THE WORKING EFFICIENCY OF SOME DISINFECTANTS.

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I have lately been carrying out some work on the possibility of forming a reliable system for the standardisation of disinfectants. Thinking that my findings of the values of some of the various disinfectants might be of interest to readers of the Journal, I therefore give a short résumé of the results. The methods employed have been those known as the "Garnet," the "Thread," and the "Drop."

I will give the results of experiments carried out by the "Drop" method only. It is necessary in the first place to draw a distinction between the classes of organisms made use of, viz., the so-called "naked" bacteria and "natural" bacteria. By "naked" is meant, bacteria in pure culture grown artificially, as all laboratory cultures are carried on. By "natural" is meant, bacteria as they occur in nature, for instance, the bacterial contents of faeces.

A disinfectant may have a very different action when tested against the "naked" to that which it has against the "natural" bacteria, no doubt due almost entirely to the necessary presence of organic matter with the latter. It is obvious that the practical value of experiments made with disinfectants against "naked" bacteria will be less than those made against the micro-organisms existing in a "natural" medium.

The first table shows the "phenol co-efficients" of some of the more common disinfectants when tested against "naked" bacteria. By "phenol co-efficients" is meant the bactericidal power of a disinfectant in comparison with that of phenol, which experience shows is best adapted for the unit of comparison. In these experiments the test culture has consisted of a twenty-four hours' growth of either Bacillus typhosus or Bacillus prodigiosus. Both these organisms appear to re-act to disinfectants in nearly the same ratio. Either a broth culture or a filtered emulsion of an agar slope was employed, it being a matter of indifference whether one or the other was used.

The second table shows the values of these same disinfectants when tested against "natural" bacteria. The method was carried out in the following manner:—

One gramme of solid normal fresh human faeces was emulsified
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in a mortar with 100 cubic centimetres of fresh human urine, and filtered through a filter paper, in order to get rid of the very coarse matters, yet allowing bacteria to pass easily. Equal parts of this emulsion was then added to equal parts of disinfectant, thus making the required dilution; for instance, supposing phenol 1 in 90 was to be experimented with, the solution of phenol would be made up 1 in 45, and when a given volume was diluted with an equal volume of urine and faeces, the final dilution would be 1 in 90. Loopfuls were taken out after certain periods of contact and transferred to broth, in accordance with the procedure of the "Drop" method as originally explained by Rideal and Walker.

It will be noticed that the disinfectants of the tar derivative series act in practically the same manner against both "naked" and "natural" bacteria, but a very marked difference in the "phenol co-efficient" figure will be observed in the case of mercuric chloride, permanganate of potash, iodine and all the halogens.

It is astonishing how very greatly mercuric chloride efficiency is lowered, even when an acid is used in conjunction, to obviate the precipitation of the albuminate of mercury. Permanganate of potash comes out of the test with much greater power than many would give it credit for. Iodine is seen to lose its disinfectant properties almost completely in presence of organic matter. These experiments clearly point out that it is necessary, not only to test a disinfectant against "naked" bacteria, as is usually done, but also against "natural" bacteria, using an emulsion of faeces and urine, or some other similar mixture of organic matter.

**Phenol Co-efficient.**

<table>
<thead>
<tr>
<th>TABLE I. Against &quot;naked&quot; bacteria</th>
<th>TABLE II. Against &quot;natural&quot; bacteria</th>
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</thead>
<tbody>
<tr>
<td>Phenol</td>
<td>Phenol</td>
</tr>
<tr>
<td>Mercuric chloride</td>
<td>Mercuric chloride</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>3,000</td>
<td>2:5</td>
</tr>
<tr>
<td>Permanganate of potash</td>
<td>Permanganate of potash</td>
</tr>
<tr>
<td>40</td>
<td>7</td>
</tr>
<tr>
<td>Tincture of iodine</td>
<td>Tincture of iodine</td>
</tr>
<tr>
<td>18</td>
<td>0:5</td>
</tr>
<tr>
<td>Formalin</td>
<td>Formalin</td>
</tr>
<tr>
<td>0:7</td>
<td>0:7</td>
</tr>
<tr>
<td>Cyllin</td>
<td>Cyllin</td>
</tr>
<tr>
<td>8:5</td>
<td>8</td>
</tr>
<tr>
<td>Kerol</td>
<td>Kerol</td>
</tr>
<tr>
<td>7:5</td>
<td>7</td>
</tr>
<tr>
<td>Isal</td>
<td>Isal</td>
</tr>
<tr>
<td>5:5</td>
<td>5</td>
</tr>
<tr>
<td>Lysol</td>
<td>Lysol</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Liquor cressyl saponatus</td>
<td>Liquor cressyl saponatus</td>
</tr>
<tr>
<td>2:7</td>
<td>2:5</td>
</tr>
<tr>
<td>Lysoform</td>
<td>Lysoform</td>
</tr>
<tr>
<td>0:5</td>
<td>0:5</td>
</tr>
<tr>
<td>Oleusaban</td>
<td>Oleusaban</td>
</tr>
<tr>
<td>0:08</td>
<td>0:08</td>
</tr>
<tr>
<td>Listerine</td>
<td>Listerine</td>
</tr>
<tr>
<td>0:03</td>
<td>0:03</td>
</tr>
<tr>
<td>Fine-phenol</td>
<td>Fine-phenol</td>
</tr>
<tr>
<td>2:5</td>
<td>2:5</td>
</tr>
</tbody>
</table>

