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ORIGINAL ARTICLE

The Antimicrobial Scrub Contamination and Transmission (ASCOT) Trial: A Three-Arm, Blinded, Randomized Controlled Trial With Crossover Design to Determine the Efficacy of Antimicrobial-Impregnated Scrubs in Preventing Healthcare Provider Contamination

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OBJECTIVE. To determine whether antimicrobial-impregnated textiles decrease the acquisition of pathogens by healthcare provider (HCP) clothing.

DESIGN. We completed a 3-arm randomized controlled trial to test the efficacy of 2 types of antimicrobial-impregnated clothing compared to standard HCP clothing. Cultures were obtained from each nurse participant, the healthcare environment, and patients during each shift. The primary outcome was the change in total contamination on nurse scrubs, measured as the sum of colony-forming units (CFU) of bacteria.

PARTICIPANTS AND SETTING. Nurses working in medical and surgical ICUs in a 936-bed tertiary-care hospital.

INTERVENTION. Nurse subjects wore standard cotton-polyester surgical scrubs (control), scrubs that contained a complex element compound with a silver-alloy embedded in its fibers (Scrub 1), or scrubs impregnated with an organosilane-based quaternary ammonium and a hydrophobic fluoroacrylate copolymer emulsion (Scrub 2). Nurse participants were blinded to scrub type and randomly participated in all 3 arms during 3 consecutive 12-hour shifts in the intensive care unit.

RESULTS. In total, 40 nurses were enrolled and completed 3 shifts. Analyses of 2,919 cultures from the environment and 2,185 from HCP clothing showed that scrub type was not associated with a change in HCP clothing contamination ($P = .70$). Mean difference estimates were 0.118 for the Scrub 1 arm (95% confidence interval [CI], −0.206 to 0.441; $P = .48$) and 0.009 for the Scrub 2 rm (95% CI, −0.323 to 0.342; $P = .96$) compared to the control. HCP became newly contaminated with important pathogens during 19 of the 120 shifts (16%).

CONCLUSIONS. Antimicrobial-impregnated scrubs were not effective at reducing HCP contamination. However, the environment is an important source of HCP clothing contamination.

TRIAL REGISTRATION. Clinicaltrials.gov Identifier: NCT 02645214

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Approximately 1 in 25 patients contracts a healthcare-associated infection (HAI) each year in the United States; 75,000 die in the hospital as a result of their HAI.[1] Pathogens that cause HAIs can spread in the hospital via healthcare providers (HCPs) and/or the environment.[2] The complex interactions involved in pathogen transmission among patients, HCPs, and the environment are largely unknown.

Healthcare textiles, including curtains, sheets, and clothing, are frequently contaminated with epidemiologically important pathogens such as methicillin-resistant *Staphylococcus aureus* (MRSA), vancomycin-resistant enterococci (VRE), and *Clostridium difficile*.[3,4] Clothing of HCPs routinely becomes contaminated during clinical duties,[5–7] and it may serve as a source for transmission to patients or recontamination of the HCP or the environment.

Antimicrobial-impregnated textiles may decrease the acquisition and transmission of pathogens by HCP clothing. Preclinical data indicate that antimicrobial-impregnated

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textiles demonstrate activity against pathogens such as *S. aureus*, *Candida albicans*, *Acinetobacter* spp., vegetative *Clostridium difficile*, and *Klebsiella pneumoniae*.[8–10] However, data to support the use of antimicrobial-impregnated textiles in clinical practice are limited.[11–15]

We designed the Antimicrobial Scrub Contamination and Transmission (ASCOT) Trial (1) to determine whether antimicrobial-impregnated surgical scrubs decrease the burden of HCP clothing contamination compared to standard surgical scrubs following a 12-hour intensive care unit (ICU) shift and (2) to characterize the transmission dynamics of epidemiologically-important pathogens among the patient, the environment, and the HCP, a group we labeled the "transmission triangle."

