PROTRACTED INFECTION IN ENTERIC FEVER, WITH
NOTES ON A SERIES OF CASES APPARENTLY
CAUSED BY A "CARRIER."

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The difficulties in the way of accounting satisfactorily for the occurrence of many cases of enterica are well known, and the more recent work of Koch, Klinger, Kayser, Davies, Hall, and a number of other observers, has drawn attention to the influence of direct infection from one patient to another as one of the chief means of maintaining both the endemic and epidemic prevalence of this disease. An increasing number of circumstances emphasise the fact that enteric infection may, in fact does, exist in a latent form among presumably healthy persons, and that the number of notified or recognised cases is no measure of the amount of enterica among the members of a given community. As endorsing this view, our experiences at Aldershot during the present year are not devoid of interest.

During the first three weeks of September, 1908, four cases of enteric fever were admitted to hospital at Aldershot, all of which came from the same regiment—1st Battalion East Kent Regiment (Buffs)—which is quartered in Badajos barracks. These barracks are situated in Wellington Lines and are constructed on a rather out-of-date plan, as they are amongst the first permanent barracks built at Aldershot. They consist of two three-storeyed blocks in which there is accommodation for over 1,000 men. The blocks face one another about thirty yards apart and the intervening space used to be covered by a glass roof, which was removed at the beginning of this year. The rooms on the ground floor are chiefly used for regimental institutes, dining-halls and store-rooms, only a few being occupied as barrack-rooms. The first floor in the northern block is occupied by C and D Companies, 1st Buffs, which form a double company, having a common dining-room on the ground floor in No. 32 room. The rooms occupied by these companies are numbered from 38 to 46, the former being used as a company store; they accommodate twenty-four men each, except No. 46 room, which is at the eastern end, and owing to the ablution room being situated at the entrance, has only accommodation for nineteen men.

Early in September, two men were admitted to the Cambridge Hospital, and were subsequently found to be suffering from enteric fever. The first man (Private H.) was admitted on September 3rd,
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1908; he belonged to D Company and had occupied No. 44 room. On investigation of his previous movements it was found that he had been on furlough at Shorncliffe from August 20th, 1908, to August 29th, 1908. The second case (Private C., of C Company) was admitted on September 4th, 1908. He had been on furlough at Ashford from August 11th, 1908, up to the date of admission to hospital. He was taken ill whilst at Ashford and returned to Aldershot before the expiration of his furlough, going direct from the station to the Cambridge Hospital without returning to barracks. Before leaving Aldershot he had lived in No. 40 room. The third case (Private B., D Company) was admitted on September 15th, 1908, to the Connaught Hospital. He, also, returned sick off furlough, having been at Ramsgate since August 11th, 1908, and, instead of coming on to Aldershot Town, got out at the North Camp Station and proceeded to the Connaught Hospital, where he was admitted. Before going on furlough he had occupied No. 45 room. The fourth case (Private G., C Company) was admitted to the Cambridge Hospital on September 17th, 1908. He had been on furlough at Sittingbourne from August 29th, 1908, to September 9th, 1908.

On making an inspection of Badajos barracks and its surroundings, nothing could be found to suggest a source of infection. The water supply is derived from the Aldershot Water Company which supplies the town of Aldershot and many other barracks in the camp. There had been no cases of enteric in the town for many months. The milk used by this regiment comes from the Deepcut Dairy, which supplies many other regiments. It is received twice daily in barracks and is taken at once to the cook-house, where it is used for tea. No milk is kept in the kitchens or store-rooms, and if a further supply is required for puddings, &c., it is sent for when needed and is used at once. The coffee-shop is kept clean, and condensed milk is used for making tea, no fresh milk being supplied. The R.A.T.A. room is also satisfactory, its milk supply being derived from the Deepcut Dairy. The possibility of infection through either milk or water in barracks appeared to be remote, as if either had been infected a much larger incidence of cases would be expected. The latrines and urinals are placed in a single block about ten yards to the north of the northern barrack block. They were reconstructed early this year and now consist of separate pedestal closets and glazed earthenware urinals; both are kept clean and free from smell. Night urine tubs are still in use; one being placed in the verandah outside each room at “retreat,” but occasionally one tub is used by the men from two rooms. The
duty of carrying down and emptying the tubs at "réveille" devolves on the "orderly man" of each room. The same system for disposal of night urine still prevails in nearly every barrack in Aldershot. The general sanitary condition of the barracks was satisfactory, and no previous cases of enteric had occurred in them since February, 1908. Consequently, on consideration of the fact that each man had been on furlough during the incubation period—Private B. having been out of barracks over a month, Private C. over three weeks, and the other two men having been away at the likely date of infection—it was thought that these four men had most probably not contracted the disease in Aldershot. The events which followed shortly afterwards tend to show that this conclusion was incorrect.