I made use of a mixture of faces and urine, since it is the chief material which we are called upon to disinfect when treating cases of infectious disease.

The practical conclusions I would draw from these experiments are as follows: In order to disinfect a liquid stool, such as that from an enteric, dysentery, or cholera case, it is both desirable and necessary to use a solution of phenol of not less strength than 1 in 20, and add a quantity equal in volume to the volume of stool to be disinfected, thus bringing the final dilution to 1 in 40 of phenol, and give a five minutes' contact, after thorough mixing. The strength of any other disinfectant to be used can be worked out from its "phenol co-efficient." Say that we elect to use Izal. The co-efficient of Izal is 5. It will therefore be necessary under similar circumstances to use a dilution of Izal 1 in 100, and add an equal volume to that of the stool, the final dilution being 1 in 200. The disinfectant should be well mixed with the stool and five minutes' contact always allowed. If the practical disinfection of ordinary excreta is to be reliable and thorough, it must be clearly recognised that the mere receiving of the material into a solution or emulsion of some disinfectant, or the mere dousing or flooding of the mass with such solution or emulsion, is useless. In all cases the intimate mixture of the faecal mass with the disinfectant must be secured, and in no way can this be better done than by deliberate stirring up of the whole by means of a stout stick or wooden spoon. It may be assumed that the volume of an average stool, as passed from a patient, is not less than eight fluid ounces, or 227 cubic centimetres, and to this must be added an equal volume of the stock solution or emulsion of whatever reagent is being used, and the whole intimately mixed. The working strengths of such stock solutions must be based on results as obtained in previous laboratory experiments on the lines detailed. These suggest that the stock solutions or emulsions of certain common disinfectants may be placed at the following strengths:—

<table>
<thead>
<tr>
<th>Disinfectant</th>
<th>Strength</th>
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<tbody>
<tr>
<td>Phenol</td>
<td>1 in 20</td>
</tr>
<tr>
<td>Mercuric chloride</td>
<td>1, 50</td>
</tr>
<tr>
<td>Mercuric chloride, 1 part</td>
<td>1, 180</td>
</tr>
<tr>
<td>Hydrochloric acid, 2 parts</td>
<td>1, 14</td>
</tr>
<tr>
<td>Permanganate of potash</td>
<td>1, 140</td>
</tr>
<tr>
<td>Formalin</td>
<td>1, 160</td>
</tr>
<tr>
<td>Cyllin</td>
<td>1, 140</td>
</tr>
<tr>
<td>Kerol</td>
<td>1, 100</td>
</tr>
<tr>
<td>Izal</td>
<td>1, 40</td>
</tr>
<tr>
<td>Lysol</td>
<td>1, 50</td>
</tr>
<tr>
<td>Liquor cresyl saponatus</td>
<td></td>
</tr>
</tbody>
</table>
The practical conclusion to be drawn from this statement is that we are in the habit of using, for routine disinfection, an acid solution of bichloride of mercury which is nearly five times too weak for the rapid disinfection of excreta. In other words, the official stock solution is a dilution of 1 in 960, while, if we want rapid and effective action upon faecal material it should be at no greater dilution than 1 in 180. This would be represented by 1 gramme of the bichloride, 2 cubic centimetres of strong hydrochloric acid, made up to 180 cubic centimetres with water. This, added to an equal mass volume of excreta, would mean an actual working dilution of 1 in 360.