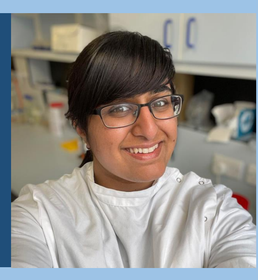
A comparison of methods for the disinfection of ultrasound probes



Authors: Sacha Bhuchar, Priyankah Karunanithy, Eleanor Blaxland, Richard Rowlands, James Blaxland.
Location: Cardiff Metropolitan University, Llandaff Campus, Western Avenue, CF5 2YB

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Introduction

Ultrasound probes are used for the visualisation of soft tissue and blood vessels. They offer a cheap and portable form of imaging that can be used within a range of healthcare settings. Because ultrasound probes come into direct contact with patients, disinfection processes are essential to remove contamination and minimise the spread of HCAIs. HCAIs pose a health burden to the patient, but also a financial burden to the institutions providing treatment. Manoukian *et al.* (2021) identified that the total annual cost of HCAI within the UK is £774 million. Within a local healthcare institution, there are currently two key methods employed for the decontamination of ultrasound transducer probes:

- Single wipe system (Active ingredient: quaternary ammonium compounds)
- Triple wipe system with activator foam (Active ingredient: chlorine dioxide)

The aim of this study was to identify if both wipe systems can perform effective decontamination of ultrasound probes so that their suitability can be compared and assessed.

Methods

A decommissioned ultrasound probe was used for the study. Three gram-positive bacteria were used: *Staphylococcus aureus* (NCTC 6571), Methicillin Resistant *Staphylococcus aureus* (NCTC 13142), and *Clostridium difficile* (NCTC 11209).

The ultrasound probe surface was dosed with 100µl bacterial solution at a concentration of 1.0 x10^7 cfu and then left for a contact time of five minutes (Figure 1A), then decontaminated with either wipe system, before recovery swabs being taken. Recovery swabs were serially diluted to identify the remaining concentration of bacteria present. Dosage and recovery without intervention was also performed.

To simulate routine practice, experiments incorporated ultrasound gel and the mixing of bacteria (Figure 1B). To assess the effect of mechanical action, paper towel with PBS was used to mimic the wipe systems, without an active ingredient.

All experiments were completed in triplicate. Between replicates and experiments, probes were submerged in Chemgene (Starlab) for five minutes (Figure 1C), with pre-swabs taken to ensure that the probe surface was free from contamination.

Standards detailing what is considered clean and dirty are outlined in BS EN 17272 (2020) with clean conditions containing 0.6% Bovine Serum Albumin (BSA) and dirty conditions containing 6% BSA. Secondary experiments in which *S. aureus* and MRSA-15 were mixed and incorporated into clean and dirty solutions were conducted.

Statistical analysis was carried out in SPSS 28 and comprised of independent sample t-tests. The level of significance was set at p=0.05.

