



No. 32

(NEW SERIES)

SCIENTIFIC MEMOIRS

BY

OFFICERS OF THE MEDICAL AND SANITARY DEPARTMENTS

OF THE

GOVERNMENT OF INDIA

AN ENQUIRY ON ENTERIC FEVER IN INDIA

CARRIED OUT AT THE CENTRAL RESEARCH INSTITUTE, KASAUJI
UNDER THE DIRECTION OF

LIEUTENANT-COLONEL D. SEMPLE, M.D.
Director of the Institute,

AND

CAPTAIN E. D. W. GREIG, M.D.

ISSUED UNDER THE AUTHORITY OF THE GOVERNMENT OF INDIA
BY THE SANITARY COMMISSIONER WITH THE GOVERNMENT
OF INDIA, SIMLA.



CALCUTTA

SUPERINTENDENT GOVERNMENT PRINTING, INDIA

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ENTERIC FEVER IN INDIA.

A report of the enquiry carried on at the Central Research Institute.

CONTENTS.

PART I.

	PAGE.
1. Introduction	1
2. General Summary	5
3. Observations on cases convalescent from enteric fever	7
4. Evidence in favour of epidemics of enteric fever being caused by "chronic bacilli carriers"	11
5. Evidence showing that enteric fever is contracted by orderlies whilst in attendance on cases	23
6. Evidence showing that orderlies on enteric fever cases become "bacilli carriers"	23
7. Diagnosis of enteric fever	25
8. Paratyphoid infections in India	28
9. Results of the examination of specimens of bile obtained <i>post mortem</i> from cases of enteric fever	38
10. The existence of <i>Bacillus typhosus</i> outside the body	40
11. General conclusions	47

PART II.

Appendix.

1. Table I.—Showing results obtained by daily observations on cases convalescent from enteric fever	49
2. Table II.—Showing the results obtained by the Widal reaction and the blood culture method in the diagnosis of enteric fever	106

610
IND

ENTERIC FEVER IN INDIA.

A Report of the enquiry carried on at the Central Research Institute.



I.—INTRODUCTION.

THE enquiry with which this report deals was commenced in April 1906 at the Central Research Institute ; it was conducted by Lieutenant-Colonel D. Semple, R.A.M.C. (retired), Director, Central Research Institute, and Captain E. D. W. Greig, I.M.S., who was placed on special duty for the purpose.

In December 1906 the services of Lieutenant-Colonel F. Wyville Thomson, I.M.S., and in January 1907 the services of Captain D. Harvey, R.A.M.C., were placed at the disposal of the Government of India (Home Department) for employment in connection with the enquiry. The services of Lieutenant-Colonel Wyville Thomson, I.M.S., were replaced at the disposal of the Military Department on the 3rd of September 1907. Assistant Surgeon Paras Ram, Captain F. N. White, I.M.S., and Captain E. C. Hodgson, I.M.S., joined the Central Research Institute to assist in the enquiry in January, August, and September, 1907, respectively.

On July 19th, 1907, Lieutenant-Colonel Semple proceeded on six months' leave to England, and Captain E. D. W. Greig, I.M.S., was appointed officiating Director.

In the case of enteric fever, as in the cases of Malta fever and malaria, after the discovery of the causal agent, a considerable period elapsed before any important fact was added to our knowledge of the disease. During this interval preventive measures had to be of the nature of general sanitary precautions. In attempting to carry out such measures a large amount of energy became dissipated, because, until we have precise knowledge, it is necessary to guard against every conceivable source of infection. As more knowledge of disease is acquired the most usual source of infection becomes apparent and it is possible to concentrate attention on it, with the result that preventive measures become more effective and cause a marked reduction in the incidence of the disease. Clearly one of the most important questions to answer is: Where is the virus of the disease stored in nature? Because if this is ascertained, we are able to explain why disease persists from month to month and year to year, and it is possible to direct measures against this receptor of the virus and thus prevent fresh infection. The additions to our scientific knowledge of Malta fever furnish an excellent

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illustration of the above statements. After the discovery of the causal agent of the disease it was, until very recently, unknown where the virus is stored and how the disease is maintained from year to year. Consequently precautions had to be taken against every possible source of infection; the result being that no appreciable progress was made in eradicating the disease. Finally scientific investigation determined the storehouse of the virus—the goat; preventive measures were concentrated on this source and a marked reduction in the prevalence of the disease resulted. The case of enteric fever in India is similar. The storehouse of the virus had not been determined by scientific investigation. Consequently the persistence of the disease amongst the troops in the cantonments could not be explained. The origin of epidemics remained obscure and was very rarely accurately determined. For the prevention of the disease general sanitary measures were adopted, but the results were not very satisfactory.

Such was the position of the enteric fever problem up to 1902-03, when Koch commenced his important investigations into the etiology and mode of spread of enteric fever. The incidence of enteric fever in Alsace-Lorraine was much higher than in the rest of Germany; consequently the Government requested Koch to conduct an investigation into the causation of the disease there. During the course of the investigations of Koch and Frosch two very important facts emerged—(1) that the saprophytic existence of the parasite outside the body is very short, but (2) that it lives for prolonged periods in the body of man after he had acquired immunity by an attack of the disease. That man, in fact, is the storehouse of the virus, which he disseminates in nature and so infects susceptible individuals. This was a great advance. That the observations were correct was proved by the results obtained by preventive measures conducted in the light of this discovery. Enteric fever was completely eradicated from some villages where it had been constantly present.

The conditions as regards enteric fever in Alsace-Lorraine were very similar to those met with in Indian cantonments. Further, the results of Koch's methods employed in his campaign against enteric were very satisfactory. Accordingly the Government of India decided to depute Captain Greig, I.M.S., to proceed to Germany to study the methods on the spot.

In 1906 an enquiry into the causation of enteric fever in India was commenced at the Central Research Institute.

The problems to be solved were—

1. What is the nature and duration of the saprophytic life of the *Bacillus typhosus*?
2. What is the duration of the life of the *Bacillus typhosus* within the human host?
3. How are epidemics produced?

These problems were attacked along certain definite lines. We made a number of observations on the duration of the life of the parasite outside the human body in urine and fæces; also in articles of clothing, etc., and we found that under natural Indian conditions the saprophytic existence of the parasite outside the body is remarkably short. To ascertain whether the *B. typhosus* continues to live for prolonged periods inside the body of the host, we have made observations for several months on men rendered immune by an attack of the disease. We examined the urine and fæces daily. Our investigations have brought out the important fact that a certain percentage of these immune men harbour the parasite and continue to do so for months and probably years. As a rule the bacilli are not excreted daily, but at intervals, which may be very long, sometimes as long as three months. In urine the bacillus is discharged in enormous numbers, but in the fæces the excretion of the bacillus may persist for a much longer time. These men show no sign of disease, and it is impossible to determine by medical inspection whether they are free from infection or not. In addition to those men who have become immune after a typical attack of the disease (convalescents), we have found men, who have passed through an attack so mild that they have not reported sick, harbouring the parasite; such cases have been observed amongst attendants on enteric fever cases (nursing orderlies). These men return to their regiments and become sources of infection. It is obvious, therefore, that there are scattered throughout the various units of the British Army in India a number of men in whose bodies the virus is living.

During the course of the investigation evidence is being collected as to what extent the natives of India harbour the parasite. Amongst the Native troops cases have been observed. At present the incidence of enteric fever amongst the civil population is being investigated. However, the number of foci of infection among the British troops in India is considerable and would account for a large number of cases of enteric fever, if not for all.

As regards the production of epidemics of enteric fever in India, a scientific study has been made of several of these and the results are fully recorded in this report. We have been able to show conclusively that when individuals harbouring the parasite have to deal with food supplies they are capable of infecting the food and so produce epidemics. Kossel* of Giessen has recently shown that an individual harbouring the parasite infected a milk supply and so produced a milk epidemic. He very pertinently remarks at the end of his paper that the most careful inspection of the dairy, its vessels, water supply, etc., will be vain if we fail to detect an individual harbouring the parasite who is employed in the dairy. Hence great care is necessary in selecting the personnel of dairies, cookhouses, etc., in order to eliminate, if possible, individuals harbouring the parasite.

* Deutsche Med. Wochenschrift, No. 39, 26th September 1907.

As will be readily understood from the above observations, the recognition of individuals harbouring the parasite is of great importance. This can only be done by a careful bacteriological examination of the blood, fæces, and urine of the individual. The technical methods are fully discussed in a previous report and in the present one.

Our investigations suggest the lines for the more effective control of the disease. In the first place segregation of convalescents with careful bacteriological control is essential. The bacteriological examination must be prolonged and thorough, both urine and fæces being examined for a considerable period. The necessity for this will be seen from a perusal of our observations recorded in this report. At present the examination is incomplete or not carried out at all; therefore a number of men still harbouring the parasite are returned to duty. This we have learned from observations made on a large number of convalescents. In the next place the question of attendants on enteric fever cases requires careful consideration. For this purpose a special body of trained men should be employed. The constant change of men from duty as enteric fever orderlies to ordinary regimental duty as at present carried out is, as we shall see, a means of propagating the disease. Lastly, the personnel of cookhouses, dairies, etc., should be subject to careful bacteriological control. As will be seen in the report, the source of two epidemics of enteric fever in India has been scientifically proved, and in both cases the infection originated from a cook harbouring the parasite, who infected the food and so occasioned the epidemic. Food appears to be the most important channel of communication between the harbourer of the parasite and the susceptible individual. This is readily understood when we consider that articles of food, e.g., milk, form a favourable medium for the development of the bacillus.

It will not be a simple matter to put into practice the measures indicated above, but they are founded on scientific observation, and an effort should be made to overcome the difficulties. These difficulties would be considerably lessened by the concentration of the individuals to be examined at one or two central stations with a laboratory suitable for undertaking the examinations required. By such examinations, if properly carried out, individuals harbouring the virus of enteric fever would be detected and the number of foci of infection in the various units of the British Army in India would be diminished, and so, gradually, a reduction in the incidence of the disease would be brought about.

The literature of the subject is not dealt with in this report as a very complete summary with references is given in the Annual Reports of the Sanitary Commissioner with the Government of India for 1905 and 1906, to which the reader is referred.

II.—GENERAL SUMMARY.

The enquiry has been carried out at Kasauli, which is a large convalescent depôt for British troops, at Meerut in Northern India, and Poona in Southern India. Meerut and Poona have large garrisons and enteric fever has been prevalent in both. These three stations have afforded us opportunities for investigating various problems connected with enteric fever.

In this report evidence is brought forward to show—

- (1) That the bacillus typhosus continues to be excreted for long periods in the urine and fæces of a certain percentage of patients convalescent from enteric fever.
- (2) That the number of bacilli excreted in the urine is very large.
- (3) That the excretion of the bacilli in the urine and fæces is markedly intermittent.
- (4) That the "chronic bacilli carrier" exists in different units in India and can cause epidemics and cases of enteric fever.
- (5) That enteric fever orderlies may become "chronic bacilli carriers."
- (6) That enteric fever is a septicæmia from the outset of the disease and that the most accurate method of making a diagnosis is by blood culture.
- (7) That paratyphoid fever exists in India, but the number of cases is, in comparison with infection by *B. typhosus*, small. The *B. paratyphosus* A. (Brion-Kayser) is a commoner cause of paratyphoid infection than *B. paratyphosus* B. (Schottmüller) in India.
- (8) That *B. typhosus* is present in the bile of cases of enteric fever in very large numbers.
- (9) That in India the saprophytic existence of the *B. typhosus* outside the human host is short.

In a previous report* the various methods employed in Germany for the detection of *B. typhosus* were described. In this enquiry we have used throughout the Drigalski Conradi medium for the detection of the *B. typhosus*. In the course of our investigations we have found that better results are obtained in the examination of fæces, if the fæces are diluted considerably previous to plating. When the sample of fæces is received it is diluted about 20 times with sterile normal salt solution and carefully mixed in a conical glass. The heavier material is allowed to settle to the bottom. About two or three hours after mixing 1 or 2 c. c. of the supernatant fluid is plated in the usual manner on three large Drigalski Conradi plates. The *B. typhosus* was more

* Report on the methods employed in the Campaign against typhoid fever in Germany, by Captain E. D. W. Greig, I.M.S.

frequently detected by this method than when a more concentrated solution of fæces was used. For the examination of the blood we have used the bile-glycerine-peptone medium (Conradi) and have found it very useful. This method has greatly simplified the technique of blood culture. About 20 c.c. of this medium is placed in a bottle (30 c.c. capacity), which is closed with a rubber cap, sealed with paraffin. Five c.c. of blood is taken, with sterile precautions, from a vein at the bend of elbow and at once transferred to the bile; this is done by simply passing the needle of the syringe through the rubber cap of the bottle and the blood is injected into the bile, the small opening in the cap being closed by heating the paraffin with a match. The bottle is returned to the laboratory, and after incubation a small quantity is plated on Drigalski plates. The initial procedure can be very easily carried out in hospital and in the early diagnosis of enteric fever cultivation gives more satisfactory results than the Widal reaction.

It may be convenient before entering into details to summarise briefly the results obtained during the course of the enquiry.

In elucidating the problems connected with the propagation of enteric fever certain facts connected with the disease process require careful attention. The results of a series of blood cultivations have shown that the typhoid bacillus is found in the blood stream during the first days of the disease.* In our experience the bacillus is seldom found in the fæces at that stage and there are, as a rule, no intestinal symptoms. It is probable that the bacillus gains an entrance to the blood stream from one point in the alimentary tract and it is only when it enters the blood stream that the clinical signs called enteric fever begin to manifest themselves. The point of entry may be high up, *e.g.*, the tonsil or low down, below the stomach. The bacillus, as a rule, after circulating in the blood for a time begins to deposit in some or all of the following organs; skin causing the rose spots; kidneys, causing bacilluria; liver producing infection of the bile; the Peyer's patches leading ultimately to ulceration; and in other organs. From the point of view of the propagation of the disease the most important deposits are those in the kidney, liver, and Peyer's patches, and probably, of these foci those in the kidneys and liver play the most important rôle in the propagation of enteric fever. The urine and the bile become infected from the deposits of bacilli, and as both are excellent culture media for the *B. typhosus* we find bacilli present in both bile and urine, in a high percentage of cases, in practically pure culture. In a certain number of cases the bacilli persist in the bile or urine for months and in some cases for years after the patients are perfectly well. The patient becomes in fact a reservoir of the parasite, which he sheds in enormous numbers into the external world in the urine and fæces. In

* *Vide* Table II, page 107, Appendix of this report.

Germany such an individual is called *Bazillenträger*. In English the most suitable equivalent is "bacilli carrier." These "bacilli carriers" have at some time previously passed through an attack of enteric fever; it may be an ordinary severe attack or so mild as to have passed unrecognized. The detection of these "bacilli carriers" is most important, as round them, probably, hinges the whole problem of the prevention of enteric fever. Unfortunately their detection is an extremely difficult matter and requires for its successful accomplishment specially skilled observers. Experience has shown that it takes several months to train a worker to become really efficient in the detection of *B. typhosus* in the excreta: for ordinary workers to express an opinion on the presence or absence of *B. typhosus* in the fæces, particularly, is not only useless but, as a rule, misleading. The difficulties are further increased on account, as we shall see, of the very intermittent discharge of the bacilli in the urine and fæces. In one case in which daily observations were made the urine remained sterile for a month and then there was a sudden output of bacilli.

The observations recorded in the present report have been made chiefly amongst British troops, but a certain number of cases of enteric fever amongst Natives have been studied. That the disease occurs in Natives of India is definitely proved. We have examined the urine and fæces of several Natives, and found that they also continue to discharge the bacilli after freedom from fever and all other signs of disease. Such individuals if employed in connection with food supplies would be a source of danger.

A question of considerable importance, but one difficult to test by experiment, is, whether the European is infecting the Native or *vice versa*? Certain facts tend to support the former view. The incidence of the disease amongst Natives in jails is low, whilst amongst Natives in contact with large European communities with a large number of British troops it appears to be higher. We are at present endeavouring to collect more precise details on this important subject, and the results will be set forth in a future report.

III.—OBSERVATIONS ON PATIENTS CONVALESCENT FROM ENTERIC FEVER.

The observations on convalescents were made at Kasauli, because it is a large convalescent depôt for Northern India and supplied us with a considerable amount of material for investigation. We have examined this year 86 convalescents and found ten excreting the bacilli either in the urine or fæces for periods longer than six weeks after freedom from fever. If a convalescent continues to excrete the bacilli for longer than six weeks, the German workers regard such an individual as a "chronic bacilli carrier." So that in our observations we had 11.6 per cent. of "chronic bacilli carriers" amongst the convalescents. Some

of the patients still continue to excrete the bacilli, months after freedom from fever.

Some of the observations on the urine and fæces were commenced on the admission of the cases into hospital and kept up daily throughout the disease and for several months after freedom from fever. We have thus accumulated a large number of facts on which to base conclusions.

In regard to Natives of India we have examined the blood, urine, and fæces of several cases of enteric fever in Natives which came under our observation at Poona and elsewhere. It will be seen that they continue to discharge the *B. typhosus* in the urine and fæces after all signs of the disease have disappeared.

The results of the daily observations on the patients convalescent from enteric fever, both Europeans and Natives, are shown in Table No. 1 of the Appendix. Particular attention is directed to this table, as it is the record of numerous observations which prove that a certain percentage of immune individuals harbour the parasite for a very long time.

In discussing the results obtained by the above-mentioned observations the points may, for convenience, be considered under the following heads:—

(a) *The number of bacilli excreted in the urine.*—It will be seen from the counts which are given in the table that in some cases the bacilli are excreted in enormous numbers, as many as 100,000,000 in each c. c. of urine and the men at the time showing no signs of illness. The urine in many cases is a pure culture of the germ. The danger of such an individual infecting food supplies, etc., is very great. He is acting as a reservoir of the parasite and he may continue to do so for months.

