CONCISE COMMUNICATION

Effectiveness of an Antimicrobial Polymer to Decrease Contamination of Environmental Surfaces in the Clinical Setting

Kerri A. Thom, MD, MS;[1] Harold C. Standiford, MD;[1] J. Kristie Johnson, PhD;[1] Nader Hanna, MD;[1] Jon P. Furuno, PhD[2]

We performed a real-world, controlled intervention to investigate use of an antimicrobial surface polymer, MSDS Poly, on environmental contamination. Pathogenic bacteria were identified in 18 (90%) of 20 observations in treated rooms and 19 (83%) of 23 observations in untreated rooms ($P = .67$). MSDS Poly had no significant effect on environmental contamination.

Infect Control Hosp Epidemiol 2014;35(8):1060-1062

Bacterial contamination of environmental surfaces may lead to patient-to-patient transmission and subsequent infection of at-risk patients via the hands of healthcare workers or through direct acquisition from environmental fomites.[1,2] However, compliance with environmental cleaning has been historically poor.[1] Even with adequate environmental cleaning, surfaces may become rapidly recontaminated. Novel methods are needed to decrease environmental contamination and limit spread of organisms. This study aimed to determine whether rooms treated with a silicone quaternary amine antimicrobial surface polymer (MSDS Poly; Dow Chemical) were less likely to become environmentally contaminated with important, common pathogenic bacteria compared with untreated rooms.

METHODS

A controlled intervention trial was performed in the 10-bed adult surgical intermediate care unit at the University of Maryland Medical Center (UMMC) during September and October 2007 to compare bacterial contamination of environmental surfaces in rooms treated with MSDS Poly ($n = 5$) and rooms left untreated ($n = 5$). Because the antimicrobial surface polymer is invisible, neither patients nor staff were aware of room treatment status. Study personnel performing data collection and microbiologic evaluation were additionally blinded. Daily environmental and postdischarge cleaning were performed according to hospital protocol.

The product investigated in this study is a silicone quaternary amine, MSDS Poly, which has broad-spectrum antimicrobial activity against a range of viruses, fungi, and bacteria. The active ingredient is 3-(trimethoxysily)-propyl dimethyl octadecyl ammonium chloride; the product safety has been studied previously.[3,4]

Room treatment status was based on room availability and therefore was approximately random. Before application, rooms were cleaned according to standard UMMC protocol, and vaporized hydrogen peroxide was used to decontaminate all surfaces. Aerosolized MSDS Poly was applied to all surfaces (eg, walls, floors, beds and other furniture, and hospital equipment including bedside patient-monitoring systems) in the treated rooms using an air-assisted electrostatic sprayer, ESS Sprayer (AMG Scientific).

We collected environmental cultures using a single swab of each of the following sites: sink basin and surrounding counter, call button apparatus, bedside table, bedside patient vital signs monitor, telephone, supply cart, door handle, and floor. In addition, a "composite swab" was used to sample multiple surfaces simultaneously (all sites excluding floor). Environmental cultures were obtained 2 days per week during the study period from all rooms provided that they were occupied by a patient for at least 24 hours.

Only the composite and floor swab specimens were processed initially. Additional swab specimens from individual sites were analyzed only if the composite swab was positive. Swabs were analyzed using standard methods for the presence of any of the following bacterial species: *Staphylococcus aureus, Enterococcus* species, *Acinetobacter baumannii, Pseudomonas aeruginosa, Klebsiella pneumoniae,* and *Escherichia coli.* If either enterococci or *S. aureus* were identified, strains were additionally processed for vancomycin resistance (vancomycin-resistant enterococci [VRE]) and methicillin resistance (methicillin-resistant *S. aureus* [MRSA]), respectively.

The proportion of positive environmental cultures was calculated for all. The Fisher exact test was used to compare the 2 proportions.

RESULTS

Environmental samples were obtained on 7 separate days in September and October of 2007. There were 43 total observations (20 treated and 23 untreated); where an observation included environmental sampling of a single room on 1 of the 7 sampling days. In total, 343 environmental samples were obtained; 159 samples were from rooms treated with MSDS Poly, and 184 were from untreated rooms.

