SOME OBSERVATIONS RELATING TO THE
STERILIZATION OF SYRINGES
I. BY AUTOCLAVING

BY
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INTRODUCTION

It is generally accepted that syringes can be effectively sterilized by autoclaving, provided certain basic conditions are observed. There is, however, still some divergence of opinion on certain details connected with the procedure. Instructions on the preparation of syringes for autoclaving vary, particularly in regard to whether they can be packed assembled or not. The Medical Research Council's War Memorandum No. 15, The Sterilization, Use and Care of Syringes (1945), states that packing for autoclaving should be as for hot air sterilization, i.e. syringes should be lubricated and assembled. Alexander & Rollason (1955) found that spore-contaminated, assembled syringes, some of which were oiled, were sterilized at temperatures of 120° C. at a pressure of 20 lb. for twenty minutes [sic] except in two instances where the autoclave concerned was old. Other workers point out that as sterilization depends on penetration of steam to all parts, syringes must be taken apart before autoclaving (Lancet, 1955; Darmady & Hughes, 1955). In order to overcome this difficulty it has been recommended (War Office, 1956) that syringes should be assembled wet to promote the production of steam throughout the syringe during autoclaving.

This paper reports investigations into the problems of the preparation of syringes for sterilization and also includes a few observations on indicators of autoclave efficiency.

EQUIPMENT

Electric laboratory type autoclave. A standard vertical model with a thermostat, pressure gauge and dial thermometer was used.

Maximum thermometer. This was inserted into a test tube plugged with cotton-wool and was placed in the centre of the syringes to be sterilized.

All-glass and nylon syringes. A selection of 2, 5, and 10 ml. syringes was used.

Contaminating organism. This was an aerobic spore-bearing organism, Bacillus cereus, obtained from the National Collection of Type Cultures (N.C.T.C. 9687) in response to a request for a suitable organism. It was grown in the medium recommended by Stokes (1955) for the production of spores. The presence of numerous spores was confirmed by a stained film. The spores of B. cereus were found to be more heat resistant than the spores of Bacillus subtilis, which in our experience were relatively easily destroyed.
Some Observations Relating to the Sterilization of Syringes

METHOD

The method in each experiment was similar. Half of the syringes were lubricated with silicone M.S. 550. All syringes had a needle mounted and each was placed in a glass tube plugged with cotton-wool. The syringes were first sterilized to eliminate extraneous organisms and then contaminated.

Experiments 1 and 2. Contamination was carried out by drawing up and then ejecting the culture followed by dipping the plunger into the culture (to ensure contamination of the washer on nylon syringes). The plungers were replaced in their barrels. These syringes were regarded as “assembled wet.”

Experiments 3 and 4. The plungers were contaminated by dipping them into the culture and were then dried at 37° C. before being replaced in their barrels. These syringes were regarded as “assembled dry.”

Experiment 5. The centrifuged deposits of several cultures were pooled and freeze-dried. The plungers were ground in the freeze-dried spore mixture in a sterile petri dish and the syringes assembled.

Experiment 6. The syringes were contaminated as for experiments 3 and 4 but were not reassembled until after sterilization.

The syringes were autoclaved at a temperature as near as possible to that usually recommended, i.e. 120° C. (15 lb. pressure) for twenty minutes (Medical Research Council War Memorandum No. 15, 1945; Ministry of Health Report, 1954; War Office Memorandum, 1956). After autoclaving, the syringes were tested for sterility by drawing up broth into the syringe and returning into its original container all but a few drops. Three drops were placed on an agar plate and spread out. Finally the plunger was dipped into the broth. All cultures were incubated for forty-eight hours. Turbid cultures were plated out and in several instances the recovery of the contaminating organism was confirmed by biochemical reactions.

Control syringes, all-glass and nylon, lubricated and non-lubricated, were used in each experiment and these differed from the test syringes only in that they were not autoclaved.

RESULTS

Table 1 shows the number of syringes from which B. cereus was recovered (numerator) and the total number of syringes used (denominator). The contaminating organism was recovered from all control syringes.

