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Brief Report

Evaluation of disinfectants and wiping substrates combinations to inactivate *Staphylococcus aureus* on Formica coupons

Elizabeth Brown MS, MLIS [a], Karthik Dhanireddy BS [a], Calvin Waldron PhD, MS, BS [a], Peter Teska MBA, BS [b], Joseph Eifert PhD, MS, BS [a], Renee Boyer PhD, MS, BS [a,*]

[a] *Department of Food Science and Technology, Virginia Tech, Blacksburg, VA*
[b] *Diversey Inc, Charlotte, NC*

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Effective disinfection in healthcare facilities prevents healthcare–associated infections. This study evaluated the ability of Environmental Protection Agency–approved disinfectants (quaternary ammonium compound, QAC; sodium hypochlorite, and hydrogen peroxide) applied with 3 wiping substrates (microfiber, nonwoven, and cotton) to remove *Staphylococcus aureus* from Formica surfaces. All treatments reduced *S aureus* on Formica squares with the exception of QAC applied with cotton and QAC, nondisinfectant, and control applied with a nonwoven cloth. Sodium hypochlorite or hydrogen peroxide applied with cotton or microfiber, respectively, may be the best choice for disinfection of Formica surfaces in healthcare settings.

INTRODUCTION

Patients can acquire healthcare–associated infections through direct contact with contaminated surfaces in a hospital.[1] Environmental Protection Agency (EPA)-approved disinfectants are recommended for use in hospitals in the United States. The EPA method to evaluate efficacy of disinfectants uses a stainless steel testing substrate, which may not accurately represent how disinfectants act on Formica surfaces in hospital rooms. This study evaluated the effect of 3 EPA-approved disinfectants applied using 3 wiping substrates on reduction of *Staphylococcus aureus* on Formica.

METHODS

Culture Preparation

Frozen cultures of *S aureus* (ATCC #6538) were prepared according to EPA SOP Method MB-25-02.[2]

Inoculation

Ten microliters of inoculum were placed on the center of sterile Formica squares (1 in × 1 in). Squares were dried in a desiccator (0.068 MPa-0.085 MPa for 60 min ± 10 min).[2]

Application/sampling of substrate/cloth combination

Five treatments were tested with 3 different wiping substrates (cotton, microfiber, and nonwoven) twice. Treatments included 4 Diversey, Inc products (quaternary ammonium compound – Virex II 256, sodium hypochlorite – Avert, improved hydrogen peroxide – Oxivir, nondisinfectant/detergent – Prominence) and phosphate-buffered saline (PBS). Additional controls include uninoculated squares and inoculated unwiped squares.

Dry cloths (2 in × 2 in) were weighed, and submerged in 250 mL of disinfectant separately, for 10 seconds to simulate the cloth/bucket method of applying disinfectant commonly used in hospitals. Cloths were wrung until no longer dripping and weighed. Cloths were wrung a second time to remove most of the liquid, weighed again, and used to wipe inoculated squares 4 times. Cloths were then placed in a sterile stomacher bag, and the cloth and square were held for the recommended contact time. Next, the square was placed in a sterile specimen jar with 10 mL of neutralizing buffer and vortexed. Twenty milliliters of neutralizing buffer was added to the cloth and agitated. This process was repeated for each of 5 cloths consecutively dipped in the same disinfectant. The liquid from the

* Address correspondence to Renee Boyer PhD, MS, BS, 1230 Washington St SW, Blacksburg, VA 24060
E-mail addresses: rrboyer@vt.edu, rraiden@vt.edu (R. Boyer).

