

CLINICAL ASPECTS OF TYPHUS FEVER:

OBSERVATIONS ON SOME 2,000 CASES IN
A PRISON CAMP IN GERMANY.

BY

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AND

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We were captured on August 26th and 27th, 1914, and were kept in various prisons with other British officers, without being employed in our medical capacity, until February 11th. On this date we were sent to Gardelegen, and made our first acquaintance with a *Kriegsgefangenen Lager* for non-commissioned officers and men.

THE CAMP AT GARDELEGEN.

The camp at Gardelegen is situated in an opening amongst pine forests, on a gentle slope facing north-west. The soil is excessively sandy, and is in winter a sea of most appalling mud, and in summer a perfect horror of dust.

When we arrived there was about a foot of snow on the ground, and this continued with scarcely any intermission until the middle of April.

The camp occupies an area of about 350 by 550 yards. It is surrounded by a triple fence of barbed wire about 8 ft. in height. Within, the camp is divided in two equal parts, known as the first and second battalions. Each battalion is again subdivided into four companies. Each company is 230 metres (252 yards) long and 52 metres (57 yards) broad. In each company there are two rows of three barrack rooms, built facing each other. Each room is intended for 300 men. Each company is quite self-contained, with its own administrative staff of officers and under officers. The prisoners of one company can see and even talk to those of another, but they are separated from each other by barbed wire fences, and in normal times do not leave their company. Each of the two battalions has its own cookhouse, where the preparation of the food is done by the prisoners, assisted by some German women.

The total number of prisoners is between 11,000 and 12,000, made up chiefly of Russians and French, the latter slightly predominating; and include about 800 or 1,000 Belgians and 230 British prisoners.

At the upper end of the camp is a hospital which contains 200 beds. It is grossly overcrowded even in ordinary times; and allowing even the minimum cubic space per patient, it should not have contained more than 90 beds. The dimensions of a ward containing 62 beds are: Length, 25 metres (=27½ yards); breadth, 10.5 metres (=11½ yards); height, 2.80 metres (=3 yards).

Conservancy.

Each company has its own latrine and urinal under one roof. These are permanent latrines, built over trenches about 7 ft. deep with boarded sides. They are emptied at irregular intervals by hot air suction pumps into tank carts. The hand system of emptying into carts is also employed as a supplementary measure. The entire supervision and management of these latrines is erratic in the extreme. It is a frequent occurrence for a latrine to overflow and its contents to foul a large area of ground around.

Water Supply.

This is drawn from the main supply of the town. It is pumped to a water tower and distributed by pipes. Wells have also been dug, but are generally out of action for various reasons. We were informed that a bacteriological analysis of the water was made weekly. The water supply is very insufficient even in winter. The supply is cut off most days from 10 a.m. until 3 or 4 p.m. in the hospital, and the supply in the rest of the camp is even more precarious.

Ablution.

In each company are one or two stand-pipes leading to troughs used for personal ablution, washing of clothes, and washing of eating utensils. There is also one bath-house

for the entire camp, in which are twenty-four shower jets. The number of men who could pass through this place in an ordinary working day is never large, and there are many days on which for some reason or other the apparatus is not working. The men could occasionally get a small handful of soft soap on entering the baths. Inquiries showed that no man could go to the bath unless he was detailed to go, and many men waited for more than one month—some nearly three months—till their turn came round. It is only fair to say that, recognizing the gross inadequacy of the bathing facilities, the Germans hastily erected, towards the end of the epidemic, a second bath-house, with a dry heat disinfecter attached.

Barrack Rooms.

The dimensions of these buildings are: Length, 65 metres (= 71 yards); breadth, 10 metres (= 11 yards); height, 2.80 metres (= 3 yards); giving a cubic space of 1,820 metres. Each barrack accommodates 300 men, giving approximately 6 cubic metres a man (= 21.87 cubic feet a head). The barracks and camp generally were lit by electric light. Ventilation is carried out mainly by doors and windows, and is very defective. The prisoners live in an atmosphere of fetid warmth. Each barrack room is divided up into two parts, and each half is heated by a closed stove. The men sleep on palliasses on the ground in four rows—the palliasses nearly touching. No tables or chairs are provided. Each man gets a small enamelled bowl and a spoon, and a larger bowl for washing purposes, and a towel.