(b) *The marked intermittent character of the excretion of the *B. typhosus* in the urine and fæces of patients.*—This important fact has emerged in the course of our observations. Its practical significance is very great, because if the urine and fæces were examined once, twice or even twenty or more times during the bacilli-free interval a wrong conclusion would be arrived at and a man still infective would be returned to duty. The rule in Germany is to examine a case three times after freedom from fever at intervals of ten days, and if he is found free from bacilli at the last examination he is discharged from hospital. From the above observations it is seen that this examination is not sufficiently exhaustive. It becomes, therefore, a matter of great difficulty to determine when a case is permanently bacilli free. In case No. 3 it will be seen that the urine was examined on the 7th August 1907 and found to contain bacilli. It was examined every day after that with negative results until 8th September 1907, thirty-one days after, when bacilli again appeared. If such a case had been examined on any of the bacilli-free days he would have been regarded as permanently

free and discharged. This fallacy is to be carefully borne in mind by those engaged in such investigations. The examination of the fæces shows that the discharge of bacilli has the same intermittent character. In case No. 7 the fæces were examined on 12th and 13th August 1907 and the presence of bacilli determined; daily examination showed the absence of bacilli from the fæces until the 29th August 1907, fifteen days after the last occasion on which it was found. Again, in case No. 12 the fæces were examined on 31st July 1907, and found to contain bacilli and after that remained negative until 6th September 1907. Also in case No. 3 the fæces were found to contain *B. typhosus* on 6th August 1907 and remained negative till 21st October 1907, an interval of seventy-five days. The most reasonable explanation of the intermittent character of the excretion of bacilli in the urine and fæces is that the urine in the urinary tubules becomes infected by a focus of bacilli in the kidney and the bacilli continue to cultivate themselves in the urine for a time, but are finally washed out by fresh uninfected urine. When another focus again infects the urine the process is repeated. So long as the bacilli in the focus are cut off from the urine a bacilli-free interval results. In a certain number of cases infection of the urine never occurs. As regards the occurrence in the fæces we know that the bile in cases of enteric fever contains practically a pure culture of *B. typhosus*. The bile is infected by bacilli lying in the deposits in the liver. The bile and its contained bacilli obtain an exit into the external world *viâ* the intestinal tube in the fæces. All the evidence is in favour of the liver and bile being the reservoir which supplies the intestine with bacilli. So that the two great storehouses of the bacilli in the "chronic carrier" are the urinary and biliary organs. It is noteworthy that the bile and urine are both excellent culture media for *B. typhosus* and the bacillus finds in these fluids far more favourable conditions for its development than it does outside the body. As we shall see later, the extra-corporeal existence of the parasite under natural Indian conditions is short as compared with that inside the body of the host.

(c) *The absence of the bacilli from the urine and fæces throughout the whole course of the infection.*—In case No. 8, Mrs. W., which developed in Kasauli, a blood culture was made on 19th July 1907 and *B. typhosus* obtained. Examination of the urine and fæces from 20th July 1907 to 20th September 1907 was made nearly every day and the bacilli never appeared on a single occasion in either the urine or fæces.

This was an example of a pure septicæmia throughout the whole course of the disease and convalescence, and is of interest on that account. From the point of view of prevention of the spread of the disease this case had no great significance, because the bacilli were never voided into the external world at all. They could only have escaped with the blood, *e.g.*, by being taken up by a blood-sucking insect.

(d) *The action of urotropine on bacilluria.*—An important practical question requires to be answered. Can urotropine be relied upon for the permanent cure of typhoid bacilluria? The results of our observations have shown that we cannot depend on urotropine for the permanent cure of bacilluria.

Urotropine or hexamethylene tetramine is soluble in water 1—1 with alkaline reaction, in alcohol 90 per cent. 1—8, almost insoluble in ether. It acts by liberating formaldehyde in the urinary passages.

A study of cases Nos. 1, 2, 4, 7, 12, and 14 in Table No. 1 of the Appendix shows that although urotropine was given in full doses yet the bacilluria was not in any way checked by its administration. Further, in case No. 3, S., to whom no urotropine was given, the bacilluria ceased spontaneously and the urine remained bacilli free for a long time. The same fact is observed in other cases when the patients received no urotropine. The probable explanation of the failure of urotropine to check the bacilluria permanently is, that the formaldehyde acts only on the urine in the urinary passages, but does not reach the bacilli in the deposits in the substance of the kidneys. The practical conclusion to draw from these observations is that urotropine cannot be regarded as an effective agent for permanently destroying bacilli in the urinary organs.

(e) *Those convalescent after enteric fever act as reservoirs of the parasite.*—We see from the above observations that a fairly high percentage of the cases which recover from enteric fever continue to harbour the bacilli although they themselves appear perfectly healthy. It is impossible by any ordinary medical examination to say when a man is free from bacilli. As a systematic examination of the fæces and urine of convalescents has hitherto not been carried out in India and as our observations have shown that the bacilli continue to be voided intermittently in the urine and fæces of a certain percentage of convalescents for very long periods, there must be a considerable number of such "carriers" scattered about in various units of the British Army in India, and we have in this fact the explanation of the persistence of the disease in spite of vigorous sanitary measures taken to destroy the germ in places outside the human host. As we shall discuss later, the saprophytic existence of the bacillus typhosus outside the human body under natural Indian conditions is a short one. Hence we see that for its continued life a host is necessary, and it finds in certain parts of the human body a nidus suitable for a prolonged existence. An epidemic of enteric fever is determined by bringing a "bacillus-carrier" in contact with some form of food supply. By ordinary sanitary enquiry it is impossible to trace such an epidemic to its source. We see, therefore, the very important rôle which the "bacilli carrier" plays in the production of epidemics in India.

We must regard flies, dust, milk, etc., as being merely channels of communication of varying significance between the "carrier" and the uninfected

individual. Hence the great importance of concentrating attention on the "carrier," whether he is a sick man or apparently healthy, in all measures for the prevention of enteric fever.

We pass to consider next—

IV.—THE EVIDENCE IN FAVOUR OF EPIDEMICS OF ENTERIC FEVER BEING CAUSED BY THE "CHRONIC BACILLI CARRIER."

In most epidemics of enteric fever it is difficult to show conclusively what is the source of infection.

Up to the present in India there has been a good deal of mystery surrounding the persistence of this disease in Indian cantonments in spite of vigorous sanitary measures. In the light of scientific research the mystery surrounding the subject becomes dispelled and the whole question is placed on a sounder basis.

The evidence brought forward in support of the statements in this section is based on the results of scientific investigation. The blood, urine, and fæces of a large number of apparently healthy people were examined several times, in order to determine the presence or absence of a "carrier" amongst them. Hence the observations may be regarded as being as complete as it is possible to make them in the present state of knowledge.

A study of several epidemics was made to ascertain the source of the infection, and the results of this enquiry are stated below.

(1) *An epidemic in a detachment of the Bedfordshire Regiment at Kasauli.*—During the month of August 1907 five cases of enteric fever occurred in this detachment. Four of these were admitted into the Station Hospital, Kasauli, and were proved by cultivations made from the blood to be infections caused by bacillus typhosus. One man of this section left Kasauli on 31st July 1907 and was admitted into hospital at Jhansi on 2nd August 1907 for enteric fever, having, undoubtedly, become infected at Kasauli. So that five men of the detachment of Bedfords acquired the infection about the same time in the same place. The disease did not extend to any of the other units. We had, therefore, to deal with an epidemic localised to one unit.

The cases occurred in two barracks, Nos. 12 and 13, in which the detachment of the Bedfords was quartered. Each barrack is divided into four wards. The cases did not occur in one of the rooms of the barrack, but each in different rooms, so that there was no direct personal communication between the patients. These two barracks were supplied with food from a common cook-house and they had a common latrine and urinal.

A careful sanitary inspection by the Senior Medical Officer was made to determine the origin of the epidemic. As the cases were confined to this detachment the general water and milk supply could be eliminated as factors in the causation. It was considered that the men might have contracted the infection at one of the religious institutes. The evidence supporting this hypothesis, however, was not very satisfactory. The source of the epidemic remained obscure.

In order to determine scientifically the origin of the epidemic a systematic examination of the blood, urine, and fæces of all the cooks and "contacts" of this unit was made. The examination of the urine and fæces of each individual was repeated at least twice. The result of this long series of repeated observations proved that a cook of this detachment (Pte. 4805 G. W.) was excreting bacillus typhosus in large numbers in his fæces. This man was in fact a "chronic bacilli carrier." None of the other contacts were found to be excreting *B. typhosus* in the stools or urine.

The distribution of the disease suggested that the source of infection was in the food supply of this unit. The disease did not spread from man to man in one room. Had this been so it would have indicated that the infection was spreading by direct personal contact. On the contrary, with the exception of one room, not more than a single case occurred in each room. Hence the working hypothesis, which agreed best with all the facts, was that some individual dealing with the food of the unit in the cookhouse was a "chronic carrier." The detection, therefore, of a "carrier" (Pte. W.) in the cookhouse fully substantiated this hypothesis and satisfactorily explained the origin of the epidemic which would otherwise have remained in complete obscurity. An interesting feature in this epidemic was that the Native element could be completely eliminated as no Natives are employed in the cookhouse of the unit.

The information of the discovery of this "chronic bacilli carrier" was given to the Senior Medical Officer, who at once segregated him. The result was that no further case of enteric fever occurred in this unit. If this man had continued at duty in the cookhouse it is almost certain he would have infected another series of men. As we have observed in other cases, this man excretes the bacilli very intermittently. If we had been content with one examination of the fæces only, he would not have been detected. Our previous experience, however, indicated the great importance of making repeated examinations.

A careful enquiry was made into the past and present history of this "bacilli carrier." No. 4805 Private G. W., E. Company, Bedfordshires, has a total service of thirteen years and eight months and eleven years eight months in India. An examination of his medical history sheet shows that he has no entry for enteric fever, but at Ferozapore he was in hospital seventy days from

31st December 1897 to 10th March 1898 for 24a Ague described as "severe." He was admitted to the Mooltan Hospital for forty-two days for 799 Abscess, described as "severe," from 23rd May to 3rd July 1899. The next entry is at Dalhousie for 24a Ague for twenty-three days, from 3rd October to 25th October 1900, and is described as "mild." The only other admission after this is eleven days for 143a Conjunctivitis catarrhal acute at Mooitan from 1st to 11th March 1901. He never acted as a nursing orderly. At present he looks the picture of health and has no sign of disease. In reviewing this case the occurrence of a past enteric infection has to be considered. The entry of seventy days for ague of a severe character raises the question as to whether or not this was an unrecognised typhoid infection. The admission into hospital a year later for severe abscess is noteworthy, as suppurations following typhoid infections are not very uncommon and the pus is often found to contain a pure culture of typhoid bacilli. If the infection was enteric fever, he has been a "bacilli carrier" since 1898, nearly ten years. His Widal reaction to *Bacillus typhosus* is similar to that found in many convalescents.

The following table shows the result of the Widal reaction to *Bacillus typhosus* and the presence or absence of *Bacillus typhosus* in the fæces and urine of No. 4805 Private G. W., E. Coy., 1st Bedford Regiment :—

Date.	Number, rank, name and Regiment.	WIDAL REACTION TO BACILLUS TYPHOSUS.		BACILLUS TYPHOSUS IN	
		20	40	Fæces.	Urine.
August 1907	G. W., of 1st Bedford Regiment, E. Coy.				
17th	+	—	...	—
18th	—	...
19th	*+ +	—
25th	+	—
27th	—	...
28th	—	—

* For explanation of signs used, *vide* page 49, Appendix of this report.

Date.	Number, rank, name and Regiment.	WIDAL REACTION TO BACILLUS TYPHOSUS.		BACILLUS TYPHOSUS IN	
		30	40	Fæces.	Urine.
August 1907 29th	-	-
30th	-	-
31st	+ +	-
September 1st	-
2nd	-	-
3rd	+	-
October 2nd	-	...
10th	-	...
November 1st	+	...

The following table shows the cases of enteric fever which occurred in the detachment of the 1st Bedford Regiment at Kasauli and Jhansi and the result of the examination of the blood:—

Serial No.	Number, rank, name and Regiment.	Date of admission to hospital.	Date of observation.	Bacillus typhosus in blood.
1	8367 Pte. B. F., 1st Bedfords.	6th August 1907	12th August 1907	+
2	8173 Pte. H. L., 1st Bedfords.	10th do.	20th do.	+
3	7993 Pte. J. D., 1st Bedfords.	12th do.	14th do.	+
4	8089 Pte. G. S., 1st Bedfords.	18th do.	20th do.	+
5	Pte. F., 1st Bedfords	2nd do. at Jhansi.	Not examined.	

The following table shows the result of the examination of the blood, urine, and fæces of the healthy men (cooks, enteric orderlies and contacts) of the 1st Bedfords at Kasauli :—

Designation of healthy individuals.	Total No.	Total examined.	Widal reaction to Bacillus typhosus.	BACILLUS TYPHOSUS IN	
				Urine.	Fæces.
Cooks	5	5	1 Man complete 1—80 2 Men „ 1—20. 1 Man „ 1—10. 1 „ no reaction.	5 Negative	4 Negative. 1 Positive.
Nursing Orderlies	3	3	1 Man complete 1—10 2 Men no reaction.	3 Negative	3 Negative.
Enteric Contacts	34	34	2 Men complete 1—40 8 „ „ 1—10. 24 „ no reaction.	34 Negative	34 Negative.

The following table shows the characters of the organism separated from the stools of Private No. 4805 W. G., E. Coy., 1st Bedfords :—

	B. typhosus. (Private W.)	Stock Bacillus typhosus (Berlin).	Microscopic characters.
	Actively motile rods; gram negative.	Actively motile rods; gram negative.	Ordinary troth.
	Uniform turbidity; no scum.	Uniform turbidity; no scum.	Ordinary agar.
	Good whitish translu- cent growth.	Good whitish translu- cent growth.	Potato.
	Moist growth.	Moist growth.	Litmus mannite.
	Red.	Red.	Litmus milk.
	No clotting; red.	No clotting; red	Litmus lactose nutrose.
	No change.	No change.	Litmus glucose nutrose.
	Red.	Red.	Litmus whey.
	Red.	Red.	Neutral red agar.
	No change. No gas.	No change. No gas.	Indol reaction after 14 days.
	None.	None.	Serum reaction. Titre serum 1—8,000.
	Complete 1—8,000.	Complete 1—8,000.	

The result of this investigation has thrown a flood of light on the source of this epidemic. It would have been impossible by ordinary sanitary inspection or enquiry to have arrived at a correct conclusion. It further demonstrates that the "chronic bacilli carrier" can produce an epidemic of enteric fever.

(2). *Two cases of enteric caused by a "chronic carrier."*—In July 1906 a boy (Joseph T.) was admitted to the Station Hospital, Kasauli, from the married quarters, suffering from enteric fever. Later in the month a next-door neighbour of this family, Mrs. C., was admitted for enteric fever. In both cases the *Bacillus typhosus* was recovered from the fæces. In order to trace the source of these two cases the blood, urine, and fæces of all the members of the T. family were examined. The result of this investigation showed that Mrs. T., the mother of the first patient, was excreting bacilli in her fæces. The Widal reaction to *Bacillus typhosus* was complete in 1 in 80 dilution. Mrs. T. was a "chronic bacilli carrier."

A careful enquiry was made into her previous history. She had never passed through a typical attack of enteric fever. About two months previously she had been sick for a few days, her symptoms being diarrhoea and fever. At the time of examination she looked perfectly healthy.

The following table shows the result of the examination of blood, urine, and fæces of the abovementioned cases of enteric fever:—

NAME.	Age.	Clinical diagnosis.	WIDAL REACTION.		BACILLUS TYPHOSUS IN		REMARKS.
			Bacillus typhosus.	Bacillus paratyphosus B.	Fæces.	Urine.	
T. J., son of Sergeant T., Royal Welsh Fusiliers.	3 $\frac{10}{12}$	Enteric	1-100, complete positive, 2nd July 1906.	...	Present, 2nd July 1906. Absent, 10th August 1906. Absent, 5th September 1906.	Absent, 5th September 1906.	
C., Mrs., wife of Sub-Conductor C., S. & T. Corps.	40	Enteric	1-200, complete positive, 14th July 1906.	Negative, 14th July 1906.	Present, 20th August 1906. Absent, 30th August 1906.	Absent, 20th August 1906. Absent, 20th August 1906.	Mrs. C. lived in the next quarters to Mrs. T., "bacilli carrier," and associated with her.

The following table shows the result of the examination of the blood, urine, and fæces of the healthy individuals :—

NAME.	WIDAL REACTION.		B. TYPHOSUS.		REMARKS.
	B. typhosus.	B. paratyphosus B.	Fæces.	Urine.	
1. L. Corp. T. (father of patient).	Negative, 3rd July 1906.	Negative, 3rd July 1906.	— 3rd July 1906.	— 3rd July 1906.	The T. family arrived Kasauli 26th April 1906. Mrs. T. had an attack of diarrhoea for several days from 7th May 1906. She was in close contact with the boy T., who developed enteric about the end of June 1906. She was a "bacillus carrier."
2. Mrs. T. (mother).	Positive, 1—80. Complete, 3rd July 1906.	Negative, 3rd July 1906.	Present, 8th July 1906. Present, 19th August 1906. Absent, 30th August 1906.		
3. Thos. T. (brother).	Negative, 3rd July 1906.	Negative, 3rd July 1906.	— 3rd July 1906.	— 3rd July 1906.	Mrs. C. was a next-door neighbour of Mrs. T. and had associated with her. Mrs. C. developed enteric about the beginning of July.
4. Jos. T. (brother)	Negative, 3rd July 1906. Negative, 30th August 1906.	Negative, 3rd July 1906.	— 3rd July 1906.	— 3rd July 1906.	

There can be little doubt that the mother, Mrs. T., a "chronic bacilli carrier," infected her son, with whom she was in very close contact. Further, her relations with her next-door neighbour, Mrs. C., the second case of enteric fever, were intimate. This observation again shows the important part which the "chronic carrier" plays in the propagation of enteric fever.

(3). A "chronic bacillus carrier" in the Scottish Rifles (Cameronians) and in this unit a considerable number of enteric fever cases occurred.

In examining a large number of healthy soldiers at Meerut, from the different units stationed there, one man was found to be excreting *Bacillus typhosus* in considerable numbers in his fæces. He belonged to the Scottish Rifles (Cameronians) and had been a nursing orderly on enteric cases. He had never suffered from enteric fever. It was a noteworthy fact that seven out of the ten cases of acute enteric fever which we examined at Meerut came from this unit

The result of this investigation has thrown a flood of light on the source of this epidemic. It would have been impossible by ordinary sanitary inspection or enquiry to have arrived at a correct conclusion. It further demonstrates that the "chronic bacilli carrier" can produce an epidemic of enteric fever.

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A careful enquiry was made into her previous history. She had never passed through a typical attack of enteric fever. About two months previously she had been sick for a few days, her symptoms being diarrhœa and fever. At the time of examination she looked perfectly healthy.

The following table shows the result of the examination of blood, urine, and fæces of the abovementioned cases of enteric fever:—

NAME.	Age.	Clinical diagnosis.	WIDAL REACTION.		BACILLUS TYPHOSUS IN		REMARKS.
			Bacillus typhosus.	Bacillus paratyphosus B.	Fæces.	Urine.	
T. J., son of Sergeant T., Royal Welsh Fusiliers.	3 $\frac{10}{12}$	Enteric	1-100, complete positive, 2nd July 1906.	...	Present, 2nd July 1906. Absent, 10th August 1906. Absent, 5th September 1906.	Absent, 5th September 1906.	
C., Mrs., wife of Sub-Conductor C., S. & T. Corps.	40	Enteric	1-200, complete positive, 14th July 1906.	Negative, 14th July 1906.	Present, 20th August 1906. Absent, 30th August 1906.	Absent, 20th August 1906. Absent, 30th August 1906.	Mrs. C. lived in the next quarters to Mrs. T., "bacilli carrier," and associated with her.

