DESCRIPTION OF A SIMPLE AND READILY PORTABLE FORM OF EXCRETA AND SULLAGE WATER STERILISER, ADAPTED FOR USE IN MILITARY HOSPITALS, CAMPS, OR ON FIELD SERVICE.

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My arrival at Ambala, towards the latter end of October, 1904, coincided with an outbreak of enteric fever in two British Infantry Battalions (no connection, however, between the two events, will I trust, be inferred) which resulted in the admission of forty men to hospital before the end of the year. Early in November I was appointed to the charge of the District Laboratory located at this station, and was also detailed to perform the duties of Special Sanitary Officer for the garrison. These somewhat uninteresting personal details are mentioned, as it was owing to them that I came to design (or adapt) the apparatus described in this article.

The question as to the best method of dealing with the infectious excreta of the daily increasing admissions had soon to be considered. The practice hitherto had been to separate the solid from the liquid sewage, boil the latter, and incinerate the former, after admixture with sawdust. While nothing more efficient in the way of sterilisation could be desired, this method was found to be inconvenient and expensive when the excreta of a large number of cases had to be dealt with. The Officer Commanding the Station Hospital desired me, consequently, to turn my attention to the subject, and suggest some more convenient and less expensive plan, which at the same time would effectually prevent the spread of contagion.

On going into the question I found that, thanks to the excellent sanitary organisation devised by the Officer Commanding, no such danger need be apprehended, so far as the inmates of the hospital were concerned. In connection with this organisation he had constructed what he termed his "sanitary enclosure," where all contagion-bearing stools and urine were at once taken (each disease having its own allotted place within the enclosure) to undergo sterilisation or incineration. I first suggested erecting here the excellent excreta steriliser designed by Major Cummins, C.M.G., R.A.M.C., having become familiar with it when at the Royal Herbert Hospital, Woolwich. When, however, the designs for the
apparatus (taken from Major Cummins' own article in the *Journal of the Royal Army Medical Corps*) were laid before the best local workmen available, they declared it to be too complicated and beyond their powers, and declined to undertake its construction. I was therefore reluctantly obliged to abandon this idea, and tax my own inventive faculties for a solution of the problem.
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It was clear that, if any form of steriliser by means of heat were adopted (which was the kind I favoured myself), it would have to be simple in construction, fairly economical as regards fuel, capable of dealing with both liquid and solid excremental matter in considerable quantities, easy to work, and not liable to get out of order. In addition, of course, the "sterilising process" would have to be effectual and not give rise to any nuisance. Lastly, it was desirable, under local conditions, that the apparatus should be easily portable. This somewhat formidable list of requirements has, I trust, been satisfactorily met by the pattern of steriliser I am about to describe.

Description of the Steriliser.—By the time this problem was given to me for solution, I had already made the acquaintance of a particular kind of water heater, very generally used for warming bath water in this part of India. It struck me that I might construct an "excreta steriliser" on the principle of this same water heater, called locally, I believe, a "Peepah" (I spell the word phonetically), by introducing certain necessary alterations in its structure. I prepared designs for such an apparatus, and submitted them, together with a written description and instructions as to method of working, to the Officer Commanding Station Hospital. This officer was good enough to accept my suggestion, and gave orders for a steriliser to be constructed in accordance with my designs. No difficulty was encountered in getting it made locally, the general idea of the structure being so familiar. The total cost amounted to Rs. 16, or about £1 1s. On completion it was placed within the "sanitary enclosure" for practical trial.

Structural Details.—The diagram on page 607 (scale, one inch to one foot) shows a vertical section of one of these sterilisers. The method of construction and the principle underlying its working will be clear on reference to these drawings, so no lengthy description is required; indeed, any officer who has served in the Punjab will not fail to at once recognise an old friend, slightly disguised, and adapted to perform different and more responsible duties.

The steriliser represented in figs. 1 and 2 of the diagram depicts the latest one made for me, not that first tried; the differences between them, however, relate only to minor details, since introduced. This apparatus measures two and a half feet by one and a half feet, and its capacity equals 23 gallons. I have adopted this as the "standard size," as being sufficiently large for practical purposes, yet, at the same time, light and compact enough to be easily carried by one man.
The material used is galvanised iron; the shape can be rectangular or circular as preferred. I chose the former shape, in the first instance, as it was slightly the cheaper. Having found it satisfactory, I have seen no reason to make a change. For active service, however, I should recommend the circular shape, as being more resistant on the whole to very rough usage. The flue has a diameter of six inches, but instead of continuing throughout in the usual way (i.e., the Peepah) of the same diameter, it is expanded for its lower two-fifths (inside the receptacle) to one foot in diameter, so as to increase the fuel space and obtain a greater heating surface.

