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Transmission of MRSA to Healthcare Worker Gowns and Gloves during Care of Residents in VA Nursing Homes

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Abstract

Objective: Estimate the frequency of methicillin-resistant *Staphylococcus aureus* (MRSA) transmission to gowns and gloves worn by healthcare workers (HCW) interacting with Veterans Affairs Community Living Center (VA nursing home) residents in order to inform MRSA prevention policies.

Design: Observational study

Setting and Participants: Residents and HCW from 7 VA nursing homes in 4 states and Washington, DC.

Methods: Residents were cultured for MRSA at the anterior nares, perianal skin and wound (if present). HCW wore gowns and gloves during usual care activities. After each activity, a research coordinator swabbed the HCW's gown and gloves. Swabs were cultured for MRSA.

Results: 200 residents were enrolled; 94 (46%) were MRSA colonized. Glove contamination was higher than gown contamination (20% vs. 11%, $p < 0.01$). Transmission varied greatly by type of care from 0-19% for gowns and 7-37% for gloves. High risk care activities (OR > 1.0, $p < 0.05$)

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for gown contamination included changing dressings (e.g., wound), dressing, providing hygiene (e.g., brushing teeth) and bathing. Low risk care activities (OR<1.0, p<0.05 or no transmission) for gown contamination included glucose monitoring, giving medications and feeding.

Conclusions: MRSA transmission from colonized residents to gloves was higher than transmission to gowns. Transmission to gloves varies by type of care, but all care had a risk of contamination demonstrating the importance of hand hygiene after all care. Transmission to gowns was significantly higher with certain types of care. Optimizing gown and glove use by targeting high risk care activities could improve resident-centered care for MRSA colonized residents by promoting a home-like environment.

Introduction

Infections caused by antibiotic-resistant bacteria are one of the top five causes of death in nursing homes, with approximately 2 million infections occurring each year.^{1,2} These infections lead to increased antibiotic use and acute care hospital admissions, which are both costly and often result in poor outcomes.²⁻⁵ Methicillin-resistant *Staphylococcus aureus* (MRSA) is a common and important cause of healthcare-associated infection. MRSA colonization, the presence of MRSA on a person without infection, is common in hospitalized patients and nursing home residents. Between 26% and 58% of nursing home residents are colonized with MRSA.^{5,7,8} Person-to-person transmission plays a central role in the spread of MRSA in healthcare settings with healthcare workers (HCW) serving as the primary vector. In acute care hospitals, Contact Precautions (single room, gown and gloves for all patient-HCW contact, patient room restriction) are used for patients colonized with MRSA to prevent transmission to other patients.⁶ In nursing homes, Contact Precautions are less feasible because of the communal setting where residents are encouraged to leave their rooms and interact with other residents and the emphasis on a home-like environment.

The Department of Veterans Affairs (VA) operates 133 nursing homes (called Community Living Centers, CLC) which provide care for 12,000 veterans.⁷ The VA is committed to providing a home-like environment for VA nursing home residents while maintaining resident safety. In 2007, the VA launched the MRSA Prevention Initiative to reduce MRSA transmission and infection. As part of this initiative, the VA conducts MRSA surveillance on all nursing home residents on admission, discharge and every six months and recommends care practices to manage MRSA colonized and infected residents. In 2013, the VA released its *Guideline for Implementation of the VHA MRSA Prevention Initiative in Community Living Centers*. The guideline recommends managing residents colonized with MRSA using “Enhanced Barrier Precautions”, which include separate rooms and use of gowns and gloves for all care activities in the colonized resident’s room. Despite this, there is wide variation in MRSA prevention practices across the 133 VA nursing homes likely because of the lack of empirical evidence about MRSA transmission in nursing homes. Strategies for the optimal use of gowns and gloves to prevent MRSA transmission have not been evaluated in VA nursing homes.⁸⁻¹¹

Detection of MRSA on HCW gowns and gloves during HCW-resident interactions allows evaluation of the risk of transmission associated with individual types of care.¹¹⁻¹⁴

Contamination of HCW gown or gloves is a surrogate for transmission to HCW clothing or hands, which is the first step in the causal pathway for MRSA transmission to other residents. Our primary objective was to inform optimal use of gowns and gloves in long term care settings and VA nursing homes in particular. In order to do this, we estimated the risk of MRSA transmission to gowns and gloves by type of care provided during interactions with residents. We hypothesized that MRSA transmission would vary significantly by type of care. We also hypothesized that caring for residents with wounds would lead to higher risk of MRSA transmission.

Methods

Study Design

We conducted a multi-center, prospective observational study to estimate the frequency of and risk factors for MRSA transmission to gowns and gloves worn by HCWs when providing care to VA nursing home residents. During the study, we asked HCWs to wear gowns and gloves when interacting with enrolled residents. The protocol was approved by the VA Central Institutional Review Board.

