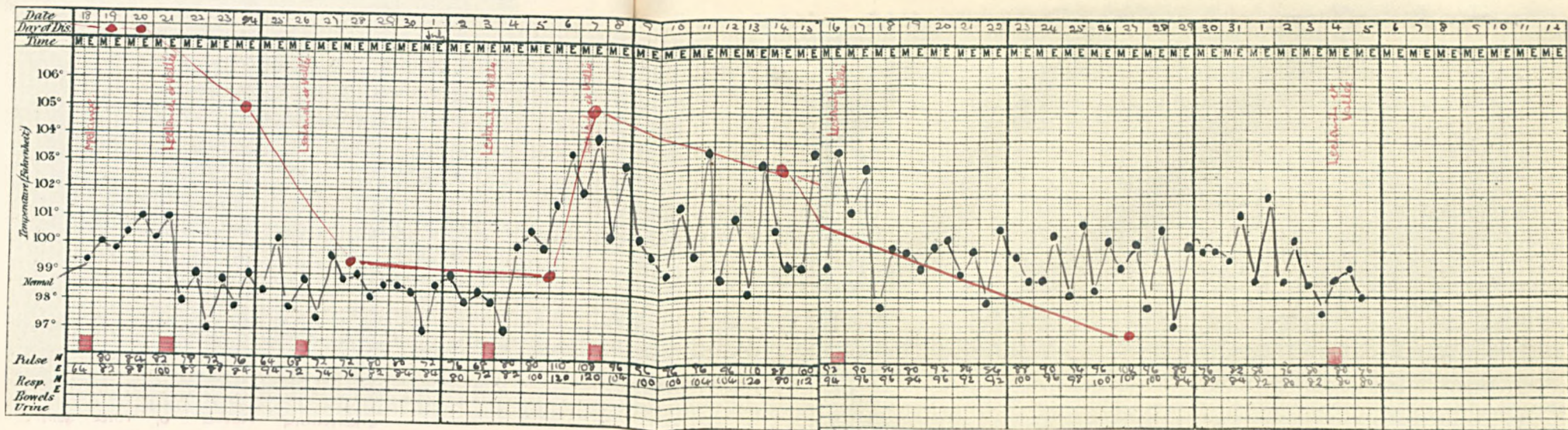
Admitted 21st August; penetrating wound of right knee joint, redness and swelling of the joint; bullet lodged in external condyle of femur, localized under the X Rays, general condition good.

Operation 22nd August ; knee joint opened up, pus and blood evacuated, external condyle trephined, bullet not found, Carrel Dakin tubes inserted, bacteriological report, Gram Positive Bacilli of varied types, 30cc Melange Serum given - Wound healed up.

20th November; knee joint again opened up; bullet removed under X Rays, wound sutured, 10cc of Serum given.

Healing occurred by first intention and the patient recovered perfect movements of the joint.

January 1920. - patient reported that he can walk and cycle for miles without the least discomfort to the knee.



Streptococcal Infection of Knee Joint.

Serum Treatment Recovery. One square = 10cc Serum.

B.

Wounded 18th June 1918; admitted 8 hours afterwards with wounds of right patellar region.

Operation 18th June - piece of shell removed from the right knee joint; Carrel Dakin tubes inserted.

30cc Mélange Serum was given with subcutaneous saline. During the next few days the cultures showed numerous Streptococci and on 21st June 20cc Leclainche & Vallée Serum was given and repeated on June 26th and again on July 3rd.