The 3rd Battalion Rifle Brigade, at present stationed at Bordon Camp, sent 123 N.C.O.'s and men into Aldershot on October 10th, 1908, to go through a course of musketry, as the range at Bordon is closed. This detachment was quartered in Badajos barracks, and five barrack-rooms were handed over to them by the 1st Buffs; two of these, viz., Nos. 43 and 46, being on the same landing as C and D Companies, 1st Buffs, and having been previously occupied by men of these companies. A separate cook-house was given to the Rifle Brigade detachment. The musketry being finished, the detachment marched back to Bordon on November 3rd, 1908, but one man (Private B.) went sick that morning and was admitted to the Cambridge Hospital. On the following day a second man (Private D.) was sent into hospital from Bordon. Both these men had been in No. 46 room, Badajos, whilst in Aldershot. On November 8th, 1908, I was asked to see the latter man at the Cambridge Hospital and to examine his blood by the culture method, to endeavour to recover the Bacillus typhosus and verify the diagnosis of enteric fever, as his symptoms pointed to this disease. Ten cc. of Conradi's glycerine ox-bile peptone medium were inoculated with 1 cc. of the patient's blood taken aseptically from the median basilic vein in a sterilised hypodermic syringe. After incubation a motile bacillus was grown, which subsequently gave the characteristic reactions of the B. typhosus. A similar culture was made in Private B.'s case on November 11th, 1908, with a like result. On this latter date, a third man (Private O.) arrived sick from Bordon, and on November 12th, 1908, a fourth (Private P.) was admitted to the Cambridge Hospital suffering from symptoms which suggested enteric fever; both men whilst in Aldershot had also occupied No. 46 room, Badajos. Enteric bacilli were recovered from the blood in both cases from cultures made on
November 13th, 1908. Besides these four men, two others belonging to the 1st Buffs were admitted to the Cambridge Hospital about this time and were subsequently diagnosed enteric. Private A., of C Company, reported sick on November 4th, 1908; he came from No. 42 room. The attempt to recover the *B. typhosus* from his blood made on November 14th, 1908, proved unsuccessful, but later his serum gave a positive Widal's reaction. The other man was Private S., E Company, who was admitted on November 7th, 1908, from No. 23 room, which is situated on the first floor of the southern block. The *B. typhosus* was recovered from his blood on November 11th, 1908.

Four cases of enteric fever having now occurred among the men of the Rifle Brigade detachment who had been in No. 46 room, and two other cases from the Buffs being in hospital, there was little doubt that there must be some local source of infection in the barracks, and five out of the six having come from rooms occupied by C and D Companies of the Buffs where previous cases had arisen, it was thought that the infecting focus was probably in these companies.

The food supplies of the Buffs and the Rifle Brigade whilst in Badajos were quite distinct, as the latter had a separate cook-house and took their meals in their barrack-rooms, whereas the former used a dining-room on the ground floor. The regimental institutes, &c., were common to both, but, excepting Private S., cases had not occurred amongst the other companies of the regiment, nor among the men of the Rifle Brigade who had occupied other rooms.

Infection through bedding was not probable, as clean bedding had been issued from the barrack-store to the Rifle Brigade on arrival in Aldershot. The nature of the outbreak suggested that there was a "carrier" among the men of C and D Companies who had originally infected the four men belonging to these companies in August, and had subsequently given the disease to the men of the Rifle Brigade and the two others of his own regiment.