The following table shows the result of the examination of the blood, urine, and faeces of the healthy individuals :—

NAME.	WIDAL REACTION.		B. TYPHOSUS.		REMARKS.
	B. typhosus.	B. paratyphosus B.	Faeces.	Urine.	
1. L. Corp. T. (father of patient).	Negative, 3rd July 1906.	Negative, 3rd July 1906.	— 3rd July 1906.	— 3rd July 1906.	The T. family arrived Kasauli 26th April 1906. Mrs. T. had an attack of diarrhoea for several days from 7th May 1906. She was in close contact with the boy T., who developed enteric about the end of June 1905. She was a "bacillus carrier."
2. Mrs. T. (mother).	Positive, 1—80. Complete, 3rd July 1906.	Negative, 3rd July 1906.	Present, 8th July 1906. Present, 19th August 1906. Absent, 30th August 1906.		
3. Thos. T. (brother).	Negative, 3rd July 1906.	Negative, 3rd July 1906.	— 3rd July 1906.	— 3rd July 1906.	Mrs. C. was a next-door neighbour of Mrs. T. and had associated with her. Mrs. C. developed enteric about the beginning of July.
4. Jos. T. (brother)	Negative, 3rd July 1906. Negative, 30th August 1906.	Negative, 3rd July 1906.	— 3rd July 1906.	— 3rd July 1906.	

There can be little doubt that the mother, Mrs. T., a "chronic bacilli carrier," infected her son, with whom she was in very close contact. Further, her relations with her next-door neighbour, Mrs. C., the second case of enteric fever, were intimate. This observation again shows the important part which the "chronic carrier" plays in the propagation of enteric fever.

(3). A "chronic bacillus carrier" in the Scottish Rifles (Cameronians) and in this unit a considerable number of enteric fever cases occurred.

In examining a large number of healthy soldiers at Meerut, from the different units stationed there, one man was found to be excreting *Bacillus typhosus* in considerable numbers in his faeces. He belonged to the Scottish Rifles (Cameronians) and had been a nursing orderly on enteric cases. He had never suffered from enteric fever. It was a noteworthy fact that seven out of the ten cases of acute enteric fever which we examined at Meerut came from this unit

The connection between this "carrier" and the cases of enteric could not be so clearly established as in the two above described epidemics, but the fact is nevertheless very significant.

The following table shows the result of the examination of the blood, urine, and faeces of Private 6934 R. J., B. Coy., Scottish Rifles, Meerut :—

Number, rank, name, and Regiment.	Date of examination.	WIDAL REACTION B. TYPHOSUS.				B. TYPHOSUS.	
		20	40	80	120	Urine.	Faeces.
No. 6934 R. J., Cameronians, B. Coy.	14th February 1907.	+	+	+	—	—	+ +

The following table shows the result of the examination of the blood of the other cases admitted from the Scottish Rifles, Meerut :—

Serial No.	Number, rank, name, and Regiment.	Date of admission to hospital.	Date of examination.	Bacillus typhosus in blood.	Widal reaction.
1	Pte. M., Cameronians, A. Coy.	19th February 1907.	1st March 1907.	+	Complete 1—80.
2	8422 L.-C. K. W., Cameronians, G. Coy.	5th March 1907.	7th March 1907.	+	
3	850 Pte. B. W., Cameronians, G. Coy.	1st March 1907.	1st March 1907.	—	Complete 1—320.
4	8367 Pte. E. B., Cameronians, D. Coy.	31st December 1906.	31st December 1906.	+	
5	8544 L.-C. T., Cameronians, D. Coy.	24th February 1907.	28th February 1907.	+	
6	8534 Pte. A., Cameronians, D. Coy.	25th December 1906.	25th December 1906.	—	Complete 1—320.
7	8691 Pte. M., Cameronians.	12th December 1906.	18th December 1906.	+	
8	8969 Pte. K., Cameronians.	12th December 1906.	22nd December 1906.	+	

(4) *An epidemic of enteric fever in a Convent School at Poona.*—This epidemic is of interest because the source was found on investigation to be the cook of the school, who had passed through an unsuspected attack of enteric fever. He infected a certain number of children before he went on leave in June 1907, and again on his return he infected another batch of children in July 1907.

This is an instance of an individual excreting the bacilli and dealing at the same time with the food supply of a large number of individuals, the result being, as previously pointed out, an epidemic of enteric fever. This man was at work during a considerable part of his illness. He was, probably, excreting

bacilli in his urine in large numbers. He was, in fact, the reservoir from which the supply of bacilli which infected the children came.

None of the children could be shown to have contracted the infection whilst he was at Goa, but following his return a fresh epidemic took place.

The after-history of the Goanese cook, B. S., was very interesting. He was admitted to the Sassoon General Hospital, Poona, in October 1907. He had signs and symptoms pointing to an affection of the gall bladder. Examination of his blood on October 9th showed that the Widal reaction to *B. typhosus* was nearly complete in 1—10,000 dilution. On September 5th his Widal reaction to *B. typhosus* was 1—100. Therefore between September 5th and October 9th his agglutinins had increased very greatly, pointing to the fact that the *B. typhosus* was still present in his body, probably in the bile, and agglutinins were being manufactured. His symptoms indicated that there was some affection of the gall bladder, probably produced by the *B. typhosus* in the bile, and this condition probably interfered with the discharge of the bacilli from the gall bladder, and hence the difficulty of detecting them in the fæces.

The man left for Goa in October at his own request, so that further observations were not possible.

The following report is by Captain D. Harvey, R.A.M.C. :—

REPORT ON OUTBREAK OF ENTERIC FEVER IN THE CONVENT SCHOOL, POONA.

July and August 1907.

The school is situated in the centre of Poona Bazaar, and the buildings of the institution are completely surrounded by a wall of six feet in height. The dormitories and other buildings of the school are arranged in the form of a square, which encloses an open space. Three sides of this square are built in proximity to the surrounding wall, but the fourth side is separated from it by a space of 30 yards. In this space the cookhouse, which is built against the wall, is situated. A narrow street runs all round the outside of the Institution between it and the houses in the bazaar. There is accommodation for 150 boarders, and the children include Europeans, Eurasians and Native Christians. The management is in the hands of a Roman Catholic sisterhood, who pay the utmost attention to the cleanliness of the premises and to the care and comfort of the children. The food supply is ample; water is taken from the municipal mains, and all the milk used is boiled under European supervision.

Although plague has raged in close proximity to the school, there has never been a case of plague in the Convent, nor for 15 years has there been a case of enteric fever although this disease, also, was prevalent in the city and Cantonment.

About the 17th of July 1907 three of the children, Daisy R., Annie F., and Josephine C., were noticed to be ailing; they refused food and complained of headache.

They were admitted to hospital on 21st, 22nd, 22nd July, respectively, with fever. As there had never been a case of enteric in the Convent within the memory of the present nuns, this disease was not at first suspected; two other children who had also been ailing for some days were admitted on 25th and 28th July, respectively.

The Staff Surgeon who had been called in to see these five cases, suspected enteric and the serum was sent to the Divisional Laboratory, a positive reaction to enteric being obtained in all these cases. Naturally this result put the nuns on the alert, with the result that the second batch of cases was diagnosed at once. Hence the date of admission to hospital in their case coincided with the date of the onset of fever. This is well shown by the charts, the temperature falling to normal on the 21st day in hospital. This second batch of cases were admitted to hospital on the 16th, 17th, 18th, 19th, 22nd and 22nd August. On the invitation of Lt.-Col. Bull, I.M.S., Staff Surgeon, I visited the Convent with a view to seeing if we could in any way clear up the origin of this outbreak. The Convent is beautifully clean, there are three dormitories, large, airy, upstairs rooms. Cases No. 1 and 9 came from No. I dormitory. Cases 2, 3, 4, and 5 from No. II. Cases 6, 7, 8, 10, 11, and 12 from No. III. On enquiry the nuns positively stated that all the boarders had been in excellent health since their return from the holidays on 31st May 1907. Nor had there been any sickness among the day scholars or amongst the nuns themselves.

On further enquiry I discovered that one of the Goanese cooks had been ill for a few days in the month of June. After some difficulty I obtained the following facts regarding this man:—

About the 20th June he complained of pain in the side and, according to the statement of the Hospital Assistant attached to the Convent, had fever, which lasted for two days only. He continued to do work although in great pain and losing flesh. At the end of June he asked for and obtained leave and departed for Goa on the 3rd of July. He returned on the 31st July and resumed work. I took his serum on 5th September 1907, and found that it reacted strongly to *B. typhosus* up to a dilution of 1—100. I also took the serum of four other cooks employed in the same kitchen, 2 Goanese and 2 Natives; their serum gave a negative result in a dilution of 1—20.

The children all have the same food, and this food is prepared in the same cookhouse.

There are two mess rooms. Cases Nos. 1, 2, 3, 4, 5, and 9 used one mess, cases 6, 7, 8, 10, 11, 12 the other.

They are not all in the same classes and the cases were dotted over the three dormitories.

Deducting four days from the date of admission to hospital from the first three cases, *i.e.*, time ailing before detected, gives the 17th July as the day of commencement of the disease and about the 1st of July as the day of infection.

The other two cases, 4 and 5, had also been ill for at least five or six days before admission; this would give 20th and 22nd July as the day of commencement of disease and the day of infection as 2nd or 3rd of July.

The day of infection in Case No. 6 shown as admitted on 11th August is more difficult to discover.

The nuns state that on 11th August this child was treated for "fever," but she was not admitted to hospital till 15th August 1907.

She was removed from the Convent on 16th August 1907 by her friends. There are three suppositions possible as regards this case.

I. She was removed from the Convent within a day or two of being taken ill, the diagnosis was not confirmed by Widal test; therefore her disease may not have been enteric. I have made enquiries and find that this child was very seriously ill at her home in Khandala for one month after her return. I think, therefore, that this was a true case of enteric.

II. Case No. 5 was ill for some days before admission to hospital. She used the same latrine as Case 6, and it is possible that Case 6 was thus infected although they used different messrooms and slept in different dormitories.

III. The cook, B. S., returned to duty on 31st July; this child, No. 6, although out of sorts on 11th August, was not admitted to hospital until 15th August. It is quite possible that she was infected by contaminated food on 1st August and developed the fever after a shorter incubation period than the others.

The other cases Nos. 7, 8, 9, 10, 11, 12 all went sick, 17, 18, 19, 20, 23 and 23 days after the return of the Goanese cook.

In my opinion, therefore, the Goanese cook passed through a fairly severe attack of enteric fever between June 20th and July 10th; he contaminated the food of the children in the first batch of cases 1 to 5 about July 1st before his departure.

Case 6 is a contact case or a case with short incubation period, and the second batch of cases 7 to 12 were due to contamination of the food after the return of the cook on 31st July.

The last case of the second batch was admitted to hospital on the 22nd of August; up to the 16th of September there have been no fresh cases.

I have examined the faeces and urine of the cook, B. S., daily from the 8th September, but so far without finding any enteric bacilli; he is, therefore, not infective at present. This is shown by the fact that there have been no

fresh cases since the last batch which were infected during the first week of August.

*Statement of Enteric cases at the Convent Girl School, Poona,
11th September 1907.*

No.	Names.	Age.	Caste.	Date of admission.	Date of discharge.	REMARKS.
*1	Daisy, R.	14	European	21st July 1907.		
*2	Annie, F.	10	Do.	22nd July 1907.		
*3	Josephine, C.	8	Native Christian	Ditto.		
*4	Filamina, F.	7	European	25th * July 1907.		
*5	Helen, Roberts	7	Eurasian	28th July 1907.		
†6	Nathaline, D.	8	Native Christian	11th August 1907.	16th August 1907.	Proceeded to Khandala.
†7	Augollo, F.	7	Do.	16th August 1907.	17th August 1907.	Went to her home in Poona.
†8	Christoline, D.	10	Do.	17th August 1907.	Ditto.	Ditto.
*9	Mary, N.	14	Do.	18th August 1907.		
†10	Mary, F.	12	Do.	19th August 1907.	19th August 1907.	Went to her home in Poona.
*11	Mary, F.	12	Do.	22nd August 1907.		
†12	Juauha, P.	15	Do.	Ditto.	27th August 1907.	Proceeded to Bombay.

* Diagnosis confirmed by Widal reaction.

† Diagnosis not confirmed.

Cook B. S., age 21 years, reported sick on 20th June 1907.

Proceeded to Goa on 3rd July 1907.

Returned to duty on 30th July 1907.

Widal reaction, positive 1—100 dilution on 1st September 1907.

" " " 1—10,000 " on 8th October 1907.

NOTE.—Cook B. S. was doing his duty while sick from 20th June 1907 until he left for Goa on the 3rd July 1907.

V.—EVIDENCE SHOWING THAT ENTERIC FEVER IS CONTRACTED BY ORDERLIES WHILST IN ATTENDANCE ON PATIENTS.

During the course of the enquiry we obtained evidence to show that nursing orderlies contracted the disease and passed through a typical attack of enteric fever. At Poona nine men attended a class for instruction as nursing orderlies on patients suffering from enteric fever; out of this number three men acquired the infection and one died. The cases were all proved to be enteric fever by blood examination, and from the bile of the case which ended fatally a pure culture of *B. typhosus* was obtained. One of the men had been twice inoculated recently.

The following table gives the details of the outbreak:—

Number of men attending the cases.	Date of appointment.	Date of discharge.	Date on which men were admitted to hospital for enteric.	REMARKS.
Nine.	19th May 1907.	1. 27th July 1907. Remainder 12th August 1907.	{ 1 27th July 1907. 3 { 1 16th August 1907. { 1 17th August 1907.	Died. Inoculated— 1 28th March 1907. 2 22nd April 1907.

The above observation shows that the danger of becoming infected whilst attending a case of enteric fever is considerable. In this case three out of a total of nine became infected, 33·3 per cent. Apart from men who develop a typical attack of enteric a number of men appear to become infected whilst in attendance on cases but show no sign of disease. This class of individuals is particularly dangerous, because some of them become "chronic bacilli carriers" and sources of infection. We proceed next to consider this question in detail.

VI.—EVIDENCE SHOWING THAT ORDERLIES ON ENTERIC FEVER CASES BECOME "BACILLI CARRIERS" WITHOUT HAVING PASSED THROUGH AN ATTACK OF THE DISEASE.

At Kasauli we made a very careful bacteriological examination of the urine and faeces for a prolonged period of four enteric fever orderlies who had finished

their course and were returning to their regiments. None of these men had ever suffered from a typical attack of enteric fever. The result of this examination showed that two of these men were excreting *B. typhosus* in their fæces.

This observation is of great importance, because the rule is that after six months' duty as orderlies the men return to their regiments and a fresh supply is sent, and as these orderlies are not submitted to a complete bacteriological examination they must on their return to regimental duty increase the number of "bacilli carriers" in the various units of the British troops in India.

The following table shows the result of the examination of the urine and fæces of the enteric fever orderlies at Kasauli :—

Name.	Regiment.	Date of observation.	B. TYPHOSUS IN		Widal reaction.
			Fæces.	Urine.	
1. Private 7156 W.	Bedford, A. Coy.	18th August 1907 to 15th October 1907.	—	—	Negative.
2. Private 3835 J.	R. F. A.	9th September 1907 to 16th October 1907.	—	—	Ditto.
3. Private 6956 V.	R. Sussex	7th October 1907 to 10th October 1907.	—	—	Complete 1-40.
		11th October 1907.	+		
		22nd October 1907.	++	n	
4. Private 7635 O.	Bedford, F. Coy.	5th October 1907.	++		
		22nd October 1907.	+	—	

In addition to the enteric fever orderlies at Kasauli we discovered at Meerut, whilst examining a large number of healthy soldiers, a man who was excreting *B. typhosus* in his fæces. This man had no previous history of having passed through an attack of the disease, but had acted as an orderly on enteric fever cases. As already mentioned, the unit in which this man was serving at Meerut supplied the majority of the enteric fever cases which we had an opportunity of observing. Further particulars of this are given on pages 17 and 18 of this report.

VII.—DIAGNOSIS OF ENTERIC FEVER.

In the prevention of enteric fever a correct diagnosis is a matter of supreme importance. Should a slight or anomalous case pass unrecognised, it would obviously prove a serious source of infection. This is illustrated in the case of the epidemic at the Convent school, Poona, described above. Such a case might show very few signs of disease but still be excreting the bacilli in enormous numbers; hence the important question arises, What is the best method for the diagnosis of enteric fever? The serum agglutination test (Widal reaction) has been very generally employed up to the present. If it is carried out with care, the results are quite satisfactory; but it is necessary to bear in mind the fallacies that may creep in.

To obtain a standard to work on, we have carried out the serum agglutination test (Widal reaction) with the blood of a large number of apparently healthy European soldiers, including those who had been inoculated against enteric fever or passed through an attack of the disease recently. Also the blood of a number of healthy Natives was examined.

The following statement shows the result of the examination of the blood by the serum agglutination test (Widal reaction) of apparently healthy European soldiers:—

Widal reaction in apparently healthy individuals.

European Soldiers.

(a) *Not inoculated.* No history of enteric. Total examined = 416.

No reaction	.	.	.	.	.	.	.	.	.	166=39·8 per cent.
Incomplete	1—10 dilution	.	.	.	.	.	.	.	.	76=18·2 "
Complete reaction	1—10 "	.	.	.	.	.	.	.	.	97=23·3 "
Ditto	1—20 "	.	.	.	.	.	.	.	.	64=15·3 "
Ditto	1—40 "	.	.	.	.	.	.	.	.	13= 3·1 "

(b) *Inoculated (recently).* Total examined = 28.

No reaction	.	.	.	.	.	.	.	.	.	3=10·7 per cent.
Complete	1—10 dilution	.	.	.	.	.	.	.	.	6=21·4 "
Do.	1—20 "	.	.	.	.	.	.	.	.	12=42·8 "
Do.	1—40 "	.	.	.	.	.	.	.	.	3=10·7 "
Do.	1—80 "	.	.	.	.	.	.	.	.	1= 3·5 "
Do.	1—160 "	.	.	.	.	.	.	.	.	3=10·7 "

(c) *Convalescent enterics (recent).* Total examined = 137.

