Summary:

Worker risk from ultrasonicator aerosolization in medical device reprocessing: a particulate and bio-burden approach

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Background & Rationale

Reprocessing reusable medical devices - from surgical instruments to delicate endoscopic accessories - requires multiple steps: pre-cleaning, cleaning, disinfection, inspection, packaging, and sterilization. Ultrasonic cleaners are widely used during the cleaning phase; they employ cavitation to dislodge soils from complex surfaces. While patient safety literature has extensively characterized surface bioburden and device-level contamination, the occupational exposure dimension for workers in Central Sterile Supply Departments (CSSDs) is less developed.[1,2] Cavitation can aerosolize liquid from bath tanks, raising concerns that bioaerosols (microorganism-containing particles) or particle-rich mists could be released into room air during operation, potentially reaching workers' breathing zones.[3]

A key gap in the existing literature is the lack of real-world measurements of bioaerosol composition near ultrasonic baths under routine CSSD conditions. There is limited understanding of particle concentration profiles during operation compared to background levels, and the implications this has for occupational exposure. This highlights the need for practical guidance on personal protective equipment (PPE), ventilation strategies, and work practices specifically tailored to ultrasonication processes in CSSDs.

Objectives

This study set out to answer a simple but important question: Do ultrasonic baths in real-world hospital reprocessing areas actually put workers at risk of breathing in harmful microbes?

The researchers wanted to measure:

- Whether ultrasonic baths release microorganisms into the air
- Whether ultrasonic baths increase airborne particle levels
- What these findings mean for the safety of reprocessing staff

Methods

The study took place at Mount Sinai Hospital in Toronto, Canada, inside the CSSD. Researchers collected air samples during normal work conditions when ultrasonic baths were used in routine instrument cleaning. I.e., representative of real-world processes, not a lab simulation.

- **Air sampling:** Special devices collected airborne microorganisms onto culture plates, which were then grown in the lab to see which organisms were present.[4]
- **Particle measurements:** Air particle counters tracked the number of small airborne particles during ultrasonic bath use compared to background levels.
- **Ultrasonic bath procedure**: During the cavitation process, the ultrasonicator lid remained closed, and it was opened only after the cleaning program finished.

This approach provided both biological data (which microbes were present) and physical data (whether the machines increased airborne particles).

Results

- Predominant organisms found were low-risk skin microflora and water bacteria such as Micrococcus luteus and Staphylococcus species.
- Occasionally, opportunistic bacteria like Citrobacter and Acinetobacter were detected. These can cause infections in vulnerable patients but were only found at low levels.
- Fungal genera such as Aspergillus, Cladosporium, and Penicillium were also detected, which are widespread in indoor air.
- Particle monitors showed little to no increase in airborne particles during ultrasonic bath use compared with background levels.

The organism profile is consistent with low intensity aerosolization from water baths and the general indoor environment, rather than sustained release of high-risk pathogens. However, the presence of opportunistic gram-negative bacteria - even at low levels - supports maintaining robust occupational protections.

Discussion

This study provides valuable insights into the occupational safety of ultrasonic bath use in CSSDs under routine hospital conditions. Although the overall microbial risk appears low, the presence of opportunistic organisms and detectable particle concentrations during operation suggests that exposure cannot be entirely ruled out. These findings underscore the importance of maintaining vigilance in daily work practices.

The combination of microbial sampling and particle monitoring offers a more nuanced understanding of potential exposure pathways. However, limitations such as the inability to distinguish biological particles from non-biological ones, and the single-site study design, mean that broader generalizations should be made with caution.

Conclusion

While ultrasonic baths do not appear to pose a high infection risk under normal conditions, the study highlights areas where exposure could occur - particularly through aerosol generation. This reinforces the need for continued protective measures and thoughtful equipment placement and usage. The findings support the idea that risk mitigation should be proactive rather than reactive, especially in environments where staff are routinely exposed.

Implications and recommendations for clinical practice

To translate these findings into practice, CSSDs should adopt a layered approach to safety:

- Ensure adequate room ventilation and consider local exhaust systems where feasible. Position ultrasonic baths to minimize direct exposure and keep lids closed during operation.
- Implement standardized protocols for ultrasonic bath operation, cleaning schedules, and surface disinfection. Regular monitoring of particle levels can help detect changes in exposure risk.
- Staff should consistently wear appropriate PPE, including masks, gloves, gowns, and eye protection. Respirators may be warranted in poorly ventilated areas or during high-risk procedures.
- Ongoing education on safe work practices, including behavioral strategies like stepping aside before opening bath lids, can further reduce risk.

These recommendations aim to enhance worker safety without disrupting workflow, ensuring that ultrasonic cleaning remains both effective and safe in clinical environments.

Reference

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