ON THE SPREAD OF ENTERIC FEVER BY URINE, AND ITS PROPHYLAXIS.

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(1) PREVALENCE OF ENTERIC FEVER AMONG BRITISH TROOPS.

The prevalence of enteric fever among British troops in time of war and occasionally in epidemics in foreign stations, indicate that each and every link in the chain of infection by the Bacillus typhosus must be studiously worked at, recognised, and rigorously attacked, experimentally and otherwise, in time of peace, if we as officers responsible for the health efficiency of the Army are to prevent a repetition of the ravages of this great life-destroyer, the greatest that has afflicted every army that ever took the field in time of war. Among the links in the chain of primary infection there stands out one above all others, and recognised by all, as the arch source of all infection; this, needless to say, is the excreta of enteric patients.

Under this heading falls, in the too menial guise of sub-agent, the urine—a sub-agent which I propose to prove as worthy of consideration, and one that may have a much more important bearing on the dissemination of enteric fever than that with which it is commonly accredited or certainly recognised, by virtue of its very varying, erratic, and difficult bacteriological analysis.

The possibility of investigating such a source of infection must
of necessity be intimately associated with a series of continuous observations of the urine of a large number of enteric patients. Such opportunity presented itself to me in the patients arriving at the Royal Victoria Hospital, Netley, during the latter period of the South African War, when all patients at any stages in the disease that were available were placed under my personal observation for treatment. Many of these cases were in the first week of the disease; others close to it, and others, again, convalescing. I have also had the opportunity of observation and treatment of other cases in the military hospitals at Bulford, Aldershot, and latterly in Bullary, Madras, India. Before detailing the technique of the experiments carried out by me it will not be out of place to summarise some of the work done by other observers of recent years relating to enteric bacilluria. Neumann¹ (1890) examined the urine of forty-eight cases of enteric and found bacilli in eleven instances. The bacilli were always present in large numbers, and in some cases persisted far into convalescence. Wright² and Semple (1895) obtained bacilli in six out of seven cases. Besson (1897) found typhoid organisms in six out of thirty-three cases. Horton Smith³ (1897) examined the urine of seven patients with positive results in three, and stated that he could often demonstrate the bacilli in cover-glass preparations from the urine; and further that the organisms may be so numerous as to render the urine distinctly turbid. Petruschky⁴ (1898) obtained three positive results in fifty cases. In one case bacilluria persisted two months after the beginning of convalescence; in another case six weeks; and in a third patient eight days after the temperature had become normal. In one of his cases Petruschky estimated that 1 c.cm. contained 170,000,000 bacilli.

Richardson,⁵ of Boston, in three series of investigations (1898-1899), obtained positive results in eight out of thirty-seven in the first, fourteen out of sixty-six in the second, and twenty-three out of 104 in the third series.⁶

¹ Neumann, Berliner Medizinischen gesellschaft, 1900.
⁵ Richardson, The Journal of Experimental Medicine, New York, 1898, No. 3; and 1899, No. 1.
Horton Smith\(^1\) (1900) in forty-five cases found bacilli in seventeen, thus giving a percentage of nearly thirty-eight for positive results. This undoubtedly high percentage he attributes to the fact that six of his cases were those in which the abnormal condition attracted attention and in which a bacteriological examination of the urine was requested. Schuder\(^2\) found the \textit{B. typhosus} in five out of twenty-two cases, and states that from a close examination of collective records of other observers it has been found in 117 cases out of 599, or in a percentage of 29.55. Neufeld\(^3\) (1899) examined twelve cases, three of which had bacilluria caused by typhoid bacilli.

The comparison of these results, the importance of which collectively are manifest at first sight, and which give evidence of a condition so frequently met with as to be a menace to the public health, is a condition recognised more than a dozen years ago, but unfortunately one that does not seem to have attracted the attention that should be its due. It certainly has been my experience, and also that of many others whom I have questioned on the subject, that while modern lecturers and teachers have laid particular stress on the infective nature of the stools, few, if any, have urged prophylactic measures against the urine, which must now be considered as worthy of our attention.