Incomplete	1—10 dilution	.	.	.	.	.	.	.	.	21=15·3 per cent.
Complete	1—10 "	.	.	.	.	.	.	.	.	33=24·8 "
Do.	1—20 "	.	.	.	.	.	.	.	.	35=25·5 "
Do.	1—40 "	.	.	.	.	.	.	.	.	30=21·8 "
Do.	1—80 "	.	.	.	.	.	.	.	.	15=10·9 "
Do.	1—160 "	.	.	.	.	.	.	.	.	1= 0·7 "
Do.	1—160 " over	.	.	.	.	.	.	.	.	2= 1·4 "

<i>Native Followers.</i>		Total examined = 111.	
No reaction	.	.	26 = 23.4 per cent.
Incomplete	1-10 dilution	.	24 = 21.6 "
Complete	1-10 "	.	40 = 36.03 "
Do.	1-20 "	.	21 = 18.9 "
<i>Native Children (Gurkhas).</i>		Total examined = 21.	
<i>(7 to 12 years of age.)</i>			
No reaction	.	.	2 = 9.5 per cent.
Incomplete	1-10 dilution	.	2 = 9.5 "
Complete	1-10 "	.	10 = 47.6 "
Do.	1-20 "	.	6 = 28.5 "
Do.	1-40 "	.	3 = 14.3 "
<i>Native Children (Gurkhas).</i>		Total examined = 71.	
<i>(7 to 14 years of age.)</i>			
No reaction	.	.	25 = 35.2 per cent.
Incomplete	1-10 dilution	.	7 = 9.8 "
Complete	1-10 "	.	15 = 21.1 "
Do.	1-20 "	.	17 = 23.9 "
Do.	1-40 "	.	2 = 2.8 "
Do.	1-60 "	.	4 = 5.6 "
Do.	1-120 "	.	1 = 1.4 "

The results show that a reaction in a dilution of 1 in 40 either for natives or Europeans cannot be taken alone as positive evidence of the existence of an infection by the *B. typhosus*. Comparing the results in Europeans and natives it is seen that the percentage of complete sedimentations in 1 in 20 dilutions is 18 in natives (adults) as compared with 3 in Europeans (adults); hence the necessity of using higher dilutions when the test is being carried out with the blood of natives. The method which gives more accurate and certain results is that of cultivating the bacillus from the blood-stream. Formerly the technique of this procedure was very elaborate; very recently, however, improved methods have been introduced which have greatly simplified this investigation. More particularly the method introduced by Conradi has been found to be specially useful. Conradi's medium is composed of bile, peptone and glycerine, but bile alone is said to act equally well. The medium is sterilised in the autoclave, no filtration being necessary. In practice we have put this medium in vaccine bottles of 30 c.c. capacity, about 20 c.c. of medium in each bottle. The bottle is closed with a rubber cap, which is sealed with paraffin. These bottles can be very conveniently sent to hospitals for the collection of blood. The operator has merely to remove with aseptic precautions 5 c.c. of blood in a syringe from a vein at the bend of the elbow, and then pass the needle of the syringe through the rubber cap and eject the contents into the bile bottle. The paraffin is melted and the hole closed. The bottle is labelled and returned to the laboratory where it may require to be incubated, but, as a rule, this is unnecessary, as the organism incubates on the journey. A few drops of the contents of the bottle are plated on Drigalski plates and incubated at 37°C. and next day the colonies are examined and tested. By this procedure we recover the germs

in most cases of enteric fever and the diagnosis is made absolutely certain. This method has been practised at certain hospitals in India with success, *e.g.*, Meerut, Kasauli, Poona, and Jullunder. As the technique becomes better known it will be more universally adopted, because it is simple and certain.

In Table II of the Appendix the results obtained by the serum sedimentation test and the blood culture in bile are given, *vide* page 107, Appendix.

From a study of this table it will be seen that the bacilli enter the bloodstream at a very early stage in the disease. The clinical signs called enteric fever begin to develop at the same time as the bacilli enter the blood. The disease is, indeed, a blood-poisoning. The fact that an early invasion of the blood occurs in enteric fever makes blood culture an extremely valuable means of making a prompt diagnosis.

It is further demonstrated that it is possible to cultivate the bacillus before the agglutinins have appeared in the blood in sufficient quantity to make a certain diagnosis by the Widal test.

Again in this relation the question of group agglutination (between typhoid and paratyphoid) has to be considered. In a certain percentage of cases it is often difficult to say which is the main infection. Cultivation of the bacillus from the blood generally settles this difficulty.

The following table shows the result of the examination of blood by the serum agglutination test and the blood culture method in cases in which a marked group agglutination occurred:—

Name, rank, number, and regiment.	Date.	WIDAL REACTION.										BLOOD.				
		B. TYPHOSUS.					B. PARATYPHOSUS.					B. TY- PHOSUS.	B. PARATY- PHOSUS.			
		40	80	160	320	1000	A.			B.			A.	B.		
							20	40	80	20	40				80	
6962, M., Pte., Oxford L. I.	20th July 1907.	+	+	+	+	-	-	-	-	-	-	-	-	-	+	
23950, Gr. K., 9th M. B., R. G. A. (convalescent).	13th May 1907.	+	+	-	-	-	-	-	-	-	-	-	-	-	+	in faeces.
2250, Dr. C. E. W., 11th Batty., R. F. (convalescent).	28th August 1906.	+	+	+	-	-	-	-	+	+	+	+	+			
7501, Pte. V., 2nd East Surrey.	9th September 1906.	+	+	-	-	-	-	-	-	-	-	-	-	-		+ in urine.
Z. A., 5th Mule Cadre.	12th December 1906.	+	+	-	-	-	+	+	+	+	-	-	-	+		

In the case of Private M. a very puzzling reaction occurred. An organism, *Bacillus paratyphosus* A., was cultivated from the blood-stream and fæces. The agglutination test, however, showed a high reaction with *Bacillus typhosus*, but practically none with *Bacillus paratyphosus* A. or B. The reason of this "apparent" group reaction was explained later. A daily examination of the fæces and urine during convalescence was made and in the ninth week a few colonies of *B. typhosus* were detected in the stools. The case, therefore, was one of mixed infection.

Case of Dr. C. shows that the agglutination titre was the same both for *B. typhosus* and *paratyphosus* B. Cultivation of the blood proved that the organism was *B. typhosus*.

From a consideration of the above cases it will be readily understood that the universal adoption of the blood culture method for making a diagnosis of enteric fever in hospitals should be aimed at, and if it is combined with a serum sedimentation test, very few cases of enteric should pass unrecognised. Should the case be at an early stage the blood culture will show the presence of *B. typhosus*; if it is at a later stage a definite agglutination reaction will be got.

VIII.—PARATYPHOID INFECTIONS IN INDIA.

Up to the present in India there have been no recorded observations on paratyphoid infections based on cultural examinations. During this enquiry several cases have come under our observation, and these are now placed on record. The number of infections due to *B. paratyphosus* which we have met with is small as compared with those occasioned by *B. typhosus*.

Paratyphoid infections are produced by two organisms, *Bacillus paratyphosus* B. (Schottmüller) and *Bacillus paratyphosus* A. (Brion Kayser). In Europe *B. paratyphosus* B. appears to be far more widely distributed than *B. paratyphosus* A. Most of the cases recorded in Germany have been due to infection by *B. paratyphosus* B. Our experience in India, on the contrary, shows that the *B. paratyphosus* A. is a commoner cause of infection. Thus of the six cases of paratyphoid infections which we have studied, four have been caused by *B. paratyphosus* A. and only two by *B. paratyphosus* B. As the subject is new and of some interest, a summary of the observations which we made on the cases is given.

Case 1.—Infection caused by B. paratyphosus A.—No. 7277, Pte. B. age 23 years, service 5 years 8 months and 12 days, Durham Light Infantry, was admitted to the Station Hospital, Kasauli, on May 4th, 1906, complaining of

pains in the head and back, with loss of appetite and nausea. He began to feel ill on May 1st.

State on admission.—Face pale, skin moist, lips dark, eyes bright, pupils dilated, demeanour listless and apathetic, tongue coated with a dirty yellow fur, except at the sides and tip, which were red. Breath had a musty smell, bowels loose, motions yellow and watery, urine normal, body well-nourished, no rash visible. Heart, lungs and liver normal. Spleen not enlarged. Abdomen resonant on percussion, no pain or tenderness, gurgling quite perceptible in right iliac fossa. Temperature 100, pulse 75, respirations 20. Since his arrival in Kasauli from Lucknow on April 6th, 1906, he had not left the station. He denies having ever taken any food or drink outside barracks. None of the men in his barrack room lately had enteric, nor had any of his friends from other rooms. He does not remember to have used any latrine except that belonging to his barrack room. He had been "vaccinated" for enteric in May 1902. Prior to admission he had always been in good health.

May 8th, 1906.—A few rose spots were observed on the skin over the abdomen to-day. The blood was examined and an organism cultivated (*vide* description given below). Widal reaction to *B. typhosus* negative.

May 12th, 1906.—The spots seen on May 8th have disappeared and a fresh crop has appeared. Epistaxis to a slight extent occurs daily.

May 21st, 1906.—The temperature was normal to-day for the first time.

May 25th, 1906.—Slight relapse set in, which may have been the result of constipation, from which he has been suffering for the last two days.

June 1906.—Patient passed a partly formed stool.

June 16th, 1906.—Examination of the blood showed that it was sterile. No Widal reaction to typhoid.

June 20th, 1906.—Patient convalescent. Bowels regular, formed motions being passed naturally every day.

June 27th, 1906.—The patient is now out of bed; feels well but weak. He is rapidly gaining strength, however, while his appetite and appearance improve daily.

The temperature ranged between 99° and 103° F. from May 4th to 20th, 1906. It did not touch normal at all during this period. It became normal on May 21st and remained so until May 24th, when it rose to 100°. The temperature continued elevated until May 31st, when it touched normal. After this there was an evening rise to 100° but dropping to normal each morning until June 11th, when the temperature became normal and remained so.

The following table shows the result of the enumeration of the blood cells, the percentage of hæmoglobin, the Widal reaction for Typhoid and Paratyphoid

bacilli, and the presence or absence of bacilli in the peripheral blood :—

Date 1906.	R. B. C.	W. B. C.	PERCENTAGES.				Hb. %	WIDAL REACTION.		Bacilli in blood.
			P. N.	S. M.	L. M.	E.		Typhoid.	Paratyphoid B.	
May 6th . . .	...	...	...	...	...	...	...	—	—	+ (pure culture).
19th . . .	...	...	...	...	...	...	...	...	...	—
30th . . .	...	...	...	...	...	...	...	...	...	+ (pure culture).
June 2nd . . .	4,560,000	7,810	76	13	11	0	90	...	...	...
5th . . .	6,480,000	6,390	77	6	17	0	80	...	...	...
14th . . .	...	...	...	...	...	...	...	...	—	—

The following table shows the result of the examination of the urine and fæces :—

Name, rank, number and Regiment.	Date of examination.	URINE.			FÆCES.		
		B. typhosus.	B. paratyphosus.		B. typhosus.	B. paratyphosus.	
			A.	B.		A.	B.
7227, Private B., Durham Light Infantry.	6th May 1906 .	—	—	—	—	—	—

The following table shows the characters of the organism cultivated from the blood of Private B. :—

	Private B. B. paratyphosus A.	Stock B. paratyphosus A.
Microscopic characters	Motile rods ; gram negative .	Motile rods ; gram negative.
Ordinary broth	Diffuse cloudiness ; no scum .	Diffuse cloudiness ; no scum.
Ordinary agar	Whitish growth	Whitish growth.
Potato	Moist, transparent growth .	Moist and transparent growth
Ordinary milk	No change	No change .
Litmus milk	No clotting, slight red .	No clotting, slight red.

	Private B. B. paratyphosus A.	Stock B. paratyphosus A.
Litmus lactose nutrose	No change	No clotting, slight red.
Litmus glucose nutrose	Red	Red.
Litmus whey	Slightly red	Slightly red.
Neutral red agar	Gas and fluorescence pro- duced.	Gas and fluorescence produced.
Litmus mannite nutrose	Red	Red.
Indol production after 14 days	Nil	Nil.
Serum reaction (Titre 1—2,000)	Complete 1—2,000	Complete 1—2,000.

Case II.—Mixed infection (Bacillus paratyphosus A. and Bacillus typhosus).—

No. 6962, Private C. M., 1st Oxford Light Infantry. Service 5 years 7 months.

Admitted—15th July 1907.

Patient was in hospital for pain over the dorsal vertebræ for one week from 9th May 1907; no fever. Discharged cured. On 14th July 1907 came to hospital again with pain in the back, temperature 99°. There was tenderness on pressure over the dorsal vertebræ. The skin was very hyperæsthetic and the patient could not bear to be touched at the level of or below the twelfth dorsal spine. This area extended right round the body and down the buttocks. Bowels slightly loose.

22nd July 1907.—Complained of severe pain in abdomen. Rigidity of muscles on palpation, maximum point of pain over cæcal region; stools loose.

23rd July 1907.—Pain is most severe over the gall bladder and the region of cæcum.

25th July 1907.—Pain is still severe over the gall bladder. The muscles are very resistant over this area. Liver or splenic dulness not increased. Rose spots on abdomen. Spinal pain much diminished.

27th July 1907.—The temperature is normal. The patient had colic in the night.

30th July 1907.—Progressing satisfactorily.

2nd August 1907.—Now quite convalescent. Slight diarrhœa.

The temperature on July 14th was a little above 100° F. in the evening; next day it rose to 103° F. The temperature continued to range between 100° and 103° F. until July 27th, when it became normal in the morning. It rose to

100° F. in the evening, but came to normal next morning; after this date the temperature remained normal.

The following table shows the result of the examination of the blood:—

NAME.	Date.	WIDAL REACTION.							B. paratyphosus A. in blood.
		B. typhosus.				B. paratyphosus A.			
		80	160	320	1000	20	40	80	
Private M.	20th July 1907	+	+	+	—	...	...	...	+
	22nd July 1907	+	±	—	...	—	—	—	...
	26th July 1907	+	+	+	±	...	...	...	...
	28th July 1907	±	±	—	—	...	...	...	—
	4th August 1907	+	±	—	—	...	...	...	...

The following table shows the result of the examination of the fæces and urine of Private M. :—

NAME.	Date of observation.	B. PARATYPHOSUS A. IN	
		Fæces.	Urine.
	<i>July 1907.</i>		
Private M.	20th . . . . .	...	...
	22nd	—	...
	24th	+ + +	—
	25th	+ + +	—
	26th	⊖	—
	27th	—	—
	28th	—	—
	29th	—	—
	30th . . . . .	...	...
	31st . . . . .	...	...
	<i>September 1907.</i>		
	9th . . . . .	...	...
	15th . . . . .	...	...
	16th	+ (B. typhosus)	...
	18th	+ " "	...

NAME.	Date of observation.	B. PARATYPHOSUS A. IN	
		Fæces.	Urine.
Private M.	September 1907.		
	22nd	—	...
	24th	—	...
	30th . . . . .	...	...

See also Case No. 6, Table I, of Appendix.

The following table shows the characters of the organisms separated from the blood and stools of Private M. :—

	Private M. B. paratyphosus A.	Stock B. paratyphosus A.	Stock B. typhosus.
Microscopic character.	Motile rods ; gram negative .	Motile rods ; gram negative.	Motile rods ; gram negative.
Ordinary agar .	Good growth	Good growth	Good growth.
Ordinary broth .	Uniform turbidity, no scum .	Uniform turbidity, no scum.	Uniform turbidity, no scum.
Potato	Moist, transparent growth .	Moist transparent growth.	Moist transparent growth.
Litmus mannite nutrose.	Red	Red	Red.
Milk	No change	No change	No change.
Litmus milk . . .	No clotting, red	No clotting, red	No clotting, red.
Litmus lactose nutrose.	Red	Red	Red.
Litmus glucose nutrose.	Red	Red	Red.
Litmus whey.) . .	Slightly red	Slightly red	Very slightly red.
Neutral red agar .	Gas fluorescence	Gas fluorescence	No change.
Litmus saccharose .	No change	No change	No change.

100° F. in the evening, but came to normal next morning; after this date the temperature remained normal.

The following table shows the result of the examination of the blood:—

NAME.	Date.	WIDAL REACTION.							B. paratyphosus A. in blood.
		B. typhosus.				B. paratyphosus A.			
		80	160	320	1000	20	40	80	
Private M.	20th July 1907	+	+	+	—	...	...	...	+
	22nd July 1907	+	±	—	...	—	—	—	...
	26th July 1907	+	+	+	±	...	...	...	...
	28th July 1907	±	±	—	—	...	...	...	—
	4th August 1907	+	±	—	—	...	...	...	...

The following table shows the result of the examination of the fæces and urine of Private M. :—

NAME.	Date of observation.	B. PARATYPHOSUS A. IN		
		Fæces.	Urine.	
Private, M.	July 1907.			
	20th	...	...
	22nd	—	...	
	24th	+ + +	—	
	25th	+ + +	—	
	26th	±	—	
	27th	—	—	
	28th	—	—	
	29th	—	—	
	30th	...	...
	31st	...	...
	September 1907.			
	9th	...	...
	15th	...	...
	16th	+ (B. typhosus)	...	
18th	+ " "	...		

NAME,	Date of observation.	B. PARATYPHOSUS A. IN	
		Fæces.	Urine.
Private M.	September 1907.		
	22nd	—	...
	24th	—	...
	30th . . . . .	...	...

See also Case No. 6, Table I, of Appendix.

The following table shows the characters of the organisms separated from the blood and stools of Private M. :—

	Private M. B. paratyphosus A.	Stock B. paratyphosus A.	Stock B. typhosus.
Microscopic character.	Motile rods ; gram negative	Motile rods ; gram negative.	Motile rods ; gram negative.
Ordinary agar	Good growth	Good growth	Good growth.
Ordinary broth	Uniform turbidity, no scum	Uniform turbidity, no scum.	Uniform turbidity, no scum.
Potato	Moist, transparent growth	Moist transparent growth.	Moist transparent growth.
Litmus mannite nutrose.	Red	Red	Red.
Milk	No change	No change	No change.
Litmus milk	No clotting, red	No clotting, red	No clotting, red.
Litmus lactose nutrose.	Red	Red	Red.
Litmus glucose nutrose.	Red	Red	Red.
Litmus whey.†	Slightly red	Slightly red	Very slightly red.
Neutral red agar	Gas fluorescence	Gas fluorescence	No change.
Litmus saccharose	No change	No change	No change.