There is a plentiful supply of blankets, and the men do not appear to have suffered from cold in their rooms last winter.

The four nationalities are distributed as far as possible in equal proportion in every room. Very stringent orders were issued to ensure that English and Russian prisoners should always occupy the same rooms together.

Meals are usually as follows:

From 6 to 7 a.m.: A black liquid which claims to be coffee, accompanied by the slice of bread which forms each man's daily allowance.

From 11 to 12 noon: Soup made with meal, barley, potatoes, or preserved vegetables, and a suggestion of meat or fish. Each man gets about two pints of this.

From 4 to 6 p.m.: A soup of watery consistency in similar amounts.

In June the amount of bread was reduced to 250 grams a head a day.

The foregoing brief description of the camp is necessary for a proper understanding and appreciation of the conditions which obtained when the epidemic started.

THE EPIDEMIC.

The earliest cases of typhus which occurred were mild and atypical, and had undoubtedly been unrecognized. There was at this time a large number of cases of scarlet fever and of acute tonsillitis with anomalous rashes. When typical cases occurred, a few days after our arrival in the camp, a commission of German doctors came, to whom our French colleagues and we showed the cases, which had aroused our suspicions. These cases were at once pronounced to be typhus. Immediately the camp was declared to be in quarantine, and every German officer, under officer, and man was withdrawn. The locked gates between the various companies were opened, allowing the prisoners to circulate freely anywhere within the camp limits. It will thus be seen that any hope of limiting the outbreak to the companies from which the first cases came was instantly destroyed.

In the hospital the German doctor remained in charge till he contracted typhus a few days later. He quickly succumbed to the disease. All the German hospital orderlies were withdrawn from the onset, and thereafter the sick were nursed by their fellow prisoners.

CLINICAL ASPECTS.

Etiology.

The case against the body louse as the carrier of the disease appears quite clearly established as far as clinical observation can make it. The lice swarmed everywhere in the camp; it is not too much to say that every prisoner in the camp was infested with them. On the other hand, there was a singular immunity from other parasites. We never once saw fleas or bugs. The transference of lice

was facilitated by the gross overcrowding and the lack of facilities for personal cleanliness. The mixing of the nationalities in the rooms of course led to a nearly equal race incidence. The general power of resistance was considerably lowered by malnutrition, confinement, and mental depression. There is some vague but interesting evidence for the influence of mass dose infection, in the heavier incidence and case mortality amongst those most exposed to infection. These were seen in the following order: First, sick attendants; secondly, doctors; thirdly, prison population generally.

Age.

The average age of the population was probably 29. It must be remembered that the prisoners were nearly all reservists in their armies. Apart from a few Belgian civilians there were no persons of the extremes of life. We found, however, that the prognosis was distinctly graver in persons over 40, of whom there were considerable numbers in the camps. Most of the material for statistical purposes was taken by our captors, so we are unable to substantiate this, and many other statements, by figures. They must therefore remain largely the impressions we formed from a study of some 2,000 cases.

There is no evidence that the infective agent is carried by any of the dejecta. The twelve doctors in the camp who contracted typhus were all nursed by the same six orderlies. The period of attendance of these orderlies lasted in all over three months; their personal precautions in the handling the dejecta were of the scantiest, yet none of these attendants contracted the disease. The explanation that occurs to us is that they nursed their patients in separate huts, and they and their patients remained for the whole period lice-free.

The case incidence amongst the orderlies employed in the hospital where lice swarmed was excessively high, as will be seen below. There is further evidence against the infectivity of dejecta in the fact that several patients remained in hospital for long periods, suffering from other diseases, but nursed by the same orderlies as attended the typhus cases, yet these in all cases escaped the disease, as long as they were protected from lice. We found evidence that the infective agent resides in the body for at least three weeks after defervescence. Fresh outbreaks occurred when patients were returned to their companies after the three weeks' period, though they and their clothes were disinfected and were presumably lice-free. When this period of isolation was extended to one month, recrudescence of the epidemic in the companies of these returned patients did not occur.

Incubation Period.