It was therefore decided to parade C and D Companies, with a view to finding the men who had previously suffered from enteric, and this was done on November 11th, 1908. Every man was inspected and questioned as to whether he had had the disease, and out of the two companies nine men were found who had recovered from enteric, and returned to duty on dates varying from 1895 to 1907. The statements made by these men were verified by inspection of the medical history sheets of the two companies, and no other entry of this disease was found on the sheets of the other men. The following day (November 12th, 1908) these nine
men attended at the School of Sanitation, and each was fully questioned as to whether he had any symptoms suggestive of gall-bladder infection; enquiries were also made as to the condition of their urine, but nothing of importance was discovered. The men were then made to pass urine, and the last ½ ounce from each was collected in a sterile test-tube. At the same time specimens of blood were taken in capsules from each man, as it was thought that the serum of a man still infected by the *B. typhosus* would sediment and agglutinate at higher dilutions than that of one who had definitely overcome the infection some time previously. The results obtained did not bear out this theory, as the only man whose serum did not sediment completely in a dilution of 1 in 100 in twenty-four hours was Corporal 1., of D Company, who will be mentioned again later.

One cc. of each of the urine samples was put in a test-tube containing 10 cc. of Conradi’s ox-bile medium, and was incubated at 37° C. for twenty-four hours.

The following day neutral-red glucose agar plates were stroked from each tube and put in the incubator for twenty-four hours, and the plates numbered from 1 to 9. On November 14th, 1908, the plates were examined: Nos. 5 and 7 had no growth on them, and were again inoculated from the ox-bile tubes after forty-eight hours incubation, but still gave no growth; Nos. 3, 4, 6 and 9 gave growths which, on examination, proved to consist entirely of cocci; the growth on No. 8 plate was a short bacillus which, on further investigation, proved to be non-motile. No. 1 plate gave a growth of cocci and bacilli; the latter were non-Gram staining, but were also non-motile. On No. 2 plate there was an apparently pure culture of a non-Gram staining bacillus showing short forms and filaments, which at first was only feebly motile. The No. 2 bacillus was now planted out on different media, and the following results were obtained:

*On Gelatine.*—No liquefaction; growth was very slow and restricted, owing to the lack of a 22° C. incubator.

*Mannite Litmus Broth.*—Acid formed no gas.

*Glucose Litmus Broth.*—Acid formed no gas.

*Neutral-red Glucose Agar.*—No fluorescence.

*Peptone Broth.*—No formation of indol in six days.

*Milk.*—No clotting in six days.

*Litmus Milk.*—No acid formed; no clotting.

An agar slope of the No. 2 bacillus, together with growths of the bacilli recovered from the blood of Privates D., S., and E., were sent to the Royal Army Medical College, Millbank, for examination.
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A report received from Major Grattan, R.A.M.C., on November 28th, 1908, stated that all four cultures gave similar reactions, and were apparently identical, and his results were the same as those given above, except that all four produced slight acid with lactose.

The next step was to test the bacillus with an antityphoid serum. An emulsion was made from a twenty-four hours growth on agar, and at the same time a similar emulsion was made of the stock B. typhosus. These emulsions were tested by Widal's reaction with serum from Private C. (one of the first cases mentioned above). Both the No. 2 bacillus and the B. typhosus agglutinated in a dilution of 1 in 30 serum in half an hour, as seen both macroscopically and microscopically; both sedimented in dilutions up to 1 in 200 serum in capillary tubes in twenty-four hours.

A second experiment was tried on November 22nd, 1908, with serum from Private A., whose symptoms pointed to enteric, but from whose blood the B. typhosus had not been recovered on November 14th, 1908, and with serum from an animal immunised against the B. typhosus which had been received from the Royal Army Medical College, Millbank. The results were as follows:

One part Cl. serum 1 in 15, diluted with normal saline solution + 1 part B.T. emulsion, gave some clumping, but not a complete reaction in half an hour.

One part Cl. serum 1 in 15 + 1 part No. 2 bacillus emulsion gave a complete reaction in the same time.

One part A.T. serum 1 in 15 + 1 part B.T. emulsion gave fairly good clumping in the same time.

One part A.T. serum 1 in 15 + 1 part No. 2 emulsion gave good clumping under the same conditions.

From the above results, it was nearly certain that the No. 2 bacillus was a true B. typhosus. The urine from which it had been recovered had been passed by Corporal I., of D Company, 1st Buffs. He had suffered from enteric fever at D'thalla, Aden Hinterland, in 1904, having been in hospital from July 12th, 1904, to November 10th, 1904.

