A PRELIMINARY FIELD-RELEVANT TEST TO ASSESS DECONTAMINATION OF HIGH-TOUCH ENVIRONMENTAL SURFACES: TESTING WITH *STAPHYLOCOCCUS AUREUS*

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ABSTRACT

Background: High-touch environmental surfaces (HITES) can be vehicles for healthcare-associated infections (HAI). However, their decontamination by wiping is rarely assessed reflecting field use. Here, we report the development and application of a new carrier platform to quantitatively assess HITES decontamination by wiping with a microfiber based-fabric dampened with a neutral pH solution (~ 200 ppm chlorine) of sodium hypochlorite.

Materials & Methods: The platform (30 cm X 60 cm) was custom-designed and made out of Teflon with perforations to separately imbed nine carrier disks in it (**Fig 1**). Each disk (1 cm diam.; 0.7 mm thick) of brushed stainless steel was individually placed into the holes for a tight fit and the platform sterilized by autoclaving. Six of the disks received 10 µL of a *Staphylococcus aureus* (ATCC 6538) suspension ($\geq 10^6$ CFU) in a soil load, and the inocula dried under ambient conditions for two hours. Three of the disks were left uncontaminated to assess any transfer of contamination during wiping. For decontamination, the entire platform was wiped in two steps with a dampened microfiber fabric in a field-relevant manner (**Fig 2**). After 30 seconds the disks were then retrieved directly and simultaneously into separate vials containing 10.0 mL of an eluent/diluent/neutralizer (**Fig 3**). The eluates were assayed for CFU by membrane filtration and $\log_{10}$ reductions calculated. Normal saline with 0.1% Tween-80 (saline-T) was used as a control solution for wiping.

Results: This preliminary testing showed the platform to keep the disks in place during wiping and also allowed the wiping itself to better represent the decontamination process in the field. Wiping with the disinfectant brought the contamination to an acceptable level with no transfer of contamination to clean disks.

Conclusion: The device and the protocol described can quantitatively determine HITES decontamination in a field-relevant manner. The platform and the decontamination process are also potentially applicable to not only other kinds of carrier materials but also to assess HITES decontamination using other classes of pathogens implicated in HAI.

INTRODUCTION: High-touch environmental surfaces (HITES) are increasingly being recognized as vehicles for healthcare-associated infections (HAI). However, their multi-step decontamination process is rarely assessed simulating its field application. This study used a new carrier method to test HITES decontamination under such conditions.

MATERIALS

- **Carriers:** Disks (1 cm diam. and 0.7 mm thickness) of magnetized and brushed stainless steel (AISI 430).
- **Platform:** The platform (30X60 cm) was locally made from a sheet of Teflon and nine holes were placed in it to tightly hold in place one carrier disk each (**Fig 1**). It was autoclave-sterilized with the disks loaded. After each use, the platform was decontaminated, cleaned and used again.
- **Test Bacterium**: *Staphylococcus aureus* (ATCC #6538) was grown in Trypticase soy broth (TSB) with recovery on plates of Trypticase soy agar (TSA) after incubation at 36±1ºC for 18-24 h.
- **Microfiber Cloth**: Pieces of microfiber cloth (36X36 cm), made from a mixture of 85% polyester and 15% polyamide, was uniformly wetted after pipetting on it 40 mL of the test disinfectant. The cloth was then folded into a square (18X18 cm) for wiping the disks on the platform (**Fig 2**).
- **Carrier Disk Retrieval:** A spring-loaded disk ejection device was also prepared locally. It allowed the quick and simultaneous collection of the disks directly in vials containing an eluent/diluent/neutralizer (**Fig 3**) 30 seconds after the end of the wiping process.
- **Disinfectant:** 40 mL of a neutral pH solution (~ 200 ppm chlorine) of sodium hypochlorite was used to dampen a piece of the microfiber cloth for wiping the platform. For control, saline-T was used instead.
- **Soil load:** It consisted of a mixture of albumin, mucin and yeast extract (ASTM International)