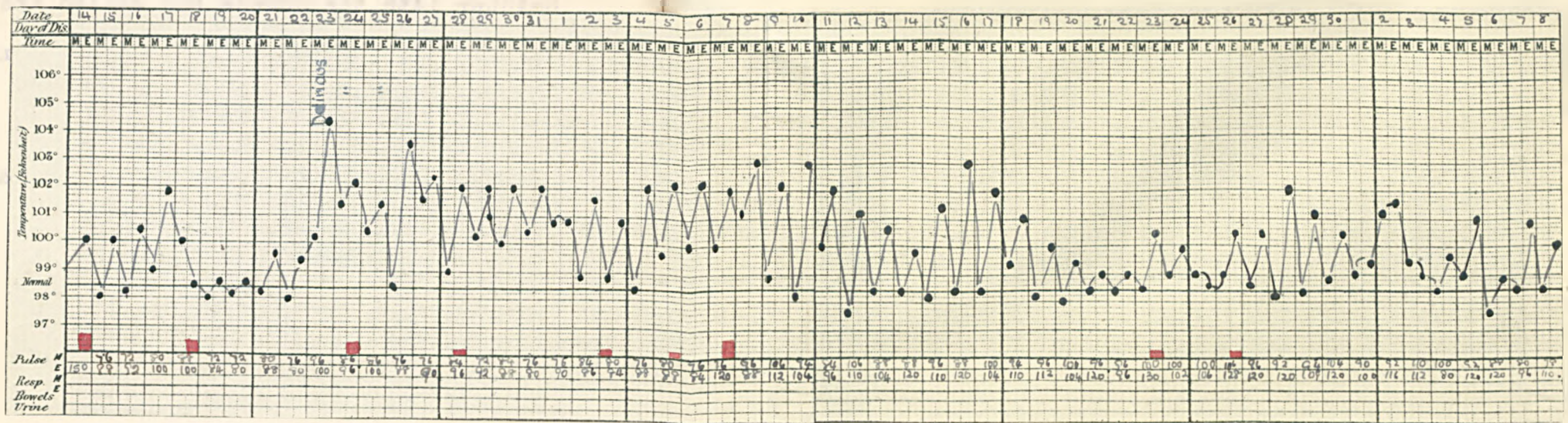
On 5th July the knee joint was distended and the fluid was turbid and contained numerous Streptococci. The joint was washed out and 30cc Leclainche & Vallée Serum was given.

The general condition was far from satisfactory and on August 4th 30cc Leclainche & Vallée Serum was repeated.

From that time onwards the patient began to improve, and by October 14th the wounds had healed and massage was begun. When the patient was evacuated at the beginning of December he could walk fairly well.

Total of Serum (30cc Mélange
given (160cc Leclainche & Vallée

Bills.



Severe Streptococcal Infection. Toxaemia. Recovery.
 subcutaneous & local serum treatment.

M.

1 square = 10cc. subcut. serum.

Wounded 13th August 1918

Admitted 14th August with a perforating wound of the right ankle; there was no swelling of the leg and the wound looked harmless, the temperature was 100, pulse 100. The X Rays showed a fracture of the internal malleolus into the ankle joint. No operation was performed; the patient was given 20cc Leclainche & Vallée Serum and watched for further symptoms. The temperature gradually ascended till August 17th when slight swelling of the ankle was observed. The wounds were excised and the tissues were found to be oedematous and discoloured; drainage was established; 20cc Leclainche & Vallée Serum was again given. The Bacteriologist reported the absence of micro organisms from the swabs. On August 23rd - the foot was very swollen and the tissues much