Population

All residents with a history of MRSA in the year prior to enrollment from seven VA nursing homes in Baltimore, MD, Boston, MA, Batavia, NY, San Antonio, TX and Washington, DC were approached for enrollment. We identified these residents by reviewing MRSA surveillance results. Over the same time period, we enrolled a random sample of residents without a history of MRSA in the year prior to enrollment. Eligible residents had an expected length of stay of at least one week, were not identified by nursing staff as having behavioral problems, and were enrolled with written informed consent from them (88%) or their legally authorized representative (12%). HCWs were enrolled with verbal consent.

In our primary analysis, we assessed the risk of MRSA transmission when HCWs interacted with residents with MRSA colonization based on cultures obtained at enrollment. A resident was defined as MRSA colonized if the anterior nares, perianal skin or wound swab grew MRSA. As a control group, we also assessed MRSA transmission rates when care was provided to residents who were not colonized with MRSA on enrollment.

Data Collection

We recorded demographic characteristics, type of long term care, recent hospitalizations, current antibiotic use, medical devices and uncontrolled secretions from the residents' medical records. We recorded this information for both enrolled and non-enrolled residents with and without a history of recent MRSA in the year prior to screening.

For enrolled residents, cultures were obtained from the anterior nares, perianal skin and wound (if present) using a nylon flocked swab (Copan ESwabs; Copan Diagnostics). We obtained a schedule of the resident's usual care from nursing staff. For up to 28 days after enrollment, we asked HCWs to wear gowns and gloves during usual care activities. A research coordinator observed and recorded the type and duration of care delivered with

each activity. When the HCW was finished, the coordinator used a dual tipped rayon flocked swab (BBL CultureSwab; Becton Dickinson) to culture the HCW's gown and gloves as described previously.^{12–14} HCWs followed standard infection control practices for gown and glove use during the study. If they needed to change gown or gloves between activities, the gown and gloves were swabbed and a new observation started. An enrolled resident was deemed to have a wound if any of the following were true during the 28 days after enrollment: a wound swab was collected, wound dressing was included in the resident's schedule of usual care, or at least one HCW observation included wound dressing.

Laboratory Procedures

Swabs were cultured for MRSA at a central research laboratory. Swabs from residents were vortexed and 50µL of Amies media plated onto CHROMagar *Staph aureus* (SA) (Beckton Dickinson). Gown and glove swabs and resident swabs were both enriched in Tryptic soy broth with 6.5% NaCl (TSB with salt) and incubated overnight at 37°C for 24 hours. For gown and glove swabs, one swab tip was placed in TSB with salt and for resident swabs, 50µL of Amies media was pipetted into TSB with salt. After overnight incubation 50µL of broth was plated onto CHROMagar SA. Mauve-colored colonies on CHROMagar SA suspicious for *S. aureus* were confirmed by the detection of coagulase (Staphaurex; Remel). Cefoxitin susceptibilities were performed on all *S. aureus* isolates using disk diffusion following Clinical Laboratory Standards Institute guidelines.¹⁵

Data Management and Statistical Analysis

All study data were entered into a centralized relational database. Quality control was performed every four months via logic checks on the entirety of the database and comparison of source documentation to the database values for 10% of the participants. The association between MRSA colonization and resident characteristics was measured using the chi square test or Fisher's exact test for categorical variables, Student t-test or the Wilcoxon rank-sum test for continuous variables.

The risk of MRSA transmission for a particular type of care was estimated using a proportion. (e.g. number of glove specimens collected during a specific type of care that grew MRSA divided by number of glove specimens collected during a specific type of care).

Odds ratios (the odds of MRSA transmission given receiving a particular type of care divided by the odds of MRSA transmission given not receiving that care) were calculated using the generalized estimating equations (GEE) method of Liang and Zeger¹⁶ with an exchangeable covariance structure. GEE accounts for the serial auto correlation of multiple observations from the same resident. Odds ratios significantly greater than 1 were considered high risk types of care and those significantly less than 1, low risk types of care. Care interactions with no transmission were also considered low risk care. To determine whether certain resident characteristics increased the risk of transmission for a particular type of care, resident characteristics were included in the model as a potential effect modifier. All statistical tests were two-tailed and *p* values <0.05 were considered statistically significant. All statistical analyses were conducted with Stata 12 software (Stata Corporation) and SAS 9.3 (SAS Institute).

