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Bacterial contamination of health care workers' white coats

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Abstract

Background—Patient-to-patient transmission of nosocomial pathogens has been linked to transient colonization of health care workers, and studies have suggested that contamination of health care workers' clothing, including white coats, may be a vector for this transmission.

Methods—We performed a cross-sectional study involving attendees of medical and surgical grand rounds at a large teaching hospital to investigate the prevalence of contamination of white coats with important nosocomial pathogens, such as methicillin-sensitive *Staphylococcus aureus*, methicillin-resistant *S aureus* (MRSA), and vancomycin-resistant enterococci (VRE). Each participant completed a brief survey and cultured his or her white coat using a moistened culture swab on lapels, pockets, and cuffs.

Results—Among the 149 grand rounds attendees' white coats, 34 (23%) were contaminated with *S aureus*, of which 6 (18%) were MRSA. None of the coats was contaminated with VRE. *S aureus* contamination was more prevalent in residents, those working in inpatient settings, and those who saw an inpatient that day.

Conclusion—This study suggests that a large proportion of health care workers' white coats may be contaminated with *S aureus*, including MRSA. White coats may be an important vector for patient-to-patient transmission of *S aureus*.

Antibiotic-resistant bacteria are an increasing problem in the United States and worldwide. Among infected patients, antibiotic resistance is associated with increases in length of hospital stay, health care costs, and patient morbidity and mortality.¹⁻⁴ Mortality among patients with methicillin-resistant *Staphylococcus aureus* (MRSA) and vancomycin-resistant enterococci (VRE) bacteremia is significantly higher than mortality among patients with susceptible forms of the same bacteria.^{1-2,4}

Both *S aureus* and enterococci can be transmitted through direct contact or through fomites. Previous studies have suggested that potential fomites include stethoscopes, bedding, environmental surfaces, and clothing.⁵⁻⁸ Despite increased concerns about antibiotic-resistant bacteria and improved infection control measures, health care workers may unknowingly carry *S aureus* and enterococci on their attire, including nursing uniforms and white coats.⁹⁻¹² Recently, the United Kingdom's Department of Health recommended that hospitals adopt a “bare below the elbows” dress code (ie, short sleeves, no wrist watch, no jewelry), that personnel avoid wearing a tie when performing clinical activities, and that white coats be

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disallowed, in an attempt to decrease the transmission of bacteria.¹³ Interestingly, a recent UK evidence-based guideline and a review suggested that current literature does not support that uniforms/clothing are vehicles for transmission of organisms.^{14,15}

In the present study, we aimed to assess the prevalence *S aureus*, including MRSA, and VRE on health care workers' white coats, as well as the potential risk factors associated with contamination. This study improves on previous research by using a larger and more diverse study population and by evaluating for multiple organisms (methicillin-sensitive *S aureus* [MSSA], MRSA, and VRE) in a US setting with a known endemic prevalence of these bacteria among both intensive care unit (ICU) and non-ICU inpatients.

Methods

Study population

We conducted a cross-sectional study at the University of Maryland Medical Center in Baltimore, Maryland, an inner-city tertiary care hospital with 669 beds.¹⁶ In previous studies, this facility was found to have a colonization prevalence of 25% *S aureus*, 7% MRSA, and 5.2% VRE among recently admitted non-ICU patients, as well as a colonization prevalence of 7.2% MRSA, 10.1% VRE, and 2.7% co-colonized with MRSA and VRE among recently admitted medical and surgical ICU patients.^{17,18} The medical center's Institutional Review Board approved this study before commencement.

Attendees of medical grand rounds on November 15, 2006 at 12:15 PM EST and surgical grand rounds on August 9, 2007 at 7:00 AM EDT who were wearing white coats were asked to participate in this study. Grand rounds conferences were selected because of the high number of staff members at 1 time in 1 location and the fact that attendees were encouraged to wear their white coats to these conferences. The purpose of the study was disclosed just before the start of grand rounds. Each participant completed an anonymous questionnaire and cultured his or her white coat as described below. Informed consent was not collected, but a staff member could elect not to participate.

Data collection

A brief, self-administered questionnaire was used to collect demographic data and information on white coat laundering habits of the participants. Demographic variables included staff position (attending, fellow, resident, student, or other), specialty (medicine or surgery), current work location (inpatient, outpatient, ICU, operating room, administrative, or other), and the time of last interaction with an inpatient (that day, last week, last month, or more than a month). Information on white coat laundering included the length of time that the specific white coat had been worn since laundering (<3 days, <7 days, <2 weeks, <4 weeks, or >4 weeks), location of laundering (home, shared laundry, hospital laundry, or other), the wearer's perception of whether the coat was dirty or clean, and the reason for wearing the white coat (to cover clothing, to keep warm, to appear professional, to appear as part of the team, or other). The surveys were anonymous and linked to the culture specimen only by a unique number.