The small communicating flues are to allow any offensive gases given off to escape with the products of combustion, and are curved upwards to guard against passage of the heated sewage through them. The “high sewage mark” must, of course, be kept below their openings, as shown by dotted lines. The chimney is made just double the height of the receptacle, i.e., five feet, and it is removable to allow the fuel to be put into the heater, and to facilitate transport. Wood-covered handles are affixed, as it naturally gets unpleasantly warm to the touch. One half only of the cover of the steriliser is made to lift up, to allow of slop water or sewage being poured in. An opening, two inches in diameter, fitted with a leather-bound wooden plug, having a light chain attached to it, is cut in the bottom of the apparatus; the position of this opening ensures complete discharge of the contents on dislodging the plug, which is effected by a jerk of the chain, when the sterilising process is over. Two small tubes with tightly-fitting thick indiarubber stoppers are let in, one being inserted through the side about a quarter of the way up, and the other through the cover; the stoppers are perforated to allow of a chemical thermometer, graded to 100° C., being passed through. Small wooden plugs to replace the thermometers when not in use should be provided. A separate iron support to raise the steriliser off the ground is also necessary. Lastly, the exterior is covered with thick felt, so as to diminish loss of heat by radiation. The relations these dimensions bear to each other are of importance and should be strictly adhered to in constructing a steriliser of this pattern and of standard size.

Result of the Practical Trial held at the Station Hospital, Ambala, during the Epidemic of Enteric Fever.—The apparatus on completion having been placed within the “sanitary enclosure” already referred to, the excreta of all the enteric cases in hospital,
numbering at that time over thirty, were sterilised in it daily. The test was thus a fairly severe one. As I propose later on to give a summary of the results arrived at by means of these and subsequent trials, it will be sufficient to say that, so far as I could judge, the protection against the spread of contagion was perfect (provided, of course, the instructions I had drawn up for working the steriliser were followed), as in no instance was the B. typhosus (or any of its cousins of the coli group) found to survive the process in the test cultures on agar, which were made from time to time. The saving in fuel was at the same time very great, the daily consumption amounting only to 60 lbs. instead of 160 lbs. of wood, while the work was done sufficiently rapidly for practical purposes. As regards the last point it will be seen later that the question of time comes to be really a question of the kind and quality of the fuel available. The only fuel issue allowed us at Ambala is wood, generally consisting of roughly trimmed boughs and roots of trees, in fact, much the same kind of fuel as would probably be issued on active service, so that in this particular the steriliser may be said to have been working under active service conditions. Lastly, no unpleasant odour was emitted.

**Principle and Method of Working the Steriliser.**—The large fuel consumption, which was one of the drawbacks of the old method, appeared to be due to two factors: (1) That the work was done piecemeal, instead of in bulk; (2) that the liquid, that is to say, the far larger portion of the sewage, was raised to boiling temperature. Both of these factors were got rid of, and a great saving effected: (a) By having the apparatus of sufficient size to be capable of dealing with many gallons of sewage at a time; (b) by abandoning the boiling method and effecting “practical sterilisation” by raising the temperature to 60° C., and maintaining the temperature at this height for thirty minutes. The results of actual trials have proved this change of system to be both economical and efficient. As regards the method of using this apparatus nothing further need be said here, as all necessary information on the point is given in the instructions I drew up for working the steriliser, a copy of which is given at the end of this paper.

**Range of Utility.**—Although only introduced in the first instance to meet a temporary emergency, the success which attended its use during the enteric fever outbreak at this station suggested to me that a simple, economically workable apparatus of this kind might be used with advantage under all kinds of military conditions as a substitute for the present dry-earth system, with its attendant...
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drawbacks and dangers, and that by submitting all excreta to a simple but efficient process of sterilisation, prior to removal to the trenches, a great and most desirable reform would be effected in our conservancy system, and one which could not fail to prove an immense safeguard to the health of the British troops serving in India, especially against enteric fever. As this apparatus also possesses features which specially adapt it for use under active service conditions it might, I am convinced, become a most useful agent in the protection of a fighting force in its three worst foes, viz., enteric fever, cholera and dysentery. The special advantages which I claim that this particular form of excreta and sullage water steriliser possesses, rendering it capable of becoming a sanitary weapon of such far-reaching practical utility, are as follows:—

(1) Inexpensive to make, and simple as regards construction, so that any "tin-wallah" can make it.