The following table shows the characters of organism separated from the fæces of Gr. K.—

	Gr. K. B. paratyphosus A.	Stock B. Paratyphosus A.
Microscopic characters	Motile rods ; gram negative	Motile rods ; gram negative.
Broth	Diffuse typical growth	Diffuse typical growth.
Ordinary agar	Growth typical	Growth typical.
Potato	Moist typical growth	Moist typical growth.
Litmus mannite nutrose	Slightly red	Slightly red.
Milk.	No change	No change.
Litmus milk	Slightly red. No clotting	Slightly red. No clotting.
Litmus lactose nutrose	Unchanged	Unchanged.
Litmus glucose nutrose	Red	Red.
Litmus whey	Slightly red	Slightly red.
Neutral red agar	Gas and fluorescence	Gas and fluorescence.
Indol, after 14 days	Nil	Nil.
Serum reaction B. paratyphosus A. (titre 1—2,000).	Complete 1—2,000	Complete 1—2,000.

Case IV.—Infection caused by B. paratyphosus A.—Driver Z. A., age 28, 5th Mule Cadre, was admitted on 29th October 1906 to Meerut cantonment hospital. The initial pyrexia lasted for 12 days, the highest point touched being 104°. The temperature did not become normal until the 9th day; then, for the next three days it was intermittent. It remained normal until the 19th day. On the 20th day it rose to 99°; then fell to normal, but rose next evening to 104°. It remained high, varying between 102° and 104°, until the 31st day of the disease; when it gradually became lower and touched normal on the 35th day. It remained about normal until the 40th day, when it rose and

remained between 103° and 104° until the 52nd day, when it gradually fell. It became normal on the 56th day, and remained so.

The patient had a hæmorrhage from the bowel on the 45th day. He was very much reduced by this long illness. He had two relapses after the original attack. Apart from the pyrexia and the hæmorrhage from the bowel there was nothing noteworthy in his clinical history. The chief interest lay in the results of the bacteriological investigation of his case.

The following table shows the result of the examination of the blood of driver Z. A. :—

NAME.	Date of observation.	WIDAL REACTION.			B. paratyphosus A. in blood.
		B. typhosus.	B. paratyphosus.		
			A.	B.	
Driver Z. A.	12th December 1906.	1—40 Complete.	1—320 Complete.	1—10	+

The following table shows the characters of the organism separated from the blood of Z. A. :—

	Driver Z.A. B. paratyphosus A.	Stock B. Paratyphosus A.	Stock B. typhosus.
Microscopic characters.	Motile rods ; gram negative.	Motile rods ; gram negative.	Motile rods ; gram negative.
Broth	Uniform turbidity, no scum.	Uniform turbidity, no scum.	Uniform turbidity, no scum.
Ordinary agar	Good growth	Good growth	Good growth.
Litmus mannite nutrose	Red	Red	Red.
Litmus glucose nutrose	Red	Red	Red.
Litmus lactose nutrose	No change	No change	No change.
Litmus whey	Stronger red	Stronger red	Slight red

	Driver Z.A. B. paratyphosus A.	Stock B. paratyphosus A.	Stock B. typhosus.
Litmus milk	Motile rods ; gram negative.	Motile rods ; gram negative.	No clotting, red.
Milk	No change	No change	No change.
Neutral red agar	Gas fluorescence	Gas fluorescence	No change.
Potato	Moist transparent growth	Moist transparent growth	Moist transparent growth.
Litmus saccharose nutrose.	No change	No change	No change.
Litmus dextrine nutrose.	Red	Red	Red.
Indol, after 14 days	Nil	Nil	Nil.
Serum reaction B. paratyphosus A. titre 1—2,000.	1—2,000 complete	1—2,000 complete	Nil.

Case V.—Infection caused by B. paratyphosus B.—No. 7501, Pte. Y. of the 2nd East Surrey Regiment, was sent up to Kasauli to convalesce after an attack of enteric fever. A systematic examination of his urine and fæces was made and showed that he was excreting B. paratyphosus B. in considerable numbers in his urine.

The following table shows the result of the examination of the blood of Pte. Y. :—

NAME.	Date of observation.	WIDAL REACTION.			B. Paratyphosus B. in blood.
		B. typhosus.	B. paratyphosus.		
			A.	B.	
Pte. Y.	5th September 1907.	1—20 Complete.	—	—	...

The following table shows the result of the examination of the fæces and urine of Pte. Y. :—

NAME.	Date of observation.	B. PARATYPHOSUS B. IN		
		Fæces.	Urine.	
Pte. Y.	9th May 1906	...	+	...
	12th May 1906	...	+	...

Remarks.

This case is of interest as showing that although it was regarded clinically as an ordinary case of enteric fever, the bacteriological examination showed that the man was suffering from a paratyphoid infection and he continued to excrete *B. paratyphosus B.* in his urine for a long period after freedom from fever. This was the only case in which we have cultivated *B. paratyphosus B.* from a patient.

Case VI.—Infection caused by B. paratyphosus B.—A specimen of blood taken from a lady at Nowshera, who was suffering from what appeared to be an atypical attack of enteric fever, was sent for examination. It was found that her serum agglutinated *B. paratyphosus B.* in very high dilution, about 1—1500. The examination was repeated with another specimen of blood and the same result obtained.

In this case we were not able to make a cultural examination, but from the high serum agglutination titre, there can be little doubt of the nature of the infection.

IX.—RESULTS OF EXAMINATION OF BILE.

An important observation to confirm was, whether or not the *B. typhosus* is excreted in the bile of cases of enteric fever? To obtain material to work out this problem a request was sent to all military hospitals in India to send samples of bile from fatal cases of enteric fever. Also a similar request was sent to the large civil hospitals in Bombay, Madras, Calcutta, and Lahore.

Should the *B. typhosus* be found constantly and in large numbers in the bile of cases of enteric fever, it will strongly support the view outlined above, namely, that the bacilli deposited in the liver from the blood stream infect the bile in the biliary channels and the bile being a very favourable medium for its development the bacillus typhosus grows very richly. This culture of *B. typhosus* is

poured into the intestinal tube with the bile and so gains an exit in the fæces to the external world.

The bacillus typhosus can give rise to cholecystitis. In the case of Corporal W., at Mhow, the medical officer in forwarding the bile sample stated that "the gall bladder was nearly empty and the bile withdrawn looks like thin yellowish-green pus. The gall bladder when subsequently opened was intensely inflamed." The sample had the appearance of pus and was plated as usual on Drigalski Conradi plates. Our examination next day showed an almost pure growth of *B. typhosus*. In several of the cases of enteric fever which we have observed, both during the acute phase of the disease and during convalescence, signs and symptoms have appeared which clearly pointed to an affection of the gall bladder. The occurrence of this condition during convalescence lends additional support to the view that it is in the biliary channels that the *B. typhosus* continues to exist.

The intermittent discharge of bacilli in fæces is, probably, dependent on infection of the bile stream from time to time by the bacilli deposited in the liver.

The results of the examination of the samples received up to date fully confirm the view above stated. We have found in the bile of fatal cases of enteric fever the bacillus typhosus in very large numbers and frequently in pure culture.

The following table shows the result of the examination of samples of bile collected from fatal cases of enteric fever :—

Name, number, rank and Regiment.	Date of death.	Date of examination of bile.	Bacillus typhosus in bile.
No. 6259 Pte. C. H., 1st Gloucester Regiment.	16th August 1907 .	19th August 1907 .	—
No. 6441 Pte. M. T., Cameronians .	16th August 1907 .	20th August 1907 .	+ + +
No. 7431 B. A., 2nd South Staff Regt.	Not known . .	25th August 1907 .	—
No. 7696 Pte. P., 1st R. S. F. . .	22nd August 1907 .	25th August 1907 .	+ +
No. 5240 T., 1st Royal Dragoons .	23rd August 1907 .	27th August 1907 .	—
No. 8707 Corpl. S., H. L. I. . .	24th August 1907 .	30th August 1907 .	+ + +
No. 7628 Pte. J. G., 1st Northampton.	30th August 1907 .	1st September 1907	+
No. 5526 Pte. H., 1st Lanc. Regiment.	28th August 1907 .	30th August 1907 .	+ + +
No. 6991 Pte. A., XIII Hussars .	4th September 1907	6th September 1907	+ +

Name, number, rank and Regiment.	Date of death.	Date of examination of bile.	Bacillus typhosus in bile.
No. 5926 Pte. H., Lincoln. Regiment	8th September 1907	12th September 1907	—
No. 569 L/C. D. L., 2nd Rifle Brigade.	10th September 1907	13th September 1907	+
No. 4013 Pte. K. A. Sqd., 10th Royal Hussars.	7th September 1907	19th September 1907	—
No. 10924 Gr. G. F., 8th By., R. F. A.	25th September 1907	28th September 1907	++
No. 15531 Gr. D., No. 90th Coy., R. G. A.	29th September 1907	3rd October 1907	+
No. 9102 L/C. S. G., 1st Durham L. I.	7th October 1907	9th October 1907	—
No. 6948 Pte. S. W.	6th October 1907	11th October 1907	—
No. 6039 Pte. F., 1st Lincoln. Regiment.	14th October 1907	20th October 1907	—
No. 8365 S/C. W. S., 2nd E. Surrey.	20th October 1907	24th October 1907	+++

We have not received any samples of bile from enteric fever cases in the civil hospitals.

In addition to the examination of bile from fatal cases of enteric fever, cultivations from the bile of fatal cases of other diseases are being made, in order to determine with what frequency the bacillus typhosus is found in the bile of individuals who have no history at all or no recent history of having passed through an attack of enteric. The results of these observations will be published in a subsequent report as at the date of writing only a few samples of bile have been received from cases which have died from other causes than enteric fever.

X.—THE SAPROPHYTIC EXISTENCE OF THE BACILLUS TYPHOSUS AND PARATYPHOSUS OUTSIDE THE HUMAN BODY.

The experiments on this subject are still in progress and will be recorded in full in a future report. A few of the completed investigations are dealt with in this report.

It is important to know whether or not under natural conditions in India the bacillus typhosus has or has not a prolonged existence outside the human body.

We found that if urine and fæces containing bacillus typhosus, either naturally or artificially infected, be allowed to stand at room temperature, 80° F., protected from sun, the bacilli very rapidly die out. Urine which contained

about 60,000,000 bacilli per c.c. was found to be sterile at the end of 72 hours. Also a sample of fæces from a native suffering from enteric fever which contained *B. typhosus* in practically pure culture was allowed to stand at room temperature protected from the sun, and at the end of 96 hours it was found that the *B. typhosus* had died out.

The general trend of the observations shows that the conditions met with outside the human host are not favourable to the prolonged existence of the *B. typhosus* and therefore the persistence of the disease cannot be explained by a hypothesis that postulates long extra-corporeal existence of the bacilli. The chief value of these experiments is that they define by exclusion the conditions necessary for the prolonged life of the parasite. It is brought home to us more clearly that conditions outside the human body cannot favour the growth of the parasite; at the best they can act only as channels of communication, and these channels will soon dry up unless fed from the reservoir, the human host.

The following table shows the result of allowing urine from a case of enteric fever containing many bacilli to stand at room temperature, 80° F., protected from the sun:—

No. of experiment.	Name, number, Regiment of patient.	Date of passing sample of urine.	Date of examination of urine.	Number of colonies of bacillus typhosus.
I.	S., No. 8089, Oxford L. Infantry.	13th June 1907	13th June 1907	36,000,000 per c.c.
	Ditto	Ditto	16th June 1907, 72 hours.	Sterile.
II.	Ditto	14th June 1907	14th June 1907	30,000,000 per c.c.
	Ditto	Ditto	16th June 1907, 72 hours.	Sterile.
III.	Ditto	15th June 1907	15th June 1907	62,000,000 per c.c.
	Ditto	Ditto	16th June 1907, 24 hours.	1,000,000 per c.c.
	Ditto	Ditto	17th June 1907, 48 hours.	100,000 per c.c.
	Ditto	Ditto	18th June 1907, 72 hours.	Sterile.
IV.	Ditto	16th June 1907	16th June 1907	60,000,000 per c.c.
	Ditto	Ditto	17th June 1907, 24 hours.	29,060 per c.c.
	Ditto	Ditto	18th June 1907, 48 hours.	Sterile.

The following table shows the result of allowing fæces containing many bacilli to stand at room temperature, 85° F., protected from the sun :—

Name, number, Regiment of patient.	Date of passing sample of fæces.	Date of examination of fæces.	Bacillus typhosus in fæces.
Sepoy G. Rao, 114th Mahratta Light Infantry, Poona.	19th September 1907	19th September 1907	+ + +
		20th ditto	+ +
		21st ditto	+ +
		23rd ditto	+ +
		24th ditto	—
		26th ditto	—
		27th ditto	—
			Large numbers of B. Coli.

The following table shows the duration of life of B. typhosus in normal European fæces kept at room temperature, 80° F., protected from sun :—

Amount of fæces.	Amount of B. typhosus added.	No. of days after infection of fæces.	B. typhosus in fæces.
5 grms. emulsified in normal salt solution.	One loopful of an emulsion	5	+
Ditto	Ditto	10	—
Ditto	Ditto	14	—
Ditto	Ditto	21	—

The following table shows the duration of life of the B. typhosus in sewage effluent kept at room temperature (80° F.) and protected from light :—

Source.	Amount of effluent.	Amount of bacillus typhosus added.	Days after infection of effluent.	B. typhosus in effluent.
Meerut septic tank	One test tube full.	One loopful	5	+
Ditto	Ditto	Ditto	17	—
Ditto	Ditto	Ditto	23	—

The following experiments were made in order to determine the effect of the Indian sun on the *B. typhosus* in articles of clothing.

A piece of used dirty cotton sheeting and a piece of used dirty coloured blanket of Indian make were soaked with the fresh urine of case No. 645, S., containing 60,000,000 bacilli per c.c.

The pieces of material were dried in the air, and each divided into two portions.

One piece of each was laid on a wall and exposed to the July sun at Kasauli for two hours. The other halves were put in a dark cupboard in Petri dishes. Immediately after exposure to the sun, about a square inch of cloth and blanket were put in bile medium and incubated for 24 hours.

On plating the result was—

Cloth sheet	No typhoid colonies.
Blanket	A few do.

The cloth plate was nearly sterile, and the blanket plate had many coli like colonies.

Forty-eight hours later they were again cultivated in bile and plated, with an exactly similar result.

The previously sunned blanket was then exposed to the sun for a further period of six hours, being turned over twice.

On cultivation and planting, *no* typhoid colonies were recovered and the plate shewed only a very few coli like colonies.

As far as this one experiment goes, it seems that typhoid bacilli are killed in thin white cotton by two hours' exposure to an Indian sun, and it takes an exposure of between two and six hours to destroy them in a thick dark coloured blanket.

The *unsunned* cloth and blanket were kept in the cupboard for six days and cultivated and plated as above. They showed—

Cloth sheet	Very many typhoid colonies.
Blanket	Ditto.

They were cultivated and plated again 17, 20, and 25 days after infection with the following results:—

17 days	No typhoid colonies.
20 „	Ditto.
25 „	Ditto.

So that within 17 days typhoid bacilli had died out of the above typhoid urine soaked cloth and blanket kept in a cupboard.

Experiment to note the effect of the exposure to the sun of a blanket soiled with fæces from an enteric case.

A further experiment was undertaken to test the duration of life of *B. typhosus* on a blanket soiled with fæces from a case of enteric in a native; the fæces contained enormous numbers of bacilli. The experiments were carried out at Poona.

Half a gramme of fæces of Sepoy G. Rao was spread on a blanket, a similar piece of blanket being spread on the top. This was placed in a sterile Petri dish. The dish was placed on the window sill and exposed to the light from dawn to dusk and to direct sunlight from 10 A.M. to 3 P.M. The experiment was continued from 23rd September 1907 to 1st October 1907. A portion of the fæces was removed from the blanket with a portion of the blanket adherent. This was emulsified in 0.5 c.c. normal salt solution with care. The emulsion was drawn up in a pipette and transferred to a Drigalski Conradi plate.

The following table shows the result of the experiment:—

Article.	Date of observation.	Date of passing fæces.	B. TYPHOSUS IN BLANKET.	
			Before exposure to sun.	After exposure to sun.
Blanket soiled with fæces of enteric fever case (G. Rao).	23rd September 1907	23rd September 1907	+ + +	...
	26th ditto	...	...	+
	28th ditto	...	...	—
	1st October 1907	...	...	—

*Experiment to note the effect of exposing a blanket soiled with fæces from a case of a man excreting *B. typhosus* in considerable numbers (a "chronic bacilli carrier").*

Small portions (1 sq. c.m.) of ordinary Indian blanket were soaked in an emulsion of fæces of Pte. H. The fæces contained numerous bacilli. The blanket was exposed to the sun daily for fixed periods. After certain intervals 1 sq. c.m. of the blanket was carefully emulsified in 1 c.c. of sterile normal salt and this was plated on large Drigalski Conradi plates in the usual way. The presence or absence of *B. typhosus* in the plates was noted. The temperature

in the sun during the experiment varied from 85° Fahr. to 95° Fahr. The experiment was conducted at Kasauli in the month of October.

The following table shows the details of the experiment :—

Source of faeces and article infected.	Date of observation.	Period of exposure to sun.	B. typhosus in blanket.
Blanket soaked in emulsion of faeces of Pte. H. Case No. 1, Table I of Appendix.	29th October 1907		+ + (Before exposure.)
		3 hrs. 15 mins.	+ +
	30th ditto	6 hrs.	+
	31st ditto	3 hrs. 15 mins.	—
	1st November 1907	4 hrs.	— Sterile.

Remarks.—This experiment again shows that *B. typhosus* is readily destroyed in articles soiled with enteric faeces even when exposed to a comparatively low sun temperature.

In order to estimate the bactericidal action of the sun on *B. typhosus* in various kinds of cloth a series of experiments were undertaken. An emulsion of *B. typhosus* in unsterilised urine was made. The cloth was cut up into small squares, each measuring exactly 1 sq. c.m. They were dipped into the urine. The number of typhoid bacilli in 1 sq. c.m. of cloth was estimated before exposure to the sun. This was done by washing the piece of cloth very carefully in 1 c.c. of sterile normal salt solution and then a measured quantity of this was planted out on Drigalski Conradi plates and the number of colonies counted. The small portions of cloth were then exposed to the sun. After certain fixed intervals small pieces of cloth were removed and the number of colonies estimated. In this way it was possible to determine the exposure necessary in order to destroy the *B. typhosus* in articles of clothing when exposed to the Indian sun. With each article a control experiment was done by keeping the cloth in a dark cupboard protected from the sun's rays. The experiments are at present in progress, but one of the completed experiments is given below to illustrate the rapid destructive action of the sun on the *B. typhosus* in articles of clothing.

The following experiment shows the result of exposing white drill contaminated with bacillus typhosus to the sun at Kasauli:—

DATE OF OBSERVATION.	Nature of cloth.	NUMBER OF COLONIES OF B. TYPHOSUS IN WASHINGS OF 1 SQ. C.M. OF CLOTH IN 1 C.C. STERILE NORMAL SALT SOLUTION.							
		Before exposure to sun.	AFTER EXPOSURE TO SUN FOR						Temperature.
			30 minutes.	60 minutes.	120 minutes.	150 minutes.	180 minutes.	200 minutes.	
28th September, 1907.	White drill.	10-15 A.M. 240,000.	1000	5.	nil.	nil.	nil.	nil.	105° F. sun. 92° F. shade.
									2nd experiment: no typhoid bacilli found at 60 minutes.