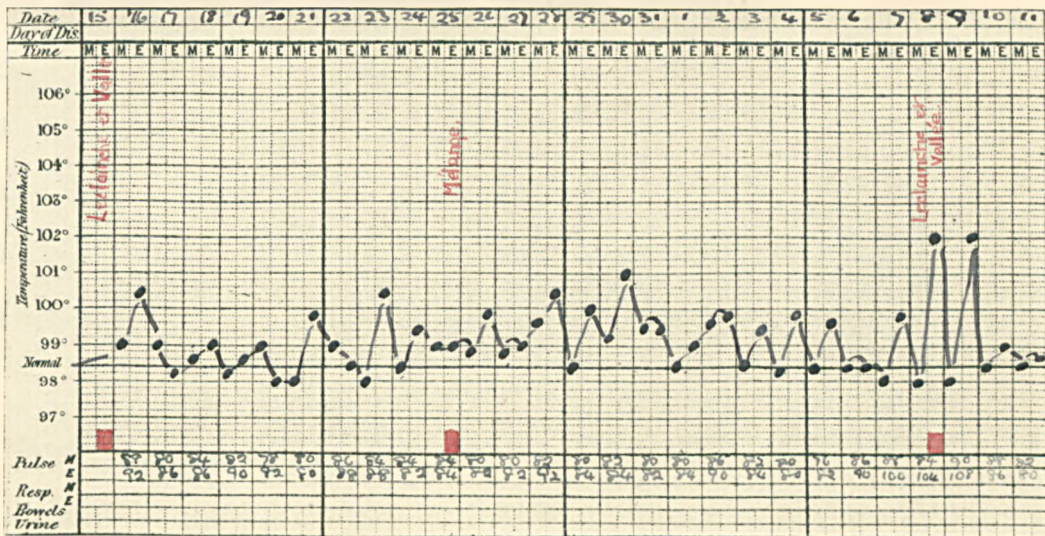
discoloured; temperature was 104.4.

From Aerobic and Anaerobic cultures Streptococci were isolated for the first time. Operation was again performed and loose fragments of the Tibia excised and the whole of the articular surface of the astragalo-tibial joint; through drainage was established. 20cc Leclainche & Vallée Serum was given in saline. During the next few days the patient was delirious and vomited constantly; the tongue was dry and he looked thoroughly septic. On two occasions the blood culture was reported negative. o

On August 28th and)
3rd September)

10cc Leclainche & Vallée Serum was given
and repeated at frequent intervals during

the next few days. The patient was jaundiced and nauseated and his mind wandered at night. The wounds were dressed with the local Leclainche & Vallée Serum. The tarsal articulations became infected one after another and the question of amputation was repeatedly considered but improvement was always noticed after serum was given. The foot had become a pulpy mass and it was necessary to arrange it in an improvised Hodgen with a special extension to the foot, fore and aft, to retain the shape. He was evacuated in December with the foot healed and the general condition excellent. Only a few weeks ago he reported that the use of the foot was slowly returning.



Mixed Infection which remained localised.

F.

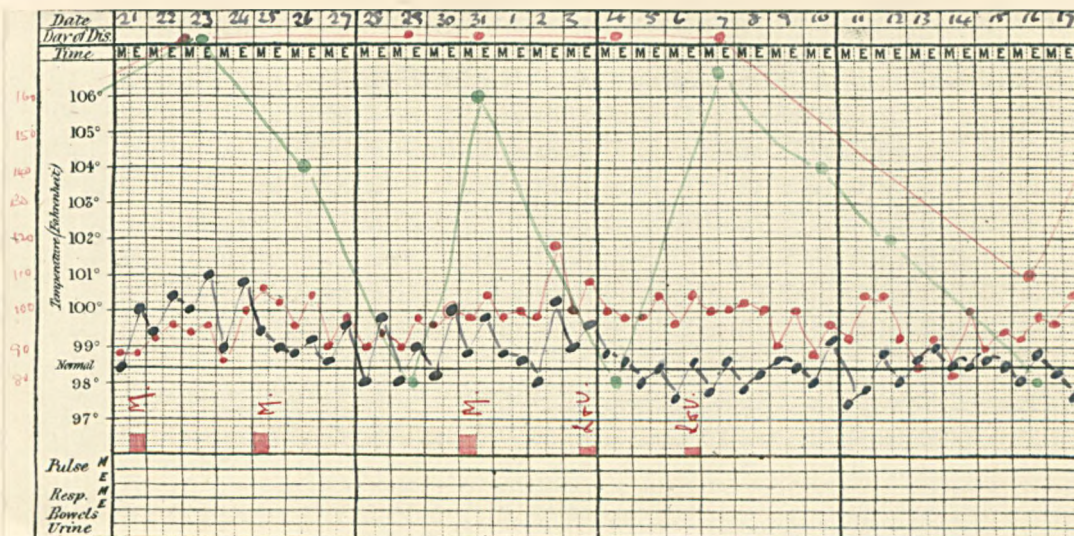
Wounded August 14th 1918 at 11 p.m.