\textbf{(2) \textit{The Characteristics of the Bacillus Typhosus}.}

It must not be forgotten that year by year our knowledge of the cultural characteristics of the enteric bacillus has improved, the value of highly diluted reactions with specific serum has modernised teachings but a few years old, and many a bacillus that would ten years ago—aye, much less—pass muster as a \textit{B. typhosus} will not to-day be accepted as such by those familiar with the "mill" through which the modern bacillus has to go before its position is accredited, and the so-called \textit{B. typhosus} of even a few years ago would under modern diagnosis find itself relegated to a back seat in the "democratic" coli group. In prosecuting any investigations as to the personality of any bacillus in the urine no bacteria can be accepted that does not fall in line with the formula promulgated by Firth and Horrocks\(^4\) and now generally accepted, which is as follows:—

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\(^1\) Horton Smith, "Goulstonian Lectures," 1900, p. 50.


\(^3\) Neufeld, \textit{Therapeut}, January 15, 1901.

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(1) A non-spore-bearing, actively motile rod, decolourising by Gram; (2) giving a thin, moist, greyish-white growth on an agar slope; (3) yielding surface colonies on gelatine plates as thin bluish films with an irregular margin which do not liquefy gelatine, and require seventy-two to ninety-six hours' incubation at 22° C. before showing these specific characters; (4) showing a turbid or diffuse growth in broth without pellicle; (5) producing no gas in glucose media; (6) yielding no indol in peptone and salt solution after seven days' incubation at 37° C.; (7) giving a moist, colourless growth on potato; (8) not changing milk after seven days' incubation at 37° C.; (9) producing not more than 6 per cent. of acidity in litmus whey after seven days' incubation at 37° C., when titrated with decinormal alkali; (10) producing no growth or change in reaction when grown for twenty-four hours at 37° C. in Proskauer and Capaldi's No. 1 medium; (11) growing with production of marked acidity after twenty-four hours at 37° C. in Proskauer and Capaldi's No. 2 medium; (12) yielding acid but no gas in 1 per cent. glucose peptone at 37° C. after twenty-four hours; (13) not affecting in any way 1 per cent. lactose peptone at 37° C. after twenty-four hours; (14) agglutinating at once with an anti-typhoid serum diluted 1 in 1,000.

(3) Method Employed in Collecting the Urine of Enteric Fever Patients for Macroscopic Examination.

For the purpose of making as full and as accurate an investigation as possible of the urine of my enteric patients, with regard to the turbidity said to occur at and after the onset of typhoid bacilluria, I adopted the following procedure: A number of clear glass half-litre flasks, such as are commonly used for laboratory purposes, were borrowed from the departments of the Professors of Pathology and Hygiene at the Army Medical School, Netley. Each of these flasks, after being thoroughly sterilised, and provided with a cotton-wool pledget as a stopper, was labelled with the name of the patient for whose use it was intended. Each typhoid patient was directed to micturate into the flask direct, and the urine taken for examination was invariably that first passed from the bladder each morning, as such urine would have the advantage, in coming from a full bladder, of being in all probability the largest amount evacuated at the one time during the twenty-four hours, and being high in specific gravity, the facility for observation of turbidity would be increased; the danger of extra-vesical decomposition would be
reduced to a minimum, as my observations were made at an early hour each day.

Before paying my morning visit to patients all the urine flasks of each ward were collected in the ward lavatory and placed in rows on a table in good light, and in such a position that I could readily contrast their colour and density.

For the purpose of arriving at the means of classification of colour and transparency, I adopted the terms "dark," "medium," "light," for colour; and "clear," "slightly turbid," "turbid" or "muddy" for transparency. The last-named term I used to indicate the condition produced by a deposit of chemical salts, urates, phosphates, or oxalates.