Each participant was asked to culture his or her own white coat after a demonstration of how to do so given by a member of the research team. According to the culture technique, the participant swabbed lapels, hip pockets, and outer surfaces of the cuffs with 2 passes (ie, up and down twice) with a single provided culturette. The participants returned the questionnaires and swabs at the end of grand rounds.

Laboratory analysis

All study supplies were obtained from BBL Microbiology Systems (Sparks, MD) unless stated otherwise. Culturette swabs were soaked in 1 mL of normal saline solution, inoculated to brain-heart infusion (BHI) broth, and incubated for 24 to 48 hours. The broths were examined for growth; if positive, then the BHI was subcultured to blood agar plates (trypticase soy agar with 5% sheep's blood); CHROMagar, to assess for the presence of MRSA; and bile esculine azide agar with 6 µg/mL of vancomycin (Remel, Lenexa, KS), to assess for the presence of VRE. An aliquot of BHI broth was frozen in 50 µL of glycerol at -80°C. Blood agar plates were evaluated for qualitative colony growth for *S aureus* and enterococci by latex agglutination (Staphyaureux; Remel) and coagulase-positive reactions (Bactistaph; Remel).

Statistical analysis

Ninety-five percent confidence intervals (CIs) were calculated for the main summary proportions of participants colonized with *S aureus* or MRSA.

Results

Among the 149 participants who were wearing their white coats at study entry, 109 attended medical grand rounds and 40 attended surgical grand rounds. Table 1 shows the frequency of participants contaminated with *S aureus* isolates based on the demographic data and laundering habits. Overall, 22.8% (95% CI = 16.1% to 29.6%) were contaminated with *S aureus* and 4% (95% CI = 0.8% to 7.1%) were contaminated with MRSA. Twenty-nine white coats of the internal medicine participants (26.6%; 95% CI = 18.3% to 34.9%) and 5 coats of the surgery participants (12.5%; 95% CI = 2.3% to 22.7%) were found to be contaminated with *S aureus*. Six white coats of the internal medicine participants (5.5%; 95% CI = 1.2% to 9.8%) and no white coats of the surgery participants were contaminated with MRSA. Eighteen percent of all *S aureus* isolates were MRSA. No coats were contaminated with VRE.

The participants included 38 students (26%), 64 residents (43%), 12 fellows (8%), and 31 attendings (21%). The highest prevalence of coat contamination with *S aureus* was seen in the residents (30%; 19/64); for MRSA, the prevalence was greatest in the attendings (13%; 4/31). The most common reasons given for wearing white coats were for “professionalism” and “to hold things.”

Many participants listed more than 1 area as their work location. Of the 34 participants wearing white coats found to be contaminated with *S aureus*, 32 (94%) worked in an inpatient location (27 in an inpatient unit and 5 in an ICU). This translates to 28% of those working in an inpatient location and 28% of those working in the ICU wearing white coats contaminated with *S aureus*.

Twenty-six of the 34 participants wearing white coats contaminated with *S aureus* (76%), and 3 of the 6 participants wearing white coats colonized with MRSA (50%) had seen an inpatient earlier that day.

No association was found between time since laundering and contamination by *S aureus*; however, 17% of all participants had not washed their white coat in more than 28 days, and 64% had not done so in more than a week.

Twenty of the 34 participants wearing white coats contaminated with *S aureus* (59%) used personal laundry facilities, and 10 (29%) laundered their coats at the hospital laundry facility. Four of the 6 participants wearing white coats contaminated with MRSA (67%) used the hospital's laundry facility.

Discussion

Our data suggest that health care workers' white coats frequently are contaminated with *S aureus*, and that many of those isolates are methicillin-resistant, contradicting the conclusion of a recent review.¹⁵ The data are similar to those from previous evaluations of *S aureus* but lower than expected for resistant isolates of *S aureus* and enterococci.⁹⁻¹² These numbers also mirror the published rates of *S aureus* colonization seen in medical and surgical ICU inpatients and non-ICU inpatients at the index hospital.^{17,18}

S aureus, including susceptible and resistant isolates, was found on those working in all positions and in all locations. Characteristics associated with a high likelihood of *S aureus* colonization included being a resident, having seen an inpatient within the past week, and working in the inpatient or ICU setting. No associations were found among time since laundering, location of laundering, and likelihood of *S aureus* colonization; however, those with *S aureus* colonization were more likely to have laundered their white coat in a personal facility. Characteristics associated with increased likelihood of MRSA colonization over MSSA colonization included being an attending and washing the white coat in the hospital laundry. Internal medicine respondents were more likely than surgery respondents to be colonized with MSSA and MRSA.

Previous studies have found variable rates of *S aureus* and VRE contamination. In a point-prevalence study, Wong et al⁹ evaluated white coats of 100 physicians by pressing contact plates onto 3 areas of each coat and found *S aureus* contamination in 29 of the coats (none of which was MRSA). They also found that physicians in the surgical specialties were more likely ($P < .05$) to be carrying *S aureus* than those in medical specialties. Loh et al¹⁰ evaluated white coats of 100 medical students at 3 sites with blood agar plates and found bacterial contamination in all coats, but *S aureus* in only 5 of these.