Results

Resident Characteristics

Over 40 months, 468 residents were screened for enrollment of whom 216 with history of MRSA in the year prior to screening were eligible and 152 (70%) gave informed consent and were enrolled. 243 residents without a history of MRSA in the year prior to screening were eligible and a random sample of these residents were enrolled (N=51). Nine residents with a history of MRSA in the year prior to screening were screened for enrollment and found to be ineligible. Of these 9 residents, 3 had an expected length of stay of less than 1 week and 6 were identified as having behavioral problems. Of the 64 residents with a history of MRSA who were eligible but not enrolled, 46 did not consent, 7 did not speak English and 11 were not approached about the study due to coordinator time constraints. Enrolled and non-enrolled residents with a history of MRSA were similar with regard to age, sex, rehabilitation care, antibiotic use, and devices. The only statistically significant differences were African American race (33% vs 18%, $p=0.01$) and length of stay (216 vs 425, $p<0.01$). Three residents withdrew from the study prior to cultures being taken, for a final study population of 200 residents of whom 149 had a history of MRSA in the year prior to enrollment and 51 did not.

Among the 149 residents with a recent history of MRSA, 60% were culture positive at enrollment compared to 10% of the 51 residents without a recent history of MRSA. Overall, a total of 94 residents were colonized with MRSA by culture at enrollment. Nasal swabs were obtained from all MRSA positive residents; 91% were colonized in the anterior nares (86/94). Of the 87 MRSA colonized residents who had a perianal swab collected, 30 (34%) were colonized at the perianal skin. Of the 24 MRSA colonized residents who had wound swabs obtained, 17 (71%) were colonized at the wound. Table 1 compares MRSA colonized residents to non-MRSA colonized residents. Of note, MRSA colonized residents were more likely to be receiving antibiotics at enrollment and to have a wound which required a dressing.

Gown and Glove Contamination with MRSA by Type of Care

We observed a median of 18 (IQR 12-21) interactions per MRSA colonized resident, with each interaction lasting a median of 7 minutes (IQR 5-10). Eighty-three percent of the interactions had one type of care during the interaction; 10%, two; 3% three and 4% four or more types of care. Overall, gowns were contaminated with MRSA during 11% of 1543 interactions with MRSA colonized residents. Gloves were contaminated during 20% of 1543 interactions. 1465 observations were completed with 106 MRSA negative residents. Out of the 1463 glove swabs tested, 35 (2%) were MRSA positive. Of the 1462 gown swabs tested, 21 (1%) were MRSA positive. Eleven of these residents negative for MRSA colonization at enrollment had two or more positive HCW gown or glove cultures; 20 MRSA negative residents had a single positive HCW gown or glove culture.

Transmission varied by type of care activity from 0% to 19% for gowns and 7% to 37% for gloves (Figure 1). We identified changing dressings (e.g., wound, j-tube), dressing the resident, providing hygiene (brushing teeth, combing hair) and bathing the resident as high

risk activities for gown contamination (OR >1.0, $p < 0.05$, Table 2). Glucose monitoring, giving medications and feeding were low risk activities for gown contamination (OR <1.0, $p < 0.05$, Table 2). Changing dressings, providing hygiene, bathing and transferring the resident were high risk activities for glove contamination (OR >1.0, $p < 0.05$; Table 2). Giving medications and feeding were low risk activities for glove contamination (OR < 1.0, $p < 0.05$; Table 2).

Resident characteristics that increase gown and glove contamination with MRSA

We also assessed whether resident characteristics, specifically the presence of body secretions, increased the risk of transmission. Diarrhea, heavy wound secretions and heavy respiratory secretions were rare in the study population (Table 1). Thus we examined stool incontinence (13%) and wounds (45%) as risk factors for transmission. Stool incontinence did not increase the risk of transmission to gown or gloves (data not shown). We found that residents with wounds had significantly higher odds of gown contamination compared to residents without wounds (OR 2.9, $p < 0.01$). The rates of gown contamination were generally higher across all types of care in residents with wounds compared to residents without wounds (Figure 2).

Discussion

The VA has a robust initiative for reducing MRSA transmission and infection; however, nursing homes are a unique environment requiring a balance between optimal infection prevention and home-like environment. This study provides data on care activities that are high risk for transmission of MRSA and, just as importantly, care activities that are low risk. Using these data and data from our previous work, we can construct a VA nursing home-specific approach to optimal MRSA prevention that is evidence-based.

Glove contamination was significantly higher than gown contamination, reinforcing the importance of hand hygiene to prevent the transmission of MRSA and other bacteria. We identified high risk care activities including: dressing change, device care, providing hygiene, transferring and dressing the resident. These data provide more concrete guidance for the use of gowns and gloves during Enhanced Barrier Precautions; gowns could be reserved for high risk care activities rather than all care activities in the resident's room. Finally we identified the presence of wounds as a resident characteristic that increases the risk of MRSA transmission to gowns during most types of care. The presence of wounds could be used as a marker of residents at high risk for transmitting MRSA as suggested in a recent editorial.¹⁷ These "high transmission" residents could be placed in single rooms and have gowns and gloves worn for all care similar to the recent cluster-randomized study¹ which focused on residents with medical devices. Other practices such as decolonization with chlorhexidine bathing could be used in this population to reduce the burden and therefore reduce transmission of MRSA while preserving a home-like environment.