For the sake of abbreviation and for combinations of the varied conditions found, I employed the letters "D," "M," "L," for colour; and "C," "ST," "T," "M," for transparency: these abbreviations could be easily and rapidly filled in on a tabular form having spaces for each day of the month opposite each patient's name. Thus a diurnal record of the appearance of each patient's urine was recorded.

All suspicious urines were microscopically and bacteriologically examined, when possible, without delay. In the case of a proposed bacteriological examination, in order to avoid the hazard of extra-vesical contamination of a urine which had been previously noted as suspicious from its colour and turbidity in the flask, the following method (the sterility of which I tested on a normal subject and with the efficiency of which I was satisfied) was adopted. The glans penis of the patient was thoroughly washed with corrosive sublimate (1 in 1,000), and he was told to pass his urine into an ordinary vessel without touching it with the penis. He was then told to direct the last of the stream into a small, sterile, wide-necked bottle, and this was at once closed up under the usual precautions and conveyed to the laboratory for microscopic examination.

(4) General Observations on the Macroscopic Characters of the Urine as Occurring during the Course of Enteric Fever.

(a) Quantity.—The quantity of urine passed by a case of enteric fever varies within wide limits, and seems to depend to a great extent upon the stage of the disease, the amount of fluids ingested, and upon the degree of activity of the cutaneous surface of the body. In the earlier stages of the fever it was always observed to become
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much diminished, and during convalescence it either reached the normal or rapidly increased. *A suddenly occurring abundant excretion of urine in the case of a convalescing enteric patient should be noted as of great importance, for in many cases I found it to be diagnostic of the onset of bacilluria.*

(b) Colour.—Following the general rule in fevers, the colour was found to be always intensified from concentration during the height of the attack (i.e., during the second and third weeks), and it lightened in shade as convalescence was reached. *Urine of a straw-yellow shade, with an opalescent shimmer, was found to be the most suspicious, and if associated with turbidity, almost invariably contained pathogenic bacteria.*

(c) Transparency.—When no chemical deposit of urates, phosphates, or oxalates was present in the urine during the disease, it was in most cases clear. *Any turbidity not due to these salts was always found to be associated with swarms of micro-organisms.* The clear urines and the urines showing chemical deposits were in the majority of cases not observed to contain any pathogenic bacteria.

(d) Specific Gravity.—This followed the usual laws as laid down for fevers in general.

(e) Bacilluria.—The occurrence of a sudden and abundant excretion of urine of a pale yellow or straw-yellow colour with an opalescent shimmer and showing a distinct macroscopic turbidity was found in all cases to contain bacilli, either the *B. typhosus* or the *B. coli communis*.

Such an occurrence, though a typical bacilluria, rarely produced any clinical symptoms referable either to the bladder or kidneys. A few cases, nevertheless, did complain of frequency of micturition and slight pain after micturition, with a little tenderness over the region of the bladder; it was in these cases that the *B. coli communis* was found to exist in such enormous numbers that I believe the cystitis was mainly due to that organism. No pus in quantity deserving mention was perceived in any instance. It was noticeable that the larger percentage of infected urines occurred in those cases in which the clinical symptom of delirium had been of rather long duration, or where a patient had reached the stage of convalescence in a state of extreme emaciation; hence I am inclined to think that bacilluria is much more likely to occur in cases where the pyrexia is distinctly marked than in those where it is less pronounced.

I have made examination of the urine of 100 cases of enteric
fever for the purposes of this report. Seventy-five of these were examined daily while in the acute stage and later, in wards under my personal charge. Twenty-five were convalescents on arrival and their urine was daily examined by me in the convalescent wards of the Royal Victoria Hospital, Netley, by kind permission of Lieut-Col. Allport, R.A.M.C. Among the former thirty-seven developed bacilluria at some period of the disease, and of the latter fourteen developed the same affection, thus giving a total percentage of fifty-one cases of bacilluria.