Our observations on this point show it to be extremely variable. From the two fresh outbreaks mentioned above it would seem to be from seven to twelve days. One doctor contracted the disease fourteen days after entering the camp, another sixteen days after, a third twenty-one days after, and this was the longest period which could be accurately fixed.

SYMPTOMS.

The onset is sudden and fairly well defined, but the severity of the initial symptoms is variable. The most constant are general malaise, cold shivers, headache generally confined to the frontal region, and tenderness of the eyeballs. A definite rigor is extremely rare in our experience. Coupled with the above is a sense of lassitude and faintness; our French patients invariably described themselves as "complètement courbaturé." In many cases the patient is suddenly seized with general convulsions which subside into a fairly active delirium; these cases were not by any means always of bad prognosis.

Epistaxis at some time in the course of the disease is extremely characteristic. We were accustomed during the epidemic to regard this as pathognomonic. In more than half the number of cases in which it occurs it is seen in the first three days of the disease and is often very profuse and persistent. In the remainder it occurs between the middle and end of the pyrexial period.

Early Symptoms.

In speaking of the early symptoms, an important practical point is the correlation of the pulse-rate and tempera-

ture. One of us (A. J. B.) kept a careful record of pulse-rates and temperatures of those men who reported sick in their barrack rooms. It was found that at the hour that these men were seen (from 9 to 10 a.m.) many presented for one, two, or even three days the symptoms of headache with rapid and increasing pulse, whilst the temperature was normal, the evening rise of temperature not being observed. It was possible to make a provisional diagnosis and isolate these cases, which, with very few exceptions, proved to be typhus.

Table I gives some cases illustrating this point.

TABLE I.—To Illustrate the Correlation of the Pulse-rates and Temperature in the Early Days of the Disease.

	Day of Illness.	Temp. C.	Pulse.	Symptoms.
Patient No. 232	2nd	36.8°	98	"Courbaturé," headache.
	3rd	37.0°	120	As above.
	4th	36.6°	116	"Courbaturé," headache better.
	5th	38.0°	130	Very ill; rash on abdomen.
Patient No. 390	12 hrs.	37.2°	72	General malaise.
	2nd day	36.8°	100	Headache, etc.
	3rd "	37.0°	92	No headache; still "courbaturé."
	4th "	37.2°	110	As above.
	5th "	36.4°	116	Headache, "courbaturé."
	6th "	37.4°	128	Rash, epistaxis, headache.
Patient No. 228	2nd day	36.4°	120	"Courbaturé."
	3rd "	37.0°	132	As above.
	4th "	36.8°	128	As above.
	5th "	37.2°	140	Rash, "courbaturé," headache.
Patient No. 265	3rd day	37.0°	116	Headache.
	4th "	36.8°	98	Feeling better.
	6th "	37.5°	126	Headache, epistaxis, rash.

In the first three or four days of the disease congestion of the conjunctivae and occasionally swelling and redness over the malar eminences are seen. Later, slight nasal discharge with obstruction in the nasal passages is very commonly noticed. Subjectively, a sensation of congestion of all the air sinuses is common.

Temperature.

In most typical cases there is an initial rise with morning remissions and a characteristic saddle-back fall on the third or fourth day; thereafter there is a rise with the onset of the rash to 103° or 104° with very slight remissions till the thirteenth or fourteenth day, when the temperature falls by a not very abrupt crisis (see Fig. 1). Fall by lysis during the eleventh, twelfth, thirteenth, and fourteenth days is also seen (see Fig. 2). In both cases there is often a slight reactionary rise at the beginning of the convalescent period.

Hyperpyrexia was never seen. Cases with a low irregular temperature throughout and marked asthenia were generally of very bad prognosis.

Prodromal Rash.

We saw occasionally what we regarded as a prodromal rash (P.C.T.D.). It appears on the backs of the wrists and exterior surface of the forearms as a vague but definite mottling resembling much the mottled skin of the young infant. It is seen twenty-four hours before the typical rash appears, is very transient, and is often quite gone before the main eruption is seen. It is generally an indication that the subsequent rash will be profuse.

The Eruption.

The typhus eruption appears usually on the fifth day. We saw it rarely as early as the third and as late as the seventh day.