The following experiment shows the result of keeping white drill contaminated with B. typhosus in a cupboard protected from the sun:—

Date of observation.	Nature of clothing.	Number of colonies of bacillus typhosus in washings of 1 sq. c.m. of cloth in 1 c.c. normal saline.
4th October 1907	White drill	240,000
10th October 1907	.....	25,000
14th October 1907	.....	Sterile.

From a general consideration of the above experiments we are led to the conclusion that the B. typhosus under natural Indian conditions has a very limited life outside the human host. Our previous observations have shown that inside the body of the host it may have a very prolonged existence, because it finds favourable conditions for its life. Hence in preventive measures the human host should be primarily considered.

XI.—GENERAL CONCLUSIONS.

1. *Enteric Convalescents.*—Our investigations have shown that a certain percentage of cases of enteric fever remain infective for a long time. In order to detect such cases the urine and fæces of all convalescents should be submitted to a careful daily bacteriological examination for a prolonged period. By this means it will be possible to state when men are free from bacilli and safe to return to their units.

2. *Enteric Orderlies.*—As has been shown in this report, a number of men whilst in attendance on enteric fever cases contract the disease and some of them so slightly that they do not report sick. A certain number of these orderlies become "chronic bacilli carriers" and under the present system at the end of the period of duty as enteric nursing orderlies, these men return to their units and so take fresh foci of infection to their various stations. By creating a special permanent body of trained men to nurse enteric patients a considerable danger as regards the spread of enteric fever would be removed.

3. *Men dealing with food supplies, e.g., in cookhouses, dairies, aerated water and ice factories, etc.*—As we have seen, epidemics of enteric fever can be caused by men dealing with food supply while they are excreting the germ of the disease. The elimination of this danger can be accomplished only by a careful bacteriological examination of all men (European and Native) before permitting them to be employed in connection with the preparation and distribution of articles of food and drink.

It will be seen from the above that the problem of the prevention of enteric fever amongst the British troops in India is the detection and isolation of the individual harbouring the bacillus typhosus.

PART II.

APPENDIX.

Table I.*

In this table are recorded the results of the daily observations made on a number of convalescent enteric fever cases at Kasauli. The urine and fæces of each of the cases was examined daily. During the investigations of these cases a large number of important facts have been collected.

(*Vide* page 8, Part I, of this Report for discussion of results.)

As these observations have an important bearing on the prevention of enteric fever in India, the attention of all those who have to deal with this difficult problem is particularly directed to this table.

In recording the results of the examination, the signs used have the following meaning:—

1. Fæces + = up to 10 colonies on 3rd plate.

+ + = 10-30 " " " "

+ + + = 30-60 " " " "

+ + + + = Over 60 " " " "

2. Urine. If counted, the number of colonies (bacilli) per c.c. of urine is stated.

The method of plating the fæces is described in the previous report.

TABLE I.

CONVALESCENT ENTERIC NO. 1.

RANK—PRIVATE, No. 8364.

NAME—H.

REGIMENT—BEDFORDS.

DATE ON WHICH FEVER CEASED—8TH JUNE 1907.

ADMINISTRATION OF UROTROPINE (DATES AND DOSES)—GR. X TWICE DAILY FROM
6TH JUNE 1907 TO 18TH JULY 1907.

Date of observation.	Widal reaction to Bacillus typhosus.				Bacillus typhosus in	
	10	20	40	80	Urine. Number of bacilli per c.c.	Fæces
July 1907.						
18	+ +
19	+	+	+	±
22	+	...
23	+ 200,000 per c.c.	+ +
24	+ 20,000 per c.c.	+ + +
25	+ 200 per c.c.	+ + +
26	+ 40,000 per c.c.	+ +
27	+ 100,000 per c.c.	...
28	—	—
29	+ 100,000 per c.c.	+
30	—	—
31	—	—
August 1907.						
1	—	—
2	—	—
3	—	—
5	—	—
6	+ 20,000 per c.c.	—

TABLE I—*continued.*CONVALESCENT ENTERIC NO. 1—*continued.*PTE. H.—*continued.*

Date of observation.	Widal reaction to <i>Bacillus typhosus</i> .				Bacillus typhosus in	
	10	20	40	80	Urine, Number of bacilli per c.c.	Fæces.
August 1907— <i>contd.</i>						
8	+	+	±	—	—	+ +
9	—	...
11	—	—
12	—	+ + +
13	—	+ + +
14	—	+ +
15	—	+ +
16	—	+
17	—	+
18	—	+ +
19	—	+ +
20	—	+ +
21	—	+ + +
22	—	+ +
23	—	—
24	—	—
25	—	—
26	—	—
27	—	—
28	—	—
29	—	+ +
30	—	+
31	—	+ +
September 1907.						
1	—	—
2	—	—
3	—	—

TABLE I—*continued.*CONVALESCENT ENTERIC NO. 1—*continued.*PTE. H.—*continued.*

Date of observation.	Widal reaction to <i>Bacillus typhosus</i> .				<i>Bacillus typhosus</i> in	
	10	20	40	80	Urine. Number of bacilli per c.c.	• Faeces.
September 1907— <i>contd.</i>						
4	—	—
5	—	+ +
6	—	+ + +
7	—	+
8	—	—
9	—	+
10	—	+
11	—	+
12	—	+
13	—	—
14	—	—
15	—	—
16	—	—
17	—	—
18	—	—
19	—
20	—	—
21	—
22	—	—
23	—	+
24	—
25	—
26	—
27	—	—
28	—	+
29	—	+
30	—	+ + +

TABLE I—*continued.*CONVALESCENT ENTERIC NO. 1—*continued.*PTE. H.—*continued.*

Date of observation.	Widal reaction to <i>Bacillus typhosus</i> .				<i>Bacillus typhosus</i> in	
	10	20	40	80	Urine. Number of bacilli per c.c.	Fæces.
October 1907.						
1	+	—
2	—	...
3	—	—
5	—	+ + + +
6	—	+ + +
7	—	+ + +
8	+ +
10	—	—
11	—	+ + + +
12	—	+ + +
13	—	+ +
14	—	—
15	—	+ +
16	—	...
17	—
18	+ + +
19	—	—
20	—	+ + +
21	—	+ + +
22	—	...
23	—	...
24	—	...
25	—	—
26	—	...
28	—	+ +
29	—	+ + + +

TABLE I—*continued.*CONVALESCENT ENTERIC NO. 1—*continued.*PTE. H.—*continued.*

Date of observation.	Widal reaction to <i>Bacillus typhosus</i> .				<i>Bacillus typhosus</i> in	
	10	20	40	80	Urine, Number of bacilli per c.c.	Fæces.
September 1907 — <i>contd.</i>						
4	—	—
5	—	+ +
6	—	+ + +
7	—	+
8	—	—
9	—	+
10	—	+
11	—	+
12	—	+
13	—	—
14	—	—
15	—	—
16	—	—
17	—	—
18	—	—
19	—
20	—	—
21	—
22	—	—
23	—	—
24	—
25	+
26	—
27	—	—
28	—	+
29	—	+
30	—	+ + +

TABLE I—continued.

CONVALESCENT ENTERIC NO. 1—continued.

PTE. H.—continued.

Date of observation.	Widal reaction to Bacillus typhosus.				Bacillus typhosus in	
	10	20	40	80	Urine. Number of bacilli per c.c.	Fæces.
October 1907.						
1	+	—
2	—	...
3	—	—
5	—	+ + + +
6	—	+ + +
7	—	+ + +
8	+ +
10	—	—
11	—	+ + + +
12	—	+ + +
13	—	+ +
14	—	—
15	—	+ +
16	—	...
17	—
18	+ + +
19	—	—
20	—	+ + +
21	—	+ + +
22	—	...
23	—	...
24	—	...
25	—	—
26	—	...
28	—	+ +
29	—	+ + + +

TABLE I—*continued.*CONVALESCENT ENTERIC NO. 1—*concluded.*PTE. H.—*concluded.*

Date of observation.	Widal reaction to <i>Bacillus typhosus</i> .				<i>Bacillus typhosus</i> in	
	10	20	40	80	Urine. Number of bacilli per c.c.	Fæces.
October 1907— <i>contd.</i>						
30	—	...
31	—	...
November 1907.						
1	+ + + +
4	—	—
6	—	+ +
8	—	+ + + +
9	—	+ +
10	—	+ + + +
11	—	+ + + +
13	—	+ + + +
14	—	—
15	—	+ + +
16	—	+ +
18	—	+ + + +
20	—	+ + + +
21	—	+ + + +
22	—	+ + +
23	—	—
24	—	...
25	—	+ + + +

REMARKS.

In this case we have an example of a "chronic bacilli carrier." He was free from fever on the 6th June, but it is shown that he is excreting bacilli in very large numbers in his fæces at the end of October, nearly five months later. The man looks perfectly well. Such a man as this, returning to his regiment, would be a focus of infection. If he were employed in a cookhouse, dairy, etc., he would be very liable to

cause an epidemic of enteric. The sanitary conditions of the cookhouse or dairy might be perfect and the source of such an epidemic would be very difficult to determine.

In November the faeces of this man contained enormous numbers of bacilli in pure culture. There were several hundred colonies on the third Drigalski-Conradi plate. The danger of such a case in a regiment requires no comment. This case should be very carefully studied by all those engaged in the prevention of enteric fever.

TABLE I—*continued.*

CONVALESCENT ENTERIC No. 2.

RANK—PRIVATE, NO. 6821.

NAME—W. L.

REGIMENT—BEDFORDS.

DATE ON WHICH FEVER CEASED—26TH JUNE 1907.

ADMINISTRATION OF UROTROPINE (DATES AND DOSES)—GR. X TWICE DAILY FROM
29TH JUNE 1907 TO 13TH JULY 1907.

Date of observation.	Widal reaction to Bacillus typhosus.				Bacillus typhosus in	
	10	20	40	80	Urine. Number of bacilli per c.c.	Fæces.
July 1907.						
17	—
18	+ +	...
19	+	+	+	±
20	1,000 per c.c. +	—
21	4,000 per c.c.	...
22	— +	...
23	1,000,000 per c.c. +	...
24	20,000 per c.c. +	—
25	1,000 per c.c.	...
26	+	—
27	— +	...
28	8,000,000 per c.c.	...
29	—	...
30	—	...
31	—	...
August 1907.						
2	2 per c.c.	...
3	—	...
5	—	...
6	+	—
8	—	—
9	+	+	±	—	—	...
10	—	...

TABLE I—*continued.*CONVALESCENT ENTERIC No. 2—*continued.*PTE. W. L.—*continued.*

Date of observation.	Widal reaction to <i>Bacillus typhosus</i> .				Bacillus typhosus in	
	10	20	40	80	Urine. Number of bacilli per c. c.	Fæces.
August 1907— <i>contd.</i>						
11	—	...
12	—	...
13	—	...
14	—	...
15	—	...
16	—	—
17	—	...
18	—	...
22	—	...
23	—	—
24	+ 1,000 per c. c.	...
25	+	...
26	—	—
27	—	—
28	—	—
29	—	...
30	+ 1,000 per c. c.	...
31	—	—
September 1907.						
1	—	—
2	—	—
3	—	—
4	—	—
5	—	—
6	—	—
7	—	—

TABLE I—*continued.*CONVALESCENT ENTERIC NO. 2—*continued.*PTE. W. L.—*continued.*

Date of observation.	Widal reaction to <i>Bacillus typhosus</i> .				Bacillus typhosus in	
	10	20	40	80	Urine. Number of bacilli per c. c.	Fæces.
September 1907— <i>contd.</i>						
8	—	—
9	—	—
10	—	—
11	—	—
12	—	—
24	—	—
25	—	—
26	—	—
27	—	—
28	—	—
29	—	—
30	—	—
October 1907.						
1	—	—
2	—	—
3	—	—
4	—	—
5	—	—
6	—	—
7	—	—
8	—	—
9	—	—
10	—	—
11	—	—
12	—	—
13	—	—
14	—	—

TABLE I—*continued.*CONVALESCENT ENTERIC NO. 2—*concluded.*PTE. W. L.—*concluded.*

Date of observation.	Widal reaction to <i>Bacillus typhosus</i> .				Bacillus typhosus in	
	10	20	40	80	Urine. Number of bacilli per c. c.	Fæces.
October 1907— <i>contd.</i>						
15	—	...
16	—	...
17	—	—
18	—	—
19	—	—
20	—	—
21	—	...
22	—	—
23	—	—
24	—	—
25	—	—
26	—	—
27	—
28	—	—
29	—	—
30	—	—
31	—	—

REMARKS.

This case became free from fever on June 26th, but he continued to excrete bacilli in his urine up to the end of August. He never discharged any bacilli in his fæces. This case illustrates the markedly intermittent character of the excretion of *B. typhosus* in urine and emphasises the importance of repeated examinations before declaring a patient bacilli free. He has not excreted any bacilli during September or October. In the previous case urotropine had no effect in permanently checking the bacilluria.

TABLE I—*continued.*

CONVALESCENT ENTERIC NO. 3.

RANK—PRIVATE, NO. 8089.

NAME—S.

REGIMENT—OXFORD LIGHT INFANTRY.

DATE ON WHICH FEVER CEASED—8TH JULY 1907.

ADMINISTRATION OF UROTROPINE (DATES AND DOSES)—NONE.

Date of observation.	Widal reaction to <i>Bacillus typhosus</i> .								<i>Bacillus typhosus</i> in			
	100	200	400	500	600	800	1000	1250	Urine. Number of bacilli per c.c.	Fæces.	Blood.	
June 1907.												
23	+	+	+	+	+	+	+	+	+	—	+	
26	+	
28	+	+	+	±	
29	
July 1907.												
1	+	+	+	+	+	+	+	±	+	—	...	
2	
3	+	—	...	
5	+	+	±	+	—	...	
6	30,000,000 per c.c. +	—	...	
7	+	+	±	70,000,000 per c.c. +	+	...	
8	56,000,000 per c.c. +	+	...	
9	+	+	+	+	+	50,000,000 per c.c. +	...	...
10	33,000,000 per c.c. +	+	+	+
11	+	+	+	+	+	±	44,000,000 per c.c. +	...	...
12	77,000,000 per c.c. +	+	+	+
13	+	±	35,000,000 per c.c. +	...	...
15	+	+	+	+	±	36,000,000 per c.c. +	+	+	+
16	62,000,000 per c.c. +	...	...
17	6,000,000 per c.c. +	...	...
18	20,000 per c.c. +	+	+	
19	22,000 per c.c. +	...	...
									1,000 per c.c.	...	...

TABLE I—*continued.*CONVALESCENT ENTERIC NO. 3—*continued.*PIE. S.—*continued*

Date of observation.	Widal reaction to <i>Bacillus typhosus</i> .								<i>Bacillus typhosus</i> in		
	100	200	400	500	600	800	1000	1250	Urine. Number of bacilli per c.c.	Fæces.	Blood.
July 1907— <i>contd.</i>											
20	+ 2,000 per c.c.	+	...
21	+ 10,000,000 per c.c.	...	...
22	+ 60,000,000 per c.c.	—	...
23	+ 30,000,000 per c.c.	—	...
24	+ 100,000,000 per c.c.	—	...
25	+ 60,000,000 per c.c.	...	...
26	+ 100,000,000 per c.c.	—	...
27	+ 4,000,000 per c.c.	...	...
28
29	+ 70,000,000 per c.c.	—	...
30	+ 20,000,000 per c.c.	—	...
31	+ 10,000 per c.c.	...	...
August 1907.											
1	+ 20 per c.c.	...	...
2	—	—	...
3	—	—	...
4	—
5	+ 1,000 per c.c.	—	...
6	+ 5,000 per c.c.	+	...
7	+ 1,000 per c.c.	...	...
8	—
10	—
11	—
12	—
13	—
15	—

TABLE I—*continued.*

CONVALESCENT ENTERIC NO. 3.

RANK—PRIVATE, NO. 8089.

NAME—S.

REGIMENT—OXFORD LIGHT INFANTRY.

DATE ON WHICH FEVER CEASED—8TH JULY 1907.

ADMINISTRATION OF UROTROPINE (DATES AND DOSES)—NONE.

Date of observation.	Widal reaction to Bacillus typhosus.								Bacillus typhosus in		
	100	200	400	500	600	800	1000	1250	Urine. Number of bacilli per c.c.	Fæces.	Blood.
June 1907.											
23	+	+	+	+	+	+	+	+	+	—	+
26	+
28	+	+	+	±
29
July 1907.											
1	+	+	+	+	+	+	+	±	+	—	...
2
3	+	—	...
5	+	+	±	+	—	...
6	30,000,000 per c.c.	+	...
7	+	+	±	70,000,000 per c.c.	+	...
8	56,000,000 per c.c.	+	...
9	+	+	+	+	+	+
10	50,000,000 per c.c.	+	...
11	+	+	+	+	+	±	33,000,000 per c.c.	+	+
12	+
13	+	±	44,000,000 per c.c.	+	+
15	+	+	+	+	±	77,000,000 per c.c.	+	+
16	+
17	35,000,000 per c.c.	...	...
18	36,000,000 per c.c.	+	+
19	+
	62,000,000 per c.c.	...	...
	+
	6,000,000 per c.c.	...	...
	+
	20,000 per c.c.	+	+
	+
	22,000 per c.c.	...	...
	+
	1,000 per c.c.	...	...

TABLE I—continued.

CONVALESCENT ENTERIC NO. 3—continued.