I made an attempt to keep a register of the exact day of disease on which the bacilluria occurred in each of my cases, but unfortunately this proved futile in the majority, as many of the patients had developed the disease before coming under my treatment and others had been ambulant cases. In nearly half the cases, however, I was able to arrive at a conclusion with some degree of exactitude, and the earliest day of the disease that bacilluria was noted was in one case on the twelfth and three on the thirteenth, and the latest was on the one hundred and thirty-seventh day. It may be of interest to contrast these figures with the data of other observers.

Horton Smith\textsuperscript{1} states he has isolated the \textit{B. typhosus} as early as the thirteenth day of the fever, and that in this case it had undoubtedly been present from a much earlier date. He has also isolated the bacillus in three other cases on the twenty-fourth, twenty-seventh and fifty-first days respectively. Richardson\textsuperscript{2} is of opinion that it may occur at the earliest on the fifteenth day of the disease, but that the third or fourth week is more favourable. Kronjajeff\textsuperscript{3} has not found the bacillus before the third week. Neufeld\textsuperscript{4} found bacilli in one case on the twentieth day in acid urine to the large amount of 60,000,000 per cubic centimetre, and in another case to the amount of 20,000,000 per cubic centimetre; this latter case was complicated by cystitis and the urine was acid. Neufeld is of opinion that bacilluria may occur at the earliest towards the end of the second week, or about the beginning of the third in a few cases, but that in the majority of cases it appears later, and frequently it may be entirely absent until convalescence.

(5) Method Employed in Isolating Bacilli from the Urine of Enteric Fever Patients.

Great difficulty accompanies any attempt to isolate the \textit{B. typhosus} from bacilluric urine owing to the fact that in bacilluria

\textsuperscript{1} Horton Smith, \textit{loc. cit.}
\textsuperscript{2} Richardson, \textit{loc. cit.}
\textsuperscript{3} Kronjajeff, see Neufeld, \textit{loc. cit.}
\textsuperscript{4} Neufeld, \textit{loc. cit.}
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The urine almost invariably contains swarms of other organisms, prominent amongst these being the \textit{B. coli communis}. This organism, though not a normal inhabitant of enteric urine, yet seems always associated with the \textit{B. typhosus} when the latter is present, and in very many of the severer cases of bacilluria in which I have been unable to detect the typhoid bacillus, I have isolated pure cultures of different varieties of the \textit{coli} group.

For the purpose of investigating the urine in typhoid bacilluria and the subsequent effects of urotropine on patients suffering from bacilluria, I employed several of the methods laid down in the textbooks for the isolation of the \textit{B. typhosus} from water, but had to abandon most of these methods as either not applicable to urine or as impossible to carry out in the time at my disposal. I finally employed, with considerable success not only in results, but in gain of time, a method devised by Horrocks\(^1\) for the isolation of enteric bacilli from stools. The more important details of this method (which is a modification of Parietti's process, combined with the use of glucose-litmus-agar plates, based on the difference of the acid-producing powers of \textit{B. coli} and \textit{B. typhosus}) may be summarised as follows: The turbid urine of an enteric patient, suspected to be bacilluric, after having been drawn off under the sterile precautions previously described in (3), is shaken up and a small quantity measured off and allowed to evaporate on a slide; this is stained and a rough estimate is made of the number of organisms present, so that if they appear abundant it is necessary to dilute the urine with sterile water for the purposes of further bacteriological examination. Should only a few organisms be present 1 c.c. is spread out in a series of lines over the surface of a glucose-litmus-agar plate with a platinum needle. This medium contains 2 per cent. glucose added to ordinary agar, containing sufficient aqueous extract of litmus to give it a light blue colour. When this medium is required for use it is melted and cooled down to 42° C. and a decinormal solution of NaHO added, so that each 10 c.c. of the medium has an alkalinity equal to 1.8 c.c. of decinormal alkali. The alkaline glucose-litmus-agar is now poured into Petri dishes and allowed to solidify, and when "set" these are placed in an incubator for twenty-four hours, which process has the double advantage of testing their sterility and allowing the medium to become more rigid. The plates are then ready for use. After inoculation with the suspected urine they are incubated,

