

TESTING A WASTE TREATMENT AUTOCLAVE AT A HOSPITAL IN TANZANIA: A TECHNICAL BRIEF

INTRODUCTION AND OBJECTIVES

The United Nations Development Programme's Global Environment Facility (GEF) project on healthcare waste and the NGO Health Care Without Harm, in collaboration with AGENDA and John Snow, Inc., are conducting a pilot project to demonstrate proper healthcare waste management and the use of an autoclave and shredder imported from India to disinfect healthcare waste in the context of sub-Saharan Africa. This technical brief summarizes the results of microbial inactivation testing of the healthcare waste treatment autoclave at the 98-bed Bagamoyo District Hospital in Tanzania.

The objectives of the testing were to determine proper operating conditions for the autoclave that correspond at least to Level III disinfection and to test the use of a shredder for sharps waste.

MATERIALS

- Obromax autoclave (Acmas): vertical cylindrical vessel with internal dimensions of 550 mm diameter and 750 mm height; working pressure set to 17 psig; a thermocouple was added at 66 cm below the top of the internal vessel to measure steam temperatures
- Removable, perforated, stainless steel container that fits inside the autoclave to serve as a basket to hold waste bags and safety boxes
- 3M Attest 1292 self-contained biological indicators for steam at 250°F/121°C corresponding to 10^5 concentration of *Geobacillus stearothermophilus* (donated to Bagamoyo District Hospital by 3M)
- Attest Auto-reader, 12-well, 3-Hour Rapid Readout Incubator (donated to Bagamoyo District Hospital by 3M)
- Autoclave Tape and SteamPlus Sterilization Integrators (SPS Medical)
- 1 ml *Geobacillus stearothermophilus* ampoules with 10^4 and 10^5 concentrations (PolySpore PS1-4-100 and PS1-5-15, Raven Labs) and a 15-well dry block 56°C incubator
- PTFE tubes for affixing the biological indicators and integrators, with wooden plugs to seal the tops of the tubes
- 20-liter infectious waste bags containing surrogate waste (crumpled newspapers) or actual hospital waste
- 5-liter safety boxes for sharps (Kojak Safety Box, Hindustan Syringes & Medical Devices) and unused 10 ml syringes (VanishPoint Syringes, Retractable Technologies, Inc.)
- Shredder (Pimco Manufacturing Corp., India) with a 3 HP motor (1420 rpm)

PROCEDURE

Fourteen experimental runs were conducted using different combinations of steam flushes, pressure pulses, and exposure times, using both surrogate and actual hospital waste. Initially, the test bags were filled with crumpled newspapers and about 150 ml of water. An Attest biological indicator and integrator were affixed to the bottom end of a PTFE tube using autoclave tape. The tube was then inserted into the middle of the test bag with the top of the tube protruding above the bag; the bag was then tied. The test bags were placed at the bottom of the autoclave basket, which was then filled to capacity with six bags of surrogate waste.

Once the biological indicators showed sterility, the test waste bag was replaced with real hospital waste. PTFE tubes with biological indicators and integrators were additionally inserted into safety boxes filled with syringes and into extra surrogate waste bags. For a few runs, 1 ml ampoules of *Geobacillus stearothermophilus* at 10^4 and 10^5 concentrations were also attached by autoclave tape to the tube. Table 1 below shows the experimental conditions for two successful runs using real hospital waste as the main test bag, one test sharps safety box, and one test surrogate waste bag. The safety boxes and surrogate waste bags were placed at different locations in the autoclave for testing. The table also shows a test run wherein 14 safety boxes (the autoclave's capacity) were treated and then shredded in a Pimco shredder.

RESULTS

The results of the autoclave tape, integrators and biological indicators are summarized in Table 1 below. Figures A, B and C are plots showing the temperature and pressure variations with time corresponding to runs A, B and C in Table 1. Figures D and E show photographs of sharps after steam treatment and then after shredding.

TABLE 1

Run	Test Waste and Location in the Autoclave Basket	Operating Parameters	Steam Tape	Integrator	Biological Indicator
A	Hospital waste bag, bottom Sharps safety box, top Surrogate waste bag, top	Four pressure pulses at 5, 4, 3 and 2 minutes respectively, plus 30-minute exposure at 124°C	Passed	All passed	Attest – all passed Ampoules – all passed (both 10 ⁴ and 10 ⁵ concentrations)
B	Hospital waste bag, bottom Sharps safety box, middle Surrogate waste bag, top	Two pressure pulses for 15 minutes each, plus 20-minute exposure at 124°C	Passed	All passed	Attest – all passed
C	14 sharps safety boxes (test safety box at the bottom)	One pressure pulse for 15 minutes, plus 20-minute exposure at 124°C	Passed	Passed	

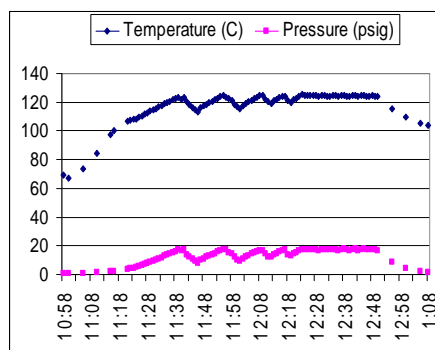


Figure A. Run A

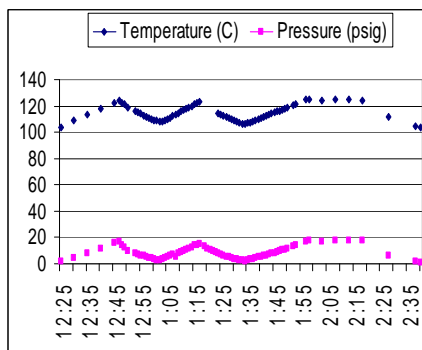


Figure B. Run B

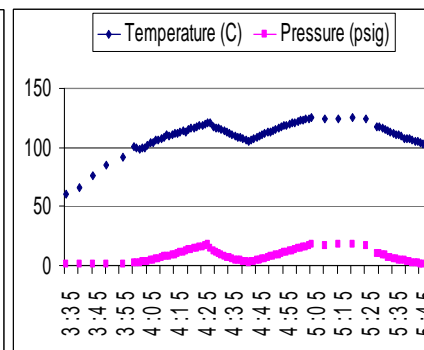


Figure C. Run C



Fig. D. Contents of a safety box after autoclaving



Fig. E. Close-up of shredded waste

DISCUSSION AND CONCLUSIONS

The tests show that at least Level III disinfection or higher can be achieved in the gravity-fed autoclave as long as at least two deep pulses are used followed by a 20-minute exposure at 124°C or four shallow pulses followed by a 30-minute exposure at 124°C. Since conditions are site specific, steam integrators and biological indicators should be used to validate disinfection levels. The autoclave tape only shows that the desired temperature was reached but provides no additional information. Integrators and biological indicators are more useful tools and were found to correlate well with each other. Residual air in the autoclave chamber and in the bags is a major factor in the failure to achieve proper disinfection. The reduction in air concentration is dependent on the ratio of absolute pressure in the chamber before evacuation divided by the absolute pressure of the chamber at the end of the evacuation. Thus, deeper pressure pulses are more effective than shallow pulses. The study shows that a relatively inexpensive gravity-fed autoclave and a shredder can be used effectively for treating healthcare waste including sharps in a small hospital in a developing country. For more information, contact kellyh@unops.org.