The effects of contact time and concentration on bactericidal efficacy of three disinfectants on hard non-porous surfaces

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INTRODUCTION

Healthcare associated infections (HAI) have been identified as a significant source of patient harm both in the US and globally[1]. The contamination of high-touch environmental surfaces (e.g. bedside rails, door handle, call button) and shared clinical equipment (e.g. blood pressure cuff, computers) play a significant role in the transmission of pathogens in hospitals[2,3]. While regular cleaning and disinfection of these surfaces and equipment effectively reduce the occurrences of HAIs, choosing properly registered disinfectants and following label use conditions are key to ensure effective disinfection. In practice, however, label instructions are not always followed.

The objective of this study was to evaluate the influence of off-label contact times and concentrations on the bactericidal efficacy of three types of disinfectants on hard, non-porous surfaces using three EPA registered disinfectants from the United States.

RESULTS

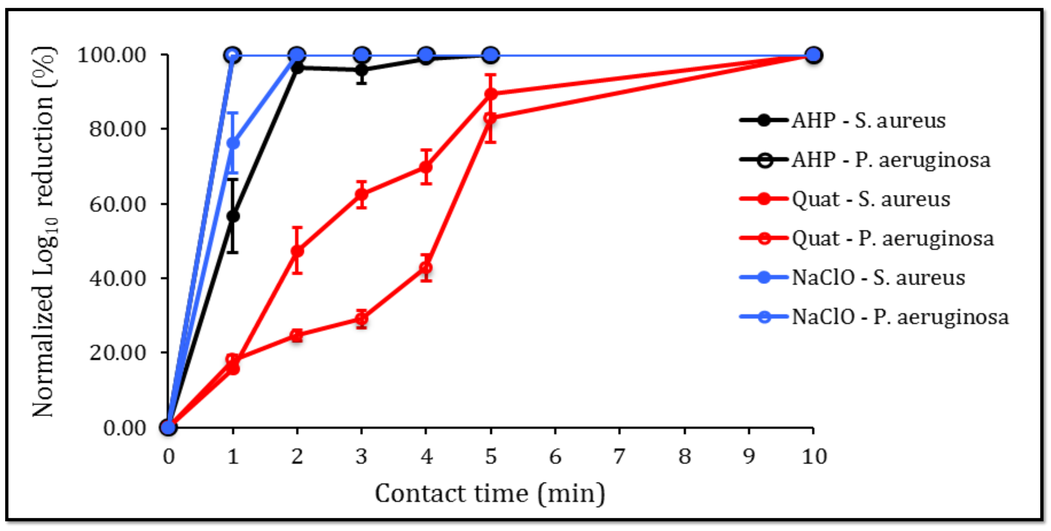

Figure 1: Bactericidal efficacy of three disinfectants with varying contact time

- All three disinfectants were significantly less bactericidal against *S. aureus* at one or more less than label contact times **(Figure 1)**
- Quat treatments at contact times of 1, 2, 3, and 4 min resulted in 15.7%, 47.4%, 62.5%, and 70.0% reduction in *S. aureus*, respectively, compared to 100% at label contact time of 10 min (all P_{adj} <0.001) **(Figure 1)**