It first appears on the upper abdomen and thence spreads upwards and downwards. Its usual limits are the level of the nipples above and the intertrochanteric line

below. The rash is indeed often well developed in the region of the hip-joints. Very rarely indeed does it appear as high as the neck and down to the calves of the legs. The face always escapes.

The rash is somewhat polymorphic. Degrees of intensity of eruption varying from seven or eight ill-defined macules, and so transitory as almost to pass unnoticed, up to a profuse morbilliform grouping are seen. In every case the macule becomes haemorrhagic within twenty-four hours of its appearance. Macules vary in size from that of a pin's point to 3 mm. in diameter. We looked in vain for anything in size or colour justifying its ancient appellation, "mulberry." The macules when matured are reddish-coppery colour, and leave a copper stain for from three to five days. A fairly profuse, very fine desquamation is the rule during convalescence.

As the disease progresses a slight cough is present in nearly every case, accompanied by thin muco-purulent expectoration, which is often of fetid odour.

In the multiplicity of smells which pervaded the hospital we were unable to detect any characteristic odour of the disease. The tongue, coated with white fur in the first twenty-four hours, quickly develops a central brown band; later it is wholly brown and dry, and accompanied by

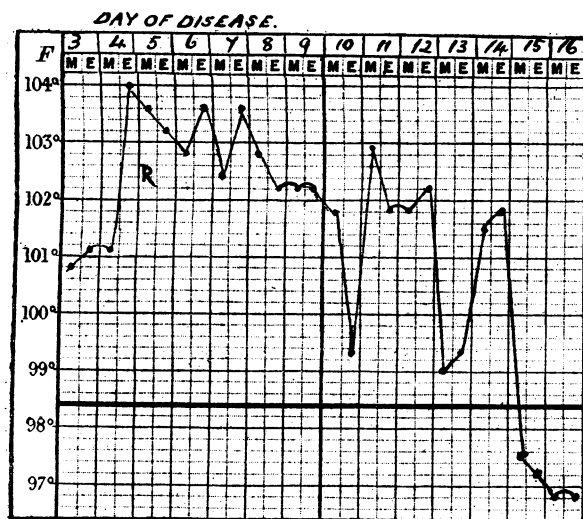


Fig. 1.—R, Rash.

exceeds perception to watch contact. It is apparently of the conductive order. It seldom appears before the eighth or ninth day. It is in no way dependent on the mental state; indeed it is seen in its most marked form in those whose minds remain clear throughout.

It often persists well into the third week of convalescence. It is not dependent on suppurative otitis media (of which we speak later). As far as we could see, the hearing always completely returns.

Delirium occurs at some time in the course of the disease in about 75 per cent. of the cases. It is usually active and often extremely violent. Persistence and violence of delirium is generally of grave prognosis. It may persist after the temperature reaches normal. Real mania is occasionally seen, accompanied by hallucinations of sight and sound. It is of interest to note that hallucinations were often connected with the "fighting line."

Types of the Disease.

It is a disease difficult to classify into types. All degrees were seen, from the very slight larval form to those with initial symptoms of extreme gravity and a fatal termination on the eighth or ninth day.

Cerebral Type.—This is perhaps not happily named, as

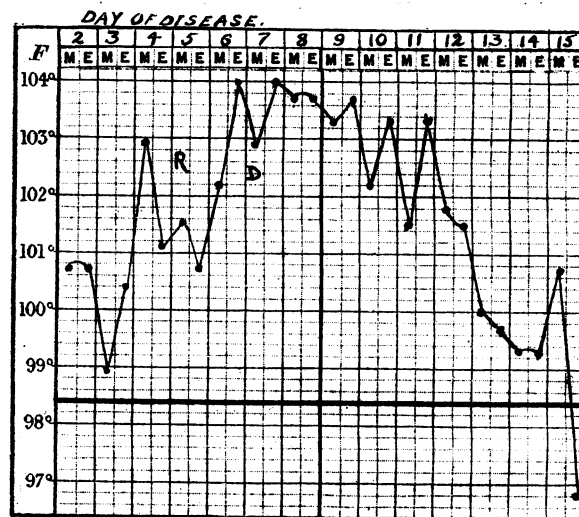


Fig. 2.—R, Rash; D, delirium.

sordes and general oral sepsis in an extreme degree. One of the earliest signs of a favourable turn in the disease is a moistening and cleaning of the tongue.