Admitted August 15th at 4 p.m. - with a filthy gaping wound on the outer side of the right ankle, full of shell and cloth; the foot was much swollen and oedematous. The wound was excised and extremely foul smelling necrotic tissue was removed. There were fractures of most of the tarsal bones and the astragalo-calcanean joint was involved. 30cc Leclainche & Vallee Serum was given in saline. During the week the types of Gram Positive Bacilli with numerous spores, isolated from the wound, were varied. The patient was placed out of doors, the smell from the wound being overpowering.

25th August - 30cc Melange Serum was given.

The Anaerobic organisms gradually disappeared from the wound and Streptococci remained in possession.

On September 8th - and September 16th - 30cc Leclainche & Vallée Serum was given. The wound healed up and the patient could walk before evacuation in December; the ankle joint movements being unaffected. He reported in January 1920 that with the support of a strong boot he ^{could} ~~can~~ walk without pain or effort.



Severe Mixed Gas Gangrene Infection of foot Serum treatment.
 & streptococcal } red line for Streptococci.
 Green Gram positive Bacilli.

P.

Wounded 19th July 1918.

Admitted 28 hours later - filthy wound on the outer surface of the left foot with an extremely offensive odour, which was almost intolerable in the receiving ward. The X Rays showed a large irregular piece of shell in the posterior aspect of the foot. The tarsal bones were almost completely disintegrated, and pending amputation 30cc M^elange was given at once in saline. The bacteriological report was returned as numerous Streptococci and equally numerous Gram Positive Bacilli of various types the majority resembling Bacillus Perfringens. The general condition was so excellent - even after the few days fasting, which he had suffered with the other Americans - that it was decided to defer amputation and to push the specific Anti serum. The wound was

cleaned up as far as possible and pieces of disorganised bone removed. A small foreign body was extracted; another was reported as having been removed in the receiving ward. The patient was placed out of doors with the foot exposed to the air under a gauze cage. A continuous Carrel Dakin drip was applied and the limb carefully washed for spread of the gangrene.

30cc Melange was again given on the 25th with saline.

Gram Positive Bacilli with terminal oval spores; Bacillus Perfringens and numerous Streptococci were constantly reported - streptococci being now in the majority.

The foot was still foul and Leclainche & Vallée Serum was given on the 3rd and 6th August. The wound began to look more healthy. By August 27th only a few Gram Positive Bacilli were reported - Streptococci being still the majority.

August 30th - the patient was sent to the X Rays for another photograph and much surprise was caused in finding the original foreign body firmly embedded in the os calcis.

August 31st - The shell was removed by a counter incision which was afterwards sutured. 20cc Leclainche & Vallée Serum was given.

Cultures made from foreign body produced -

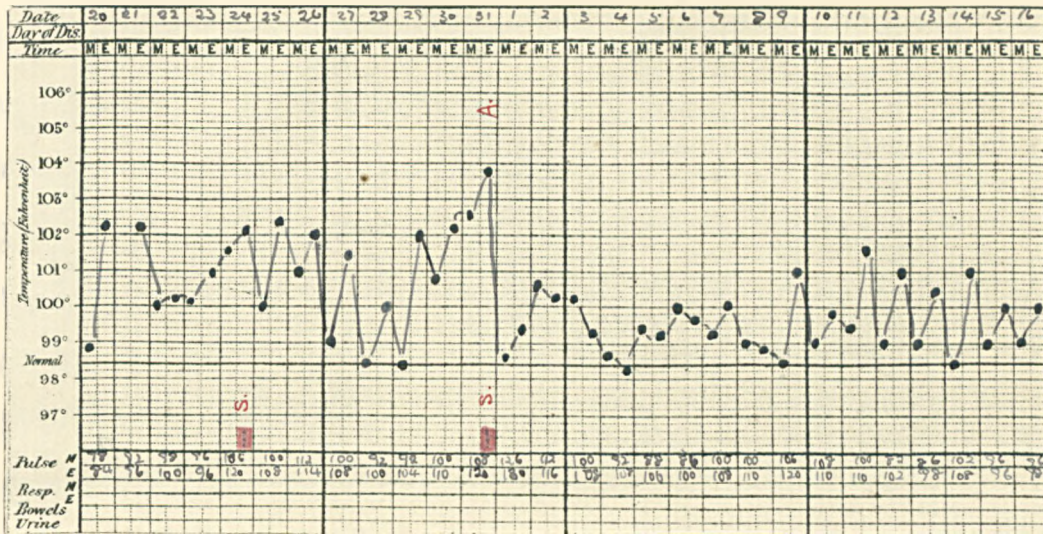
Aerobically - abundant streptococci.