METHODS

Study Design and Participants

We performed this blinded, 3-arm, randomized controlled trial with crossover design in 2 ICUs at Duke University Hospital between June 15, 2015, and January 10, 2016. The study included 1 control arm and 2 intervention arms. Nurses wore standard cotton-polyester surgical scrubs in the control arm. In the Scrub 1 intervention arm, nurses wore surgical scrubs that contained a complex element compound with a silver alloy embedded in its fibers. In the Scrub 2 intervention arm, nurses wore surgical scrubs impregnated with an organosilane-based quaternary ammonium and a hydrophobic fluoroacrylate copolymer emulsion. Nurses participated in each arm during 3 consecutive 12-hour shifts in the ICU. Study personnel laundered all study scrubs 5 times and delivered them to nurse participants in plastic bags. Nurses donned the study scrubs at home and presented to work according to their routines.

In this study, we enrolled nurses from the medical ICU and surgical ICU at Duke University Hospital, a 936-bed tertiary-care hospital in Durham, North Carolina, where ICU nurses typically care for patients in 2 ICU rooms each shift. All nurses working in the medical ICU or the surgical ICU were eligible for enrollment. Data from enrolled nurses who failed to complete all 3 shifts were excluded. Patients known to be colonized or infected with any multidrug-resistant pathogen were routinely placed on contact precautions, during which all HCPs wore gowns and gloves upon entry into the room. These ICUs did not perform routine active surveillance during the study period.

The Duke University Health System Institutional Review Board approved the study. Nurses provided written informed consent. We received a waiver of informed consent to collect data and specimens from the patients receiving care from enrolled nurses. The study is registered on ClinicalTrials.gov (NCT 02645214).

Randomization and Blinding

After obtaining consent from the nurse subject, the study coordinator provided the nurse with 3 sets of scrubs. Nurses were blinded to the type of scrub. Brands and labels were removed from scrubs; all scrubs were "Duke blue" in color. The study coordinator provided written and verbal instructions on which scrubs to wear with each shift. Nurse participants were randomized to 1 of 6 sequences of scrubs (Supplementary Table 1). The nurses wore a different scrub type during each of the 3 12-hour shifts, so each nurse participated in each study arm in a 1:1:1 ratio. The study team was not blinded during specimen and data collection. However, microbiology personnel were blinded to study arm allocation during the analysis of specimens.

Procedures

The study coordinator arrived at the ICU prior to the beginning of each shift to obtain cultures from each nurse's scrubs (sleeve, abdomen, and pocket) as well as specified "high touch" surfaces (bedrail, bed, and supply cart) in each of that nurse's 2 assigned rooms (Supplementary Figure 1). The coordinator repeated the process of obtaining samples from each nurse's scrubs and assigned rooms at the end of the nurse's shift. The study coordinator also obtained cultures from each patient who received care from a participating nurse during that shift. Specimens were collected from the anterior nares, the perirectal area, and from the integument (i.e., wounds, drains, or axilla). Microbiological methods are provided in detail in the Supplementary Material.

Cultures from each nurse/patient/room grouping were analyzed for the presence of similar species. A potential transmission event or "acquisition" was defined as the new identification of a target pathogen on nurse clothing, the patient, or the environment. A confirmed transmission event or "transmission" was defined as an acquisition event for which a source from the transmission triangle could be identified and confirmed. Organisms involved in acquisition events were analyzed for transmission events using pulsed-field gel electrophoresis (PFGE; see Supplementary Material).[16]

Finally, each nurse completed a 4-question survey at the end of the shift to describe how the scrubs worn during the shift compared to their standard work scrubs. Ultimately, each nurse answered 3 surveys, corresponding with each arm in the study.

Outcomes

The primary outcome of our study was the change in total contamination on nurse scrubs, measured as the sum of colony-forming units (CFU) of bacteria identified on nurse scrubs from each clothing location. The following predetermined secondary outcomes were measured: (1) the presence or absence of individual target pathogens; (2) the number and proportion of acquisitions and transmission events; and (3) HCP perceptions of clothing.