In a typical case of moderate severity the initial headache grows more intense and persists till the eighth or ninth day, when delirium usually supervenes and the patient does not complain of headache in his lucid intervals. The patient becomes weaker, the tongue is with difficulty protruded, the hands tremulous. With the full development of the rash he is usually in what may be called the "typhus state." The following table contains an attempt to contrast this with the "typhoid state":

Typhus State.

1. Is not commensurate with physical weakness.
2. A condition of mental hebetude and slow cerebration from which the patient can be roused.
3. A vacant stare, tendency to divergent squint, and a condition which is best described by the expressive French word "abrutissement."
4. A delirium more active and often violent.
5. Appears early in the course of the disease and develops quickly.
6. Often accompanied by evidence of cortical irritation, twitching, and hyperaesthesia.

Typhoid State.

1. Is commensurate with the physical weakness.
2. Cannot be roused when fully developed.
3. A more profound stupor.
4. Low muttering delirium.
5. Appears later and develops more gradually.
6. Not so.

Deafness is another symptom which we observed in certainly more than 50 per cent. of cases. This very often

the nervous system is affected to a greater or less degree in every case. The cases were of two kinds:

- (a) One with very early delirium and slight convulsions, well marked cutaneous hyperaesthesia, incontinence of urine and faeces, resentment of examination or disturbance. Prognosis most grave of all.
- (b) With early onset of mild delirium, early prostration, but with absence of other symptoms of (a). Prognosis quite favourable.

High-tension Type.—We have ventured to so name a certain type of case from its clinical appearance. It was not uncommon. It is characterized by absence of grave cerebral symptoms. The temperature is moderate. The headache is generally extreme, violent, and persists throughout the entire pyrexial period. There is a sensation of intense discomfort in the maxillary and frontal sinuses, great tenderness of the eyeballs, and marked photophobia. There is no delirium, but the patient is mentally very irritable. The pulse-rate is relatively very slow throughout, but is very full and bounding. A chart characteristic of this type is shown in Fig. 3.

Abdominal Organs.—Taking the disease as a whole, neither diarrhoea nor constipation are the rule; perhaps the latter was most often seen. The spleen was rarely enlarged to palpation point, and then only in severer cases and in the later stages—that is, the twelfth to the fourteenth day. The liver is occasionally enlarged. A mild degree of jaundice was seen in some three cases—all fatal.

Urine.—Albumin is usually present, but disappears early in convalescence. Retention of urine to a degree needing catheterization is very rarely seen.

COMPLICATIONS AND SEQUELAE.

Respiratory System.—Hypostatic congestion was seen in a considerable number of cases, some of which terminated fatally; yet on the whole the lungs escape in a remarkable manner. As has been mentioned, the majority of patients have some slight cough and expectoration. In some cases there is a profuse secretion of viscid and extremely tenacious mucus. We recall two cases in which such grave obstruction was thus caused that the question of tracheotomy was seriously discussed.

Pyæmia.—One case terminated fatally with pus in the larger joints and multiple superficial abscesses.

Otitis media (suppurative) was extremely common. The intense oral sepsis which most patients exhibited (the result, no doubt, of our limited nursing facilities) is sufficient to account for this.

Suppuration of the parotid was very common for the same reason.

Cardiac System.—There is an extensive degeneration of all muscle tissue, and the heart muscle naturally does not escape. We found evidence of this to a greater or less degree in every case. During convalescence a pulse, intermittent and of persistent rapidity, was extremely common. Dilatation bruits were commonly heard. Syncopal attacks frequently occurred, and we saw many sudden deaths in the early days of convalescence.

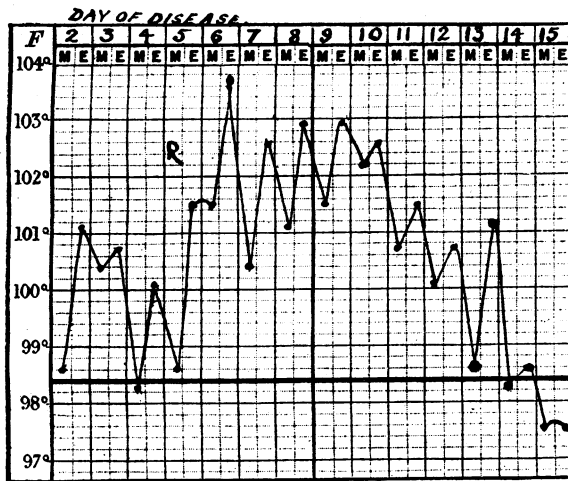


Fig. 3.—R, Rash.

