THE DIRECT TRANSMISSION OF ENTERIC FEVER, AND ITS PREVENTION BY THE "STAMPING OUT" METHOD.

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In Murchison's "Treatise on the Continual Fevers of Great Britain" we read: "Although enteric fever is communicable, my experience is entirely opposed to the view that it is contagious in the strict sense of the term. Visiting, or contact with, the sick is neither sufficient nor necessary to produce it, and it is never propagated by a third person." And Dr. W. Cayley supplements this by saying that "although it may not be safe to affirm that enteric fever is incapable of being communicated by direct contagion, it is quite certain that this plays a very small part in the dissemination of the disease, and that widespread epidemics are never due to this cause" (op. cit., third edition, 1884, p. 466). As a recent expression of opinion may be quoted that of Schuder (Zeitschrift f. Hygiene, 1901, xxxviii., p. 343) who, having studied the records of 638 epidemics in different countries, in which the cause and manner of spread appeared to be satisfactorily established, states that 70.8 per cent. of these outbreaks were due to drinking water, 17 per cent. to milk, 3.5 per cent. to food of other kinds, and the remainder (8.7 per cent.) to all other causes, dust, fomites, &c. Direct infection was particularly enquired into, and appeared to be answerable for 1,179 cases out of a total number of 35,647, i.e., 3.3 per cent.

In spite of the preponderance of drinking water as a cause of epidemic spread, the extreme rarity of the instances in which the specific bacillus has been detected in water is well known. It was apparently the consideration of this fact, and a close study of the conditions obtaining in several outbreaks that occurred in Westphalia and on the Franco-German frontier during the years 1898-1902, that induced Koch to enter on his campaign against enteric fever ("Die Bekämpfung des Typhus"), an exposition of which he gave in Berlin, November, 1902, and which has since attracted so much attention. The following account is derived chiefly from a valuable paper by M. Talayrach, Médecin-Major de première classe (La Lutte contre la Fièvre Typhoïde) in the Archives de Médecine et de Pharmacie Militaires, xlii., 1903.
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I.—The Stamping Out of Enteric Fever.

During the years 1898-1902, the German Government was much exercised at the frequency of typhoid epidemics in its western provinces; in the Ruhr basin in Westphalia, and in the Sarre basin in the Rhine Province. Nearly all were manifestly due to water. In 1898 occurred an outbreak of 883 cases at Haspe-Gevelsburg (Westphalia); in 1899 one of 1,282 cases at Bochum and Gelsenkirchen, where also there were 1,360 cases in 1900, and 3,516 cases in 1901; like these outbreaks in the Ruhr basin, others occurred in the basin of the Sarre, where the disease, dying out in one spot, started afresh in another, then became endemic in some parts of the Rhine province, and extended to Alsace-Lorraine. Not only were the industrial populations of Sarrebrück, Treves and Sarrebourg attacked, but the frontier garrisons also suffered severely at Sarrebrück, Sarrebourg and Strasbourg. The military medical authorities on their side feared an increase in the typhoid morbidity, which had stood at a satisfactorily low figure ever since 1870.

The Government accordingly called in Robert Koch to conduct an enquiry and to advise as to the measures to be taken to combat the disease.

Since the abandonment by the majority of German writers of Pettenkofer's ground-water theory, the causes of an epidemic have been considered to be either: (1) Infection by water; (2) infection by food; or (3) infection by contact. The morbidity curve presents a characteristic aspect, according as one or other of these causes comes into play. An outbreak due to water furnishes at the beginning, after a few days' ascending oscillations, a sudden fastigium, the sharper and more elevated according as the pollution has been more abundant. Food epidemics have the same characters, but less pronounced. It is altogether different when the outbreak depends upon contact infection; the graphic tracing shows a level prevalence, but slightly elevated, and with little variation, and is often prolonged over several months.

The 1901 epidemic at Gelsenkirchen (Westphalia) was a typical water epidemic to begin with, followed by a prevalence due to contact. The first cases occurred on August 27th, the curve mounted by oscillations to its maximum on September 10th, and then rapidly sank, as if the outbreak was going to cease, the fall corresponding with the closing of the incriminated source of water supply. Nevertheless the epidemic dragged on, with a continuous but little elevated curve until March, 1902; this continuance being
due to contact infection from scattered foci, which gradually came into existence.