\(^1\) Horrocks, "Introduction to Bacteriology of Water." Churchill and Co. 1901.
with covers downwards (as recommended by Firth), at 37° C. for twenty-four hours. Should the *B. typhosus* be present its colonies appear on the surface of the plates as small, round, transparent droplets of a bluish tint, while the medium surrounding them is of a very light delicate pink shade, due to the fact that the small acid-producing power of this organism is almost neutralised by the alkali of the medium. The colonies of the *B. coli* are larger, more opaque, and red in colour, while their relatively higher acid-producing power colours the surrounding medium a brighter red by converting the alkali litmus into acid litmus. Colonies of cocci did not change the blue of the media and were easily discarded.

All suspicious blue colonies with a delicate pink zone of media around are now marked and individually examined, each being first "fished" and examined in a hanging drop. If motile bacilli like the *B. typhosus* are seen, samples of this drop are taken and tested for agglutination with 1 in 50, 1 in 500, and 1 in 1,000, dilutions of anti-typhoid serum of a known strength added to equal portions of the suspected drop. Should a positive result be obtained a sample of the original emulsion is planted out on an ordinary agar slope, and the resulting growth, after further incubation, tested still further with the various other media used for the differentiation between *B. coli* and *B. typhosus*, of which the following are among the more important: Gelatine plates, stab and slope cultures, Witte's peptone and salt solution, milk, litmus whey, neutral red glucose agar, glucose gelatine and lactose gelatine shake cultures, and glucose agar, gelatine 25 per cent. incubated at 37° C., potato, Proskauer and Capaldi's Nos. 1 and 2 media, neutral broth. As no bacillus isolated from urine by the glucose-litmus-agar method or any other method can be bacteriologically stated to be the *B. typhosus* until it has passed through the final tests enumerated, some estimate can be formed of the enormous task that would be involved in carrying out a series of investigations daily throughout 100 cases of enteric fever.

(6) **Experiments Undertaken to Test the Bactericidal Power of Urotropine When Used as a Mechanical Mixture Outside the Body with Normal Urine, to Which Action Typhoid Bacilli Had Been Added.**

Before investigating the effects of urotropine on the urinary system of enteric patients, I thought it advisable to try its action on normal urine, and made the following series of experiments. To ensure sterility and to be the better able to check my results, I used
my own urine as a “control” to correct the results of each and every experiment. A series of sealed tubes of urine were taken from the patient under the precautions laid down in (3). Each of these tubes contained a known quantity. Half of them were put into an autoclave and still further sterilised. To each tube was added a known quantity of urotropine and also a known quantity of an active culture of typhoid bacilli of twenty-four hours’ growth in bouillon. After inoculation, these tubes were put into an incubator together with control tubes and examined every twenty-four hours in order to ascertain the “killing-off” power of urotropine when mixed with urine outside the body. In order to prove that the bacilli were able to grow in similar urine to which no urotropine had been added, such a tube was also inoculated and put into the incubator; this tube on examination twenty-four hours afterwards showed a dense turbid growth of active typhoid bacilli; the other tubes showed a growth in the inverse ratio to the amount of urotropine added. The bactericidal power of the drug under these conditions can be seen from the following table:

<table>
<thead>
<tr>
<th>Number of hours incubated before examination</th>
<th>2.5 % solution of urotropine in normal urine</th>
<th>5 % solution of urotropine in normal urine</th>
<th>7.5 % solution of urotropine in normal urine</th>
<th>10 % solution of urotropine in normal urine</th>
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<tr>
<td>24</td>
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<td>48</td>
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<td>72</td>
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<td>96</td>
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<td>120</td>
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(7) Experiments Undertaken to Test the Bactericidal Power of Urotropine after Excretion in the Urine of a Normal Subject of an Active Culture of Bacillus Typhosus.