Gangrene of the feet occurred in a few cases, and was invariably a fatal complication.

Bedsores unfortunately were frequent. The lowered vitality of all the tissues renders the patient specially liable to this complication.

Peripheral Neuritis.—A sequela distressing to the patient and difficult to deal with is a condition of peripheral neuritis which manifests itself as extreme painfulness and tenderness of the extremities. It is seen in the first or second week of convalescence. We met this condition very often, but never observed any accompanying trophic or circulatory change. It adds considerably to the discomfort of a patient already helpless from prostration. More rarely sciatica and neuralgia of the fifth nerve is seen as a later sequela.

Scarlet Fever coincident with Typhus.

We saw a few cases, all of which terminated fatally. Several cases of typhus supervening upon scarlet fever were seen, and several of these recovered.

PROGNOSIS.

From this somewhat formidable list the impression may be gained that typhus is a disease of many and grave complications. In our opinion this is not so. The vast majority of cases run an uncomplicated course. Given proper facilities for nursing and supervision, many of these troubles would be avoided or successfully dealt with.

The symptoms of grave prognosis we found to be early violent and persistent delirium, signs of cortical irritation, incontinence of urine and faeces, and well-marked jaundice. The intensity of the eruption was of

no prognostic value. The convalescence in the majority of cases was extraordinarily rapid and complete.

The mortality in our 2,000 cases was 15 per cent. The mortality-rate amongst the French and Belgian prisoners was the highest. Next came the British; there occurred 129 cases amongst the 230 British present in the camp, with a mortality-rate of 6 per cent.

The Russian mortality was the lowest. There is no doubt we were fortunate in having a milder type of the disease in our camp. Since our return we have learnt that in other camps—notably Cassel and Wittenburg—the mortality percentage was far higher.

There were 10 French abbés in the camp, all of whom volunteered their services as nursing orderlies, and displayed devotion and zeal beyond all praise. Of these, 8 (80 per cent.) contracted typhus, and 5 (62 per cent.) died.

There were 16 doctors of different nationalities in the camp. Of these, 12 (75 per cent.) contracted typhus, and 2 (16 per cent.) died.

The British soldiers employed as nursing orderlies numbered 22. Of these, 20 (91 per cent.) contracted typhus, and 2 (10 per cent.) died.

The figures for the French and Russian nursing orderlies we have not got; but they were practically the same as for the English.

TREATMENT.

The secret of the successful treatment of typhus lies (as with enteric fever) in the nursing of the patient. Force of circumstances condemned our patients to starvation diet, and they did well on it. Absolute rest in a recumbent position is essential from the onset; as is also the care of the mouth. Plenty of liquid should be given throughout the disease. Solid diet of the most easily assimilated character should be given as soon as the tongue begins to clean, at which moment a vigorous appetite usually asserts itself. The patient should be kept in bed until the pulse has been normal at least one week. In those cases in which special attention could be paid to the condition of the mouth, the ear and parotid, complications did not occur.

Our energies in the matter of medication were curbed by a scarcity and even lack of all but some four drugs—namely, calomel, aspirin, quinine, and Epsom salts. Generally speaking, two lines of treatment were attempted.

1. *Early and continuous stimulation*, mainly by hypodermic and intramuscular injection of camphorated oil, and to a lesser extent of strychnine and ether.

2. *Purely expectant and symptomatic*, combined with free use of morphine in every case in which it was not obviously contraindicated. Our preference was, and still is, for the second method. We are inclined to regard morphine as a sheet anchor in most cases, and we never had cause to regret its use. At any rate, it satisfies some of the Hippocratic injunctions.