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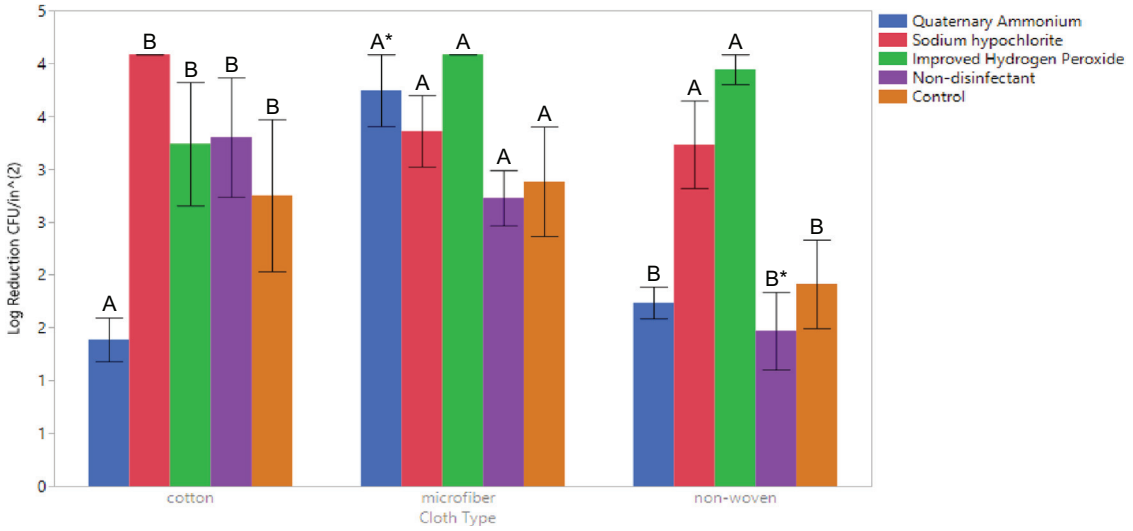

Fig. 1. Reductions (log CFU/in^2) of *S aureus* on formica squares after wiping with cloths (cotton, microfiber, and nonwoven) dipped in disinfectant treatments (quaternary ammonium — Virex II 256, sodium hypochlorite — Avert, improved hydrogen peroxide — Oxivir, nondisinfectant — Prominence, and phosphate-buffered saline as control). An asterisk * indicates a significant difference between bars representing the same disinfectant. A capital letter indicates a significant difference between bars within cloth type. Control refers to cloths dipped in phosphate-buffered saline and used to wipe inoculated Formica squares. *CFU,* colony-forming units.

squares and cloths was enumerated on Tryptic Soy Agar (Becton Dickenson, Sparks, MD) in duplicate and triplicate, respectively. Plates were incubated at 36°C ± 1°C for 48 hours. Data were compared using one-way ANOVA (JMP statistical software, Cary, NC); means separated using students t-test.

RESULTS

Approximately 4.08 log colony-forming units (CFU)/mL of *S aureus* was inoculated on each square. Bacterial reduction on squares or cloths was not significantly different with each consecutively dipped cloths within each treatment category. There were no differences between the PBS control and nondisinfectant (Fig 1).

Sodium hypochlorite (SH) applied with a cotton cloth, and improved hydrogen peroxide (IHP) applied with a microfiber cloth were the only combinations to reduce bacteria to undetectable levels (>4.08 log CFU/mL). Quaternary ammonium compound (QAC) applied with a cotton cloth was less effective ($P < .05$) than all other treatments applied with cotton. IHP and SH were more effective ($P < .05$) than all other treatments applied with a nonwoven cloth. QAC was significantly more effective ($P = .0002$) when applied with a microfiber cloth; however, this reduction was not significantly different from other disinfectants applied with a microfiber cloth (Fig 1).

