

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

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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. We also examined the potential of the products to stain clothing.

### 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- $\beta$ -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-cm<sup>2</sup> 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-cm<sup>2</sup> 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) 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

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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  $\geq 5.5$  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 ( $P \leq .01$ ) and a composite of any pathogen recovered ( $P < .001$ ); for both disinfectants,

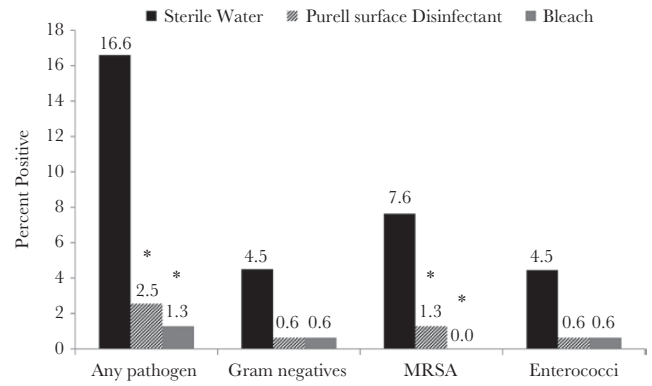


Figure 2. Percentage of hard or soft surfaces with positive cultures for pathogens after a 30-second exposure to sterile water (negative control), Purell Healthcare Surface Disinfectant, or Clorox Healthcare Bleach Germicidal Cleaner applied as a spray followed by wiping with a paper towel to ensure thorough coverage of the surface. MRSA, methicillin-resistant *Staphylococcus aureus*. \*,  $P \leq .01$ .

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 ( $P \geq .49$ ).

## 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

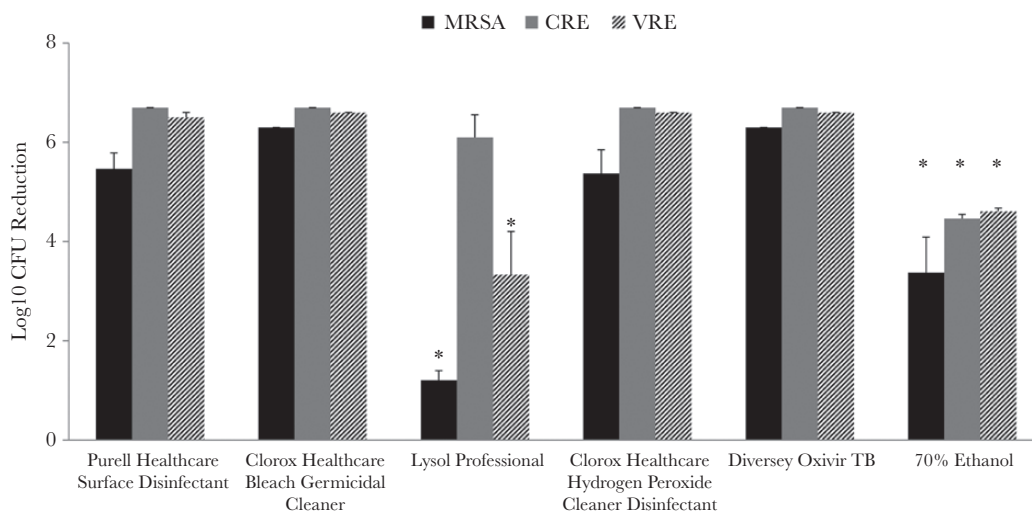


Figure 1. Log reduction of methicillin-resistant *Staphylococcus aureus* (MRSA), carbapenem-resistant *Escherichia coli* (CRE), and vancomycin-resistant *Enterococcus* (VRE) after 30 seconds of exposure to commercial disinfectants or 70% ethanol on steel disk carriers. Log reductions for each disinfectant 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.

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