Statistical Analysis

This prospective, blinded, randomized trial was designed to test the hypothesis that antimicrobial-impregnated scrubs

would have a smaller increase in total contamination compared to control scrubs following a single 12-hour shift in the ICU. Data were summarized using standard statistical methods, as appropriate.

Power calculations were performed based on 2 primary assumptions. First, we assumed that the scrubs used in the control arm would have 2-log increase in total CFU from the beginning to the end of the shift (SD = 2).[12,13] Second, we assumed a within-nurse, between-shift correlation of 0.5 given the crossover design of the study. Based on these assumptions, we found that 40 subjects and 120 (40 subjects × 3 shifts) repeated measures would provide 90% power to determine a mean 1-log decrease (SD = 1) in HCP clothing contamination compared to the control. Power calculations were done with 2-sided significance level of 0.025 for each of the 2 primary comparisons.

We utilized a generalized estimating equation (GEE) linear regression model to compare the amount of contamination (log total CFU) between arms at the end of the shift. The model included type of scrubs, log total CFU in the beginning of shift, randomization sequence, patient characteristics (i.e., presence of a percutaneous drain, diarrhea, rectal tube present, or wound; the use of contact precautions; and mechanical ventilation), and total environmental contamination during the shift as covariates. An unstructured working correlation matrix was used. Adjusted mean difference estimates (compared to control) and 95% confidence intervals (CIs) were calculated for each intervention arm. The statistical significance for each of the 2 primary comparisons (each antimicrobial-impregnated scrub vs control) was corrected for multiple comparisons, and $P < .025$ was considered statistically significant. Responses to nurse questionnaires were compared using GEE logistic regression with type of scrubs as a covariate using unstructured working correlation matrix. We performed all statistical analyses using SAS version 9.4 software (SAS Institute, Cary, NC).

RESULTS

Randomized Controlled Trial Results

In total, 41 nurses were enrolled and randomized for study participation. We excluded 1 nurse because she failed to complete all 3 shifts due to illness. A total of 102 unique patients received care from 40 nurse subjects over 120 individual 12-hour ICU shifts and 167 patient encounters for an average of 1.4 patients per nurse per shift. Patients were generally similar across the 3 study arms (Table 1), though 4 of the patient characteristics were slightly less common in the Scrub 2 arm.

In total, 2,919 cultures were obtained from the environment in patient rooms during the 120 shifts. Environmental contamination was generally similar in the rooms entered by nurses during each arm, though contamination was highest during the control arm (Table 2; supplemental Figure 2). Of the 3 environmental locations tested, bed rails had the highest amount of contamination, followed by beds and supply carts.

A total of 2,185 cultures were obtained from HCP clothing during the 120 shifts. Our primary outcome, the increase in contamination of nurse clothing, was essentially unchanged across the 3 study arms (Table 3; Supplementary Figure 2). The median CFU increase was 61.5 (interquartile range [IQR],

TABLE 1. Characteristics of 102 Unique Patients and 167 Patient Encounters During 120 ICU Shifts in the ASCOT Trial

Characteristic	Overall (N = 102), No. (%)[a]	Control (N = 57), No. (%)[a]	Scrub 1 (N = 57), No. (%)[a,b]	Scrub 2 (n = 53), No. (%)[a,c]
Median length of hospitalization, d (IQR)	5.5 (2–15)	9 (2–18)	7 (2–21)	5 (1–13)
Median length of ICU stay, d (IQR)	3.5 (1–8)	4 (2–12)	4 (1–13)	3 (1–7)
Contact precautions	22 (22)	15 (26.3)	12 (21)	12 (23)
PEG tube present	19 (19)	15 (26.3)	18 (32)	10 (19)
Percutaneous drain present	27 (27)	13 (22.8)	13 (23)	14 (27)
Diarrhea	37 (36)	19 (34.5)	24 (42)	15 (28)
Rectal tube present	19 (19)	11 (19.3)	9 (16)	8 (15)
Mechanical ventilation	43 (42)	24 (42)	29 (51)	29 (56)
Wound present	52 (51)	31 (54)	36 (63)	27 (51)
Colonization or infection with target pathogens identified during admission	34 (33)	16 (29)	15 (29)	15 (29)
MRSA	13 (13)	6 (11)	4 (8)	6 (12)
VRE	18 (18)	8 (14)	7 (14)	8 (16)
MDR *Escherichia coli*	7 (7)	3 (5)	2 (4)	3 (6)
MDR *Klebsiella pneumoniae*	6 (6)	4 (7)	5 (10)	2 (4)