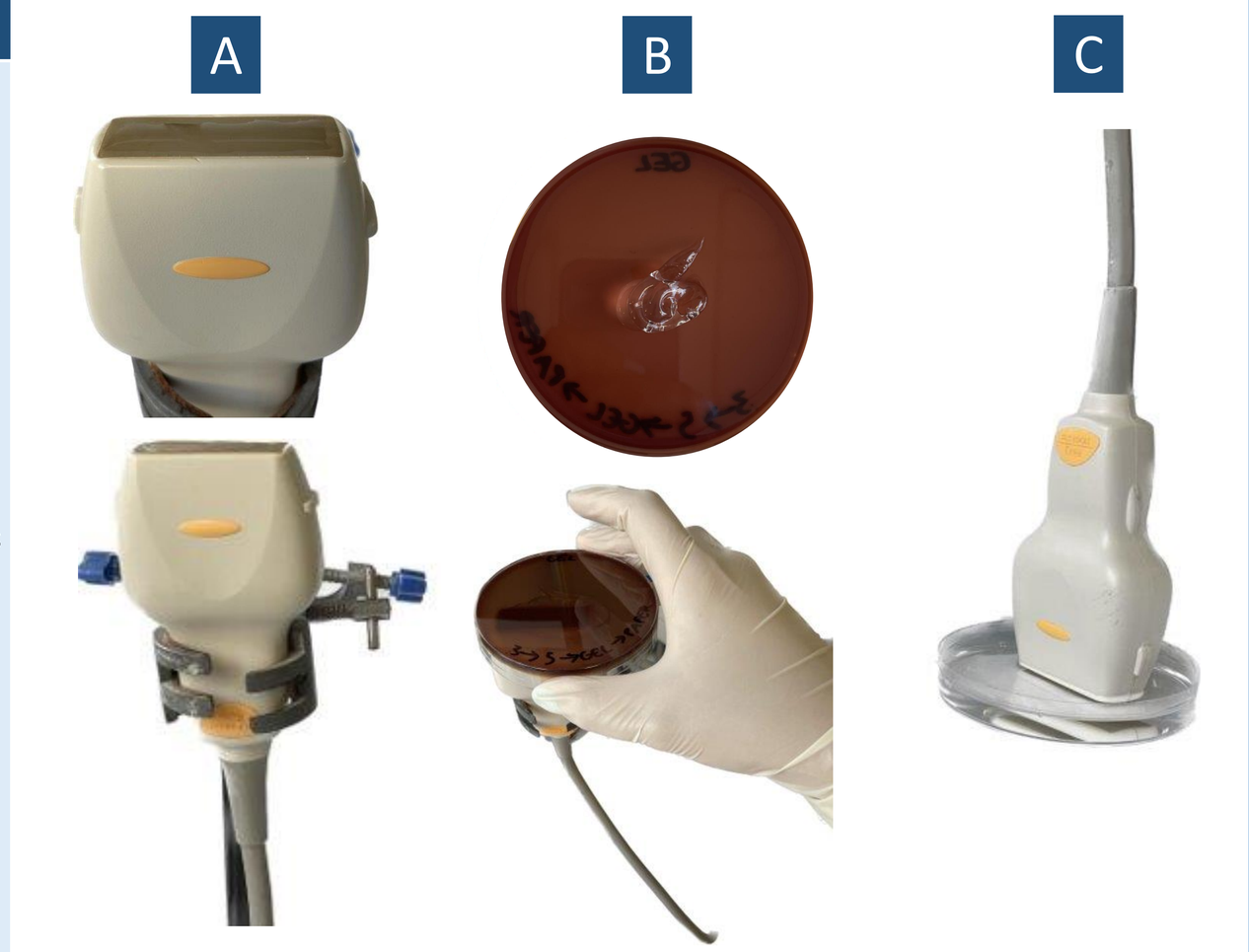

Figure 1 – Dosage of the ultrasound probe surface with bacterial solution (A), inclusion of ultrasound gel into testing (B) and baseline disinfection with Chemgene (C).

Results

- All recovery experiments saw a minimum reduction of 1.0x10^1 cfu and a maximum reduction of 1.0x10^3 cfu when compared to the loading dose.
- Mechanical action experiments showed a reduction of at least 1.0x10^2 cfu for all bacteria. Inclusion of gel saw a significantly higher concentration of bacteria recovered for all bacteria, except for the dirty mix (p=0.361).
- Experiments with mixed bacteria saw smaller reductions in the concentration of bacteria recovered, compared to individual bacterial experiments.

- The single wipe system removed bacteria in all instances, apart from an anomalous finding for *S. aureus* in which a concentration of 3.3 x10^1 cfu was recovered.
- When compared to the recovery experiments, there was a significant reduction for all bacteria, apart from MRSA (p=0.063). There were no bacteria recovered with the inclusion of ultrasound gel.

- The triple wipe system removed bacteria in all instances. This was a significant reduction when compared to recovery experiments, apart from MRSA-15 (p=0.063).

When comparing the single wipe system to the triple wipe system, there was no significant difference identified for all experiments irrespective of the inclusion of ultrasound gel or mixing of bacteria.

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Discussion

Within a local healthcare setting, two wipe systems are employed for the disinfection of ultrasound probes, with different mechanisms of action. Quaternary ammonium compounds in the single wipe system disrupt the phospholipid bilayer present on bacterial cell membranes (Morrison *et al.*, 2019), whereas chlorine dioxide in the triple wipe system sequesters electrons from key organelles (Ofori *et al.*, 2017).

Both wipe systems saw the removal of bacteria in all bar one instance, demonstrating that both systems can be used for the removal of bacterial contamination. The simulation of routine practice through a five minute contact time, the inclusion of ultrasound gel, and the mixing of bacteria is advantageous to this study, as it means that findings can be extrapolated to a clinical setting. However, a limitation of the study is that experiments focused only on the ultrasound probe surface. In normal practice, the wire and supportive equipment can often be contaminated through contact with the equipment user, the floor, and the patient. Future studies could be replicated on the probe casing and wire, and investigate how a longer contact time (for example – overnight) can impact bacterial growth on the medical device.

It can be argued that the disinfection provided by wipe systems can be fundamentally brought down to adherence to protocol (namely contact time) and sufficient training. Mechanical action experiments showed the importance of agitating the probe surface when performing disinfection, however, bacteria remained on the probe surface without the inclusion of an active ingredient.

From this study, it can be concluded that both the single wipe system and the triple wipe system are effective for the disinfection of ultrasound probes. The study has demonstrated the importance of comparing disinfection techniques to observe their adequacy.

As both systems provided the same standard of disinfection when compared to one another, it can be argued that the single wipe system is more suitable for use within the local healthcare institution, as it was noted that the single wipe system was simpler to use and took less time, when compared to the triple wipe system. This was particularly due to the multi-packaging of the triple wipe system, and the fifteen second activation time for the foam. Further research should be performed to quantify this difference in time taken and the overall ease of using each system.

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