At least 1 bacterial species of interest was identified from environmental samples in 18 (90%) of the 20 observations among MSDS Poly–treated rooms compared with 19 (83%) of the 23 observations among untreated rooms ($P = .67$). Fewer VRE were isolated from treated rooms; however, this was not true for other organisms (Table 1). *P. aeruginosa* was the most common organism isolated overall; 23 (53%) of 43 observations had a least 1 culture positive for *P. aeruginosa.*

https://doi.org/10.1086/677159 Published online by Cambridge University Press

TABLE 1. Bacterial Pathogens Identified by Treatment Status

Nosocomial pathogen	Percentage (proportion) of rooms contaminated			
	All rooms (n = 43)	Treated rooms (n = 20)	Untreated rooms (n = 23)	Fisher exact P value
Pseudomonas aeruginosa	60 (26/43)	65 (13/20)	43 (13/23)	.76
Staphylococcus aureus	33 (14/43)	40 (8/20)	26 (6/23)	.52
Methicillin susceptible		20 (4/20)	4 (1/23)	
Methicillin resistant		20 (4/20)	22 (5/23)	
Enterococcus	42 (18/43)	35 (7/20)	48 (11/23)	.054
Vancomycin susceptible		10 (2/20)	0	
Vancomycin resistant		25 (5/20)	48 (11/23)	
Acinetobacter baumannii	5 (2/43)	5 (1/20)	4 (1/23)	1.00
Escherichia coli	0	0	0	
Klebsiella pneumoniae	0	0	0	

NOTE. Microbiologic evaluation included identification of *S. aureus, Enterococcus* species, *A. baumannii, P. aeruginosa, K. pneumoniae* and *E. coli.*

Based on the single-site samples and among all rooms with any bacteria identified, the floor and the patient sink were the environmental sites most commonly contaminated with bacteria (27 [73%] of 37 and 15 [41%] of 37, respectively; Table 2).

DISCUSSION

Our results suggest that MSDS Poly had no effect on environmental contamination with important, potentially pathogenic bacteria. Environmental surfaces in the rooms treated with MSDS Poly were nearly equally likely to be contaminated by nosocomial bacteria as untreated rooms; 90% versus 83% (P = .67). Furthermore, treatment of environmental surfaces with MSDS Poly had no effect on the particular pathogen identified (with the exception of VRE) nor on the environmental site contaminated. Although the findings related to VRE are interesting, we cannot explain this decrease in light of no effect being seen for other organisms, and thus we would be hesitant to attribute the reduction to the intervention.

Few studies have evaluated the use of antimicrobial agents embedded onto environmental surfaces in the clinical setting, and to our knowledge there are no controlled trials. Varghese et al[5] used silver silica to coat environmental surfaces in a simulated setting and demonstrated significant and sustained killing of test strains of *S. aureus, Enterococcus faecalis, P. aeruginosa,* and *E. coli.* D'Antonio et al[6] coated hospital keyboards with an antimicrobial polymer (Biosafe HM 4100) embedded into polyurethane, also in a simulated setting, and observed reduced viability of MRSA, VRE, *E. coli*, and *P. aeruginosa.* The use of light-activated (photosensitizer) antimicrobial agents to reduce bacterial contamination of surfaces has also been studied and has demonstrated significantly reduced contamination of objects on a shelving unit in a clinical setting.[7-9] These studies suggest that antimicrobial coating of healthcare surfaces is a potentially useful strategy in infection prevention efforts aimed at reducing transmission of microorganisms from the environment to patients. However, more data in the clinical setting are needed to understand how these products can best be utilized.

Although the negative results of this study suggest MSDS Poly is not effective in preventing bacterial contamination of

TABLE 2. Contamination of Environmental Surfaces by Bacteria

Environmental site	Percentage (proportion) of rooms contaminated			
	All rooms with bacteria identified (n = 37)	Treated rooms with bacteria identified (n = 18)	Untreated rooms with bacteria identified (n = 19)	Fisher exact P value
Patient sink	41 (15/37)	44 (8/18)	37 (7/19)	.74
Call button apparatus	5 (2/37)	6 (1/18)	5 (1/19)	1.00
Bedside table	3 (1/37)	0	5 (1/19)	1.00
Vital signs monitor	0	0	0	
Telephone	3 (1/37)	0	5 (1/19)	1.00
Supply cart	5 (2/37)	6 (1/18)	5 (1/19)	1.00
Door handle	3 (1/37)	0	5 (1/19)	1.00
Floor	73 (27/37)	72 (13/18)	74 (14/19)	1.00

https://doi.org/10.1086/677159 Published online by Cambridge University Press

hospital surfaces, alternatively, MSDS Poly may not have adhered to the environmental surfaces. Although a bromophenol blue indicator is available to detect the presence of MSDS Poly, the active component of this indicator detects all quaternary amines, including those present in many hospital cleaning products, and is thus not reliable in this setting. Future studies of this and similar products should include a reliable test for the presence of the antimicrobial surface polymer to determine adherence.