(2) Easy to use and incapable of getting out of order.

(3) Durable. If necessary, it can easily be strengthened by the addition of a few iron bands, so that nothing short of artillery or rifle fire would be likely to materially injure it.

(4) Dealing with both liquid and solid excreta, thus obviating any necessity for separation.

(5) Readily portable, yet capacious; lightness, compactness and portability are qualities of the greatest value in military life, whether it be a magazine rifle or a weapon of sanitary warfare that is in question.

A steriliser of this pattern can, of course, be constructed of any dimensions considered desirable, but even if no larger than the easily transportable standard size, it will be found capable of dealing with a large quantity of sewage. At each process of sterilisation (lasting sixty to one hundred and five minutes, according to the kind of fuel available, as will presently be shown) 23 gallons of mixed sewage can be dealt with; so that under the least favourable (fuel) conditions, it could sterilise the excreta of 225 men (taking Munson’s figures regarding the average output) in a working day of eight hours.

(6) Economical as regards fuel. A great feature in the construction of this apparatus is the way in which the fuel space is arranged, so that full advantage is taken of all heat evolved by the combustion of the fuel, and there is practically no waste, such as is generally the case when heat is employed as the sterilising agent. The comparative inexpensiveness of the process and the small initial outlay necessary, are points of great importance in view of
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the fact that I am venturing to suggest this particular type of apparatus as suitable for general adoption in place of the now generally condemned dry-earth system. No form of steriliser, however good it might be in itself, could hope for general acceptance without possessing these two advantages.

(7) Free from nuisance. If the instructions are attended to, the same apparatus can be used daily for months without causing any nuisance in its vicinity. Should any smell be perceptible from the interior of the container when empty, it is a sign that the attendant has neglected the tarring or has omitted to wash out the interior between each process of sterilisation.

(8) Efficient. Though placed last here, that was, of course, the first point concerning which I had to satisfy myself. The reality of the protection afforded against the spread of excreta-borne disease has been tested repeatedly in the following way: (i) Two sterile agar sloped tubes—(a) and (b)—have been taken and cultures made. (a) With one or two loopfuls of the sewage prior to sterilisation. (b) With a similar quantity of the same taken direct from the chamber at the end of the sterilising process. These tubes have been placed in the incubator, the temperature of which has been kept between 32° and 37° C. At the end of twenty-four hours the uniform result has been, in the case of tube (a): the whole surface of the culture media has been found covered with colonies due to bacterial growth of all kinds. In the case of tube (b): the media has remained quite sterile, or, exceptionally, there has been a uniform growth on the surface of the agar, due entirely to accidental contamination of the Hay bacillus, but no other bacterial life of any kind. Occasionally, the incubation has had to be carried on for thirty-six hours before the colonies of the Hay bacillus have appeared.

Details concerning Time required to raise Contents to sterilising Temperature, amount and cost of Fuel consumed, &c.—With a view of obtaining permission to try my method in one of the smaller military units (a battery, R.H.A.) stationed here, in place of the existing system, I made a large number of observations in connection with the above details, which I shall now briefly summarise. The tests were made under two different conditions. (A) When wood only was used as fuel. (B) When charcoal also was employed.

In case (A) it was found that when working at full capacity it took from sixty to seventy-five minutes to reach the required temperature—60° C. As a general rule the shorter time sufficed, but
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occasionally the hour was exceeded; probably the condition of the wood as regards dampness caused the difference. At the end of the thirty minutes' sterilisation the temperature generally stood at 70° C. The whole time required thus amounted to one and three-quarter hours at the outside. When only a native sweeper is in charge I order the fire to be kept up for two hours as an extra precaution. The amount of wood used during the two hours was found to average 30 lbs., or about 1.3 lbs. of wood per gallon of sewage sterilised, representing a monetary outlay of about two annas for the twenty-three gallons. In case (B) the time required to reach 60° C. was found to be thirty minutes, consequently the whole process could be finished in one hour. To do this 15 lbs. of charcoal were used, or 0.7 lb. of charcoal per gallon. The cost of charcoal is, however, more than twice that of wood here, so the expense is a little more, probably three annas.