In regard to the first line of treatment the immense crop of abscesses which resulted (in many of which the unabsorbed camphorated oil was evacuated) condemns it at once, in our opinion, in the absence of any perceptible beneficial result. A large number of cases were tried, on the recommendation of the Germans, with *m iij* of tincture of iodine t.d.s., increased gradually. No benefit was observed.

Prophylaxis.

As regards personal prophylaxis, a rigorous search of the clothing for parasites was made twice daily by all the hospital staff. As parasiticides, powders containing iodoform, camphorated oil, and various proprietary lotions, were tried, but with disappointing results. An outfit consisting of overalls with trousers tucked into gum boots, and rubber gauntlet gloves, would, we consider, make for practical immunity.

TRIBUTE TO FELLOW WORKERS.

In conclusion, we feel we must take this opportunity of placing on record our appreciation of the whole-hearted and harmonious co-operation of our Russian and French medical *confrères*. The work, both of organization and treatment, was divided up amongst us without distinction of nationality, though naturally the confusion of tongues (as far as our Russian fellow prisoners went) sadly hampered our efforts.

Further, the services rendered us by those British soldiers in the camp who volunteered to act as nursing orderlies,

will not soon be forgotten by us, nor by the patients they tended so devotedly. Knowing the risks they ran they were indefatigable in their efforts for their comrades—British, French, and Belgians alike. The toll they paid for their devotion is shown in the figures we give above.

ON THE RECRUDESCENCE OF LOCAL SEPSIS IN COMPLETELY HEALED WOUNDS

AS THE RESULT OF SOME SURGICAL INTERFERENCE
OR PASSIVE MOVEMENT.

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(A Report to the Medical Research Committee.)

In an article published in the BRITISH MEDICAL JOURNAL of September 25th under this heading by Colonel C. J. Bond, R.A.M.C., various questions are raised involving the power of organisms to remain dormant in the tissues, and to become suddenly active after some slight surgical interference. This problem has also impressed us, and in a long series of cases routine bacteriological examination has been undertaken of the tissues surrounding fragments of shell, shrapnel bullets, etc., which have remained imbedded in the body for varying times, but in which the wound of entrance has healed. In such cases it has become necessary to remove the fragment owing to pain or other cause. Two conditions are found:

1. The fragment is enclosed in a cavity lined by a smooth wall, and containing a glairy, mucoid fluid.
2. The fragment is tightly surrounded and adherent to the tissues, with no surrounding fluid.

Bacteriological examination was made from the fluid or from the fragment itself, including pieces of cloth carried in with the fragment. In a case under our care organisms have been obtained in pure cultivation from a piece of cloth carried into the wound, without any signs of surface supuration.

The routine method of examination in all cases was as follows: Swabs were made from the incision before the foreign body was exposed, and from the cavity after exposure. Any fragment of cloth was removed intact to a sterile tube. Films were made from the material and stained by Gram's method and counterstained, and by Giemsa. Cultivations were made on (1) glucose formate broth; (2) egg broth recently boiled, with a layer of paraffin (anaërobic); (3) stab cultures on gelatin. The cultures obtained were plated out under aërobic and anaërobic conditions, and the organisms subsequently tested.

The aërobic and anaërobic organisms were thus determined, and in some instances anaërobic only were isolated.

The following cases illustrate the fact that organisms may remain for a considerable time in the vicinity of the foreign body without giving rise to constitutional symptoms.

CASE I.

Private W. M. M. was wounded by shell fragments on November 2nd, 1914, one entering just below level of right knee-joint on the outer side of the tubercle of the tibia. The wound healed at once and had never discharged. Several months later the patient began to be conscious of pain on kneeling or upon pressure on the outer side of the knee-joint. Radiographic examination demonstrated a fragment of shell casing embedded in the outer condyle of the tibia, $\frac{3}{8}$ in. from the articular surface. On August 9th, 1915, the fragment was removed by trephining the outer condyle of the tibia. There was no pus or fluid around the fragment, but attached to it was a small piece of cloth. This was removed and immediately dropped into a sterile tube. The wound was flushed with saline, and closed by suture; healing occurred by primary union.

Films failed to reveal the presence of any organisms. No growth appeared on any media for forty-eight hours, when gas formation took place in the glucose formate broth, and an organism identified as *B. proteus* was isolated in pure culture. This organism alone was present in the

anaërobic and gelatin cultures. The organism, moreover, agglutinated with the patient's serum in a dilution of 1 in 600. Normal man's serum gave no agglutination in 1 in 50. Culture from the incision was negative.