He was sent for on November 17th, 1908, and the following information was obtained: On discharge from hospital in November, 1904, he came home from Aden with his battalion and went to Dover. He was given furlough from December 15th, 1904, to March 14th, 1905, when he went to Maidstone and stayed with his relations. None of the members of his family were ill either during or after his visit. He was at Bulford from June 4th, 1905, to October 3rd, 1905, with 24th Company Mounted Infantry; at Shorncliffe from December 1st, 1905, to December 15th, 1905;
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at Longmoor from January 1st, 1906, to March 31st, 1906, with Mounted Infantry; at Shorncliffe, attached to the Royal Scots, from October 1st, 1906, to December 2nd, 1906; at Longmoor again from April 1st, 1907, to July 3rd, 1907. Two men belonging to the Buffs, who were in the same Company at Longmoor during this latter period, contracted enteric, and during the time he was at Dover, three men of D Company also suffered from the disease. Since his arrival at Aldershot on October 1st, 1907, he has been in the same barrack-room, viz., No. 45. Six cases of enteric fever were admitted from Badajos during the first six months they were occupied by the 1st Buffs. Three of these were men of the regiment from H, C, and B Companies, and the other three were among the Royal Army Medical Corps Militia, who had rooms in this barrack at that time.

On making enquiries in Badajos, it was found that one urine tub served for both Nos. 45 and 46 rooms, and that this arrangement had been in force when the latter room was occupied by the detachment of the Rifle Brigade. It was consequently imagined that the men of the Rifle Brigade might have been directly infected by handling this tub, as Corporal I. stated that he had invariably used it at night, and never made use of those outside other rooms, but on questioning them, only one man, Private O., admitted having carried it down when "orderly man." Further enquiries did not throw light on the method by which these men had become infected, but the fact that this Corporal is passing typhoid bacilli in his urine, and that several cases of the disease have occurred in his immediate vicinity, at least suggest that he is the primary source of infection, and, consequently, steps were taken for his isolation and treatment. He was given urotropine in 10-grain doses twice daily, commencing on November 17th, 1908, and it was arranged with the regimental authorities that he should be segregated in a small room in a different building from the barrack-rooms. He was supplied with cresol to disinfect any urine passed during the night, and he was warned as to the danger to others arising from neglect to use a recognised urinal. On this date his urine was again examined by the same method as on the first occasion, and a similar bacillus was recovered. The urine was somewhat cloudy in appearance when passed, had a specific gravity of 1019, contained a trace of albumen, was faintly acid in reaction, and numerous pus cells were found by microscopic examination of the sediment.

A third bacteriological examination of his urine was made on
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November 30th, 1908, and a bacillus recovered which gave the same reactions as those previously isolated.

At the last examination, made on December 6th, 1908, a mixture of cocci and bacilli was grown; the latter do not appear to be typhoid bacilli, and their identification is at present under investigation. If it is found that the bacilluria persists in spite of administration of urotropine, local treatment of his bladder will be commenced.

The question has arisen as to whether this man should be permitted to serve, or should be invalided. In my opinion, the latter course is not advisable, as not only would this man be a great source of danger to the community at large, if sent into civil life where he could not be kept under such close observation as at present, but it is our duty to endeavour to render him free from infection before allowing him to leave the Army.

In case the administration of urotopine and local bladder treatment do not arrest the excretion of the bacilli, it is probable that either the kidney or the gall-bladder is the focus of infection, and in the latter event, it is difficult to see how the case is to be treated. There is no doubt that he should be kept under observation for at least a couple of years, even if the bacilluria is controlled by treatment, when one remembers the time which has elapsed since the acute stage of the disease.

In recording this case, it is not claimed that proof has been given of the direct relationship of the carrier to the incidence of the disease; but that there is some connection is, at least, suggestive, when one considers the numbers of cases of enteric fever which have occurred in the Aldershot Command during the last three years. In 1906 there was a total of eleven cases; in 1907 there were sixteen cases, six of which originated amongst the Guards at Pirbright camp, and three came from Badajos barracks after the arrival of the 1st Buffs; in 1908, twenty-eight cases have been recorded, and thirteen of these have had their origin in Badajos. It appears probable that whatever barracks this regiment had occupied, cases of the disease would have arisen, for before their arrival in the Command there had been several men infected. The practical difficulty in dealing with a unit in which a series of cases has occurred is the discovery of a carrier of infection, and even if one is found, there is always the possibility of the existence of more than one. In the present instance, little difficulty was experienced once the examination of the men who had suffered from the disease was commenced, but on other occasions one might make prolonged investigations without practical results.