Conclusion.—Having described, to the best of my ability, the construction, mode of using, advantages, &c., of the apparatus which forms the subject of this paper, I will conclude by referring briefly, per contra, to one or two objections that have been raised to it.

(1) Sterilisation.—The use of this word is objected to on the ground that it is not "sterilisation" to raise the temperature of any fluid or mixture of solids and fluids to 60° C. This, of course, is quite true. Nor for the matter of that would it be "sterilisation" if the temperature were raised to boiling point. The point is, that the temperature is not merely raised, but is maintained at this height for a definite length of time. The sense in which the term "sterilisation" is employed in this article must, moreover, be quite clear from what has already been said.

(2) "Boiling," it is claimed, "is much safer." But in what way is it safer? Having killed our enemy by exposure to a lower temperature, why waste time and money in "boiling" him as well?

(3) The length of time required to reach sterilisation is cited as an objection.—Great rapidity has not been one of the objects aimed at; nevertheless, it can, I think, be fairly claimed that, even with wood, the work is done rapidly enough for practical purposes. Moreover, the time can be reduced by one half by burning a better quality of fuel (such as charcoal) in the heater.

Lastly, I hope it will be understood (indeed, that it is hardly necessary for me to say so), that I have no personal interest to serve in bringing this apparatus to the notice of the readers of our Journal. Any interest I have in the matter being only that
common to us all, namely, to do what in us lies, to afford better protection against disease, to those for whose health and lives we are directly responsible, especially with respect to that bugbear of the Sanitary Officer in India—enteric fever.

In a paper on the autumnal outbreak of this disease, which I had the honour of reading before the Sirhind District Medical Society last February, I ventured to submit that no great success could be hoped for in our campaign against enteric fever in India until the necessity for the adoption of far more radical and drastic sanitary measures was recognised than had been the case up to now. Among such measures the three following were specially emphasised as being of the greatest importance:

1. A rational system of quarantine, to protect a station against the frequent importation of fresh infection, as occurs at present.

2. Adoption of the cholera regulations, as regards prompt evacuation of any camp or barracks infected.

3. Abolition of the dry earth conservancy system, with the dreadful, impossible to be cleaned, excreta receptacles, and other attendant evils, and the introduction of a reformed system of conservancy, in which all excreta would be promptly "sterilised" on the spot before removal to the trenches for final disposal. As a means of effecting this I suggest that the portable excreta steriliser I have described is worth a trial.

INSTRUCTIONS REGARDING METHOD OF USING THE PORTABLE EXCRETA STERILISER.

The sterilising chamber must be well tarred inside, and no use made of the apparatus until this is quite dry. The tarring should be renewed about once a week.

When about to be used the steriliser is placed on the iron support, the attendant in charge then lays the fuel (the chimney is made to lift off to enable this to be done). He then pours in half a gallon of hot water, in which half an ounce of crude carbolic acid has been dissolved. Whenever a "gumlah" bedpan or night stool, &c., as the case may be, has been used, the contents are emptied directly into the sterilising chamber; this is continued until the working capacity of the steriliser has been reached (i.e., 23 gallons in one of the standard dimensions). The cover should be kept tightly closed, padlocked if possible. The fire is now lighted and kept burning brightly for a length of time, depending on the nature of the fuel, viz., (1) for two hours when wood alone
is being used; (2) for only half that time if charcoal is supplied.
One of the receptacles for sewage is now placed beneath, and by
a sharp jerk of the chain the plug is dislodged and the contents
allowed to escape. If preferred, the steriliser can be lifted on
to the Crowley tank, and the sewage allowed to run into the tank
direct. It is then ready for conveyance to the trenches at any time.

The sterilising chamber should now be washed out with some
strong carbolic solution, which also should be allowed to escape
into the tank, and preparations made as above for sterilising a fresh
quantity of sewage.

If the apparatus is being worked under European supervision,
or in a military hospital, a chemical thermometer should be inserted
(before anything is poured in), through the laterally placed inlet
tube by preference, and the process stopped as soon as the tempera­
ture has stood at 60° C. or more for thirty minutes.