The 1898 food epidemic at Sarrebrück (due to a contaminated potato salad) was also followed by a contact prevalence. On January 4th seven cases were notified, the next day 37; after this the curve fell rapidly, but nevertheless the epidemic continued until February 24th. It is noteworthy to remark, twenty-four days after the infection by this article of food, admissions for typhoid fever were still going on, although obviously the salad could no longer be put down as the cause. It is evident that one must refer to contact infection all the admissions after the first three weeks.

An exclusively contact epidemic, characterised by its curves, was seen in a battalion of artillery at Strasbourg in 1900; by working out the different foci of infection, Muschold was able to demonstrate the "filiation" of all the cases; their origin was either the use of a latrine in common, or a common barrack-room.

It is known that the typhoid bacillus can live outside the human body; for instance, Uffelmann has shown that specifically soiled linen and woollen stuffs kept their virulence for sixty days, dry earth twenty-one days, fecal matter thirty days. But the German bacteriologists maintain that longevity of the typhoid germ is not the rule outside the human body, and that under these conditions its virulence rapidly diminishes. The fact which, more than anything else, causes Koch and his school to regard the human organism as the best culture medium, is the extreme rarity with which it is possible to demonstrate the presence of Eberth's bacillus in water. Koch himself, having examined the manifestly contaminated water supplies in most of the extensive typhoid epidemics in Germany, has but seldom been able to discover the bacillus. This may be owing to the difficulty of its isolation in part; in part to lapse of time between the infection of the water and the examination of the sample; in part to the shortness of the survival in water of this bacillus. Koch, in fact, has come to the conclusion that it is not a very frequent inhabitant of water, and that its existence therein is of very short duration—perhaps for a day, or even for a few hours only. If it were otherwise, it would be easier to demonstrate its presence; and the ascending curve of morbidity would be followed by continuance of elevation (a "plateau") corresponding to the length of sojourn of the micro-organism in the water. The rapid fall of the curve, and the continuance of the morbidity at a low level for weeks and months after the use of the incriminated water has ceased, point clearly to the operation of the third factor in transmission—contact.
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Although always acknowledged to be possible, this mode of transmission has often been neglected. The supposed immunity of attendants on the sick has been adduced as an argument against the contact theory. But statistics show that this is not the case; as at Sonderburg, where one case infected six members of the medical personnel and ten other patients; at Metz, 1879-81, an epidemic in the hospital comprised twenty-six cases, thirteen of whom were attendants; at Strasbourg, twenty-six cases out of eighty-three originated in hospital. In the period 1881-89, of the total typhoid cases in the German Army, ninety-eight originated in hospital, being 63 per cent. of all the typhoid admissions.

Amongst the cases of direct contagion would be included those in which it occurs through linen and clothing. Still, the danger would not be great if direct contact only were concerned. But this is not the case, and the rapid extension of an epidemic is often the result of the dissemination abroad of bacilli proceeding from an enteric patient.

It is the human body, in Koch's opinion, either suffering from typhoid fever, or convalescent after it, or that has been in contact with a typhoid patient, that is the starting point of all typhoid infection. The bacillus is an "obligatory human" bacillus, obligatory to the sick man, or the healthy man, or the associates of the patient. So that the campaign against typhoid will commence, not as formerly by search for the micro-organism in water (where it is almost certain not to be found), but with the patient, with everyone who has come near to him, in everything that has touched him. Destroyed at its origin, and in its original home, the infective germ will no longer be able to contaminate water and food, or to propagate itself indefinitely and bring about epidemics.

When Koch, in 1901, started on his investigations, having in view the idea just mentioned, of the contagiousness of the person, and considering also the great frequency of the mild, ambulant forms of the disease, he applied himself above everything else to the discovery of a rapid means of diagnosis. Hitherto the demonstration of the bacillus in the fluids of the body had been laborious, and often negative, even in cases that clinically were beyond doubt. The agglutination method of Gruber and Widal does not give a certain result for the first week, especially in slight cases; and it is these ambulatory cases that, according to Koch, constitute the great danger. After a year's research by Koch and his fellow-workers, Drigalski and Conradi succeeded in preparing a favourable culture medium, which allows of an almost certain diagnosis after the first
twenty-four hours. The medium is a lactose litmus agar containing crystal violet (which is said to inhibit air-organisms, &c.); typhoid colonies are transparent—coli colonies turn the litmus red. Suspected colonies are identified by Gruber’s agglutination test, and with glucose agar and neutral red. The diagnosis can be completed in twenty-four to forty-eight hours.