NOTE. IQR, interquartile range; ICU, intensive care unit; MDR, multidrug-resistant; MRSA, methicillin-resistant *Staphylococcus aureus*; PEG, percutaneous endoscopic gastrostomy; VRE, vancomycin-resistant enterococci.

[a]Unless otherwise noted for an individual row. Numbers for each arm do not add up to the "overall" column because individual patients were often encountered in multiple arms.

[b]Scrubs contained a complex element compound with embedded silver-alloy.

[c]Scrubs impregnated with an organosilane-based quaternary ammonium and a hydrophobic fluoroacrylate copolymer emulsion.

TABLE 2. Environmental Contamination Observed During 120 Shifts in the ASCOT Trial

	Control (N = 40), Median CFU (IQR)	Scrub 1 (N = 40), Median CFU (IQR)[a]	Scrub 2 (n = 40), Median CFU (IQR)[b]
All sites	159.6 (61.5–304.2)	138.5 (62.5–278.6)	115.9 (43.8–235.4)
Bed rails	65.0 (25.0–145.5)	67.0 (27.3–123.3)	47.7 (19.4–113.3)
Bed	43.0 (15.0–157.3)	44.5 (14.0–142.5)	31.0 (12.8–97.0)
Supply cart	9.5 (3.5–20.7)	10.0 (5.8–20.6)	7.5 (4.8–14.8)

NOTE. CFU, total number of colony-forming units defined as sum of colony-forming units from each cultured high touch surface; IQR, interquartile range.

[a]Scrubs contained a complex element compound with embedded silver-alloy.

[b]Scrubs impregnated with an organosilane-based quaternary ammonium and a hydrophobic fluoroacrylate copolymer emulsion.

−3.0 to 191.0) in the control arm, 73.0 (IQR, −107.0 to 194.0) in the Scrub 1 arm, and 54.5 (IQR, −60.0 to 215.0) in the Scrub 2 arm. Nurses' sleeves and clothing covering their abdomens showed the greatest increase in contamination during the shift.

Scrub type was not associated with a change in HCP clothing contamination in multivariable linear regression that accounted for shift order, nurse crossover/clustering, pre-shift contamination, patient characteristics, and environmental contamination (overall $P = .70$). Mean difference estimates were 0.118 for the Scrub 1 arm (95% CI, −0.206 to 0.441; $P = .48$) and 0.009 for the Scrub 2 arm (95% CI, −0.323 to 0.342; $P = .96$).

Evaluation of Acquisition and Transmission Events

We identified acquisition events during 39 (33%) of the 120 shifts (Table 4), including 20 (17%) environmental acquisitions and 19 (16%) acquisitions on HCP clothing. Of all HCP clothing acquisitions, 3 (16%) occurred while caring for patients on contact precautions. The organisms most commonly involved in acquisition events were MSSA (n = 11, 9%), *Acinetobacter* (n = 10, 8%), and MRSA (n = 8, 7%). Moreover, 23 of the acquisition events (59%) were confirmed transmission events from another member of the transmission triangle. The number of acquisition and transmission events were generally similar across study arms (Table 4).

