Evaluation of a Novel Alcohol-Based Surface Disinfectant for Disinfection of Hard and Soft Surfaces in Healthcare Facilities

Heba Alhmidi,1 Sreelatha Koganti,1 Jennifer L. Cadnum,2 Herleen Rai,1 Annette L. Jencson,1 and Curtis J. Donskey2,3

1Research Service, Cleveland VA Medical Center, Ohio; 2Department of Medicine, Infectious Diseases Division, Case Western Reserve University School of Medicine, Cleveland, Ohio; and 3Geriatric Research, Education and Clinical Center, Cleveland, Ohio

We examined the efficacy of a new 1-step cleaner and disinfectant containing 30% ethanol that is applied as a spray. The product rapidly reduced vegetative bacterial pathogens on carriers and on hard and soft surfaces in healthcare settings, but it did not stain clothing.

Keywords. disinfectant; environment; ethanol; hypochlorite.

Contaminated environmental surfaces are an important potential source for transmission of healthcare-associated pathogens [1]. In addition to hard surfaces, contamination of soft surfaces is common in healthcare facilities. For example, hospital privacy curtains may be contaminated with pathogenic microorganisms that can be transferred to hands [2–5]. There is a need for disinfectants that are effective on hard and soft surfaces but also well tolerated by environmental services personnel and nondamaging to surfaces.

Purell Healthcare Surface Disinfectant (GOJO, Akron, OH) is a new 1-step cleaner and disinfectant containing 30% ethanol that is applied as a spray. The product has bactericidal and virucidal, but not sporicidal, activity and has received the lowest allowable Environmental Protection Agency toxicity rating (Category IV). The product is unique because it has 30% ethanol, whereas prior ethanol-based products have either had greater than 59% ethanol or have included quaternary ammonium compounds [6]. In this study, we tested the effectiveness of Purell Healthcare Surface Disinfectant Spray versus other commercial disinfectants for decontamination of hard and soft surfaces in laboratory and healthcare settings.

METHODS

In the laboratory, we compared the efficacy of the Purell Healthcare Surface Disinfectant versus several commercial liquid disinfectants for killing pathogens on steel disk carriers using the American Society for Testing and Materials standard quantitative carrier disk test method (ASTM E-2197-02) [7]. Five percent fetal calf serum was used as simulated organic load for all testing. The commercial products included Clorox Healthcare Bleach Germicidal Cleaner (The Clorox Company, Oakland, CA), Clorox Healthcare Hydrogen Peroxide Cleaner Disinfectant, Diversey Oxivir TB (JohnsonDiversey, Sturtevant, WI), and Lysol Professional (Reckitt Benckiser, LLC, Parsippany, NJ); 70% ethanol was also used for comparison. The test organisms included methicillin-resistant Staphylococcus aureus (MRSA) (a clinical USA400 pulsed-field gel electrophoresis type), a carbapenem-resistant Escherichia coli (New Delhi metallo-β-lactamase-1-producing strain), and vancomycin-resistant Enterococcus (VRE) strain C68. After a contact time of 30 seconds, the carriers were placed in 1 mL Dey-Engley neutralizing medium (Remel Products, Lenexa, KS), serially diluted, and plated onto selective media for quantification. Log reductions for each disinfectant were calculated in comparison to counts for sterile water exposure. The experiment was performed in triplicate.

To evaluate the potential for staining of clothing, 0.1 mL of each of the products was applied to 1-cm² cutout sections of clothing and allowed to air dry. The clothing sections were visually assessed after 10 minutes and 1 hour.