To have undertaken the campaign in one of the large centres of population where the disease makes its ravages year after year, such as the Westphalian towns of Arnsberg, Bochum, or Dortmund, would have been a Sisyphus’s task; Koch preferred to make a beginning, in the spring of 1902, in the villages of the Hochwald (Rhine Province), Waldweiler, Schillingen, &c.

The hypothesis of a water infection could be put on one side in the Waldweiler instance, where eight cases first attracted the Commission’s attention. There seemed to be no connexion between the cases notified at the beginning and those supervening later. To establish their relation, Professor Frosch constructed a table with fifty-two vertical columns for the fifty-two weeks of the year. On one horizontal line he plotted a curve of the cases notified in each week; on another line, the cases sought out and found to give a Widal reaction; on a third line, the cases in which subsequent enquiry led to the diagnosis that they must have been typhoid. Thus he found that a chain was formed, the lacunæ in which were filled in by information gathered from the school, the insurance societies’ registers, and the registers of the local authorities. At the school account was taken of all children who had been absent at least five consecutive days; the blood, both of the children and of their parents, was examined by the agglutination method; the fecal matters were tested. From the registered causes of death, Frosch was able to track out cases in the families of the deceased, and so establish long chains of connexion. From the insurance registers he found that there were numbers of persons who had drawn sick pay for eighteen, twenty and twenty-one days’ confinement to bed, due to febrile gastric trouble, intestinal hemorrhage, influenza, bronchitis, pneumonia, &c. With the exception of external injuries, all the cases of fever were considered to be suspicious, for the bacteriologist; and, in fact, Widal’s reaction often revealed cases of recovered typhoid amongst the insured persons.

A particularly interesting fact brought to light in the study of this outbreak was the extreme frequency of typhoid among infants, and their importance as infective agents; of 154 cases in Waldweiler there were eighty-six between 1 and 5 years old, forty-
seven from 15 to 30, nineteen from 30 to 40. Frosch remarks that, on separating the sex incidence, females were found to suffer more than males (contrary to what is usually found), the explanation being afforded by their more frequent and close contact with the children.

In all these cases direct infection from person to person could alone be the cause. In no way could the water be incriminated. Attacks were seen to succeed each other at regular intervals within the limits of the incubation period. The poorest dwellings, those in which the beds were fewer than the occupants, were most especially attacked. Faecal matters, dropped about everywhere, had most probably acted as the vehicle of the specific germ, which had been brought back to the interior of the houses on the feet.

Isolation, gratuitous treatment in Doeker huts, rigorous disinfection of typhoid foci, supervision of convalescents and of the parents of the sick (whose excreta and blood were bacterially examined twice a week) had for their result the disappearance of the bacilli in the dejecta of the persons supervised (and consequently of the disease) at the end of three months. Six months later it had not reappeared, although in other districts the annual recrudescence had occurred in the spring.

The campaign in the Hochwald has been the first experiment, one might say the touchstone, in the inauguration of a systematic attack on typhoid fever prevalence. The results appeared to be so conclusive that, before the end of 1902, the Government elaborated a series of measures relating to public health, in order to second the efforts of Koch's scientific commission. It was evident that the labour would have to be distributed, and that the local authorities must come to the aid of the scientific commission in order to make their efforts fully successful. Accordingly, in December, 1902, rigorous measures were undertaken by the authorities of the district of Treves.

The three points to be laid down by regulation are, according to Dr. Schlecht, Medicinalrath at Treves:—

(1) Notification of the disease.
(2) Isolation of the patient.
(3) Disinfection.

Compulsory notification is a sine qua non: at Treves it had been brought into force since November, 1900. The diagnosis of suspected cases has been made by the scientific Commission; the materials to be examined—faeces, blood, urine, expectoration—are sent by post by the district medical practitioners to the Commission,
who in due course inform them of the result of the examinations.