Of the 19 HCP clothing acquisition events, 12 (63%) were confirmed transmission events: 7 from the patient, 3 from environmental contamination, and 2 from the patient and/or the environment (i.e., both the patient and environment were contaminated with target organism during the same shift) (Figure 1). Of these confirmed transmission events, 1 (8%) occurred while the patient was on contact precautions. *Staphylococcus aureus* was involved in the most HCP transmission events (n = 6: 3 MRSA and 3 MSSA).

Of the 20 environmental acquisition events, 11 (55%) were confirmed transmission events. All 11 were transmitted from the patient. We did not identify any MDROs on HCP clothing at the beginning of a shift. Clothing from 3 HCP (7.5%) were contaminated with MSSA. No transmissions from HCP-to-patient or HCP-to-environment were observed. Finally, nurse perceptions of scrub types are provided in the Supplementary Material.

DISCUSSION

Transmission of microorganisms involves 3 elements: a source, a susceptible host with a portal of entry receptive to the agent, and a mode of transmission.[17] In the healthcare setting, these elements culminate in pathogen movement between the patient, healthcare providers (HCP), and the environment, known as the "transmission triangle." When transmission in this triangle leads to patient acquisition, healthcare-associated infections (HAIs) can follow.[1] Our randomized controlled trial focused on the use of antimicrobial-impregnated scrubs as a strategy to decrease pathogen movement in the transmission triangle. Our results demonstrated that bacterial contamination of HCP clothing was not decreased when HCPs wore the antimicrobial-impregnated scrubs used in this study compared to standard (control) scrubs. We did, however, confirm that HCP clothing frequently became contaminated during routine clinical care, and pathogens were frequently acquired from the patient care environment.

Strategies to decrease pathogen movement in the transmission triangle can be generally categorized by the points of the triangle. Interventions can focus on the patient (eg, decolonization or source control), the environment (eg, enhanced disinfection, antimicrobial surfaces or textiles), or the healthcare provider (eg, hand hygiene, gowns and gloves, antimicrobial-impregnated clothing). Growing evidence suggests that contaminated healthcare textiles may be a source for transmission of epidemiologically important pathogens and HAIs.[4] Preclinical data suggested that antimicrobial-impregnated textiles are efficacious at reducing bacterial burden,[8–10] but data to support the use of antimicrobial-impregnated scrubs in clinical practice are limited. To date, 4 other trials have examined antimicrobial-impregnated scrubs, with conflicting results.[12–15] Bearman et al[12] performed a blinded, crossover, randomized controlled trial comparing antimicrobial-impregnated surgical scrubs to standard surgical scrubs. Use of antimicrobial-impregnated scrubs led to a > 4 $\log_{10}$ reduction in the burden of MRSA on

TABLE 3. Change in Nurse Contamination During 120 Shifts in the ASCOT Trial: Overall Colony Forming Units (CFUs)

	Control (N = 40), Median CFU (IQR)			Scrub 1 (N = 40), Median CFU (Range)[a]			Scrub 2 (n = 40), Median CFU (Range)[b]		
	Before	After	Δ	Before	After	Δ	Before	After	Δ
All sites	88.5 (34.0–189.0)	199.0 (95.5–384.5)	61.5 (−3.0 to 191.0)	116.0 (60.5–234.5)	190.5 (105.0–517.0)	73 (−107.0 to 194.0)	167.5 (77.0–267.5)	226.5 (95.5–503.5)	54.5 (−60.0 to 215.0)
Sleeve	27.5 (7.5–46.5)	53.0 (18.0–113.0)	25.0 (−1.0 to 62.5)	33.0 (15.5–55.5)	59.5 (29.0–111.5)	17.0 (−23.0 to 61.0)	40.5 (18.5–67.5)	44.0 (20.0–157.0)	9.0 (−18.5 to 109.0)
Pocket	21.5 (9.0–59.0)	50.0 (20.0–84.0)	17.5 (−14.0 to 51.0)	32.0 (19.0–90.5)	49.0 (18.5–79.0)	−0.5 (−46.5 to 40.0)	46.0 (24.0–97.5)	48.0 (25.0–109.0)	−1.0 (−40.0 to 25.5)
Midriff/abdomen	21.5 (9.0–68.5)	70.0 (27.0–122.0)	25.0 (−3.0 to 75.0)	53.0 (26.0–96.0)	50.5 (26.5–138.5)	17.0 (−42.5 to 54.5)	50.0 (22.0–110.0)	59.5 (25.5–113.0)	4.0 (−34.5 to 41.5)

NOTE. IQR, interquartile range.