Anaerobically - much gas was given off and the cultures were rich in Bacillus Perfringens.

In spite of this the second wound healed up by first intention and the remaining period of convalescence was straight forward. The patient was left with quite a useful foot - the internal arch remaining in-tact. News was received from him at Xmas 1919;

and he can get about fairly well.

This case was one of the foulest of gas gangrenes which came under the writer's care; fortunately it remained localized, aided doubtless by the Mélange and Polyvalent Leclainche & Vallée Serum. It was interesting to note that although the agent was not removed at the primary operation and was still contaminated by the same organisms, their virulence remained in obedience.



Mixed Gas Gangrene & Streptococcal Infection of Knee Joint.
Amputation. Serum Treatment. Recovery.

B.

Wounded 18th July 1918; Penetrating wound of the left knee and fracture of Tibia into the joint.

Admitted 20th July; general condition very poor from exposure and lack of food.

30cc M \acute{e} lange Serum was given subcutaneously with saline at once.

Operation early on July 21st; the shell was removed from the head of the Tibia; the internal condyle of the femur being found fractured. From Aerobic cultures Streptococci were isolated.

From Anaerobic cultures abundant Gram Positive Bacilli of various types with a predominance of *Vibrio Septique* and *Bacillus Perfringens*.

July 22nd. - Much swelling of the joint.

July 23rd - Thick green pus oozing from the joint.

30cc Leclainche & Vallée Serum was given.

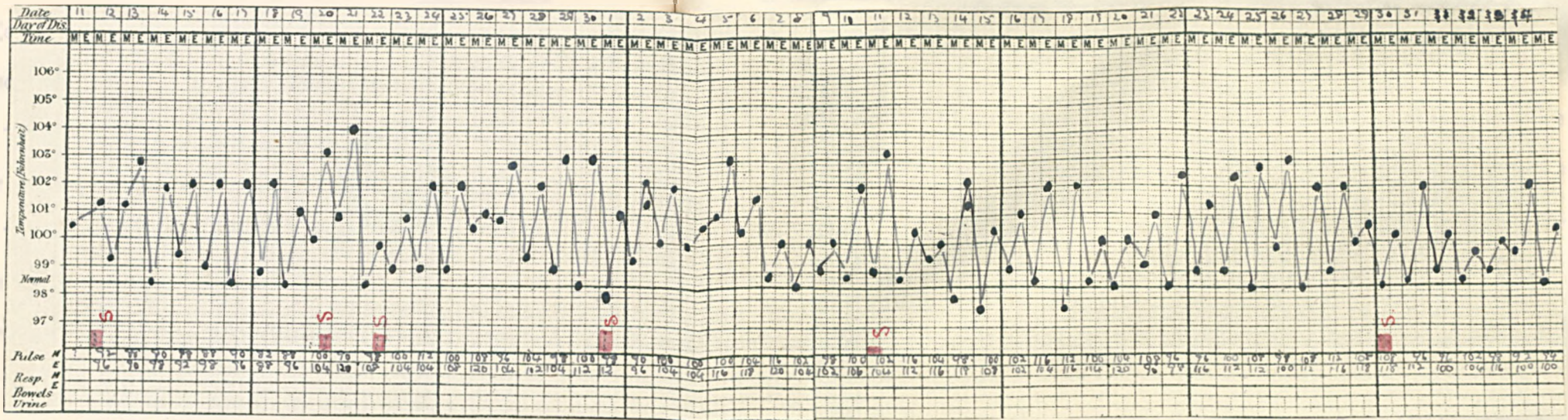
July 31st - 11-30a.m. swelling of the thigh was noticed; no crepitus nor discoloration. The swelling rapidly increased and it was feared that infection had become generalized. At 2-30p.m. amputation was performed in the lower third of the thigh; serosity was found tracking up along the line of the internal saphenous. 30cc Mélange was given subcutaneously in two pints of saline during the operation. The condition was very critical; and the pulse was not palpable; Huile Camphrée 10cc was injected hypodermically. The serosity from the amputated leg was cultured and produced much gas and abundant streptococci and various Gram Positive Bacilli with spores. A blood culture, taken at the same time, was reported negative.