An important part of the duties of the local government medical practitioners is the instruction, in concert with the school inspectors, of the educational staff of the district in the methods of transmission and prevention of the disease. Another important point is the system of mutual notification that is in force between the civil and the military authorities; the military inform the civil health authorities of all cases of men going on leave, when convalescent after typhoid; and of any cases occurring in a garrison among men lately returned from leave.

Isolation of the sick is as important a preventive measure as notification. By the regulations, absolute isolation is not required for the entire dwelling, so long as the sick room can be isolated and have a separate entrance. The best isolation is always the "hospitalisation" of the patient. But the law does not require this. All that can be done is to invite the patient to come into hospital, pointing out the danger that exists for the other inmates of the house if he refuses. If the patient is not brought to hospital, efforts are made to secure the attendance of a professional nurse.

Disinfection is carried out thoroughly, attention being directed to the necessity of dealing with all the dejections during a sufficiently long period after recovery. Preference is given to a strong solution (5 per cent.) of the Liquor cresoli saponatus of the German Pharmacopoeia; faces, vomit and urine are to be well mixed with this solution and allowed to stand for one hour before being put down the drain. Milk of lime and chloride of lime are also recommended.

In addition to the above measures of direct attack on the disease, the Government are carrying out various measures of indirect prevention, such as providing fresh water supplies, improving those in existence, regulating the removal of refuse matters and excreta, supervision of food supplies (especially milk), of public baths, &c., &c.

The following is an outline of the procedure employed in the important matter of making the diagnosis, or detecting doubtful cases of the disease. The substances sent to the laboratory for examination are:—

1. Faecal matters: 50 to 100 cc. if liquid; of the size of a nut if solid.
2. Urine, 500 cc.
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(4) Expectoration from the lung.
(5) Pus, or inflammatory exudations.
(6) Blood, taken (a) by puncture of an arm vein (2 or 3 cc.);
(b) from the lobule of the ear.
(7) Soiled linen.
(8) From a dead body: intestinal contents taken from above the ileo-cæcal valve, portions of spleen, lung, some bile, contents of abscess, pulmonary secretion.
(9) Well water, after the well has been stirred up, from 3 to 5 litres.

The operations to be performed are: cultivations, agglutination test, Pfeiffer's test.

(1) Cultivations.

(a) Substances 1, 4, 5, 7 and 8. At least two series of large Petri dishes are plated with Drigalski-Conradi medium, incubated at 37° C. for eighteen to twenty-four hours.
(b) Urine.—Centrifugalise and cultivate from the deposit as (a).
(c) Blood.—Inoculate into alkaline peptone bouillon, using 10 cc. tubes for No. 3, and 150 cc. flasks for No. 6. Incubate at 37° C.
for twenty hours, and sow into Petri dishes as (a).
(d) Water.—Place in a 2-litre flask. Add (for 2 litres of water)
20 cc. sterilised solution (7-75 p.c.) of hyposulphite of soda (German Pharmacopœia). Mix. Add 20 cc. sterilised solution (10 p.c.) of nitrate of lead. A deposit is obtained, either by centrifuge or by sedimentation for twenty-four hours: pour off supernatant water, add to the deposit 14 cc. sterilised solution (100 p.c.) of hyposulphite of soda, shake, and decant into a small sterilised tube; allow the insoluble matters to settle. With the liquid portion prepare Petri plates (2 to .5 cc. in each) as with fecal matters. Colonies are examined with the naked eye by daylight, as to their size, colour and transparency; those suspected of being B. typhosus (which are small, transparent, blue-violet in colour) are examined macroscopically, afterwards under a low power, as to their behaviour in the presence of a strongly agglutinating serum. Pure cultures are then made on sloped agar.

The final determination is made (A) by examining the shape
and motility of the organism; (B) cultivation in glucose agar;
(C) in litmus whey; (D) on potato; (E) on gelatine; (F) agglutination test macroscopically; and (G) by Pfeiffer's test.
(2) Agglutination Tests.