PTE. S.—continued

Date of observation.	Widal reaction to Bacillus typhosus.								Bacillus typhosus in		
	100	200	400	500	600	800	1000	1250	Urine. Number of bacilli per c.c.	Fæces.	Blood.
July 1907— <i>contd.</i>											
20	+ 2,000 per c.c.	+	...
21	+ 10,000,000 per c.c.	...	...
22	+ 60,000,000 per c.c.	—	...
23	+ 30,000,000 per c.c.	—	...
24	+ 100,000,000 per c.c.	—	...
25	+ 60,000,000 per c.c.	...	...
26	+ 100,000,000 per c.c.	—	...
27	+ 4,000,000 per c.c.	...	...
28
29	+ 70,000,000 per c.c.	—	...
30	+ 20,000,000 per c.c.	—	...
31	+ 10,000 per c.c.	...	...
August 1907.											
1	+ 20 per c.c.	...	...
2	—	—	...
3	—	—	...
4	—
5	+ 1,000 per c.c.	—	...
6	+ 5,000 per c.c.	+	...
7	+ 1,000 per c.c.	...	...
8	—
10	—
11	—
12
13	—
15	—

TABLE I—*continued.*CONVALESCENT ENTERIC NO. 3—*continued.*PTE. S.—*continued.*

Date of observation.	Widal reaction to <i>Bacillus typhosus</i> .								Bacillus typhosus in		
	100	200	400	500	600	800	1000	1250	Urine. Number of bacilli per c. c.	Fæces.	Blood.
August 1907— <i>contd.</i>											
18	—
23	—
24	—
25	—
26	—	—	...
27	—	—	...
30	—	—	...
31	—	—	...
September 1907.											
1	—	—	...
2	—	—	...
3	—
4	—
5	—	—	—	...
6	—
7	—
8	+	—	...
									20 per c. c.		
9	—	—	...
10	—	—	...
11	—	—	...
12	—	...
13	—
14	—	—	...
15	—	—	...
16	—	—	...
17	—

TABLE I—*continued.*CONVALESCENT ENTERIC NO. 3—*continued.*PTE. S.—*continued.*

Date of observation.	Widal reaction to <i>Bacillus typhosus</i> ,								Bacillus typhosus in		
	100	200	400	500	600	800	1000	1280	Urine. Number of bacilli per c. c.	Fæces.	Blood.
September 1907											...
— <i>contd.</i>											
18	—	—	...
19	—
20	—
21	—	—	...
22
23
24	—	—	...
25	—	—	...
26	—	—	...
27	—	—	...
28	—	—	...
29
30	—	—	...
October 1907.											
1	—
2	—	—	...
3	—	—	...
4	—
5	—	—	...
6	—	—	...
7	—	—	...
8	—	—	...
10	—
11	—	—	...
12	—	—	...
13	—

TABLE I—*continued.*CONVALESCENT ENTERIC NO. 3—*concluded.*PTE. S.—*concluded.*

Date of observation.	Widal reaction to <i>Bacillus typhosus</i> .								Bacillus typhosus in		
	100	200	400	500	600	800	1000	1280	Urine. Number of bacilli per c.c.	Fæces.	Blood.
October 1907— <i>contd.</i>											
14	—	—	...
15	—	—	...
16	—
17	—	—	...
18	—	—	...
19	—	...
21	+ +	...
23	—	—	...
25	—	...
27	—	—	...
28	—	—	...
29	—
30	—	—	...
31	—	...

REMARKS.

This case shows that the excretion of bacilli in the fæces may be very intermittent. *B. typhosus* was detected in the fæces on August 6th, after this an examination of the fæces was made almost daily with negative results until October 21st, when the bacilli were again detected in the fæces. The fæces remained free from bacilli for nearly two months. This case at one time excreted *B. typhosus* in enormous numbers in his urine.

TABLE I—*continued.*

CONVALESCENT ENTERIC NO. 4.

RANK—PRIVATE, NO. 8569.

NAME—K.

REGIMENT—BEDFORD LIGHT INFANTRY.

DATE ON WHICH FEVER CEASED—14TH MAY 1907.

ADMINISTRATION OF UROTROPINE (DATES AND DOSES)—GR. X DAILY FROM 1ST JUNE 1907 TO 14TH JUNE 1907 AND 28TH JUNE 1907 TO 12TH JULY 1907.

Date of observation.	Widal reaction to Bacillus typhosus.				Bacillus typhosus in	
	40	80	160	320	Urine.	Fæces.
July 1907.						
22	+	+	—	—	—	...
23	—	—
24	+ +	...
26	—	...
27	—	—
28	—	...
29	—	...
August 1907.						
2	—	—
3	—	—
4	—	—
5	—
8	—	—
9	—	...
11	—	—
12	—	...
14	—	...
15	—	...
16	—
23	—	—
24	—	—
25
26	—	...
30	—	...

TABLE I—*continued.*CONVALESCENT ENTERIC NO. 4—*continued.*PTE. K.—*continued.*

Date of observation.	Widal reaction to <i>Bacillus typhosus</i> .				<i>Bacillus typhosus</i> in	
	40	80	160	320	Urine.	Fæces.
September 1907.						
20	—	...
22	—	—
23	—
25	—	—
29	—	—
30	—	...
October 1907.						
1	—	...
2	—	...
3	—	—
4	—	...
5	—	..
6	—	...
7	—	...
8	—	...
9	—	...
10	—	—
12	—	—
14	—	—
15	—
16	—	...
18	—	..
19	—	...
20	—	—
21	—	—
22

REMARKS.

Bacillus typhosus was detected on only one occasion in the urine of this man more than two months after freedom from fever. Urotropine had been administered as usual.

TABLE I—continued.

CONVALESCENT ENTERIC NO. 5.

RANK—SERGEANT ARMOURER.

NAME—W.

REGIMENT—ROYAL SCOTS FUSILIERS.

DATE ON WHICH FEVER CEASED—22ND AUGUST 1907.

ADMINISTRATION OF UROTROPINE (DATES AND DOSES)—NONE.

Date of observation.	Widal reaction to Bacillus typhosus.				Bacillus typhosus in		
	40	80	160	320	Urine. Number of bacilli per c.c.	Fæces.	Blood.
July 1907.							
18	+	±	—	+
19	+
20	—
21	—
22	—
23	+
24	+	+	+	±	—
25	+
					400 per c.c.	...	...
26	+
					1,000 per c.c.	+	...
27	+
					4 per c.c.	...	...
28	—
29	—
30	—
31	—
August 1907.							
1	+
					+
2	+
					500,000 per c.c.	...	...
3	—	+	+
4	—
5	—	+	+
6	+
					100,000 per c.c.	—	...
7	+
					2,000 per c.c.	—	...
8	—	+	+
9	—
10	—	+	+
11	—
13	—

TABLE I—*continued.*CONVALESCENT ENTERIC NO. 5—*continued.*SERGT. W.—*continued.*

Date of observation.	Widal reaction to Bacillus typhosus.				Bacillus typhosus in		
	40	80	160	320	Urine. Number of bacilli per c.c.	Fæces.	Blood.
August 1907 — <i>contd.</i>							
14	—
15	—
17	—
23	+
25	100,000 per c.c.	...	...
26	+
27	3,000 per c.c.	...	...
28	+ +
29	+ +
30	+ 10,000 per c.c.	+	...
31	+ 40,000,000 per c.c.	...	...
September 1907.							
1	+ 3,000 per c.c.	—	...
2	+ 4,000 per c.c.	...	...
3	+ 11,000 per c.c.	...	...
4	+ 100,000 per c.c.	...	...
5	+ 20,000,000 per c.c.	...	...
6	+ 120,000 per c.c.	...	...
7	+ 3,400,000 per c.c.	+	...
8	+ 60,000 per c.c.	...	...
9	+ 94,000,000 per c.c.	+ + +	...
10	+ 400,000 per c.c.	...	...
11	— No colonies.	...	...
12	+ 1,800,000 per c.c.	...	...
13	+ 1,000,000 per c.c.	...	...
14	+ 8,000 per c.c.	...	...
15	+ 40,000 per c.c.	...	...
16	— + 10,000 per c.c.	...	...

TABLE I—continued.

CONVALESCENT ENTERIC NO. 5—continued.

SERGT. W.—continued.

Date of observation.	Widal reaction to <i>Bacillus typhosus</i> .				Bacillus typhosus in		
	40	50	160	320	Urine. Number of bacilli per c.c.	Fæces.	Blood.
September 1907 —contd.							
17
18	—
19	+
20	40 per c.c.	+	...
21	—	—	...
22	—	+	...
23	—	—	...
24	—	+	...
25	—
26	—
27	—	+	...
28	—
29	—
30	+	—	...
October 1907.							
1	—
2	+ +
3	—	—	...
4	—	+	...
6	—
7	—	—	...
8	—	—	...
9	—
10	—
11	—
12	—	—	...
13	—
14	—	—	...

TABLE I—continued.

CONVALESCENT ENTERIC NO. 5—concluded.

SERGT. W.—concluded.

Date of observation.	Widal reaction to Bacillus typhosus.				Bacillus typhosus in		
	40	80	160	320	Urine. Number of bacilli per c.c.	Fæces.	Blood.
October 1907 —contd.							
15	—
16	—
17	—
18	—	+ +	...
19	—
20	—
21	—	—	...
23	—
24	—	—	...
25	—
26	—	—	...
27	—
28	—
29	—
30	—	—	...
31	—	—	...
November 1907.							
8	—	+ +	...

REMARKS.

This man was followed throughout the acute phase of the disease and for several months after convalescence had commenced. It will be seen that his urine contained enormous numbers of bacilli during convalescence. The excretion of bacilli in the urine has ceased in the meantime, but it still continues in the fæces. To return this man to duty would be dangerous, accordingly when the Senior Medical Officer, Kasauli, asked if he was free from infection, we replied that he was still excreting bacilli in his fæces and should be retained for a further period.

TABLE I—*continued.*CONVALESCENT ENTERIC NO. 6—*continued.*PTE. M.—*continued.*

Date of observation.	Widal reaction to <i>Bacillus typhosus</i> .				<i>Bacillus aratyphosus</i> A. in		
	80	160	320	1000	Urine.	Fæces.	Blood.
August 1907— <i>contd.</i>							
16
17
18	—	—	...
19	—	—	...
20	+	...
21	—	...
22	—	...
23	—	—	...
24	—	—	...
25	—	...
26	—
27	—	...
28	—	...
September 1907.							
9	—	...
10
11
12
13
14
15	—	—	...
16	—	+ (<i>B. typhosus</i>)*	...
17
18	—	...
19	+ (<i>B. typhosus</i>)	...
20	—
21	—
22	—

**Vide* pages 31 and 32.

TABLE I—continued.

CONVALESCENT ENTERIC NO. 6—continued.

PTE. M.—continued.

Date of observation.	Widal reaction to <i>Bacillus typhosus</i> .				<i>Bacillus paratyphosus</i> A. in		
	80	160	320	1,000	Urine.	Fæces.	Food.
September 1907							
—contd.							
23	—	—	...
24	—	—	...
25	—
26
27
28	—	...
29	—	—	...
30
October 1907.							
1	—	—	...
2	—	—	...
3	—	—	...
4	—	—	...
5	—	—	...
6	—
7	—	+ (Para. T. A.)	...
8	—	—	...
9	—	—	...
10	—	—	...
11	—
12	—	—	...
13	—	—	...
14	—
15	—	—	...
16	—	—	...
17	—
18	—	—	...
19	—	—	...

TABLE I—*continued.*CONVALESCENT ENTERIC NO. 6—*concluded.*PTE. M.—*concluded.*

Date of observation.	Widal reaction to <i>Bacillus typhosus</i> .				<i>Bacillus paratyphosus</i> A. in		
	80	160	320	1000	Urine.	Fæces.	Blood.
October 1907— <i>contd.</i>							
20	—	—	...
21	—
22	—	—	...
23	—
24	—	—	...
25	—
26	—	—	...
27	—
28	—	—	...
29	—
30	—	—	...
31	—

REMARKS.

This case presents several features of interest. The patient was admitted to hospital at Kasauli with anomalous symptoms, *vide* page 31 of this report. A bacteriological examination of the blood, urine and fæces showed that he was suffering from an infection caused by *B. paratyphosus* A., but his Widal reaction was positive in high dilution to *B. typhosus*, but not to *B. paratyphosus* A., although the latter was cultivated from his blood and fæces. This was clearly explained at a later date. He began to excrete *B. typhosus* in his fæces late in convalescence. The case, therefore, was one of double infection. This man might have been a "chronic bacilli carrier" of *B. typhosus* and had an infection with *B. paratyphosus* A. grafted on.

TABLE I—*continued.*

CONVALESCENT ENTERIC NO. 7.

RANK—PRIVATE, NO. 8354.

NAME—L. F.

REGIMENT—BEDFORDS, G. COMPANY.

DATE ON WHICH FEVER CEASED—22ND MAY 1907.

ADMINISTRATION OF UROTROPINE (DATES AND DOSES)—GR. X TWICE DAILY FROM 2ND JUNE 1907 TO 9TH JULY 1907.

Date of observation.	Widal reaction to <i>Bacillus typhosus</i> .				Bacillus typhosus in	
	20	40	80	160	Urine. Number of bacilli per c.c.	Fæces.
July 1907.						
17	—	...
18	+	+	+	—	—	—
20	—	...
21	—
22	—	—
24	—	...
25	+	...
26	9 per c.c.	...
27	+	...
28	1,000,000 per c.c.	...
29	+	—
30	6,000,000 per c.c.	...
31	—	...
August 1907.						
2	—	++
3	—	+++
5	—	—
6	+	—
7	20,000 per c.c.	+++
8	+	+++
9	20,000 per c.c.	+++
11	—	—

TABLE I—continued.

CONVALESCENT ENTERIC NO. 7—continued.

PTE. L. F.—continued.

Date of observation.	Widal reaction to Bacillus typhosus				Bacillus typhosus in	
	20	40	80	160	Urine, Number of bacilli per c.c.	Fæces.
August 1907 —contd.						
12	—	+
13	+ 10,000 per c.c.	+ +
14	+ 8,000 per c.c.	—
15	—	—
16	—	—
17	—	—
18	—	—
19	—	—
20	—	—
21	—	—
22	—	—
23	—	—
24	—	—
25	—
26	—	—
27	—	—
28	—	—
29	—	+
30	—	—
September 1907.						
1	—
2	+ 1,000 per c.c.	—
3	—	—
5	—	+ +
6	—	—
7	—	—
9	—	—

TABLE I—continued.

CONVALESCENT ENTERIC NO. 7—continued.

PTE. L. F.—continued.

Date of observation.	Widal reaction to Bacillus typhosus.				Bacillus typhosus in	
	20	40	80	160	Urine. Number of bacilli per c.c.	Fæces.
September 1907 —contd.						
10	—	+
12	—	—
13	—	—
14	—	—
15	—	...
16
17	—	...
18	—
19	—
20	—	—
21	—	...
22	—	—
23
24	—	—
25	—	—
26	—
27	—	...
28	—	...
29	—	—
30	—	...
October 1907.						
1	—	—
2	—	—
3	—	—
4	—	—
5	—
6	—	—

TABLE I—*continued.*CONVALESCENT ENTERIC NO. 7—*concluded.*PTE. L. F.—*concluded.*

Date of observation.	Widal reaction to <i>Bacillus typhosus</i> .				<i>Bacillus typhosus</i> in	
	20	40	80	160	Urine. Number of bacilli per c.c.	Fæces.
October 1907 — <i>contd.</i>						
7	—	—
8	—	—
9	—	—
10	—	—
11	—	—
12	—	—
13	—	—
14	—	—
15	—	—
16	—	—
17	—	—
18	—	—
19	—	—
20	—	—
21	—	—
22	—	—
23	—	—
24	—	—
25	—	—
26	—	—
27	—	—
28	—	—
29	—	—
30	—	—
31	—	—

REMARKS.

This case became free from fever on May 22nd, but he was found to be excreting *B. typhosus* in his urine and fæces in September. His urine and fæces have been free from bacilli during October. In his case, also, urotropine did not permanently cure the bacilluria.

TABLE I—*continued.*

CONVALESCENT ENTERIC NO. 8.

RANK—

NAME—MRS. W. (WIFE OF SERGEANT W.).

REGIMENT—

DATE ON WHICH FEVER CEASED—20TH AUGUST 1907.

ADMINISTRATION OF UROTROPINE (DATES AND DOSES)—NONE.

Date of observation.	Widal reaction to <i>Bacillus typhosus</i> .				<i>Bacillus typhosus</i> in		
	100	200	300	400	Urine.	Fæces.	Blood
July 1907.							
18	+	+	±	—
19	+
20	—	—	...
22	—	—	...
23	—	—	...
24	—	—	...
25	—	—	...
26	—	—	...
27	—	—	...
28	—	—	...
29	—	—	...
30	—	—	...
31	—	—	...
August 1907.							
2	—	—	...
3	—	—	...
5	—	—	...
8	—	—	...
9	—	—	...
16	—	—	...
11	—	—	...
12	—	—	...
23	—	—	...

TABLE I—*continued.*CONVALESCENT ENTERIC NO. 8—*continued.*MRS. W. (WIFE OF SERGT. W.)—*continued.*

Date of observation.	Widal reaction to Bacillus typhosus.				Bacillus typhosus in		
	100	200	300	400	Urine.	Fæces.	Blood.
September 1907.							
10	—	—	...
11	—	—	...
12	—	—	...
13	—	—	...

REMARKS.

This woman never excreted *B. typhosus* either in her urine or fæces at any time during her illness or convalescence, nevertheless *B. typhosus* was recovered from her blood. This case was a pure bacillæmia.

TABLE I—*continued.*

CONVALESCENT ENTERIC NO. 9.

RANK—CORPORAL NO. 34651.

NAME—E. F.

REGIMENT—R. F. A.

DATE ON WHICH FEVER CEASED—17TH AUGUST 1907.

ADMINISTRATION OF UROTROPINE (DATES AND DOSES)—NONE.

Date of observation.	Widal reaction to <i>Bacillus typhosus</i> .				Bacillus typhosus in		
	20	40	80	160	Urine. Number of bacilli per c.c.	Fæces.	Blood.
August 1907.							
10	+	+	±	—	—	...	+
13	—
14	—
16	—
24	—
26	—	...
28	+ 5,000,000 per c.c.	—	..
29	—	—	...
31	+ 2,000 per c.c.	—	...
September 1907.							
1	+ 4,000 per c.c.	—	...
2	—	—	..
4	+ 1,000 per c.c.	...	...
5	—	—	...
6	+ 50 per c.c.	...	...
7	+ 1,000 per c.c.	—	...
8	—	+	...
9	—
10	—	—	...
11	+ very numerous.	...	...
12	+ 10,000 per c.c.	+	...
13	—	—	...

TABLE 1—*continued.*CONVALESCENT ENTERIC NO. 9—*continued.*CORPORAL E. F.—*continued.*

Date of observation.	Widal reaction to <i>Bacillus typhosus</i> .				Bacillus typhosus in		
	20	40	80	160	Urine. Number of bacilli per c.c.	Fæces.	Blood.
September 1907 — <i>contd.</i>							
14	+ 400 per c.c.	...	...
15	+ +
16	10,000 per c.c.	—	...
17	—	—	...
18	—
19	—	—	...
20	—	...
21
22
23
24	—	—	...
25	—	—	...
26	—	...
27	—	—	...
28	—	—	...
29	—	—	...
30	—
October 1907.							
1	—	—	...
2	—	—	...
3	—	—	...
4	—	—	...
5	—	—	...
7	—	—	...
8	—	—	...
9	—	—	...