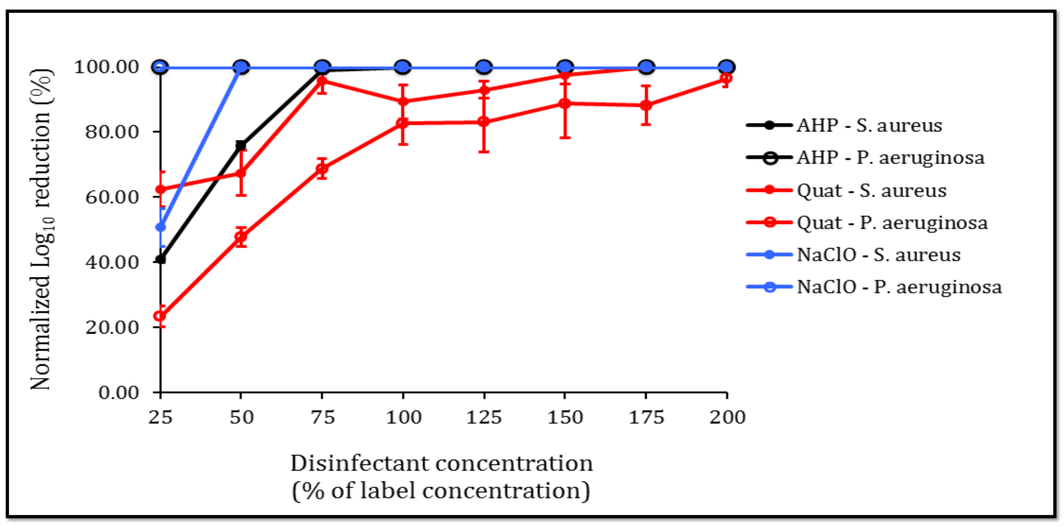

Figure 2: Bactericidal efficacy of three disinfectants with varying disinfectant concentration

- All three disinfectants were significantly less bactericidal against *S. aureus* at one or more lower than label concentrations **(Figure 2)**
- AHP treatments at 25% and 50% label concentrations resulted in 40.9% and 75.7% reductions in *S. aureus*, respectively, compared to 100% at label concentration (all P_{adj} <0.001) **(Figure 2)**

MATERIALS & METHODS

The bactericidal efficacies of three disinfectants [accelerated hydrogen peroxide (AHP), quaternary ammonium compounds (Quat), and sodium hypochlorite] were prepared according to label instructions and evaluated on stainless steel coupon surfaces at room temperature (~25°C) using EPA procedure MB-25-02[4].

Bactericidal efficacies of three disinfectants were measured at six contact times (1, 2, 3, 4, 5, and 10 min) at label concentrations and at eight concentrations (25%, 50%, 75%, 100%, 125%, 150%, 175%, and 200% of label concentrations) with a constant contact time of 5 min. Efficacies were tested against *Staphylococcus aureus* (ATCC 6538) and *Pseudomonas aeruginosa* (ATCC 15442). Each treatment was tested independently three times.

For each treatment, bacterial reduction was calculated as the reduction of log10 bacterial count on disinfectant-treated coupons compared to corresponding control coupons. To enable comparisons among treatments with different control bacterial counts, the bacterial reduction of each treatment was further divided by corresponding log10 control bacterial count to generate normalized log10 reduction.

CONCLUSIONS

The bactericidal efficacies of all three disinfectants at contact times and concentrations immediate lower than the label values were not significantly different from the efficacies at label values. Overall, the bactericidal efficacy of the sodium hypochlorite disinfectant was most tolerant to decreases in concentration and contact time, followed closely by AHP disinfectant, whereas Quat disinfectant was least tolerant.

In addition to concentration and contact time, other factors can affect the antimicrobial efficacy of disinfectants, such as the presence of organic and inorganic matter, water hardness, pH, temperature, and material of wiping cloth[5]. Therefore, under circumstances that result in lower than label concentration or contact time, antimicrobial efficacy must be tested under both laboratory and real-life conditions to understand the true efficacy achieved especially if interference of aforementioned factors are present.

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REFERENCES

1. Magill SS, Edwards JR, Bamberg W, Beldavs ZG, Dumyati G, Kainer MA, et al. Multistate point-prevalence survey of health care-associated infections. N Engl J Med 2014;370:1198-1208.
2. Weber DJ, Rutala WA, Miller MB, Huslage K, Sickbert-Bennett E. Role of hospital surfaces in the transmission of emerging health care associated pathogens: Norovirus, Clostridium difficile, and Acinetobacter species. Am J Infect Control 2010;38,S25-33.
3. Han JH, Sullivan N, Leas BF, Pegues DA, Kaczmarek JL, Umscheid CA. Cleaning hospital room surfaces to prevent health care-associated infections. Ann Intern Med 2015;163(8):598-607.
4. EPA. Antimicrobial Testing Methods & Procedures: MB-25-02: OECD Quantitative Method for Evaluating Bactericidal Activity of Microbicides Used on Hard, Non-Porous Surfaces. 2013. Available online at: https://www.epa.gov/sites/production/files/2014-12/documents/mb-25-02.pdf
5. Rutala WA, Weber DJ, and the Healthcare Infection Control Practices Advisory Committee. Guideline for disinfection and sterilization in healthcare facilities, 2008. Available online at: https://www.cdc.gov/hicpac/pdf/guidelines/Disinfection_Nov_2008.pdf

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