For the determination of a suspected colony or pure culture, these are carried out (a) in hanging drop with direct addition of serum; and (b) in dilutions of $\frac{1}{10}$, $\frac{1}{100}$, $\frac{1}{1000}$, and $\frac{1}{10000}$, each experiment being repeated with the same culture and the same dilutions, and with a known typhoid culture of the same age and the control serum. For the examination of the blood, a microscopic test is made with $\frac{1}{10}$ and $\frac{1}{100}$ of the suspected serum and a forty-eight-hour typhoid culture; macroscopic examination is also made in conical tubes, left for three hours at $37^\circ$ C. If $\frac{1}{10}$ gives positive reaction and $\frac{1}{100}$ negative, the case is doubtful, and the test should be repeated a few days later.

(3) Pfeiffer's Test.

The serum employed must have a strong agglutinating power. Four guinea-pigs are taken: A receives a five-fold immunising dose; B a ten-fold dose; C is a control, receiving a fifty-fold dose of normal serum; these animals are injected with doses of serum containing a loop of the culture to be examined (eighteen hours on agar, and then diluted with one cc. bouillon). D receives an injection of a quarter of a loop of the culture simply, this serves as a test for its virulence. The peritoneal exudation is examined in hanging drop under a high power from twenty minutes to one or two hours after the injection. With A and B the bacilli should be dissolved or transformed into granules; with C and D a large number of bacteria should be quite motile and retain their characteristic form.

In the application of the campaign against typhoid to military practice, the examination of water supplies is not to be omitted. This mode of infection may be stopped in some degree if a bacterioscopic water examination is made at regular intervals, not to discover the enteric bacillus, which practically is never found there, but to ascertain the presence and amount of colon bacilli, which are the proof of faecal pollution, and an indication of possible contamination by Eberth's bacillus. In Koch's opinion, no filter can safeguard against this danger of infection by water, sterilisation is the only way to do so.

When a case of typhoid appears in a barrack room, whether it be of alimentary origin (water, vegetables, butter, milk), or whether
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It depends upon contagion (return from furlough, children of families living outside barracks, latrines, hospital), isolation of the barrack room mess should be carried out immediately, in spare quarters in the barrack kept apart for this purpose. The men under observation live, take their meals, exercise, and use latrines apart from the rest. Their stools and blood are examined bacterioscopically; and life in common is not resumed until after a lapse of time equal to the incubation period of the disease.

In this way Conradi, Drigalski and Jurgens cut short an epidemic of paratyphus at Sarrebrück in 1902, the first example, on a large scale, of "bacteriological prevention" in the army. In the 2nd battalion of the 70th infantry nineteen men were admitted to hospital with slight diarrhoea; at first, influenza was suspected, but when enteric fever was considered to be possible, and when the bacillus was discovered in the stools of one of the patients, the scientific commission extended its researches, and the Surgeon-General of the 8th Corps caused similar examinations to be made of all suspicious cases and convalescents; three successive examinations were made, and the men were not restored to common barrack-room life until the three examinations proved negative. All the men in the battalion who had had the slightest bowel trouble, ninety in all, were isolated and bacterioscopically examined between February 2nd and beginning of March, a wise precaution, justified by the cessation of any fresh cases after the first infection. The scientific commission declared that: (1) the bacterioscopic examination defined the nature of the disease; (2) the systematic examinations enabled precautions to be taken against transmission of the germ by convalescents or clinically suspicious cases; (3) the preventive measures adopted, isolation and disinfection, stopped the spread of the epidemic. The rigorous bacterioscopic examination of stools, and the retention of the patients in hospital so long as the specific bacillus can be detected in them, are insisted on as essential preventive measures: urotropine is considered most efficacious as a bactericide for the urine.

It is recognised that the work rendered necessary on the part of the army medical service in order to achieve such results is enormous. At Treves, for instance, two months were taken up in preparing for the manoeuvres of the 8th Corps, by searching for cases of typhoid fever and other infectious diseases in the district where these operations were to take place. It was indeed a task well worth doing. But work of this kind cannot be undertaken except after long study and laboratory experience, therefore it is
necessary that medical officers should be specially selected and trained for these highly specialised investigations, in order that they may possess the necessary knowledge as well as enjoy the equally necessary scientific prestige.

II.—The Spread of Enteric Fever by Direct Contagion.