August 11th - Patient developed a localized abscess in the right buttock, containing streptococci. These were also isolated with the addition of pyocyanus, from the stump.

For the next few weeks pus appeared in the urine and patient suffered from acute diarrhoea.

Convalescence was slow but he made a good recovery.

On November 21st - the stump was re-amputated and the wound sutured; 10cc Leclainche & Vallée Serum being given at the same time. There was no re-infection and the wound healed by first intention.



Mixed Gas Gangrene of Knee Joint. Recovery.
 each small red square = 10ccs serum.

R.

Wounded 10th June 1918

Admitted 11th June - with two wounds of knee joint tracking upwards to the inner surface of the thigh; fractured femur.

Operation 12th June - two pieces of shell removed; knee joint infected. Bacteriological report - Gram Positive Bacilli of various types with free spores; the majority being Bacillus perfringens.

30cc Melange Serum (Anti Perfringens given with saline.
 (Anti Oedematiens
 (Anti Vibrion Septique

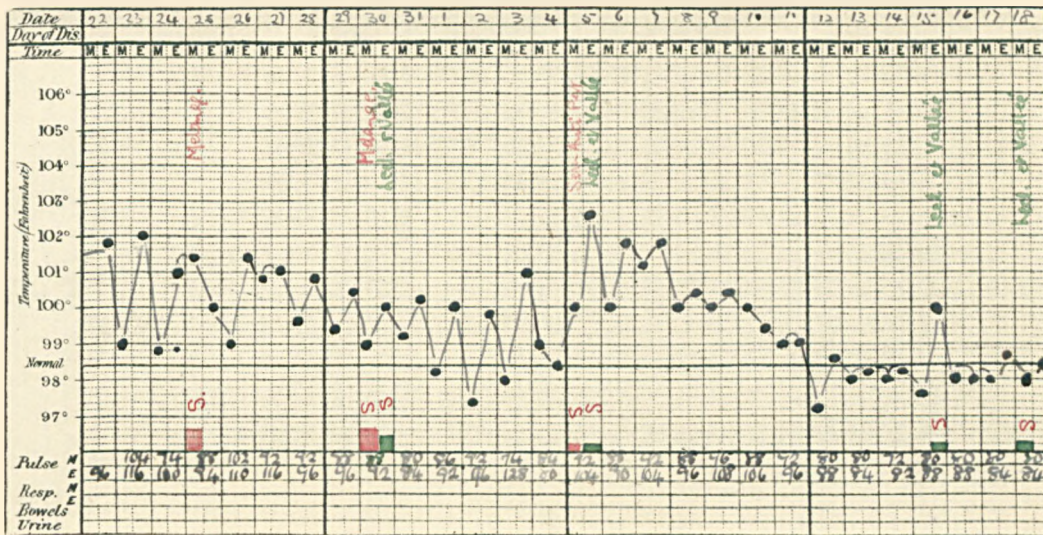
The temperature remained high and the general condition was serious. Further incisions were made in the thigh and pieces of infected cloth removed.