On hospital wards, we compared the efficacy of Purell Healthcare Surface Disinfectant and Clorox Healthcare Bleach Germicidal Cleaner for disinfection of hard (ie, bed rails, bedside tables, and physical therapy hand rails) and soft (ie, chairs, mattresses, and cushions) surfaces. The surfaces were divided into three 10-cm² sections. For each section, 5 sprays of either sterile water (control) or 1 of the disinfectants were applied and spread to cover the surface area using a paper towel; 5 sprays were applied because preliminary experiments demonstrated that this provided a sufficient quantity to thoroughly wet the surfaces. After 30 seconds of exposure, sterile swabs (BD BBL CultureSwab, Becton Dickinson) premoistened with Dey-Engley neutralizing medium (Remel Products, Lenexa, KS) were used to sample the surfaces. Vancomycin-resistant Enterococcus, MRSA, and facultative and aerobic Gram-negative bacilli were cultured by plating swabs on selective media as previously described [8]. One-way analysis of variance with a post hoc Tukey test...
was used to compare reductions for the different disinfectant groups. Fisher’s exact test was used to compare the percentages of environmental cultures positive after application of disinfectants versus water (negative control). Data were analyzed using R version 3.1.1.

RESULTS

Figure 1 provides a comparison of the effectiveness of Purell Healthcare Surface Disinfectant Spray and the other comparator disinfectants. Purell Healthcare Surface Disinfectant Spray resulted in ≥5.5 log reduction in each of the pathogens. The reductions were not significantly different from reductions achieved by Clorox Healthcare Bleach Germicidal Cleaner, Diversey Oxivir TB, and Clorox Healthcare Hydrogen Peroxide Cleaner Disinfectant (P > .05 for each comparison), but significantly greater than reductions achieved with Lysol Professional for MRSA and VRE or for 70% ethanol for all 3 pathogens (P < .01 for all comparisons). Clorox Healthcare Bleach Germicidal Cleaner stained sections of clothing, whereas the other disinfectants did not.

Figure 2 shows the percentages of hard and soft surfaces from which facultative and aerobic Gram-negative bacilli, MRSA, and VRE were recovered after application of sterile water, Purell Healthcare Surface Disinfectant Spray, or Clorox Healthcare Bleach Germicidal Cleaner. One hundred fifty-seven total surfaces (100 hard surfaces and 57 soft surfaces) were tested after application of water versus the 2 disinfectants. For each surface, 3 swabs were processed (ie, 1 swab for each test solution). In comparison to the water control, both disinfectants significantly reduced recovery of MRSA (P ≤ .01) and a composite of any pathogen recovered (P < .001); for both disinfectants, there was also a nonsignificant trend toward reduction of both Gram-negative bacilli and enterococci (P = .07). There were no significant differences in the percentages of positive cultures for the 2 disinfectants (P ≥ .49).

DISCUSSION

We found that Purell Healthcare Surface Disinfectant was effective in rapidly reducing vegetative bacterial pathogens on steel disk carriers and on hard and soft surfaces in the hospital. Spraying surfaces may enhance efficiency and allow thorough application of disinfectant on irregular surfaces. The product should have a low propensity to damage hard or soft surfaces. In contrast to a bleach product, Purell Healthcare Surface

Figure 1. Log reduction of methicillin-resistant *Staphylococcus aureus* (MRSA), carbapenem-resistant *Escherichia coli* (CRE), and vancomycin-resistant *Enterococcus* (VRE) after 30 seconds of exposure to commercial disinfectants or 70% ethanol on steel disk carriers. Log reductions for each disinfectant were calculated in comparison to counts for sterile water exposure. CFU, colony-forming unit. *, P < .05.
Disinfectant did not stain clothing. Our findings suggest that Purell Healthcare Surface Disinfectant may be a useful addition to disinfectants currently used in healthcare settings.

One notable finding was that Purell Healthcare Surface Disinfectant containing 30% ethanol was significantly more effective than 70% ethanol. This result demonstrates that proper formulation can reduce the amount of ethanol needed to meet disinfection requirements and thereby reduce the disadvantages associated with ethanol (flammability and evaporation) [9]. According to the manufacturer, the formulation change that enhances activity is the addition of low concentrations of surfactants. This enhancement of the activity of ethanol by the addition of surfactants is analogous to the enhancement of the activity of improved or accelerated hydrogen peroxide in comparison to hydrogen peroxide [10].