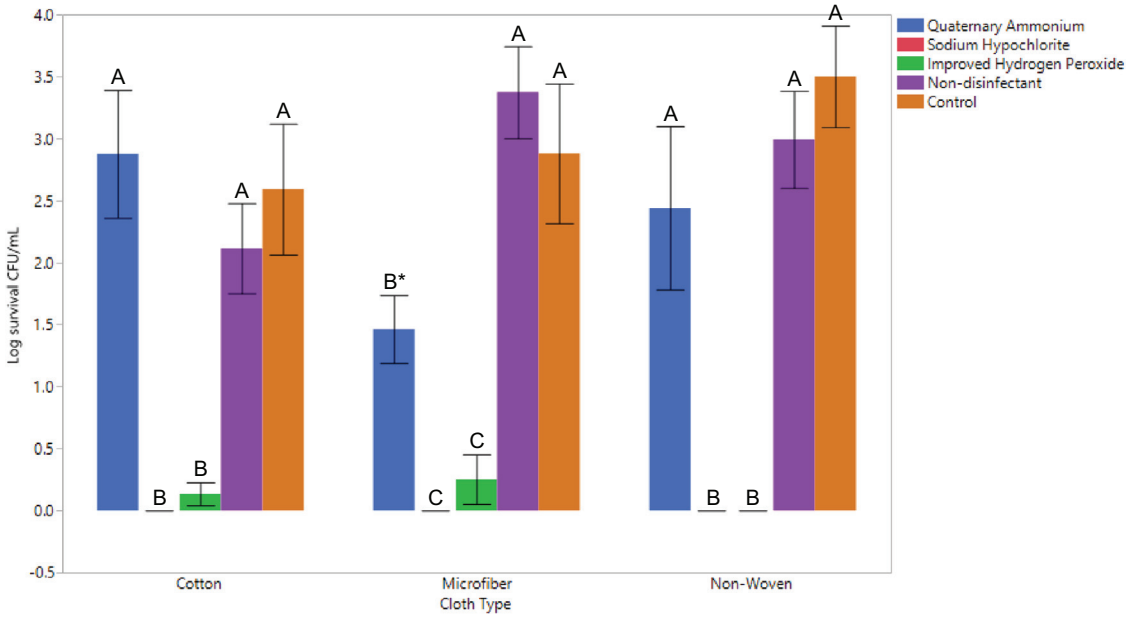

Fig. 2. Survival (Log CFU/mL) of *S aureus* on cloth substrates (cotton, microfiber, nonwoven) after dipping in disinfectant treatments (quaternary ammonium — Virex II 256, sodium hypochlorite — Avert, improved hydrogen peroxide — Oxivir, nondisinfectant — Prominence, and phosphate-buffered saline as control) and wiping Formica squares. * indicates significant difference of cloth type within disinfectant. Different upper case letters indicate a significant difference of disinfectant applied within cloth type. Control refers to cloths dipped in phosphate-buffered saline and used to wipe inoculated Formica squares. *CFU*, colony-forming unit.

Bacteria surviving in the cloth after wiping the Formica surface was also determined. There were no surviving bacteria on all cloths dipped in SH and nonwoven cloths dipped in IHP. In all cases, *S aureus* was significantly less on cloths dipped in SH or IHP than on cloths dipped in QAC, nondisinfectant, or PBS control (Fig 2). *S aureus* survived significantly better on cotton and nonwoven cloths dipped in QAC than microfiber (Fig 2).

DISCUSSION

Adequate and routine cleaning and disinfection protocols decrease pathogens on surfaces, ideally to undetectable levels, preventing spread of disease.[3,4] This study used EPA SOP Method MB-25-02 to evaluate disinfectants on Formica surfaces (a common patient contact surface in hospitals). Hospitals use diverse types of wiping cloths without understanding the impact the type of cloth has on surface disinfection. For example, QAC concentrations are reduced (50%-85%) when exposed to cotton, which would negatively affect disinfection.[5,6] These cloths are often used on multiple surfaces during cleaning. If a pathogen is removed from 1 surface, but survives in the cloth, subsequent spread to other surfaces in the room could occur.[7] The goal of a successful disinfectant is one that (1) does not bind to the cloth and limit the active ingredient, (2) removes the pathogen from the intended surface, and (3) reduces the pathogen to undetectable levels in the wiping cloth.

CONCLUSIONS

This study confirms previous work showing that QAC applied with cotton or nonwoven cloths is not the best disinfectant choice in healthcare settings.[5,6] The cotton cloth binds the QAC, reducing the action of the disinfectant.[5,6] This explains why QAC disinfection using a cotton wipe was much less effective than using a microfiber wipe. QAC applied with microfiber cloths results in similar pathogen reduction to other disinfectants evaluated. In addition, all treatments in the study maintained their efficacy over 5 subsequent wipes, indicating that the disinfectant remains active, even after treatment of multiple surfaces and/or the active ingredient binds to the cloth.

Ultimately, IHP and SH disinfectants were most effective at reducing *S aureus* on Formica squares' surface and in cloths regardless of type. The enhanced performance of both IHP and SH likely occurs because there is little interaction between the disinfectant and the cloth material. IHP and SH are compatible with a wider variety of wiping cloths. Based on the data from this study, the use of a SH applied with a cotton cloth or an IHP applied with a microfiber cloth is the best choice for disinfection of Formica surfaces in hospital patients' rooms.

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