In addition to potential problems of adherence, there are several other limitations to this study. First, hospital rooms contain many movable surfaces (eg, furniture and equipment that can move between patient rooms), which may have impacted study results. To prevent movement, surfaces were labeled, locations were recorded daily, and if surfaces were found to have been moved, they were returned to their original location. In addition, this study was performed in a single hospital unit; therefore, the results may not be generalizable to other hospital populations.

In conclusion, we observed that the treatment of hospital environmental surfaces with the antimicrobial surface polymer MSDS Poly had no overall effect on environmental contamination with potentially pathogenic bacteria. Before hospitals invest in this or similar products, more studies are needed to determine efficacy; we believe that similar studies should be repeated using this or similar antimicrobial products as long as a reliable indicator for adherence of the antimicrobial agents to hospital surfaces is available.

ACKNOWLEDGMENTS

Financial support. This study was supported in part by an unrestricted scientific grant from American Mold Guard Scientific and by the National Institutes of Health (1K01AI071015-05 to J.P.F; 1K12RR023250-05 to J.K.J.; 1K23AI082450-03 to K.A.T.).

Potential conflicts of interest. All authors report no conflicts of interest relevant to this article. All authors submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest, and the conflicts that the editors consider relevant to this article are disclosed here.

Affiliations: 1. University of Maryland School of Medicine, Baltimore, Maryland; 2. Oregon State University/Oregon Health & Science University College of Pharmacy, Portland, Oregon.

Address correspondence to Kerri A. Thom, MD, MS, 685 West Baltimore Street, MSTF Suite 334B, Department of Epidemiology and Public Health, University of Maryland School of Medicine, Baltimore, Maryland 21201 (kthom@epi.umaryland.edu).

Received January 3, 2014; accepted March 24, 2014; electronically published June 20, 2014.

© 2014 by The Society for Healthcare Epidemiology of America. All rights reserved. 0899-823X/2014/3508-0019$15.00. DOI: 10.1086/677159

REFERENCES

1. Carling PC, Bartley JM. Evaluating hygienic cleaning in health care settings: what you do not know can harm your patients. *Am J Infect Control* 2010;38(5 suppl 1):S41–S50.
2. Huang SS, Datta R, Platt R. Risk of acquiring antibiotic-resistant bacteria from prior room occupants. *Arch Intern Med* 2006; 166(18):1945–1951.
3. Siddiqui WH, Malek JR, Stanton E, Hobbs EJ. Percutaneous absorption of an antimicrobial organosilicon quarternary ammonium chloride in rabbits. *J Appl Toxicol* 1983;3(3):146–149.
4. Siddiqui WH, York RG. Quaternary silsesquioxane: a developmental toxicity study in rats. *Fundam Appl Toxicol* 1993;21(1): 66–70.
5. Varghese S, Elfakhri S, Sheel DW, Sheel P, Bolton FJ, Foster HA. Novel antibacterial silver-silica surface coatings prepared by chemical vapour deposition for infection control. *J Appl Microbiol* 2013;115(5):1107–1116.
6. D'Antonio NN, Rihs JD, Stout JE, Yu VL. Computer keyboard covers impregnated with a novel antimicrobial polymer significantly reduce microbial contamination. *Am J Infect Control* 2013; 41(4):337–339.
7. Wilson M. Light-activated antimicrobial coating for the continuous disinfection of surfaces. *Infect Control Hosp Epidemiol* 2003; 24(10):782–784.
8. Ismail S, Perni S, Pratten J, Parkin I, Wilson M. Efficacy of a novel light-activated antimicrobial coating for disinfecting hospital surfaces. *Infect Control Hosp Epidemiol* 2011;32(11):1130–1132.
9. Decraene V, Pratten J, Wilson M. An assessment of the activity of a novel light-activated antimicrobial coating in a clinical environment. *Infect Control Hosp Epidemiol* 2008;29(12):1181–1184.

https://doi.org/10.1086/677159 Published online by Cambridge University Press