Strain, disinfectant, concentration and contact time quantitatively impact disinfectant efficacy

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ABSTRACT

There has been much concern in recent years about the risks posed by antibiotic and multi-drug-resistant pathogens such as Pseudomonas aeruginosa and Methicillin-resistant Staphylococcus aureus in patient care settings. While the role of disinfection has been well established for infection prevention and control, little evidence exists on the impact of off-label disinfectant use on antimicrobial efficacy. This study compared the efficacy of commercial formulations separately based on accelerated hydrogen peroxide (AHP®), a quaternary ammonium compound (quat) and sodium hypochlorite (bleach) against the control strains of MRSA and MDR P. aeruginosa as defined by the EPA for disinfectant registration as well as additional clinically relevant MRSA and MDR P. aeruginosa strains.

BAKGROUND

In 2011 alone, an estimated 75,000 persons died from the over 722,000 healthcare-associated infections (HAIs) in the United States[1]. The leading pathogens responsible for these infections were *Pseudomonas aeruginosa* and *Staphylococcus aureus*, both of which exist as numerous antimicrobial-resistant strains[1]. While the U.S. EPA-registered disinfectants are required to show a 5-$\log_{10}$ reduction in the concentration of the pathogens tested when used as directed on the label, they may fail to do so if the prescribed conditions of contact time and concentration are not met. As environmental services staff in healthcare and other facilities are often constrained for time, they may fail to adhere to label directions, potentially leading to inadequate decontamination.

STUDY

The study tested three products separately based on AHP® (Oxivir 1; 0.5% active), a quat (Virex Tb; 0.21% active), and sodium hypochlorite (Avert; 1.2% active). Each test carrier (stainless steel coupons 1 cm in diameter) received the test inoculum consisting of the test bacterial suspension in a soil load (a mixture of yeast extract, bovine mucin and bovine serum albumin). Each disinfectant was tested at 100%, 75% and 50% of label-indicated concentrations, using hard water as defined by EPA protocols to prepare the use dilutions. Each disinfectant was also tested, at the label-indicated concentration, at four different contact times (30s, 1 min, 2 min, and 3 min); control coupons were exposed to phosphate buffered saline in place of the tested disinfectant. The pathogens tested included non-drug resistant control strains of *P. aeruginosa* and *S. aureus* along with four strains of MDR *P. aeruginosa* and MRSA.

RESULTS

Virex Tb

At label-indicated conditions, this formulation was significantly less effective against one strain of MRSA and more effective against one strain of MDR P. aeruginosa compared to all other strains. Reducing contact time and concentration had a significant effect on this product, though effects varied by strain.

Avert

At label-indicated conditions, this formulation was more effective against one strain of MDR P. aeruginosa compared to all other strains at the bactericidal (one-minute) contact time, though there were no significant differences among MRSA strains. At the sporicidal contact time, Avert was more effective against the control strain and one MRSA strain, while no differences were noted between P. aeruginosa strains. Reducing contact time and concentration had a significant effect on this product, though effects varied by strain.

Oxivir 1

Under label-indicated conditions, this formulation was more effective against one MDR strain of P. aeruginosa. No significant differences were noted between MRSA strains. Reducing contact time and concentration had a significant effect on this product, though effects varied by strain.

CONCLUSION

Differences in bacterial strain, concentration and applied contact time significantly influenced disinfectant efficacy, highlighting the importance of meeting the required contact time and ensuring that the concentration of a disinfectant product complies with label instructions. Further, the study demonstrated that for AHP® and sodium hypochlorite are equally effective against multi-drug-resistant strains of *Staphylococcus* and *Pseudomonas* compared to control strains overall. With quat-based disinfectants, there may be more challenges in killing some multi-drug resistant strains relative to AHP® or sodium hypochlorite-based disinfectants. While additional testing needs to be completed in order to better characterize these phenomena, this study highlights the importance of adhering to label conditions to ensure that the product is functioning as expected. The study underscores the issue of time constraints in healthcare settings, which can be a barrier to complying with the correct contact time, ensuring that dilutions are accurate, and ensuring disinfection protocols for non-critical devices such as blood pressure cuffs are followed.

IMPLICATIONS FOR AHP®

As the issue of antimicrobial resistance continues to grow, the importance of cleaning and disinfection will be acknowledged more than ever before. The EPA has selected the control strains of *Staphylococcus aureus* and *Pseudomonas aeruginosa* to use in the standard disinfection efficacy testing as strains representative of the general resistance to chemical disinfection for both organisms. The study showed that for AHP®, the control strain was at least as difficult to kill as the drug-resistant strains also tested. In several cases one or more of the drug-resistant strains were actually easier to kill than the control strain. Of the three products tested in this study, Oxivir 1 had the shortest contact time (1 minute, compared to three minutes for the quat product and four minutes for the sodium hypochlorite). Understanding that contact time is directly correlated to ensuring that cleaning and disinfection protocols can be met under the time constraints found in numerous healthcare facilities highlights the importance for choosing a safer and more effective disinfectant such as AHP®.

REFERENCE

West AM, Teska PJ, Lineback CB, Oliver HF. (2018). Strain, disinfectant, concentration, and contact time quantitatively impact disinfectant efficacy. *Antimicrobial Resistance and Infection Control*. 7(49).