In order to ascertain whether urotropine retained its bactericidal power after passing through the organism when brought into contact with active typhoid bacilli, I made the following series of experiments, and again to be the better able to check the results on a normal subject, I underwent a course of the drug myself, taking 10-grain doses thrice daily and following the precautions laid down in (3) to ensure sterility. The stage of autoclaving was omitted, as I found that owing to the volatilising nature of the drug it lost its properties on being heated to a high temperature. The
same methods of examination as laid down in the preceding paragraph were followed, and the results obtained were noted as follows:—

**Table II.**—Showing the Bactericidal Power of Urotropine when Taken Internally by a Normal Subject, and Excreted in the Urine, This Urine then Being Inoculated with Bacillus typhosus.

<table>
<thead>
<tr>
<th>Number of hours incubated before examination</th>
<th>3 c.c. urine, 7 c.c. sterile water</th>
<th>5 c.c. urine, 7 c.c. sterile water</th>
<th>5 c.c. urine, 3 c.c. sterile water</th>
<th>10 c.c. urine</th>
<th>10 c.c. of urine sterilised in autoclave</th>
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<td>48</td>
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<td>72</td>
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<td>96</td>
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(8) On the Administration of Urotropine and Its Effects.

Urotropine is a white crystalline powder readily soluble in water and aerated water; in alcohol it dissolves with greater difficulty and for this reason its administration ought to be some hours after stimulants are prescribed. It must be given well diluted or else a burning sensation is experienced in the pharynx; the manufacturers recommend its administration in doses from 3 to 7½ grains thrice daily, well diluted in water—preferably aerated water—and they state that up to 60 grains can be given daily.

After some weeks' trial, I found that the best results were obtained by the administration of 10 grains thrice daily in a tumblerful (half pint) of milk and soda-water, it being thus tasteless and causing no discomfort to patients, while its administration with milk avoided the ingestion of extra fluid to the necessary milk diet of enteric patients. During convalescence I gave it in combination with lemonade made from fresh lemons, a prophylactic treatment I have adopted with considerable success against the occurrence of thrombosis as a post-typhoid complication, and of which I hope to report later. Daily doses of urotropine of 30 grains, in doses of 10 grains thrice daily, were administered as routine treatment on the appearance of turbid urine, and in no case did I find any ill-effects from the drug, or discomfort to the patient. Suppan states urotropine improves the appetite, but such a condition is hard to estimate in enteric fever. In the majority of cases the bacilluria passed off and the urine became clear within a few days after administration of the drug. In a few of the more tenacious cases the drug was pushed in larger doses up to 20 grains thrice daily, and in some of these cases the patients complained of a slight
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baking sensation in the bladder, with pain referred to the glans penis on micturition, but in these cases the symptoms disappeared on the discontinuation of the drug for a few days. In no case has either haematuria, urticaria, or tinnitus resulted from extreme doses of the drug.

(9) Results Obtained in Isolating Micro-organisms from the Urine of Enteric Fever Patients and the Effects of Urotropine on the Same.

