American Journal of Infection Control 45 (2017) e69-e73

Contents lists available at ScienceDirect

American Journal of Infection Control

journal homepage: www.ajicjournal.org

Major Article

Effectiveness of cleaning-disinfection wipes and sprays against multidrug-resistant outbreak strains

Nikki Kenters BSc [a,*], Elisabeth G.W. Huijskens PhD, MD [a,b], Sophie C.J. de Wit BSc [a], Joost van Rosmalen PhD [c], Andreas Voss PhD, MD [d,e]

[a] Department of Infection Prevention and Control, Albert Schweitzer Hospital, Dordrecht, The Netherlands
[b] Department of Medical Microbiology, Albert Schweitzer Hospital, Dordrecht, The Netherlands
[c] Department of Biostatistics, Erasmus MC, Rotterdam, The Netherlands
[d] Department of Medical Microbiology, Radboud University Medical Centre, Nijmegen, The Netherlands
[e] Department of Medical Microbiology, Canisius-Wilhelmina Hospital, Nijmegen, The Netherlands

Key Words:
Cleaning-disinfecting wipes
Cleaning-disinfecting sprays
Outbreak strains
ATP
CFU

Background: Hospital rooms play an important role in the transmission of several health care–associated pathogens. During the last few years, a number of innovative cleaning-disinfecting products have been brought to market. In this study, commercially available products combining cleaning and disinfection were compared, using 2 different application methods. The aim was to determine which product was most effective in simultaneous cleaning and disinfection of surfaces.

Methods: Seven cleaning-disinfecting wipes and sprays based on different active ingredients were tested for their efficacy in removal of microbial burden and proteins. Efficacy was tested with known Dutch outbreak strains: vancomycin-resistant enterococci (VRE), *Klebsiella pneumoniae* OXA-48, or *Acinetobacter baumannii*.

Results: For all bacteria, ready-to-use cleaning-disinfecting products reduced the microbial count with a $\log_{10}$ reduction >5 with a 5-minute exposure time, with the exception of a spray based on hydrogen peroxide. Omitting the aforementioned hydrogen peroxide spray, there were no significant differences between use of a wipe or spray in bacterial load reduction. Using adenosine triphosphate (ATP) measurements, a significant difference in $\log_{10}$ relative light units (RLU) reduction between various bacteria ($P \leq .001$) was observed.

Conclusions: In general, a >5 $\log_{10}$ reduction of colony forming units (CFU) for tested wipes and sprays was obtained for all tested bacteria strains, with exception of hydrogen peroxide spray and VRE. Although ATP may show a difference between pre- and postcleaning, RLU reduction does not correlate with actual CFU reductions.

It is becoming apparent that cleaning and disinfection of patient environments in hospitals is extremely important. Multidrug-resistant microorganisms are emerging globally.[1] Hospital rooms play an import role in the transmission of several health care–associated pathogens, including (methicillin-resistant) *Staphylococcus aureus*, vancomycin-resistant enterococci (VRE), and norovirus.[2] All these microorganisms persist in the environment for an extended amount of time.[3] Research has shown that patients admitted to a hospital room that was previously occupied by a patient that harbored a health care–associated pathogen have a greater risk factor of getting colonized or infected with the same pathogen.[3]

Improved terminal cleaning and disinfection of rooms leads to decreased rates of pathogen transmission.[4] Still, multiple studies have demonstrated that <50% of hospital rooms are adequately cleaned and disinfected when chemical germicides are used.[4-6]

Over the last few years, a number of innovative cleaning and disinfecting products have come on to the market. Ultraviolet disinfection and hydrogen peroxide vapor devices are becoming common in hospitals. These devices are an asset to terminal disinfection of patient rooms.[7,8] Ready-to-use cleaning-disinfecting wipes and sprays are becoming regular for cleaning and disinfection in hospitals. Ready-to-use products can be used for routine and terminal cleaning and disinfection. The ease of use of the wipes and sprays has the potential to save time and reduce barriers for health

* Address correspondence to Nikki Kenters, BSc, Albert Schweitzer Hospital, Albert Schweitzerplaats 25, 3318 AT Dordrecht, The Netherlands.
E-mail address: n.kenters@gmail.com (N. Kenters).
Conflicts of interest: None to report.

0196-6553/
http://dx.doi.org/10.1016/j.ajic.2017.04.290

Table 1
Disinfecting-cleaning wipe and spray ingredients

Wipe-spray	Composition*	Product	Manufacturer and manufacturer location
Wipe and spray A	Glucoprotamin 26 g/100 g (1.5%)	Incidin plus wipes	Ecolab, Nieuwegein, The Netherlands
Wipe and spray B	Hydrogen peroxide (Hi-speed H_2O_2): 15 mg/g (CAS 77-22-841)	Aseptix Sterimax Sporicide wipes	Aseptix, Loenen a/d Vecht, The Netherlands
Wipe and spray C	Ethanol 140 mg/g, propane-2-ol 100 mg/g; propane-1-ol 60 mg/g, N-alkyl amino propyl glycine (CAS 1397 34-65-9) 5 mg/g	Bacillol 30 tissues	Hartmann, Nijmegen, The Netherlands
Spray D	Didecyldimonium chloride, benzalkonium chloride, polyaminopropyl biguanide, dimethicone	Formula 429 spray	Formula 429, Amsterdam, The Netherlands

*Active ingredient(s).

care workers to apply these ready-to-use products. Because antimicrobial resistance is becoming a big threat for effective treating of infections, cleaning and disinfection products are of great importance to reduce transmission between patients. Currently, there is a lack of evidence that these products are truly effective in cleaning and disinfecting at the same time. The aim of this study was to compare the effectiveness of commercially available products in simultaneous cleaning and disinfection with 2 different application methods.