The opinion of Murchison, quoted at the beginning of this paper (p. 587), that enteric fever is not, strictly speaking, contagious, was not only the outcome of his own large experience, but represented the preponderant, one might almost say the universal, opinion of the medical profession at that time. And that this was based upon observed facts, we have not the slightest reason for doubting. When Murchison wrote that it was "universally admitted to be a very rare occurrence for the nurses or medical attendants of hospitals to contract enteric fever from the sick under their care," we are justified in believing that such was the case. Bacteriological diagnosis was, of course, non-existent, and it is conceivable that mild, unrecognised cases might have occurred amongst nurses; but such a supposition must not be pressed too far. Physicians were as keen observers in the middle of the nineteenth century as they are now at the beginning of the twentieth, though not in possession of as many aids to diagnosis; it is not probable that, if any considerable number of cases of feverishness with slight bowel trouble had occurred amongst the attendants, such cases would have been overlooked; and it is still less probable that among such supposed contact cases there would have been an absence, or almost an absence, of serious and even fatal cases, which could not fail to be diagnosed and recorded.

For this is not a matter of one man's experience, or the state of things at one hospital, or in one city, or in one country. Again quoting Murchison (op. cit., p. 461), "Dr. Wilks informs me that he has never known a nurse in Guy's Hospital contract enteric fever." In 1856 Dr. Peacock remarked that he had never known enteric fever communicated to the nurses or attendants at St. Thomas's Hospital; while the only instances of enteric fever contracted in all the general hospitals of London which Messrs. Bristowe and Holmes could discover in their official inquiry¹ in 1863, were those of two nurses in the Royal Free Hospital. After five years' experience in the City of Glasgow Fever Hospital, Dr.

¹ Sixth Report of Medical Officer to Privy Council, p. 589.
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J. B. Russell thus writes: "As an interesting contrast with our experience of typhus, I may say that no case of enteric fever has ever arisen either among the staff, or among the patients beside whom cases of enteric fever are treated. During twenty-three years (1848-1870), 5,988 cases of enteric fever were admitted into the London Fever Hospital, but only seventeen residents in the hospital contracted the disease, and most of them had no personal communication with patients sick of enteric fever. Of the seventeen cases nine were nurses, only four of whom were employed in the enteric wards, one was a laundress, one a medical officer, and six servants in a building detached from all fever wards. Twelve of the seventeen cases occurred subsequently to 1864, when various extensions of the hospital buildings led to a serious derangement of the drainage, and on more than one occasion the occurrence of several cases in succession in the hospital was found to coincide with the smallest number of patients in the wards and with defects of drainage, the removal of which at once arrested any further spread of the disease. During the same period of twenty-three years, twelve patients admitted with other diseases contracted enteric fever in the hospital. . . . Since 1861. . . . the typhus, relapsing, and scarlatina patients have been kept in distinct wards, whereas the patients suffering from enteric fever have been treated in the same wards with the many patients sent to the hospital who have not been the subjects of any form of contagious fever. The two classes of patients have remained together both during the acute stage of their maladies and in convalescence, in most instances for several weeks. The same night-chairs have been used by both classes, and the employment of disinfectants has been exceptional. The result has been this. During nine years, 3,555 cases of enteric fever have been treated along with 5,144 patients not suffering from any specific fever; not one of the latter has contracted fever."

The subsequent experience at this hospital, as related by Dr. W. Cayley, was to the same effect; from 1871 to 1882 there were 1,795 enteric cases, treated in the same wards as 928 other cases, not one of whom became infected, though a few cases originated in scarlet fever patients in other parts of the hospital. During the same period seven nurses and a ward servant developed enteric, four being taken ill at about the same time; the drain of the ward where they were on duty was found to be obstructed.

In regard to provincial hospitals the only instances that Bristowe and Holmes could discover (1863) were some few cases at
Canterbury (no details supplied), and four cases following on the admission of a typical case at the Bath Hospital in 1862; but these latter cases were afterwards practically proved to have been due to the blocking of a w.c. pan.

In 1880 Dr. W. Cayley delivered his Croonian Lectures on Typhoid Fever. He maintained the same position as Murchison: "It may, I think, be laid down as absolutely certain that an epidemic of typhoid is never caused by the disease spreading by direct contagion, as epidemics of small-pox, scarlatina and typhus are." He had seen many instances of supposed direct contagion, but had generally succeeded in tracing them to an indirect source. Thus, during 1879, sixty cases had been admitted to Middlesex Hospital; six nurses contracted the disease, but five of these were engaged in the surgical wards and did not come into contact with the enteric cases.

