CONCISE COMMUNICATION

A Randomized Crossover Trial to Decrease Bacterial Contamination on Hospital Scrubs

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Healthcare worker attire may become contaminated with pathogenic organisms during a normal shift. We performed a randomized crossover study to assess whether treatment with an antimicrobial coating would decrease bacterial contamination on scrubs. Thirty percent of all scrubs were contaminated; there was no difference in the rate of contamination between the intervention and control groups.

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Healthcare worker (HCW) attire is regularly contaminated during the course of a typical shift and has the potential to serve as an important bacterial reservoir, leading to healthcare-associated infections (HAIs). Up to 40% of HAIs can be attributed to cross-contamination from HCWs who have become contaminated in the course of their daily work.[1]

We performed a blinded, randomized crossover trial to assess the efficacy of a novel antimicrobial treatment, Chitosan/DMDM Hydantoin (Sanogiene; BioMed Protect), of hospital scrubs in decreasing bacterial contamination on scrubs at the end of a typical hospital shift. Chitosan, the primary active ingredient in the Sanogiene product, is a derivative of chitin, a major component of crustacean shells, and has demonstrated antimicrobial properties. Through a proprietary curing process, Sanogiene can be applied to various textiles containing at least 20% cotton fibers and has been used in commercial and industrial applications. For more information, see http://www.biomedprotect.com/index.php/products/sanogiene/.

METHODS

We used a blinded, randomized crossover study design in which participants served as their own control. Nurses and patient care technicians from adult intensive and intermediate care units at the University of Maryland Medical Center were enrolled. Each participant was given 4 sets (top and bottom) of scrubs: 2 sets treated with the antibacterial agent using a proprietary curing process (intervention), and 2 sets left untreated (control). All scrubs were labeled 1–4, and each participant was given a randomized sequence of wear (eg, participant A wears scrubs 2, 4, 3, and 1 in a repeating pattern). Randomization was performed using an online random-sequence generator.[2] Participants were instructed to perform standard laundering at home. All scrubs looked and felt identical, and participants were blinded to which were intervention and which were control scrubs.

The outcome of interest was the frequency of scrub contamination for overall rate of scrub contamination with pathogenic bacteria (any of *Staphylococcus aureus, Enterococcus* species, or gram-negative bacteria) after a hospital shift. The secondary outcome of interest was the total colony count of all aerobic bacteria.

To detect pathogenic bacteria, a sterile, premoistened double-tipped swab (Remel) was rubbed over the front of the scrub top in a large W pattern, including the waist and chest, and down the front of both thighs. For the secondary outcome of total aerobic colony counts, a RODAC (Becton Dickinson) agar plate was directly stamped on to the scrub top near the belly button. These sampling areas are the most likely to be touched by one's own hands (especially on scrub-top styles with lower front pockets) and come into regular contact with patients and items in the environment (eg, bedding) during the course of regular duties. Samples were taken during the last 4 hours of the 12-hour shift to allow ample time within a shift for potential scrub contamination. Redundancy was included in scheduling to ensure full data collection (ie, if a participant was not wearing appropriate study scrubs during a sample collection visit, no cultures were collected, and the visit was repeated).

Enrichment cultures plated to selective media were used to detect gram-negative bacteria, *S. aureus* and *Enterococcus* species. Bacterial isolates were identified by standard laboratory protocols. Susceptibility testing was performed in accordance with CLSI guidelines.[3] Gram-negative isolates were considered to be multidrug resistant if they exhibited resistance to 3 or more classes of antibiotics.[4]

For total colony counts, RODAC plates were incubated for 48 hours, and colonies were counted using an eCount precise electronic counter (Heathrow Scientific). Analysis was performed using generalized estimating equations in SAS, version 9.2 (SAS Institute).