MATERIALS AND METHODS

Cleaning-disinfecting wipes and sprays

Seven cleaning-disinfecting wipes were obtained from different manufacturers. The wipes and sprays are currently used in health care facilities around Europe, except spray D is not yet, to our knowledge, available. Specifications of wipes and sprays are summarized in Table 1.

Bacteria isolates

Vancomycin-resistant *Enterococcus faecium* (isolate from 2013 outbreak at Canisius-Wilhelminia Hospital, The Netherlands), *Klebsiella pneumoniae* OXA-48 (isolate from 2011 outbreak at Maasstad Hospital, The Netherlands), and *Acinetobacter baumannii* (ATCC, Rockville, MD) were used as test organisms. Strains were grown overnight at 37°C on blood agar.

Efficacy of cleaning-disinfectant products in removal of microorganisms

Bacterial isolates were suspended in physiologic saline and adjusted to a McFarland standard of 0.5. Test organisms were then added to 2 different test soils. All tests were performed in triplicate, including a positive control per test organism. The colony forming units (CFU) found in the positive control were used for analysis.

The first test soil contained 3% bovine serum albumin with 0.3% sheep erythrocytes, and the second test soil contained 12% bovine serum albumin with 10% sheep erythrocytes.[9] The test solution used consisted of 1 mL of bacterial suspension, 0.2 mL of soil solution, and 0.8 mL diluent. Standardized ceramic tiles (3709/PA00; Villeroy & Boch, Mettlach, Saarland, Germany) measuring 5×5 cm were used as the test surface. Tiles were sterilized before use. Tiles were contaminated with 0.1 mL of test suspension. Test suspension was evenly spread over the whole area of the tile and was left to dry for 1 hour at room temperature under laminar airflow.

To measure adenosine triphosphate (ATP), the tiles were swabbed with a consistent pattern (up and down, left to right while the swab was rotated). The swabs were then reinserted into their container and allowed to react with the reagents in the cuvette for 10 seconds. The swabs were placed into the Clean-Trace NG Luminometer (3M; Neuss, North Rhine-Westphalia, Germany), and relative light units (RLU) were recorded.

Table 2
Mean $\log_{10}$ bacterial load reduction and mean $\log_{10}$ RLU reduction of cleaning-disinfection products with 95% CIs

Product	Log_{10} CFU reduction	Log_{10} RLU reduction
Wipe A	5.77 (95% CI, 5.61-5.94)	1.98 (95% CI, 1.85-2.11)
Spray A	5.74 (95% CI, 5.58-5.90)	1.95 (95% CI, 1.82-2.08)
Wipe B	5.58 (95% CI, 5.41-5.74)	2.27 (95% CI, 2.14-2.39)
Spray B	5.33 (95% CI, 5.16-5.49)	1.82 (95% CI, 1.69-1.94)
Wipe C	5.56 (95% CI, 5.40-5.73)	1.84 (95% CI, 1.71-1.97)
Spray C	5.69 (95% CI, 5.53-5.85)	1.78 (95% CI, 1.65-1.91)
Spray D	5.72 (95% CI, 5.56-5.89)	1.60 (95% CI, 1.46-1.76)

CFU, colony forming units; *CI*, confidence interval; *RLU*, relative light unit.

To measure CFUs, the contaminated tile was wiped with a cloth or sprayed and then wiped with a paper towel with the products described in Table 2. A single technician performed all tests. A standardized sweeping technique was used, starting in the left upper corner performing a meander-like pattern, with 4 turns, ending in the right lower corner.

The tile was then placed into the neutralizer. The neutralizer consisted of lecithin 3 g/L, L-histidine 1 g/L, and saponin 30 g/L in diluent (tryptone, pancreatic digest of casein 1.0 g/L, and sodium chloride 8.5 g/L). After 2 minutes of rest in the neutralizer (10 mL), and 3 minutes of horizontal shaking (150 rpm) with glass beads (15 g, 5 mm), an aliquot of the suspension was plated on tryptic soy agar. After the incubation time of 24 hours at 37°C on tryptic soy agar, CFU were counted.

To measure ATP after the treatment of cleaning-disinfection, products on the tile were swabbed again as previously described and then recorded.

Statistical analyses

Analysis of variance was used with the $\log_{10}$ reduction of CFU and RLU as the dependent variable and bacteria, wipes A-C and sprays A-D, and level of soil (3% and 12%) as the independent variables. Two-way interaction effects of bacteria, wipe-spray, and level of pollution were included in the model when statistically significant. Tukey method for multiple comparisons of means was used to evaluate the differences between the different products and bacteria. The results of the analysis of variance models are presented using estimated marginal means, which are the predicted values of the dependent variable adjusted for the effects of the independent variables. Association between CFU and RLU was assessed using Spearman rank correlation. All statistical analyses were carried out in R version 3.1.1 (R Core Team, Vienna, Austria), and a 2-sided significance level of .05 was used.