In cases in which mucoid fluid surrounded the fragment, *B. perfringens* (*B. welcheii*), streptococci, and a large Gram-positive diplococcus, etc., have been found.

CASE II.

Lieutenant W. Shrapnel bullet wound of right shoulder, probably ricochet. External wound healed over. Six days after injury deformed bullet removed by incision. Bullet, not in contact with bony surface, was surrounded with mucoid fluid. Films showed numerous cells, mostly mononuclear, but no organisms. The aërobic cultures gave no growth. Anaërobic cultures, on the other hand, gave a growth of Gram-positive, non-motile bacilli, conforming to the type of *B. perfringens*. The wound healed without complication.

CASE III.

Lieutenant R. Multiple small shrapnel case fragments in right shoulder. External wound healed. Fragments in closed cavity, surrounded by thick cartilaginous granulation tissue. No pus or fluid. Films showed a few cells of mononuclear type and a few Gram-positive cocci. Aërobic cultures gave no growth after seven days. Anaërobic cultures gave a growth of large Gram-positive cocci only.

These cases serve to show that organisms may remain dormant without causing clinical symptoms, and at the same time explain the lighting up of local inflammation long after the external wound is healed.

The recrudescence of local sepsis in healed wounds is by no means infrequent, and we have observed many instances, of which the following are examples:

CASE IV.

Lieutenant D. Motor accident on June 28th, 1915, when he sustained comminuted fracture of the lower end of the left femur. One sharp spicule pierced the upper pouch of the knee-joint and the skin immediately above the patella. There was also an oblique fracture of the left tibia and a simple fracture of the left radius. The area in front of the knee-joint was well scrubbed with iodine under an anaesthetic. On July 8th all the effusion into the knee-joint had disappeared. On August 12th the fractures were well united, but the patella was fixed to the articular surface of the femur and lateral movement of the patella was begun. On August 14th there was tense effusion of the knee-joint. On August 15th fluid was drawn off into a sterile tube. The fluid separated into three layers—an upper clear yellow fatty, a middle red clear, and a lower purple. Smears from the lowest layer showed numerous streptococci and diplococci, very few of them within the pus cells. The organisms stained well, and showed no signs of plasmolysis. A pure culture of a long-chained streptococcus, growing best under anaërobic conditions, was obtained.

These streptococci had evidently gained entrance to the knee-joint at the time of the fracture, but had remained dormant until lit up to an acute process by the simple expedient of breaking down the adhesions between the patella and the femur.

CASE V.

Private G. A. Severe gunshot wound of lower right arm on May 5th, 1915, with compound fracture of the humerus $\frac{1}{2}$ in. above the lower articular surface. On May 9th the wound was opened under an anaesthetic. It was very septic and foul-smelling; several pieces of bone and cloth were removed. The fracture was comminuted, extension was applied, and the wounds thoroughly drained. Bacteriological examination made at the operation showed the presence of a large number of organisms in the pus: Gram-positive bacilli, a few with spores of clostridial form; Gram-negative bacilli, fine and slender, with oval terminal spores; Gram-negative diplobacilli; and Gram-positive cocci. The aërobic cultures gave *B. proteus*, streptococci, and staphylococci. The anaërobic cultures gave a large number of motile bacilli, Gram-positive, with oval central spores, staining irregularly by Gram's method. Many free spores were also present. Gram-positive bacilli, non-motile and capsulated, were also found. In addition, many long-chained streptococci were observed. The bacillus of malignant oedema—*B. perfringens*, and an organism similar to *B. rodella* 3—were isolated anaërobically. The wounds were merely covered with layers of sterile gauze soaked in peroxide, and oxygen passed in twice daily. On May 31st, as the fragments could not be retained in alignment, a vertical incision was made through the triceps, the ends freshened and wired together. On August 13th, the wounds being entirely healed, there being little movement of the elbow-joint, the elbow was moved under an anaesthetic, which was followed next day by diffuse inflammation about the joint, requiring superficial incisions. Again, on August 30th, passive movement in the joint produced intense inflammatory reaction.