June 20th - 10cc of Anti Oedematiens) repeated.
 10cc of Anti Vibrion Septique Serum)

The Bacteriologist reported, in addition to the above organisms, numerous Streptococci, and two days later 30cc Leclainche & Vallée Serum was given.

July 1st - the knee joint was found full of pus which was drained.
30cc Mélange Serum with 10cc Leclainche & Vallée Serum was given.
Patient remained very ill with a quick irregular pulse and swinging temperature till August 31st. He looked thoroughly septic and amputation was considered many times. Occasionally localized abscesses above th knee joint were drained, from which streptococci were isolated. With each surgical interference Leclainche & Vallée Serum was given and the general condition of the patient gradually improved. the wounds healed up; the fracture united and massage and passive movements were begun in November.
Before his evacuation in December he was walking about without the aid of a stick.

	(30cc Anti Oedematiens
	(30cc Anti Vibrion Septique
	(20cc Anti Perfringens
Total amount of Serum given	(30cc Anti Tetanic
	(70cc Leclainche & Vallée



Case No. 2 Chart C. Mixed Gas Gangrene } Infection of
 + Streptococcal } Knee Joint. Recovery.
 anti-gas gangrene serum in red.
 Leclainche + Vallée green.

C

Wounded August 22nd 1918 - admitted the same day.

- a penetrating dirty wound of the left leg with much gas infection ; the Tibia was fractured into the knee joint. Bacillus Perfringens Vibrion Septique and Streptococci were isolated. a large piece of shell was removed from the midst of the fracture and the knee joint was washed out.

August 24th the wound was foul smelling, the muscles tense and discoloured and the gas was spreading; gangrenous muscle was excised and blood stained fluid was evacuated from the joint.

30cc Melange Serum was given.

August 30th Bacillus Perfringens and Streptococci were reported the latter predominating. 30cc Melange Serum and 20cc Leclainche & Vallée Serum was given.

September 8th Streptococci only were reported and on several

occasions Leclainche & Vallée Serum was repeated. There was no infection after the 20th September and the wound healed up without further trouble.

Let us compare the results on the series of cases which the writer collected; shown on the big charts. A. B. C. D.

1. Those for the years 1915-17 Fractures of Tibia and Fibula. (Chart D)
2. Similar cases of 1918 after serum therapy treatment was adopted.

In 1915-17, amongst 40 cases there were:-

14 severe streptococcal & gas gangrene infection of which
3 died - all due to gas gangrene i.e. 21.4% of the badly infected cases
12 amputations - all for gas gangrene i.e. 85% " " " "

In 1918, amongst 107 cases there were:-

65 gas gangrene and streptococcal infections in which there were:-

5 deaths - 1 only due to gas gangrene i.e. 1.5% of these badly infected cases

1 due to intestinal obstruction - after recovering from a severe generalized gas gangrene infection.

1 due to haemorrhage.

2 due to streptococcal septicaemia i.e. 3% of the badly infected cases.

10 amputations - 6 for gas gangrene.)
4 for streptococcal infection) i.e. 15.3%.

In collecting the above cases the writer chose a series of which she had personal knowledge. Reports from the majority of these patients were received Xmas 1919, and can therefore be vouched for. From the Mortality and Amputation figures alone it may reasonably be granted that a beneficial result was obtained in cases where serum therapy treatment was adopted.

That the curative treatment was more speedily effective than that of Anti Tetanic Serum may be due to the fact that these Anaerobic organisms produced exotoxins, having no predilection for the Central Nervous System, like that of Tetanus; and which it was possible to neutralize in the tissues where they were formed.