TABLE I—*continued.*CONVALESCENT ENTERIC NO. 9—*concluded.*CORPORAL E. F.—*concluded.*

Date of observation.	Widal reaction to <i>Bacillus typhosus</i> .				<i>Bacillus typhosus</i> in		
	20	40	80	160	Urine. Number of bacilli per c.c.	Fæces.	Blood.
October 1907 — <i>contd.</i>							
10	—	—	...
11	—	—	...
12	—	—	...
13	—	—	...
14	—	—	...
15	—
16	—	...
17	—	—	...
18	—	—	...
19	—	—	...
20	—	—	...
21	—	+	...
22	—	—	...
23	—	—	...
24	—	—	...
25	—	—	...
26	—	—	...
28	—	+	...
29	—	—	...
30	—	—	...
31
November 1907.							
10	—	+ + +	...

REMARKS.

In this case the examination of the urine and fæces was commenced during the acute stage of the disease and continued through convalescence. It will be seen that he continues to excrete *Bacillus typhosus* in his fæces nearly three months after freedom from fever.

TABLE I—continued.

CONVALESCENT ENTERIC NO. 10—continued.

PTE. B.—continued.

Date of observation.	Widal reaction to Bacillus typhosus.				Bacillus typhosus in		
	40	80	320	640	Urine. Number of bacilli per c.c.	Fæces.	Blood.
September 1907 —contd.							
15
16	—	—	...
17
25	—	—	...
26	—	—	...
27	—
28	—	—	...
29	—
30	—
October 1907.							
1	—
2	—
3	—
4	—
5	—	—	...
6	—
7	—	...
9	—	—	...
10	—
11	—	—	...
12	—	...
13	—	—	...
14	—	—	...
15	—
16	—	—	...
17	—	—	...
18	—	—	...

TABLE I—*continued.*CONVALESCENT ENTERIC NO. 10—*concluded.*PTE. B—*concluded.*

Date of observation.	Widal reaction to <i>Bacillus typhosus</i> .				<i>Bacillus typhosus</i> in		
	40	80	320	640	Urine. Number of bacilli per c.c.	Fæces	Blood.
October 1907 — <i>contd.</i>							
19	—	—	...
20	—	—	...
21	—	—	...
22	—	—	...
24	—
26	—
27	—
28	—	...
29	—	...
30	—
31	—

REMARKS.

The examination of this case commenced during the acute stage of the disease. He never excreted any bacilli in his fæces and only on a few occasions in his urine.

TABLE I—*continued.*

CONVALESCENT ENTERIC NO. 11.

RANK—PRIVATE, No. 8173.

NAME—H. L.

REGIMENT—BEDFORDS.

DATE ON WHICH FEVER CEASED—21ST AUGUST 1907.

ADMINISTRATION OF UROTROPINE—(DATES AND DOSES)—NONE.

Date of observation.	Widal reaction to Bacillus typhosus.			Bacillus typhosus in		
	40	80	160	Urine. Number of bacilli per c.c.	Fæces.	Blood.
August 1907.						
12	+	+	+	...	+	+
14	+	±	—	—
17	—
20
28	—
29	+ 1,000 per c.c.	...	...
31	+ 20,000 per c.c.	—	...
September 1907.						
1	+ 8,000 per c.c.	...	...
2	+ 6 col. per c.c.	—	...
3*	—	—	...
4	+ + 1,000 per c.c.	...	...
5	—	+	...
6	+	—	...
7	—	...
8	—	...
9	—	...
26	—	...
27	—	—	...
28	—	—	...
29	—	—	...
30	—

TABLE I—*continued.*CONVALESCENT ENTERIC NO. 11—*continued.*PTE. H. L.—*continued.*

Date of observation.	Widal reaction to Bacillus typhosus.			Bacillus typhosus in		
	40	80	160	Urine. Number of bacilli per c.c.	Fæces.	Blood.
October 1907.						
1	—
2	—	—	...
3	—	—	...
4	—
5	—
6	—
7	—	—	...
8	—
9	—	—	...
10	—	—	...
11	—	+	...
12	—	+	...
13	—	—	...
14	—	—	...
15	—	—	...
16	—	—	...
17	—	—	...
18	—	—	...
19	—	—	...
20	—	—	...
21
22	—	—	...
23	—	—	...
24	—	—	...
25	—
26	—	—	...
27	—	—	...

TABLE I—*continued.*CONVALESCENT ENTERIC NO. 11—*concluded.*PTE. H. L.—*concluded.*

Date of observation.	Widal reaction to <i>Bacillus typhosus</i> .			<i>Bacillus typhosus</i> in		
	40	80	160	Urine. Number of bacilli per c.c.	Fæces.	Blood.
October 1907 — <i>contd.</i>						
28	—	—	...
29	—
30	—
31	—	...
November 1907.						
12	+ 10,000 per c.c.	—	...

REMARKS.

This case was also followed from the commencement of the attack of enteric fever into convalescence. He still continues to excrete bacilli in his fæces and urine about three months after convalescence.

TABLE I—*continued.*

CONVALESCENT ENTERIC NO. 12.

RANK—GUNNER, NO. 30303.

NAME—W.

REGIMENT—11TH BATTERY.

DATE ON WHICH FEVER CEASED—10TH JUNE 1907.

ADMINISTRATION OF UROTROPINE (DATES AND DOSES)—GR. X DAILY FROM 28TH JUNE 1907 TO 10TH JULY 1907.

Date of observation.	Widal reaction to <i>Bacillus typhosus</i> .				Bacillus typhosus in	
	10	20	40	80	Urine.	Fæces.
July 1907.						
22	+	±	—	...	—	...
23
24	—	...
29	—	...
31	—	+ +
August 1907.						
5	—	—
7	—	—
10	—	—
September 1907.						
8	+
12	—
13	—
14	—
15	+
16
17	—
18	—
19
20	—
21	—

TABLE I—*continued.*CONVALESCENT ENTERIC NO. 12—*continued.*GR. W.—*continued.*

Date of observation.	Widal reaction to <i>Bacillus typhosus</i> .				<i>Bacillus typhosus</i> in	
	10	20	40	80	Urine.	Fæces.
September 1907 — <i>contd.</i>						
22
23
24	—	—
25	—	—
26	—	—
27	—	—
28	—	—
29	+	—
30	—	—
October 1907.						
1	—
2	—	—
3	—	—
4	—	—
5	—	—
6	—	—
7	—	—
8	—	—
9	—	—
10	—	—
11	—	—
12	—	—
13	—	—
14	—	...
15	—	—
16	—	—

TABLE I—*continued.*CONVALESCENT ENTERIC NO. 12—*concluded.*GR. W.—*concluded.*

Date of observation.	Widal reaction to <i>Bacillus typhosus</i> .				<i>Bacillus typhosus</i> in	
	10	20	40	80	Urine.	Fæces.
October 1907 — <i>contd.</i>						
17	—	...
18	—	—
19	—	...
20	—	...
21	—	—
22	—	...
23	—	—
24	—
25	—
26	—	...
28	—	...
29	—	...
30	—	—
31	—	...

REMARKS.

Apparently in this case the bacilli have ceased to be excreted in the urine and fæces. In the fæces bacilli were found three months after freedom from fever and in the urine nearly four months after.

TABLE I—continued.

CONVALESCENT ENTERIC NO. 13.

RANK—PRIVATE, NO. 8089.

NAME—S. G.

REGIMENT—1ST BEDFORDS.

DATE ON WHICH FEVER CEASED—4TH SEPTEMBER 1907.

ADMINISTRATION OF UROTROPINE (DATES AND DOSES)—NONE.

Date of observation.	Widal reaction to <i>Bacillus typhosus</i> .			Bacillus typhosus in		
	80	160	320	Urine. Number of bacilli per c.c.	Fæces.	Blood.
August 1907.						
19	+	+	±
20	+
21	—	...
22	—
24	—	...
28	500 per c. c.	—	...
30	—	—	...
31	—
September 1907.						
1	4,100 per c.c.	—	...
4	—
8	1,000 per c.c.	...	...
11	8 per c.c.	...	...
12	4,000 per c.c.	...	...
14	—
15
16
17
18
19	—	...
20	—	—	...
21	—	—	...
22	—	—	...
23

TABLE I—*continued.*CONVALESCENT ENTERIC NO. 13—*continued.*PTE. S. G.—*continued.*

Date of observation.	Widal reaction to <i>Bacillus typhosus</i> .			Bacillus typhosus in		
	80	160	320	Urine. Number of bacilli per c.c.	Fæces.	Blood.
September 1907 — <i>contd.</i>						
24	—	—	...
25	—	—	...
26	—
27	—
28	—
29	—	+	...
30	—	+	...
October 1907.						
1	—	—	...
2	—	—	...
3	—	—	...
4	—	—	...
5	—	—	...
6	—	—	...
7	—	+ + +	...
8	—	—	...
9	—	—	...
10	—	—	...
11	—
12	—	—	...
13	—	—	...
14	—	—	...
15	—	—	...
17	—	—	...
18	—	—	...
19	—	—	...
20	—	—	...

TABLE I—*continued.*CONVALESCENT ENTERIC NO. 13—*concluded.*PTE. S. G.—*concluded.*

Date of observation.	Widal reaction to <i>Bacillus typhosus</i> .			<i>Bacillus typhosus</i> in		
	80	160	320	Urine. Number of bacilli per c.c.	Fæces.	Blood.
October 1907 — <i>contd.</i>						
21	—	—	...
22	—	+ +	...
23	—
24	—	—	...
25	—	—	...
26	—	—	...
27	—	—	...
28	—	—	...
29	—	—	...
30	—	—	...
31	—	—	...
November 1907.						
18	—	+ +	...

REMARKS.

The examination of the blood, urine and fæces commenced during the attack of enteric and was continued into convalescence. The intermittent character of the discharge of bacilli in the fæces is well illustrated by this case. No bacilli were detected in the fæces during the acute stage of the disease. No urotropine was administered in this case and the bacilluria ceased spontaneously.

TABLE I—*continued.*

CONVALESCENT ENTERIC No. 14.

RANK—PRIVATE, No. 3118.

NAME—P.

REGIMENT—1ST R. SUSSEX, B. COY.

DATE ON WHICH FEVER CEASED—30TH JUNE 1907.

ADMINISTRATION OF UROTROPINE (DATES AND DOSES)—ADMINISTERED IN USUAL DOSES.

Date of observation.	Widal reaction to <i>Bacillus typhosus</i> .				<i>Bacillus typhosus</i> in	
	10	20	40	80	Urine.	Fæces.
August 1907.						
22	+	+	±	—	—	—
23	—
24
September 1907.						
13	—	—
14	+	...
15	+	...
16	—	...
17	+	—
18
19
20	—	—
21	—
22	—	—
23	—	—
24	—	—
25
26	—	—
27	—
28	—	+
29	—
30

TABLE I—*continued.*

CONVALESCENT ENTERIC NO. 14—*continued.*

PTE. P.—*continued.*

Date of observation.	Widal reaction to Bacillus typhosus.				Bacillus typhosus in	
	10	20	40	80	Urine.	Fæces.
October 1907.						
1	—	—
2	—	—
3	—	—
4	—	—
5	—	—
6	—	—
7	—	—
8	—	—
16	—	—
11	—	—
12	—	—
13	—	—
14	—	—
15	—	—
16	—	—
17	—	—
18	—	—
19	—	—
20	—	—
23	—	—
24	—	—
25	—	—
26	—	—
27	—	—
28	—	—
29	—	—
30	—	—
31	—	—

TABLE I—*continued.*

CONVALESCENT ENTERIC No. 15.

RANK—GUNNER, No. 23950.

NAME—K.

REGIMENT—9TH M. B., R. G. A.

DATE ON WHICH FEVER CEASED—31ST MARCH 1907.

ADMINISTRATION OF UROTROPINE (DATES AND DOSES)—NOT KNOWN.

Date of observation.	Widal reaction to <i>Bacillus typhosus</i> .				<i>Bacillus paratyphosus</i> A. in	
	10	20	40	80	Urine.	Fæces.
May 1907.						
13	+	+	+	±	—	—
31	+
June 1907.						
20	—

REMARKS.

This case was regarded clinically as one of ordinary enteric, but bacteriological examination showed that it was a case of *B. paratyphosus* A. infection. He was found to be excreting bacilli at the end of May, although he was free from fever in March.

TABLE I—*continued.*

CONVALESCENT ENTERIC NO. 16.

RANK—PRIVATE, NO. 7993.

NAME—J. D.

REGIMENT, 1ST BEDFORDS.

DATE ON WHICH FEVER CEASED—20TH SEPTEMBER 1907.

ADMINISTRATION OF UROTROPINE (DATES AND DOSES)—

Date of observation.	Widal reaction to <i>Bacillus typhosus</i> .					Bacillus typhosus in		
	10	20	40	80	160	Urine. Number of bacilli per c.c.	Fæces.	Blood.
August 1907.								
14	+	+	+	—	—	—	...	+
15	+	+	+	+	—
16
17	+++	...
18
19	—	...
20	—
21	—	++	...
22
23	—	...
24
25	—
26	+	+	+	+	—
27
28	+ 5,000 per c.c.	—	...
29	+ 200,000 per c.c.	...	...
30	+ 2,400 per c.c.	—	—
September 1907								
1	+ 12,000 per c.c.	—	..
2	+	—	...
3	—	+++	...
4	—
5
6	—
7	+ 1,000 per c.c.	+	...
8	+	...

TABLE I—*continued.*CONVALESCENT ENTERIC NO. 16—*concluded.*PTB. J. D.—*concluded.*

Date of observation.	Widal reaction to <i>Bacillus typhosus</i> .					<i>Bacillus typhosus</i> in	
	10	20	40	80	160	Urine. Number of bacilli per c. c.	Fæces.
October 1907— <i>concl.</i> 31	—	—
November 1907. 15	—	+ +

REMARKS.

The case was contracted at Kasauli. He had several hæmorrhages from his bowels during the attack. The bacilli were numerous in the fæces containing the blood. He excretes bacilli in his fæces at long intervals. No urotropine was administered and the bacilluria ceased spontaneously.

TABLE I—*continued.*

CASE NO. 17.

NO. 2019, SEPOY A. P., 114TH MAHRATTAS, POONA.

CASE IN 114TH MAHRATTAS HOSPITAL, POONA.

DATE OF ADMISSION—14TH AUGUST 1907.

Date of observation.	Widal reaction to						Bacillus typhosus in		
	Bacillus typhosus.				Bacillus para-typhosus		Urine.	Fæces.	Blood.
	20	40	100	200	A.	B.			
September 1907.									
5	+	+	+	+	—	—	—	—	+
8	—	—	...
9	+	—	...
10	10 per c.c.	—	...
11	+	—	...
12	100,000 per c.c.	—	...
13	Sterile.	—	...
14	+	—	...
15	20 per c.c.	—	...
16	—	—	...
17	—	—	...
18	—	—	...
19	—	—	...
20	—	—	...
21	—	—	...
30	—	—	...

REMARKS.

" This is a case of enteric fever in a native of India. It was proved to be an infection by *B. typhosus* by cultivation of the blood and urine. He continued to excrete bacilli in his urine during convalescence. He left for his home at Ratnagiri and so no further observations could be made. The medical officer states that this case had no clinical signs of enteric fever. The diagnosis was at first "simple continued fever." This was changed on September 5th to enteric. Had this case been overlooked, it might readily have given rise to a number of fresh cases, and it would have been very difficult to have detected the source of such cases by ordinary sanitary inspection.

TABLE I—concluded.

CASE NO. 18—continued.

SEPOY G. R. S.—continued.

Date of observation.	Widal reaction to						Bacillus typhosus in	
	Typhosus.				Bacillus paratyphosus			
					A.	B.	Fæces.	Urine.
	40	50	100	200	20	20		
October 1907 —contd.								
12	—	—
13	—	—
14	—	—
15	—	—
16	—	—
17	—	—
18	—	—
19	—	—
21	+	+	+	+	—	—
22	—	—
23	—	—
24	—	—
25	—	—
26	—	—

REMARKS.

This is another example of enteric fever in a native of India. He excreted *B. typhosus* in enormous numbers in the fæces. Sometimes as many as 5,000 colonies of *B. typhosus* were counted on the second Drigalski-Conradi plate. This discharge of bacilli continued well into convalescence. The medical officer reports that this man had at first symptoms of bronchitis. Had such a case as this not been recognised, he would have become a dangerous focus of enteric. A man like this employed in the capacity of cook in a family would almost certainly have produced an outbreak of enteric fever.

PART II.
APPENDIX.

Table II.

In this table are recorded the results of the examination of a number of cases of enteric fever both by the serum sedimentation test (Widal Reaction) and by the blood culture method. A comparison of the two methods of diagnosis is given. For the early diagnosis of enteric fever the blood culture method is the best. Conradi* has recently shown that the *B. typhosus* may be cultivated from the blood before any signs of the disease have developed in the incubation stage. For the later stages the agglutination test is valuable, as towards the end of the disease the bacilli leave the blood.

(*Vide* page 27, Part I, of this report for a discussion of the results.)

* Deutsche. Med. Wochenschrift No. 41, October 10th, 1907.

TABLE II—continued.

Serial Number.	Name, rank, No. and Regiment.	Date of admission to hospital.	Date of examination of blood.	WIDAL REACTION TO								Bacillus typhosus in blood.
				B. TYPHOSUS.				B. PARATYPHOSUS				
				A.		B.		A.		B.		
				20	40	80	160	20	40	20	40	
21	Mrs. W. (wife of Sergeant W.).	15-7-07	18-7-07	+	+	+	+	-	-	-	-	+
22	34615 Cpl. F. E., R. F. A.	6-8-07	10-8-07	+	-	-	-	-	-	-	-	+
23	8367 Pte. B., Bedfords .	6-8-07	12-8-07	+	+	+	-	-	-	-	-	+
24	8173 Pte. L. H., Bedfords	10-8-07	12-8-07	+	+	+	+	-	-	-	-	+
25	7993 Pte. J. D., 1st Bedfords.	12-8-07	14-8-07	+	-	-	-	-	-	-	-	+
26	8089 Pte. S. G., 1st Bedfords.	18-8-07	19-8-07	+	+	+	+	-	-	-	-	+
27	2050 Dr. E. W. C., 11th Battery, R. F. A.	17-8-07	25-8-07	+	+	+	-	-	-	+	+	+
28	Sepoy S. Singh, 4th Rajputs.	10-3-07	27-3-07	+	+	-	-	-	-	-	-	+
29	Pte. S. A., Bedford Regiment.	12-4-06	18-4-06	+	+	+	-	-	-	-	-	+
30	33594 Gr. B., R. F. A. .	20-4-06	24-4-06	+	+	+	+	-	-	-	-	+
31	9103 Pte. A., 1st Durham	1-6-06	7-6-06	+	+	+	+	-	-	-	-	+

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AND

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