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

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Abstract

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 90% (18/20) of treated-room-observations and 83% (19/23) of the untreated-room-observations ($p=0.67$). MSDS Poly had no significant effect on environmental contamination.

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 re-contaminated. Novel methods are needed to decrease environmental contamination and limit spread of organisms. This study aimed to determine if rooms treated with a silicone quaternary amine antimicrobial surface polymer (MSDS Poly), were less likely to become environmentally contaminated with important, common pathogenic bacteria compared to untreated rooms.

METHODS

Study Design

A controlled, intervention trial was performed in the 10-bed, adult, Surgical Intermediate Care Unit (SIMC) 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 ($n=5$). Since 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 post-discharge cleaning were performed according to hospital protocol.

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Application of the Antimicrobial Surface Polymer

The product investigated in this study is a silicone quaternary amine, MSDS Poly (Dow Chemical Company, Midland, MI), which has broad-spectrum antimicrobial activity against a range of viruses, fungi and bacteria. The active ingredient is 3-(trimethoxysilyl)- 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. Prior to 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 (e.g. 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, San Juan Capistrano, CA).

Environmental Sampling

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, phone, 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 two days per week during the study period from all rooms so long as they were occupied by a patient for at least 24 hours.

Microbiologic Methods

Only the composite and the ‘floor’ swab were processed initially. Additional swabs 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* spp, *Acinetobacter baumannii*, *Pseudomonas aeruginosa*, *Klebsiella pneumoniae*, and *Escherichia coli*. If either enterococci or *S. aureus* were identified, strains were additionally processed for vancomycin (VRE) and methicillin resistance (MRSA), respectively.

Statistical Methods

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

RESULTS

Environmental samples were obtained on seven 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 one of the seven sampling days. In total, 343 environmental samples were obtained; 159 samples from rooms treated with MSDS Poly and 184 from untreated rooms.

At least one bacterial species of interest was identified from environmental samples in 18 of the 20 observations (90%) among MSDS Poly-treated rooms compared to 19 of the 23 observations (83%) among untreated rooms; $p = 0.67$. 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, 53% (23/43) of observations had a least one culture positive for *P. aeruginosa*. Based on the single site samples and among all rooms with any bacteria identified, the floor and the patient sink were the most common environmental sites contaminated with bacteria; 73% (27/37) and 41% (15/37) 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% vs. 83%, $p=0.67$. 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. While the findings related to VRE are interesting, we cannot explain this decrease in light of no effect for other organisms seen, and thus 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.* used silver silica to coat environmental surfaces in a simulated setting and demonstrated significant and sustained killing of test-strains of *S. aureus*, *E. faecalis*, *P. aeruginosa*, and *E. coli* (5). D'Antonio *et al.*, 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*(6). The use of light-activated (photosensitizer) antimicrobial agents to reduce bacterial contamination of surfaces has also been studied and 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 potential 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 be best utilized.

Although, the negative results of this study suggest MSDS Poly, is not effective in preventing bacterial contamination of hospital surfaces, alternatively, MSDS Poly may not have adhered to the environmental surfaces. While 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 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 (e.g. furniture and equipment

that can move between patient rooms), which may have impacted study results. In order to prevent movement, surfaces, were labeled, location was recorded daily and if found to have been moved, 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.

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Table 1

Bacterial Pathogens Identified* by Treatment Status

Nosocomial Pathogen % of Rooms Contaminated (No.)	All Rooms (N = 43)	Group Assignment		Fisher's Exact p – value
		Treated Rooms (N = 20)	Untreated Rooms (N = 23)	
<i>Pseudomonas aeruginosa</i>	60% (26/43)	65% (13/20)	43% (13/23)	0.76
<i>Staphylococcus aureus</i>	33% (14/43)	40% (8/20)	26% (6/23)	0.52
Methicillin-sensitive		20% (4/20)	4% (1/23)	
Methicillin-resistant		20% (4/20)	22% (5/23)	
<i>Enterococcus</i>	42% (18/43)	35% (7/20)	48% (11/23)	.054
Vancomycin-sensitive		10% (2/20)	0	
Vancomycin-resistant		25% (5/20)	48% (11/23)	
<i>Acinetobacter baumannii</i>	5% (2/43)	5% (1/20)	4% (1/23)	1.00
<i>Escherichia coli</i>	0	0	0	--
<i>Klebsiella pneumoniae</i>	0	0	0	--

* Microbiologic evaluation included identification of: *Staphylococcus aureus*, *Enterococcus* species, *Acinetobacter baumannii*, *Pseudomonas aeruginosa*, *Klebsiella pneumoniae* and *Escherichia coli*.

Table 2

Contamination of Environmental Surfaces by Bacteria

Environmental Site	All Rooms with Bacteria Identified N = 37	Group Assignment		Fisher's Exact p-value
		Treated Rooms with Bacteria Identified N = 18	Untreated Rooms with Bacteria Identified N = 19	
Patient sink (% , No. positive)	41% (15/37)	44% (8/18)	37% (7/19)	0.74
Call button apparatus (% , No. positive)	5% (2/37)	6% (1/18)	5% (1/19)	1.00
Bedside table (% , No. positive)	3% (1/37)	0	5% (1/19)	1.00
Vital signs monitor (% , No. positive)	0	0	0	--
Phone (% , No. positive)	3% (1/37)	0	5% (1/19)	1.00
Supply cart (% , No. positive)	5% (2/37)	6% (1/18)	5% (1/19)	1.00
Door handle (% , No. positive)	3% (1/37)	0	5% (1/19)	1.00
Floor (% , No. positive)	73% (27/37)	72% (13/18)	74% (14/19)	1.00