In 1879 and 1880 Dr. Alexander Collie contributed some articles to the British Medical Journal, vigorously assailing the existing orthodox position, as stated by Dr. Cayley. He showed that, since the opening of the Homerton Fever Hospital in 1871, there had been twenty cases of enteric fever amongst the staff, sixteen of which had occurred in persons actually on duty in the enteric wards, and one other in the laundry, employed in washing soiled linen from those wards. Ten of the cases were attacked between twenty-three and fifty days of their coming on duty. There were no drain defects, and no contamination of the water supply. Dr. Collie considered that the cases were due to direct infection, and that the immunity of the nursing staff generally at the London Fever Hospital and in the large general hospitals in former years, was to be accounted for probably by their age; the employment of young nurses (between twenty and twenty-five years), as at Homerton, being of recent institution.

About the same time (1879) Dr. W. Thomson, of Peterborough, recorded in the British Medical Journal some outbreaks only to be explained on the hypothesis of direct contagion. In particular, one crucial instance may be mentioned: a young lady attending school fell ill of the disease; she was visited by her mother from a distance, who only stayed with her for half-an-hour, neither ate nor drank anything in the sick room, and washed her hands on leaving. The mother returned home, and in ten days fell ill with enteric. There were no cases in the neighbourhood.

In April, 1900, Dr. E. W. Goodall read a most valuable paper on this subject of the Infectivity of Enteric Fever at the Epidemio-
logical Society. He adduced several instances of localised spread of infection, apparently due to direct contact: three groups of cases numbering four, seven and six, reported by Dr. J. Priestley; a group of five cases, reported by Dr. Fraser Bryett; a group of ten cases, reported by Dr. Boobbyer; all these occurred in the years 1898-1899. Dr. Alfred Hill considered that in the year 1898, in Birmingham, there had been at least eighty-six cases (or one-seventh of the total number) directly due to infection from another case. Dr. John Robertson also wrote that, after investigating nearly two thousand cases, he concluded that about ten per cent. were probably due to direct infection. But the most important facts were those brought forward by Dr. Goodall himself, derived from the experience of the Metropolitan Asylums Board's Fever Hospitals. During the eight years 1892-1899 there had occurred one hundred cases of enteric fever amongst the staff of these hospitals. The total number of cases treated in the period was 5,913. Four of the hospitals, North Eastern, Fountain, Northern and Gore Farm, had never taken in enteric cases, unless by accident or very exceptionally; no cases had occurred amongst the staffs of these four hospitals (save two at the North-Eastern). With regard to the Eastern Hospital, where twenty-nine cases had occurred amongst the staff, Dr. Goodall stated that eighteen (at least) had been employed in the enteric wards when they contracted the disease. Of ten cases at the Brook Hospital, five were nurses in the enteric wards and two were men whose duty it was to keep the floors of these wards polished. Three cases at the Grove, the then most recently erected hospital, had all been working in the enteric wards. Dr. Caiger stated that at the South-Western Fever Hospital, twenty-three of the staff had contracted enteric fever, every one of them a nurse, and all (except one) nursing in the enteric wards. Dr. Bulstrode quoted Dr. Niven, of Manchester, who had stated that in the year 1898, fifty-three out of 484 cases in that city could be traced to direct infection; and that if to these were added cases occurring in public institutions, about one-seventh would be found to be so accounted for. This agrees with Dr. Hill's opinion mentioned above.

In 1898 an outbreak occurred in the Bron Asylum for the Insane, near Lyons (Public Health, vol. xiii., 1900). There were thirty-five cases, mostly amongst the female patients and attend-

1 Transactions, vol. xix.
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ants; infection by water, food, and drainage defects could be excluded. Professor Bard considered that the propagation was due to direct infection, connected with want of care in dealing with the fecal discharges of the sick.