Table 1. Recovery of B. cereus from Contaminated Syringes

<table>
<thead>
<tr>
<th>EXPERIMENT</th>
<th>Pressure (lb. per sq. in.)</th>
<th>Autoclave Temperature (°C)</th>
<th>Maximum Temperature (°C)</th>
<th>Thermometer Reading (°C)</th>
<th>Lubricated</th>
<th>Not lubricated</th>
<th>Lubricated</th>
<th>Not lubricated</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Assembled wet</td>
<td>16.5</td>
<td>120</td>
<td>120</td>
<td>0/6</td>
<td>0/6</td>
<td>0/6</td>
<td>0/6</td>
<td>0/6</td>
</tr>
<tr>
<td>2. Assembled wet</td>
<td>16.5</td>
<td>119</td>
<td>119</td>
<td>0/6</td>
<td>0/6</td>
<td>0/6</td>
<td>0/6</td>
<td>0/6</td>
</tr>
<tr>
<td>3. Assembled dry</td>
<td>16.5</td>
<td>120</td>
<td>119</td>
<td>4/6</td>
<td>0/6</td>
<td>0/6</td>
<td>0/6</td>
<td>0/6</td>
</tr>
<tr>
<td>4. Assembled dry</td>
<td>16.5</td>
<td>120</td>
<td>119</td>
<td>6/6</td>
<td>0/6</td>
<td>0/6</td>
<td>1/6</td>
<td>0/6</td>
</tr>
<tr>
<td>5. Assembled dry</td>
<td>16.5</td>
<td>120</td>
<td>119</td>
<td>3/6</td>
<td>0/6</td>
<td>0/6</td>
<td>0/6</td>
<td>0/6</td>
</tr>
<tr>
<td>6. Unassembled dry</td>
<td>16.5</td>
<td>120</td>
<td>119</td>
<td>0/5</td>
<td>0/5</td>
<td>0/5</td>
<td>0/5</td>
<td>0/5</td>
</tr>
</tbody>
</table>

Numerator = total number of syringes infected.
Denominator = total number of syringes tested.
INDICATORS OF AUTOCLAVE EFFICIENCY

Sterilization by steam is dependent on penetration, temperature and time, thus any really effective indicator should operate only if all three conditions are satisfactorily met.

A commercially produced (American) indicator which it was claimed changed colour by segments after varying exposures to pure steam at $250^\circ$ F. (15 lb. pressure) has been tested. When placed in the centre of a drum of dressings and autoclaved, the segments of these indicators changed colour approximately in the times claimed. Further tests, however, with the indicators in screw-capped bottles containing anhydrous copper sulphate gave results which suggested that colour changes occurred under conditions where the concentration of steam was probably relatively low. They were unaffected by dry heat as they could be left in the hot air oven at $160^\circ$ C. for several hours without any change being detected.

DISCUSSION

Sterilization of syringes by autoclaving requires the access of pure steam to all surfaces. The lubrication of dry syringes tends to result in a seal between the barrel and the plunger so that the effective penetration of steam is prevented and, as the results in Table 1 show, sterilization is not always achieved. It would appear that steam can penetrate into unlubricated syringes as these were successfully sterilized in all tests. The quality of the syringe, especially the precision with which the plungers and barrels fit, may well be a factor in determining the penetration of steam into unlubricated syringes and may account for the varying results obtained by different workers. When the syringes are assembled wet, sterilization results presumably from steam generated in the syringe.

It will be noted that in our experiments the contamination was carried out after the syringes were lubricated. The results might have been even less satisfactory if the syringes had been lubricated after contamination as the organisms would then have been even more protected from steam by the water-repellent silicone. Protection for bacteria can also be provided by dirt, coagulated protein, etc. Thus it would be wise to insist that if syringes are to be sterilized assembled in an autoclave they should be thoroughly clean, unlubricated and wet.

Bowie (1955) has recently drawn attention to the unsatisfactory design and performance of many of the autoclaves in general use. In discussing sterilizing efficiency tests he dismisses chemical devices as being unreliable. It is true that many of these give no indication of the actual presence of steam and are therefore only of use as an indication that the material in which they are packed has passed through an autoclave. The American indicator used in our experiments, while not affected by dry heat, appears to change colour with mixtures of steam and air. The method of testing employed was somewhat crude and it is suggested that further work with more exact apparatus is warranted before these indicators are rejected. At present therefore we are left with bacteriological tests although these have obvious disadvantages, e.g., delay and lack of agreement on a standard spore preparation.
CONCLUSION

Autoclaving at 15 lb. pressure for twenty minutes frequently failed to sterilize all-glass syringes lubricated and assembled dry and could not be relied upon to sterilize nylon syringes similarly prepared.

Autoclaving at 15 lb. for twenty minutes sterilized all-glass and nylon syringes assembled dry and un lubricated. This result may be due to the make of syringes used.

Autoclaving at 15 lb. for twenty minutes sterilized all-glass and nylon syringes assembled wet.

A commercially produced indicator of autoclave efficiency has been tested. Further information is required on the proportion of steam necessary to effect a colour change.

I wish to thank Brigadier G. T. L. Archer, M.R.C.P.I., Q.H.S., for suggesting this investigation, and Corporals Burt and Goodwin, R.A.M.C., for technical assistance.

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INTRALOBAR SEQUESTRATION OF THE LUNG

A REPORT OF TWO CASES

BY

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An intralobar sequestration of the lung is a defect consisting of a partial or complete developmental separation of a portion of the lobe of the lung from its continuity with the bronchial tree. It is supplied by a large thin-walled artery usually arising from the thoracic or abdominal aorta, but occasionally from smaller vessels such as the intercostal or phrenic artery.

Since Pryce Sellors & Blair (1947) described several such cases, the condition has been more often sought and more often recognized. As the diagnosis is rarely confirmed prior to thoracotomy, we believe that this developmental defect occurs
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