Owing to the enormous difficulties to be encountered and the prolonged time required under the more recent confirmatory tests before definitely settling that a bacillus was really the B. typhosus, I am unable to furnish a report of the exact percentage of its occurrence in my cases. In five cases, however, I worked the bacilli out to the bitter end and diagnosed their presence, and in many of the other cases of bacilluria I passed the bacilli causing it through some of the confirmatory tests. From a long series of daily examinations of the urines of my 100 cases I find that the bacilluric urines were always more or less turbid, and that this turbidity was always associated with the presence of the B. typhosus, the B. coli, or staphylococci. Sometimes all three organisms were present, sometimes either the B. coli or staphylococci preponderated; in no case have I found the B. typhosus alone, i.e., in pure culture, as some observers have stated, unassociated with the B. coli. Such a condition of affairs made the subject of the effects of urotropine upon bacilluria an extremely difficult one to report on, had I not found that not only had this drug bactericidal effects on the typhoid bacilli in urine, but also on the B. coli and its sub-families. On turbid urine containing cocci the drug had but little effect, and many of the tenacious cases which resisted the drug were entirely due to these micro-organisms. In no case have I been able to find B. typhosus in clear urine, in which, as a rule, no pathogenic organisms were ever found; in a few cases, however, bacilli of the coli group were isolated, but all of these passed the simpler coli differentiation tests. True bacilluria, due either to B. coli or B. typhosus, was found to be checked, either partially or totally, on the administration of urotropine; in no case were typhoid bacilli found after it had been in use for a week, and in the majority of cases the B. coli had also disappeared from the urine by this time. On cocci the drug had no effect. It was noted, however, in several of the more severe
cases of bacilluria that had been controlled by urotropine, that discontinuation of the drug for periods varying from a week to fourteen days caused a return of the bacilli to the urine. Urotropine cannot, for this reason, be said to destroy the bacilli in the system; the most that it can apparently do is to kill off by its presence any bacilli excreted by the kidneys and to render the urine by some means a medium unfavourable for their growth. This action in itself is a most important one, for otherwise when the drug is not used the excretion of even a single bacillus from the kidney means its immediate multiplication to millions in the vesical urine, which is under ordinary conditions a most suitable medium.

(10) SUGGESTIONS AS TO PROPHYLAXIS AGAINST THE SPREAD OF ENTERIC FEVER BY MEANS OF THE URINE AND OTHER PATHS.

As there can be no doubt whatever that a certain proportion of cases of enteric fever patients at some time during the fever, or during convalescence, are subject to bacilluria, and that this bacilluria is in some way associated with the presence of the B. typhosus in the bladder, where the urine offers a medium in which it can readily multiply, a condition of affairs is presented whereby a convalescent enteric patient can become a danger to the community by micturating in places other than the recognised urinals, not only while in hospital but also after his discharge from hospital, when he reaches his home. When we come to consider the means at our disposal for the disinfection of such urine, it will be seen that any system of extravesical antiseptics will become next to useless, not from reason of their actual efficiency when brought into contact with the bacilli, but from their very means of application. No man can either be induced to use the recognised urinals where such disinfectants are used, or use disinfectants himself, and the only means at our disposal to prevent infection by pollution of water supplies and camps by urine is to put each and every case of enteric fever, in which the urine is noted to be turbid, through a course of urotropine, 10-grain doses three times daily until the urine clears and keeps clear; this can be estimated by any medical man. All enteric fever cases in a campaign ought to be systematically treated with urotropine during convalescence, as under the conditions of war we have neither time nor material for examinations of urine, and the surrounding conditions are such that the infection power of the urine of one enteric fever case may be such as to contaminate
The Spread of Enteric Fever by Urine

the water supplies of a whole brigade or more. In the case of convalescent enterics returning to their homes, a course of urotropine, under supervision, if possible, of a medical man, should be given, but this is not absolutely necessary, as the drug is harmless and might be issued in tabloid form (pinked). Attention should be paid to the urine of convalescents before rejoining their units. All men who state, or whose medical history sheets show, that they have suffered during the year previous from typhoid should be made pass water for naked-eye examination, and this, if turbid, should be referred for bacteriological examination. Without this precaution no enteric fever patient, even when well to all appearances, ought to be returned to active service within two years of the attack. Richardson1 records a case seen at the John Hopkins' Hospital in which, five years after typhoid fever, the urine showed evidence of marked cystitis and typhoid bacilli in pure culture.