Our study has some limitations. In laboratory testing, a small number of organisms and strains were tested. However, results were consistent for each of the pathogens studied. Although it is likely that the ethanol product will be well tolerated by personnel and patients, additional studies are needed to assess acceptability when used routinely in healthcare settings. Although we found that the ethanol product did not stain clothing, additional testing will be required to assess whether the product has any adverse effects on soft or hard surfaces in healthcare settings. Although there was no significant difference between Purell Healthcare Surface Disinfectant and the bleach product with regard to reduction of MRSA on hard and soft surfaces, small numbers of MRSA were recovered after use of the ethanol product but not after use of bleach; we cannot rule out the possibility that bleach might be more effective than the ethanol product if a larger sample size were studied.

CONCLUSIONS

In healthcare settings, there is a need for disinfectants that are effective but also safe and nondamaging to surfaces. Our findings demonstrate that the new 1-step cleaner and disinfectant containing 30% ethanol rapidly reduced vegetative bacterial pathogens on carriers and on hard and soft surfaces in healthcare settings. This product did not stain clothing. Our findings suggest that the ethanol product may be a useful addition to nonsporicidal disinfectants currently used in healthcare settings.

Acknowledgments

Disclaimer. GOJO personnel participated in the study design and were provided with a copy of the final version of the manuscript for review, but they did not participate in the research or in writing or editing of the manuscript.

Financial support. This work was funded by the Department of Veterans Affairs and by a grant from GOJO (to C. J. D.). All products used for testing were provided free of charge by GOJO.

Potential conflicts of interest. C. J. D. received research grants from GOJO, Clorox, EcoLab, and Altapure and serves on an advisory board for 3M. All authors have submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest. Conflicts that the editors consider relevant to the content of the manuscript have been disclosed.

References

1. Donskey CJ. Does improving surface cleaning and disinfection reduce healthcare-associated infections? Am J Infect Control 2013; 41:S12–9.
2. Neely AN. A survey of Gram-negative bacteria survival on hospital fabrics and plastics. J Burn Care Rehabil 2000; 21:523–7.
3. Das I, Lambert P, Hill D, et al. Carbapenem-resistant Acinetobacter and role of curtains in an outbreak in intensive care units. J Hosp Infect 2002; 50:110–4.
4. Klakus J, Vaughan NL, Boswell TC. Metillin-resistant Staphylococcus aureus contamination of hospital curtains. J Hosp Infect 2008; 68:189–90.
5. Trillis F 3rd, Eckstein EC, Budavich R, et al. Contamination of hospital curtains with healthcare-associated pathogens. Infect Control Hosp Epidemiol 2008; 29:1074–6.
6. National Pesticide Information Retrieval System. Available at: http://npirspublic.cers.purdue.edu/ppis/. Accessed 1 August 2016.
7. ASTM International, Designation E2197: Standard Quantitative Disk Carrier Test Method for Determining Bactericidal, Virucidal, Fungicidal, Mycobactericidal, and Sporicidal Activities of Chemicals, 2011. Available at: https://www.astm.org/Standards/E2197.htm. Accessed 1 August 2016.
8. Nerandzic MM, Cadnum JL, Pultz MJ, Donskey CJ. Evaluation of an automated ultraviolet radiation device for decontamination of Clostridium difficile and other healthcare-associated pathogens in hospital rooms. BMC Infect Dis 2010; 10:197.
9. Rutala WA, Weber DJ. Selection of the ideal disinfectant. Infect Control Hosp Epidemiol 2014; 35:855–65.
10. Rutala WA, Gergen MF, Weber DJ. Efficacy of improved hydrogen peroxide against important healthcare-associated pathogens. Infect Control Hosp Epidemiology 2012; 33:1159–61.