[a]Scrubs contained a complex element compound with embedded silver-alloy.

[b]Scrubs impregnated with an organosilane-based quaternary ammonium and a hydrophobic fluoroacrylate copolymer emulsion.

TABLE 4. Bacterial Acquisition and Transmission Events[a] During 120 Shifts in the ASCOT Trial

Organism	Total (N = 120), No. (%)		Control (N = 40), No. (%)		Scrub 1 (N = 40), No. (%)[b]		Scrub 2 (n = 40), No. (%)[c]	
Nurse clothing contamination event	Acq	Trans	Acq	Trans	Acq	Trans	Acq	Trans
Any	19 (16)	12 (10)	6 (15)	4 (10)	7 (18)	3 (8)	6 (15)	5 (13)
MRSA	4 (3)	3 (3)	2 (5)	1 (3)	2 (5)	2 (5)	0	0
MSSA	7 (6)	3 (3)	0	0	4 (10)	1 (3)	3 (8)	2 (5)
VRE	1 (1)	1 (1)	0	0	0	0	1 (3)	1 (3)
E. coli	0	0	0	0	0	0	0	0
Klebsiella spp.	2 (2)	1 (1)	2 (5)	1 (3)	0	0	0	0
Acinetobacter spp.	4 (3)	3 (3)	1 (3)	1 (3)	1 (3)	0	2 (5)	2 (5)
Pseudomonas spp.	1 (1)	1 (1)	1 (3)	1 (3)	0	0	0	0
Environmental contamination event	Acq	Trans	Acq	Trans	Acq	Trans	Acq	Trans
Any	20 (17)	11 (9)	9 (23)	6 (15)	5 (13)	2 (5)	6 (15)	3 (8)
MRSA	4 (3)	2 (2)	2 (5)	1 (3)	1 (3)	1 (3)	1 (3)	0
MSSA	4 (3)	3 (3)	1 (3)	1 (3)	2 (5)	1 (3)	1 (3)	1 (3)
VRE	3 (3)	2 (2)	2 (5)	1 (3)	0	0	1 (3)	1 (3)
E. coli	0	0	0	0	0	0	0	0
Klebsiella spp.	1 (1)	1 (1)	1 (1)	1 (1)	0	0	0	0
Acinetobacter spp.	6 (5)	3 (3)	3 (8)	2 (5)	1 (3)	0	2 (5)	1 (3)
Pseudomonas spp.	0	0	0	0	0	0	0	0

NOTE. Acq, acquisition; MSSA, methicillin-susceptible *S. aureus*, MRSA, methicillin-resistant *S. aureus*; Trans, transmission; VRE, vancomycin-resistant enterococci.

[a]An "acquisition event" was defined as contamination identified at the end of the shift that was not present at the beginning of the shift. A "transmission event" was defined as an acquisition event for which the source of contamination was identified and confirmed from another member of the transmission triangle. A nurse or the environment could have more than 1acquisition or transmission event during each shift.

[b]Scrubs contained a complex element compound with embedded silver-alloy.

[c]Scrubs impregnated with an organosilane-based quaternary ammonium and a hydrophobic fluoroacrylate copolymer emulsion.