METHODS

- Six of the disks on the platform received 10 µL ($\geq 10^6$ CFU) of the test bacterial suspension in the soil load and the inocula dried for two hours under ambient conditions inside an operating biosafety cabinet. Three disks on the platform were uncontaminated to assess any transfer of bacteria to them during wiping.
- The entire platform was wiped in two steps with a microfiber fabric dampened with either the disinfectant or saline in a field-relevant manner (**Fig 2**). Thirty seconds after the end of the wiping process the disks were retrieved directly and simultaneously into separate vials containing 10.0 mL of an eluent/diluent/neutralizer (**Fig 3**). The contents of each vial were vortexed for 10 seconds to recover the inocula. The elutes were diluted as needed and the dilutions passed through membrane filters (47 mm diam.) with a pore diam. of 0.22 µm. Each filter was placed separately on a 100 diam. Petri plate with TSA and the plates incubated at 36±1° C for 46±2 hours.
- The CFU on the filters were counted and $\log_{10}$ reductions calculated. To determine the baseline level of bacterial contamination, two disks with the dried inoculum were eluted directly. The arbitrarily-set product performance criterion was $\geq$4 $\log_{10}$ ($\geq$99.99%) reduction in CFU of the test organism by the decontamination process.

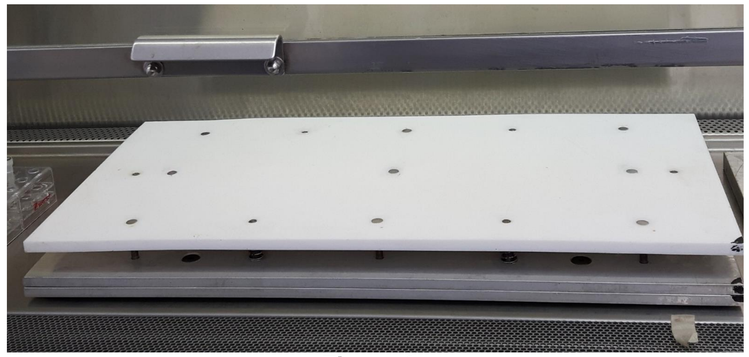

Figure 1.

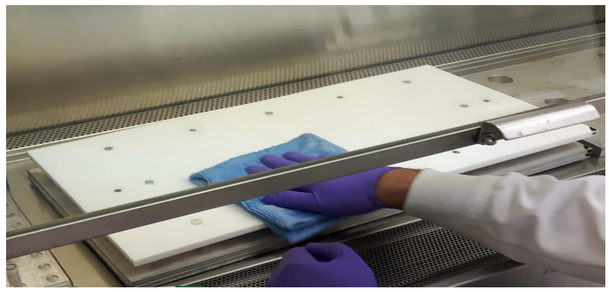

Figure 2.

Figure 3.

RESULTS: Wiping with a disinfectant-soaked microfiber fabric showed a >5 $\log_{10}$ reduction in the CFU of the test organism on the contaminated carriers. There was no transfer of CFU to the clean disks on the platform. However, wiping with a saline-T resulted in a lower reduction in the level of CFU on the contaminated disks with evidence for transfer of the contamination to the clean disks.

DISCUSSION: The method described here is fully quantitative while closely reflecting the in-field decontamination of HITES in healthcare and other settings. We chose to make the platform from Teflon because of its high resistance to a variety of chemicals as well as its ability to withstand repeated autoclaving. It also allowed the drilling of the holes to accommodate the carrier disks. Disks of brushed stainless steel were selected based on their acceptance as archetypes of hard, non-porous environmental surfaces (ASTM). *Staph aureus* was used based on its significance as a cause of HAI as well as a representative of pathogens known to spread via contaminated HITES. While the testing reported here was based on the use of a vegetative bacterium and metal disks, the test platform can be used with other classes of pathogens as well as a variety of environmental surfaces. Our previous work has led to the development of two tiers of quantitative carrier tests (QCT-1 and QCT-2), which are both standards of ASTM International. The method described here is regarded as the third tier of the quantitative carrier tests (QCT-3). Additional work is now underway to test other types of pathogens and disinfectants using the method reported here. The method can also be adapted to testing disinfectant sprays.

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