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Fugitive discharges from waste disposal treatments

SIR, Marshall *et al*[1] provide welcome experimental evidence to confirm the release of viable microorganisms from the water condense outlet air gap of steam-jacketed autoclaves. The possibility for generation of aerosols within the autoclave chamber is overlooked frequently but can occur during turbulent steam purge cycles in the early part of the autoclave cycle. Contamination of drain fluids then occurs as condensates form rapidly from collapsing saturated steam which cools rapidly on contact with the autoclave load and chamber walls, especially in non-jacketed autoclaves.

Furthermore, in autoclaves operating with full loads and without prior heating of the steam jacket from a previous cycle, the entire load may be liberally washed with steam condensates. These contaminated fluids run to drain, without effective sterilisation, for some time before sterilising conditions are achieved, and this is particularly common in circumstances where poor-quality wet steam is supplied for autoclave operation. The possibility for release of these fugitive emissions is inevitable, as drain fluids evacuated from the chamber (comprising wet steam and water condensates) must pass through an air gap before running to drain.

Chamber air venting provides further opportunity for escape of microorganisms. During early vacuum purge cycles, where chamber air is vented in the atmosphere through filters not designed to provide total particulate removal, further release of microorganisms from the load may occur when aerosols are generated internally during turbulent inflow of steam. The risk of such events can be minimised by careful engineering design and regular effective maintenance.

Autoclave installations, especially those used for terminal sterilisation of contaminated loads, should be carefully sited away from clinical areas and be well ventilated. Although fugitive emissions are possible, and may be quite common in some older autoclave installations, there have been no reported occurrences of adverse health effects associated with this. With care in the design, installation, operation and maintenance of autoclaves, discharges will be directed safely to foul sewer, with no demonstrable adverse environmental or infection control implications. Nonetheless, plant design must address these issues, especially when autoclaves are provided for use in proximity to clean-room operations or in critical clinical areas such as operating theatres and intensive care units. Air control and ventilation systems must include provision for containment or safe evacuation of air from autoclave plant and service areas.

Few, if any, waste disposal processes fully eliminate the potential for fugitive biohazardous emission. High-temperature incineration, now regarded as the 'gold standard' for effective waste treatment, may be associated with the release of small numbers of viable microorganisms in exhaust gases,[2–4] even under normal operating conditions. Potentially infective aerosols escape to the atmosphere during treatment of clinical wastes in hot-oil auger systems and in 2450m MHz microwave disinfector units (both operating at temperatures around 95°C), most commonly through the action of integral feedstock shredding systems. Additionally, treatment residues may contain viable microorganisms originating from the feedstock, as many of these devices are intended to reduce the bulk and bioburden of, but not sterilise, treated wastes. Landfill disposal, although largely abandoned as an option for clinical wastes disposal, is similarly liable to fugitive escape of microorganisms deposited within wastes. This occurs either through inadequate site operation and surface shedding of wastes or with leachate fluids in which human pathogenic bacteria may survive, and even proliferate, at least in the first weeks after deposit.[5]

Many current waste disposal technologies fail to achieve 100% destruction of wastes and effective sterilisation, with elimination of all possibility for fugitive releases to the environment. Inadequate process control and the possibility of process failure increase the likelihood of inappropriate release. Autoclave treatment of biohazardous and clinical wastes generally provides for safe and effective treatment but clearly has limitations through engineering and design constraints. This notwithstanding, detailed risk analysis of the common disposal options reveals no probability of significant adverse event following exposure to an infectious agent from wastes escaping the final treatment process, at least when such processes are managed to an appropriately rigorous standard. As the probability of occurrence of such an event is small, and the implications of any escape limited to the local vicinity where the numbers of individuals exposed would be small, the overall risk ranking for such events may be negligible.

However, care should be taken to ensure that individuals and the environment are not placed at risk. This necessitates care in the collection and transport of wastes, and in the design, construction and operation of treatment plants. Maintenance staff may be subject to a higher risk in the event of plant failure, which may occur before completion of the waste treatment process. Thus, when autoclave failure occurs before sterilisation of the load has been assured, maintenance staff will be exposed to inadequately treated biohazardous wastes when opening of the chamber, chamber drains or other part of the exhaust system is necessary to effect repair. Even without system failure, maintenance of chamber vacuum pumps, drains, traps and outlet air filters will entail exposure of service personnel to potentially hazardous residues.

For all waste treatment and disposal systems, including the laboratory autoclave, defined procedures must exist for the protection of engineering and maintenance personnel. Staff must be aware of potential hazards, wear suitable protective clothing and have access to hand-washing facilities on completion of work. Potentially contaminated materials, such as the accumulated liquid discharges from vacuum pumps, must be carefully disposed to sewer, and used air filters require formal sterilisation before disposal.

J. Ian Blenkharn
Department of Infectious Diseases and Microbiology
Imperial College School of Medicine
150 Du Cane Road
London W12 0NN, UK
e-mail: i.blenkharn@ic.ac.uk

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Reply

SIR, We appreciate the insight shared by Dr J. I. Blenkharn, who presents an even broader view of the potential for release of organisms from waste-disposal systems. While system design clearly does not result in complete containment or elimination, most people probably operate under this false assumption. Dr Blenkharn expands this belief into other disposal technologies. When we began investigating the likelihood of such release from autoclaves, we did not anticipate the results. We agree that whilst the risk may be small and local, it should be evaluated carefully, as in some situations it could be harmful. Our findings led us, as Dr Blenkhard points out, to be concerned about situations in which machinery is faulty or personnel are less than optimally trained.

Given our data and that of others, waste-disposal systems should be monitored to protect laboratory workers and maintenance personnel from the inadvertent release into the environment of potentially hazardous microorganisms. We hope that the advent of PCR and other new technologies will facilitate the testing and monitoring of waste-disposal equipment, and aid in the development of more highly contained systems.

In the meantime, we concur with Dr Blenkharn regarding the need to exercise due caution when operating, monitoring and repairing waste-disposal equipment.

Bonnie Marshall and Stuart B. Levy
Center for Adaptation Genetics and Drug Resistance
Department of Molecular Biology and Microbiology
Tufts University School of Medicine
136 Harrison Avenue
Boston
MA 02111, USA