The question of Anaphlyaxis was one which the writer was prepared to follow up with very keen interest, but during the two years spent at the hospital, no such opportunity was afforded. Only one case occurred - a case developing immediately after the second injection of Anti Tetanic Serum - given 9 days after the first dose. The clinical picture was a typical one - with sudden acute congestion of the face; eyes, lips, becoming swollen, whilst dyspnoea and signs of suffocation were present. In addition to which, gastro-intestinal symptoms, less frequently met with in ^{the} human, were very marked. On the administration of normal saline, given subcutaneously, the symptoms subsided in half an hour. The cause of the onset in this particular case was not forth coming. That Anaphlyaxis did not occur in cases treated by the Anti Gas Gangrene and Polyvalent Leclainche & Vallée Serum, can only be accounted for by the fact that normal saline was administered at the same time - either intravenously, subcutaneously or per rectum. No other precautions were taken and - as will be seen on looking at the charts - serum was given irrespective of the intervals between doses. No Anti-anaphlyactic precautions were taken at the Pasteur Institute, previous to the issue of the serum for general use. With regard to serum sickness no case of any intensity is recollected.

This paper was started before the Report of the Medical Research Committee No. 39. was issued. In this report only 89 cases of the many thousands, which must have benefited by the British Serum are quoted. The serum used in these did not contain the Bacillus Oedematiens - one of the most frequent of the anaerobes found in the flora of war wounds. This may be due to the fact that it had not been so universally isolated from war wounds before the official Welchii - Septique Serum was issued. It is agreed by the Medical Research Committee that their serum could not be expected to prove efficient in many of the cases of gas gangrene; and secondly that workers were handicapped by the difficulty of obtaining - in this country - specimens of infected muscle, from those cases, which did not re-act to the Welchii-Septique Serum given in France.

That better results were obtained by the mixed anti gas gangrene serum (Mélange) may be attributed to the facts:-

1. That serum was plentiful at the hospitals named.
2. That serum therapy treatment was begun at once.
3. That it was universally given - as far as possible.
4. That it was possible, within a very short time after wounding, to isolate the predominating organism from the wound and accordingly give the required anti sera.

The following then are the conclusions to be drawn from the cases presented:-

That when the Bacteriologist and the Medical Officer co-operate, it is possible, at an early date, to isolate the predominating organism and to anticipate its growth.

That Anti Gas Gangrene Serum and Polyvalent Leclainche & Vallée Serum have proved beneficial in Septicaemias.

That severe Gas Gangrene Infections remained localized under the influence of Anti Gas Gangrene Serum.

That Streptococcal Infections derived much benefit from the Polyvalent Leclainche & Vallée Serum. That the said infections were more difficult to control than were the Gas Gangrenes, is evident from the fact that several patients succumbed to Streptococcal Septicaemia. Whether this was due, to the fact that specific Anti sera had not been prepared for all the different strains of Streptococci met with in the later years of the war, cannot be discussed here.

That, in the event of re-infection following trauma - an occurrence likely to happen during the next few years, in cases of soldiers, who have been previously wounded in France - the above named sera might be used with great advantage.

That cases of joint infections may be treated by:-

1. Subcutaneous injections of anti serum.
2. By a local application of Leclainche & Vallée Serum.

That an important and valuable means of treatment is now at our disposal; that similar methods - the general and local application of sera - may be applied to other joint infections of

Various types, which have so far resisted treatment.

In the writer's opinion, arthritic affections, local and generalized, due to tubercle or gonorrhoea may also be benefited by specific anti sera and this she hopes to show at some future date. It is here suggested that tubercle may be due to a *Streptococcus* or a *Streptothrix* and may re-act to treatment as have other types of *Streptococci*.

References

Medical Research Committee - report series No. 39.

Reports of the Committee upon Anaerobic Bacteria Infections.

Weinberg and Séguin - La Gangrène Gazeuse. 1918.

Wallace - British Medical Journal 1917, 2nd June.

Ivens - Proc. of Royal Society of Medicine. 1917 Vol. X .

" - British Medical Journal 1918, October.

Gregoire & Mondor - La Presse Médicale. Avril 1917.

Leclainche & Vallée - " " " " 2nd "

Henry - Investigation of cultural re-actions of certain anaerobes
found in war wounds 1917.

Elliott & Henry - Infection of Haemothorax by Anaerobic gas
producing Bacilli. 1917.