During the Spanish-American War of 1898, when the United States troops were assembled in vast camps at selected sites in Virginia, Florida, Georgia and Pennsylvania, it is reported that within the five months May to September, no fewer than 20,738 officers and men (nearly one fifth of the force), were infected with typhoid fever, of whom 1,580 died. This epidemic was inquired into by a Board of Medical Officers (Reed, Vaughan, and Shakespeare) and an abstract of their report was published in 1900, the principal points of which have been summarised by Dr. Christopher Childs in the British Medical Journal (July 26th, 1902). All the circumstances were carefully investigated, infected water was excluded; a minute investigation was made into 1,608 individual cases with a thoroughness only to be compared with that characterising the German Scientific Commission of the following year, that has been already alluded to. The following important conclusion was arrived at: “Typhoid fever, as it developed in the regimental organisations, was characterised by a series of company epidemics, each one having more or less perfectly its own individual characteristics.

Men in the same company came down with the disease on the same day. This is still more marked when we study the cases with reference to the tents occupied by the men. In 1,608 cases of typhoid fever which we have been able to accurately locate in the particular tents in which they occurred, together with the date of the commencement of the attack, the results may be summarised as follows:—

<table>
<thead>
<tr>
<th>Description</th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Directly connectable attacks (in same tent)</td>
<td>568</td>
<td>35.01</td>
</tr>
<tr>
<td>Indirectly connectable attacks (in next tent)</td>
<td>447</td>
<td>27.79</td>
</tr>
<tr>
<td>Total connectable attacks</td>
<td>1,011</td>
<td>62.8</td>
</tr>
</tbody>
</table>

Certain tents were badly infected, and the majority of their inmates developed the disease, while other tents wholly escaped.” As Dr. Childs says, “the evidence adduced is sufficient to make a very strong case for the verdict of the Commission that the direct and indirect infection in tents were most important factors in the spread of the epidemics.”

In 1900 a camp was formed for the reception of Boer prisoners of war at Diyatalawa, Ceylon. Some 5,000 men were accommo-
dated here on an absolutely clean and healthy site, with a water supply above suspicion. Enteric fever was introduced into the Camp in September, and between September 22nd and November 29th there were 711 admissions for this disease. Sir Allan Perry, Principal Civil Medical Officer, considered that dissemination might have occurred through infection of the latrines, or by flies; and noted the circumstance that “the habits of the Boers at first were far from sanitary. After defecation it was usual not to use any means of cleansing the person; in this way the inside of the trousers became fouled, and the dried excrement may have been disseminated in the huts (although it should be remarked that the clothing of many men was examined bacteriologically, but no true B. typhosus was found).” Careful disinfection and segregation rapidly brought the epidemic to an end, though not before twenty-four soldiers of the military guard had been attacked, doubtless through aerial (though hardly direct) infection.

There is a very widespread impression amongst Army Medical Officers that, during the South African War, in very many cases propagation of enteric fever took place by air-borne infection (dust, flies, &c.), and more especially by soil or dust-infection in particular tents, but no exact information on this subject is available up to the present.

A very striking example was recorded by Dr. Horton Smith, in 1903 (Lancet, April 11th), in a series of nine cases. The first case, at Haggerston, a girl aged 15, was not recognised, and no precautions were taken; she died October 15th. (2) Her sister, who had slept with her during part of her illness, sickened on October 16th. (3) Her mother sickened about the same time. (4) Her brother on October 19th. (5) Her aunt stayed at the same house during the first week in October, was out of sorts the next week, and gave a positive Widal reaction (1 in 30 in ten minutes) on November 6th. (6) Her father sickened on November 2nd. (7) Another brother left the house on October 20th, went to Croydon, was slightly ailing on the 23rd, and on November 21st gave “fairly complete agglutination,” 1 in 20, “slight” 1 in 50; probably an exceedingly mild case infecting the next two. (8) A boy living in same house as No. 7, sickened November 12th. (9) An infant sister of No. 1 left the house on October 28th for Croydon, was suddenly taken ill on November 17th with shivering, vomiting, diarrhoea and fever.

*British Medical Journal, March 15th, 1903.*
A. M. Davies

afterwards bronchitis; no characteristic symptoms and Widal reaction negative until 28th, when it was positive, 1 in 30 in ten minutes; death on December 10th, but no post mortem allowed. No enteric fever was prevalent either at Haggerston or at Croydon. The diagnosis seems to be clear, and the only probable cause of the cases after the first was direct contagion.¹

(To be continued).

¹ See also a paper by Dr. Herbert Peck, on the Frequency of Sick-room Infection in Typhoid Fever (British Medical Journal, September 2nd, 1899). Twenty-eight cases are related.