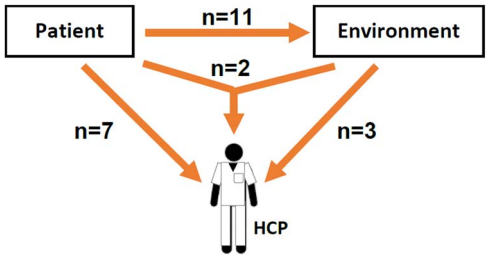

FIGURE 1. Description of 23 confirmed transmission events in the "transmission triangle" during the ASCOT study.

the HCP ($P < .01$), but no significant differences were detected in the amount of VRE or gram-negative bacilli contamination. In contrast, 3 previously published prospective randomized trials failed to show significant decreases in bacterial contamination in nurses or ambulance personnel.[13–15]

Our methods helped provide a more complete analysis of this technology, as we measured and adjusted for environmental contamination and included important organisms such as MSSA and vancomycin-susceptible *Enterococcus* in our analyses. In light of these methodological advantages and the weight of the studies summarized above, we conclude that antimicrobial-impregnated scrubs are not efficacious at decreasing the bacterial burden on HCP during a single shift. We hypothesize that the lack of efficacy in this setting is related to the low-level disinfectant capabilities of the textiles coupled with repeated inoculation events and a short time frame (eg, a shift of 8 to 12 hours) in which to have an effect. Antimicrobial-impregnated textiles may be more effective in settings with potentially prolonged exposure and activity, including curtains and linens.[11,18]

Our study confirmed that HCP clothing regularly becomes contaminated with important pathogens[6,19,20] and, as a result, can act as a source for transmission. For example, in a cohort study of 57 nurses, approximately half of the nurses' surgical scrubs became contaminated with VRE, MRSA, and/or *C. difficile* by the end of a standard shift.[21] Similarly, HCP clothing contaminated with *S. aureus*, *Acinetobacter* spp., and/or enterococci is associated with increased risk of contaminated HCP hands.[22] Indeed, HCP clothing can become contaminated by interacting with either patients or the environment.[23]

Patients regularly contaminate their environment,[24,25] which may be the biggest predictor of HCP contamination. Morgan et al[23] analyzed microbiological data from 585 HCP–patient interactions and concluded that positive environmental cultures led to a 4-fold increase in the risk of HCP contamination. In our study, the patient was the source of contamination for all organisms encountered in the environment. Nurses acquired important pathogens during 19% of shifts; we confirmed the source of transmission during 10% of shifts. Importantly, the

environment served as the source of nurse contamination in 25% to 42% of transmission events in our study.

Our study has limitations. First, cultures obtained from clothing and the environment represented random sampling from these sites. While the use of replicate organism detection and counting (RODAC) plates has been validated for use on textiles,[3] the surface area sampled using this technique may have failed to demonstrate the extent of contamination. Given the randomized nature of our study, we doubt this impacted our comparisons. Second, we obtained cultures from 3 patient locations, and we may have missed patient colonization with target pathogens in other locations. As a result, we summarized both acquisitions and confirmed transmissions in our study. Third, we did not account for pathogen-specific colonization pressure within participating ICUs in our models. However, this potential confounder would have had to shift dramatically within a short period (i.e., 24 hours) to impact our results. Finally, nurse behavior may have varied between study arms based on personal or patient-related concerns. We attempted to mitigate this risk using a crossover design, but we did not observe nurses during their shifts. Randomization led to equivalent patient numbers in each study arm.

Contamination of HCPs is an important component of pathogen transmission in healthcare settings. Results from our randomized controlled trial demonstrated that antimicrobial-impregnated scrubs were not efficacious at reducing nurse contamination and, thus, are not a useful strategy for stopping the movement of pathogens in the transmission triangle. We propose that future studies of antimicrobial-impregnated textiles focus on textiles that have frequent and long-term contact with patients, such as bed linens and gowns. Finally, our study demonstrated that the environment is an important source for HCP clothing contamination. We conclude that until additional data are available, the best strategies to reduce the risk of HCP clothing contamination remain diligent hand hygiene following all patient room entries and exits and, when appropriate, use of gowns and gloves, even if no direct patient care is performed.

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SUPPLEMENTARY MATERIAL

To view supplementary material for this article, please visit https://doi.org/10.1017/ice.2017.181.

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