In a point prevalence study, Perry et al¹¹ evaluated the uniforms of 57 nurses for bacterial contamination using a Casella slit sampler before and after a usual shift. After the shift, MRSA was detected in 14% of the uniforms; VRE, in 38%. More recently, in 2003, Osawa et al¹² evaluated white coats of physicians on wards of a university teaching hospital during 2 MRSA outbreaks. Using stamp medium, they found MRSA contamination in 80% of the white coats overall and even higher rates in those from personnel working in the wards with higher MRSA infection rates.

Our study has several limitations. First, despite the fact that this is the largest study of its kind completed and reported to date, we did not report statistically significant differences between colonized and uncolonized coats, because of the size of the population studied. Second, our sampling technique may have been less effective than that used in previous studies, in which blood agar plates were touched directly to the clothing item. We did not use blood agar, because of concerns that doing so could decrease participation due to concerns over possible staining of the white coat. Third, each participant swabbed his or her own coat, possibly leading to decreased bacterial adherence to the swab due to insufficient swabbing. But because most of the participants were clinicians, we expect that they likely did an adequate job of swabbing. Finally, the study did not include a control group of non-worn white coats, and thus we cannot rule out the possibility that the coats were contaminated in the laundry before clinical activity. However, our aim was to determine the level of contamination of the coats with pathogenic bacteria independent of site of contamination, which would suggest that the coats are potential fomites for transmission of these organisms.

White coats of health care worker may be contaminated with pathogenic and resistant bacteria. Given that in this study, most of the health care workers perceived their white coats as being dirty, and 2/3 of them had not washed their coats in more than a week, efforts could be directed

at encouraging workers to launder their coats more frequently. Further studies should be done to evaluate white coats and other health care worker clothing as fomites for the transmission of pathogenic bacteria, and alternatives to white coats, including universal use of protective gowns, should be considered.

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Table 1

Bacterial contamination by demographics and laundering habits

	Medicine			Surgery			Combined		
	n	S aureus (%)	MRSA (%)	n	S aureus (%)	MRSA (%)	n	S aureus (%)	MRSA (%)
Field	109	29 (27)	6 (6)	40	5 (13)	149	34 (23)	6 (4)	
Position									
Attending	24	5 (21)	4 (17)	7	1 (14)	31	6 (19)	4 (13)	
Fellow	11	3 (27)	0 (0)	1	0	12	3 (25)	0	
Resident	46	16 (35)	1 (2)	18	3 (17)	64	19 (30)	1 (2)	
Student	24	4 (17)	0 (0)	14	1 (7)	38	5 (13)	0	
Other	4	1 (25)	1 (25)	0	0	4	1 (25)	1 (25)	
Location									
Inpatient	81	24 (30)	3 (4)	16	3 (19)	97	27 (28)	3 (3)	
Outpatient	16	4 (25)	2 (13)	2	0	18	4 (22)	2 (11)	
ICU	12	5 (42)	0	6	0	18	5 (28)	0	
Administrative	6	1 (17)	1 (17)	1	0	7	1 (14)	1 (14)	
Operating room	0	0	0	25	2 (8)	25	2 (8)	0	
Other	8	1 (13)	1 (13)	3	0	11	1 (9)	1 (9)	
Inpatient contact									
Today	84	21 (25)	3 (4)	33	5 (15)	117	26 (22)	3 (3)	
< 1 week	11	4 (36)	1 (9)	6	0	17	4 (24)	1 (6)	
< 1 month	10	4 (40)	2 (20)	0	0	10	4 (40)	2 (20)	
> 1 month	3	0	0	1	0	4	0	0	
Laundry									
Personal	71	17 (24)	1 (1)	25	3 (12)	96	20 (21)	1 (1)	
Public	9	3 (33)	0	3	0	12	3 (25)	0	
Hospital	26	8 (31)	4 (15)	11	2 (18)	37	10 (27)	4 (11)	
Cleaners	3	1 (33)	1 (33)	1	0	4	1 (25)	1 (25)	
Other/blank	1	0 (0)	0	1	0	2	0	0	
Time since laundering									
< 3 days	10	4 (40)	1 (10)	7	0	17	4 (24)	1 (6)	
> 3 days, < 7 days	28	4 (18)	2 (7)	8	2 (25)	36	7 (19)	2 (6)	
> 7 days, < 14 days	26	10 (38)	2 (8)	11	1 (9)	37	11 (30)	2 (5)	
> 14 days, < 28 days	28	7 (25)	0	6	1 (17)	34	8 (24)	0	
> 28 days	17	3 (18)	1 (6)	8	1 (13)	25	4 (16)	1 (4)	
Perception of dirtiness									
Not	16	4 (25)	2 (13)	9	1 (11)	25	5 (20)	2 (8)	
Some	71	20 (28)	4 (6)	24	3 (13)	95	23 (24)	4 (4)	