We keep small-pox patients, scarlet-fever patients, and diphtheria patients in strict isolation while under treatment and until their systems are believed to be free from infection. We know the clothes, bedding, and surroundings are infected, and we take steps to overcome the spread of the disease; we know that the disease will be liable to spread if we do not take these steps. Why is it that enteric fever is not considered worthy of similar attention? We know that it does not and cannot arise de novo, but that it arises from infection derived from some other typhoid-fever case. Bearing this in mind, is it not better to stamp out the infection at its origin than let it spread, and then only wake up when we are perhaps in the midst of an epidemic. What is the use of shutting the stable door when the horse is out, and what is the use of urging men to boil water, when they will not, unless we make them do it unconsciously by giving them an extra ration of tea on service? If we are to reduce enteric fever we must attack it frontally; we must destroy what starts the infection; each case as it arises must be taken in detail; the bacilli must be annihilated. We must change our whole present régime and treatment, and abolish half-hearted prophylactic measures if we are to succeed. First and foremost, enteric fever must never be treated in the general wards; a typhoid patient should be as rigorously isolated as a small-pox one, for he is even more infectious. One may say, if this be so, why then do we not have more of the disease? This is readily answered. The

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human organism when in health can resist some diseases more than others: thanks to the Divine providence, we can resist the germs of typhoid more than we can resist some of the other diseases, or we would at times be saturated with them. As long as the individual keeps in good health, a normal gastric juice and the strong bactericidal properties of the blood afford him a fairly unassailable position against any moderate dose. But, on the other hand, let our vitality be low, be it from long marches, improper food, or empty bellies, as was often the case in the late Boer war—take, for example, Paardeberg, when the troops had also their digestive organs in a state of almost chronic catarrh from muddy water, a condition most suitable for infection; or take the case of a dyspeptic gourmand at some aldermanic feast; what better medium can be found for an enteric-infected oyster than the mucous membrane of a catarrhal stomach? What is the use of attacking water, sewerage, oysters, and the like, if we neglect the source from which all infection comes? The enteric patient is the fountain head; every excretion and secretion from his body is infective at some time or another during the disease: it is the very fact of their being infective only sometimes that makes us lax. If they were infective always and at all times during a case of fever, I have not the least hesitation in stating we would have much less enteric, for we would then of necessity have to take very urgent and very strict prophylactic measures, and give this subject the attention that is its due. Everything an enteric fever patient touches, or is brought into contact with, must be regarded as infective, every utensil he uses, from the tumbler he drinks out of to the bed pan he has recourse to, the very clothing he wears, sheets, blankets, bedstead, floor and surrounding walls, are all swarming with bacilli, the air, dust, and flies in the room. Disinfection in such a case at first sight may seem colossal, but it is not. Burn, boil, or bury deep everything connected with an enteric patient save himself and his attendants and the room or tent he is treated in, and disinfect these thoroughly. What you cannot kill by fire kill by boiling, and what you cannot kill by either, disinfect by some other means. Major Cummins¹ R.A.M.C., recommends boiling excreta with a small quantity of crude carbolic acid added; this is an excellent method of disposal, it takes less fuel and is cheaper and less offensive than burning. Boil or sterilise by heat all feeding utensils and remains of food used by patients; for we know the danger attendants and other patients run. Steep

in disinfectants or sterilise by heat all clothes, bed-clothes, blankets, handkerchiefs, swabs, and every form of fabric used by enteric patients. Disinfect their cots and surrounding walls in barracks, obtain and disinfect all clothing and bed clothing used before admission to hospital, and use common sense in detecting and overcoming any other means of infection. See that attendants on enterics know the responsibility of their duties and keep up their health with good food, short spells of duty, and lots of out-door exercise.

[I think the reputation of urotropine has stood the test of exhibition in practice pretty well. In my own hands I have found it not altogether infallible, but where it has failed to sterilise, it has always effected a material reduction in the degree of bacilluria; but I am not in a position to speak of its effect on B. typhosus apart from B. coli. I have only once known it set up actual strangury or hematuria, but I have never given it in larger doses than 10 grains three times a day. I believe I am right in believing that it is excreted in a form chemically different from urotropine, but this would not affect Captain Blake Knox's practical deduction as to its disinfectant action, as he found the urine to be an efficient steriliser when undiluted, according to his second table. I think the only practical objection to its wholesale administration is the expense of urotropine.—Dr. F. F. Caiger.]