RESULTS

A total of 110 HCWs were enrolled; 90 completed full data collection and were included in the analysis, for a total of 720 samples. Excluded from the analysis were 20 participants with incomplete data as a result of changes in shift or employment status. Overall, 217 (30%) of 720 scrubs were contaminated with pathogenic bacteria, which included 108 (30.0%) of 360 treated scrubs and 109 (30.3%) of 360 nontreated scrubs ($P = .93$). When stratified by type of bacteria (ie, *S. aureus, Enterococcus* species, or gram-negative bacteria), the difference in contamination on treated versus nontreated scrubs remained insignificant in each category (Table 1). There was also no difference in contamination between newer

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TABLE 1. Bacterial Contamination on Treated versus Nontreated Scrubs

	Bacteria present		
Pathogen	Treated (n = 360)	Nontreated (n = 360)	P
Overall pathogenic bacteria	108 (30)	109 (30.3)	.93
Staphylococcus aureus	61 (16.9)	55 (15.3)	.50
Enterococcus species	7 (1.9)	14 (3.9)	.17
Gram-negative rods	54 (15)	59 (16.4)	.55
MDR (MRSA, VRE, or MDR gram-negative rods)	16 (4.4)	28 (7.8)	.06

NOTE. MDR, multidrug resistant; MRSA, methicillin-resistant *S. aureus*; VRE, vancomycin-resistant enterococci.

scrubs (less than 16 days old, the median number of participation-days) and scrubs older than 16 days, and no significant difference in contamination with pathogenic bacteria by intensive care unit versus intermediate care unit or by trauma versus nontrauma unit. The average colony-forming unit (CFU) count was 49 CFU for treated and 52 CFU for nontreated scrubs (P = .67). One hundred percent of participants self-reported scrubs were home laundered before each wear. No adverse events were reported.

DISCUSSION

Antimicrobial coating of scrubs was not effective in preventing bacterial contamination. Regardless of bacterial species or resistance profile, nearly equal amounts of treated and nontreated scrubs became contaminated by pathogenic bacteria.

Other recent studies testing antimicrobial scrubs but using different products have shown similar ineffectiveness. An organosilane-based quaternary ammonium antimicrobial agent was tested against control scrubs in 2012; the treated textiles were found to be slightly protective against contamination by methicillin-resistant *S. aureus* but, in concordance with our study, not against vancomycin-resistant enterococci or multidrug-resistant gram-negative bacteria in the course of regular clinical duties among 30 participants. The investigators only sampled the opening of the pockets, and although HCW hands likely lead to contamination in this area, these sites are unlikely to be contaminated directly from interactions with the patient and their environment, which potentially lessens the opportunity to measure real-world efficacy.[5] In a similar study from 2013, 105 HCWs participated in a 3-armed randomized-control trial testing 2 different antimicrobial products (group A: proprietary antimicrobial chemical; group B: silver and 2 proprietary antimicrobial chemicals) against standard scrubs. Again, no difference in levels of contamination between either of the treated products and the control scrubs was found. It was also reported that several participants experienced dermatologic adverse effects related to wearing both types of treated scrubs.[6]

Although in vivo testing has not been positive, many studies assessing the antimicrobial effectiveness of materials including metal fibers, nanoparticles, and chemical coatings (including chitosan, one of the active ingredients in this study), have found success in the laboratory. Some bactericidal action is often detected in treated textiles in as few as 3 hours, and nearly complete bactericidal action is reported by 48 hours, whereas control textiles show essentially no reductions in contamination over time.[7-9]

Laboratory achievement may still be translated into successful non-attire-based healthcare applications. Recent research found that privacy curtains incorporating a proprietary metal alloy with antimicrobial properties in intensive care unit patient rooms increased the time of initial bacterial contamination of the curtains sevenfold (14 days vs 2 days until contamination).[10] These findings may be translatable to other environmental textiles, including bedding and other soft surfaces in the patient environment.

Breaking the link between bacterial contamination of HCW attire and HAI is an important step in the ongoing fight against these insidious infections. However, the lack of efficacy demonstrated in this study shows that more research and innovation, including in terms of the agents used and methods of impregnation, are necessary to determine the optimal mode of prevention for HCW attire contamination before hospitals or healthcare workers invest in antimicrobial scrubs.

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