In a similar study in community-based nursing homes¹¹, we found that MRSA transmission to gowns and gloves was common, with 14% of gowns and 24% of gloves contaminated with MRSA after resident interactions, and that transmission was higher during similar care activities—dressing, transferring, providing hygiene, changing linens and assistance with

toileting. In addition, residents with chronic skin breakdown (predominantly pressure ulcers) were more likely to transmit MRSA during high risk activities than residents without chronic skin breakdown. Our results closely replicated these findings for both high and low risk care activities and the effect of wounds on transmission.

We found that only 2% of glove and 1% of gown cultures were positive after care of residents not colonized with MRSA based on enrollment cultures. This is lower than in our previous study in community-based nursing homes, in which 5% were positive. Potential sources of this MRSA include residents colonized with MRSA at body sites we did not swab, the environment, study gowns and gloves, and HCWs with MRSA colonization.¹⁸ Unused gloves are not likely to be contaminated with MRSA prior to use.¹⁹ The lower rate in VA nursing homes indicates that the VA environment may have less MRSA than in community-based settings.

Forty-eight percent of enrolled residents were colonized with MRSA in nares or perianal skin or wounds. Interestingly, we found that 40% of those with a recent history of MRSA were MRSA negative in the nares, perianal skin or wound. In MRSA negative residents, transmission was very low (1-2%); providing a strong rationale for testing and removing precautions for residents with a negative test.

The study has several limitations. The contamination of HCW gowns and gloves is a surrogate measure for MRSA transmission. Although we know from our prior studies that MRSA on gown or gloves matches the resident's MRSA,¹¹ we do not know how often MRSA transmission to HCW clothing or hands would result in transmission to other residents. Hand hygiene, glove and gown use would typically prevent MRSA transmission to another resident. Although gown and glove contamination is a surrogate measure, several studies have shown effectiveness of gowns and gloves in reducing transmission. A cluster randomized trial of universal use of gowns and gloves in 20 ICUs demonstrated a 40% reduction in MRSA acquisition.²⁰ A recent cluster-randomized study involving high-risk nursing home residents with indwelling devices showed that a multi-modal strategy that included preemptive use of barrier precautions reduced new MRSA acquisitions by 22%.¹ Another recent single-site VA nursing home study showed a 62% decrease in the average annual rate of MRSA infection after implementing the VA MRSA bundle including gowns and gloves for all MRSA colonized or infected residents.²¹ Consent bias may affect our study outcome measures, but we were able to collect data from non-enrolled resident charts to look for differences between enrolled and non-enrolled residents and found that the populations were similar with respect to age, sex, antibiotic use at enrollment, and presence of medical devices.

The study has numerous strengths. It was a multi-site, prospective study involving diverse VA nursing homes in four geographically distinct areas. Demographics of the study population are generally representative of the national VA nursing home population with regard to sex and race/ethnicity (VA Central Data Repository). Finally, we were able to enroll many residents with MRSA colonization due to VA mandated active surveillance for MRSA.

To our knowledge, this is the first study to examine MRSA transmission by type of care activity and resident characteristics in VA nursing homes. Our study defines care activities that increase the risk of transmission and suggests modifications to the current VA guidelines for gown and glove use in the nursing home setting. Our findings could improve resident-centered care for MRSA colonized residents while maintaining a home-like environment.

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Figure 1.

MRSA Transmission to gowns and gloves of healthcare workers during care of MRSA colonized residents (n=94) by type of care provided during 1544 interactions

Figure 2.
MRSA Transmission to gowns of healthcare workers during care of MRSA colonized residents (N=94) with and without wounds by type of care provided during 1543 interactions

Table 1.

Description of residents with cultures (n=200) stratified by MRSA colonization status as determined by enrollment cultures

Characteristic	Overall Population N (%) n=200	With MRSA Colonization N (%) n=94	Without MRSA Colonization N (%) n=106	p-value
Age (mean $\pm$ SD)	71 $\pm$ 13	73 $\pm$ 13	70 $\pm$ 13	0.12
Male	192 (96)	92 (98)	100 (94)	0.28
Female	8 (4)	2 (2)	6 (6)	
Race/Ethnicity				0.05
Asian	1 (1)	1 (1)	0 (0)	
Black or African American	66 (34)	30 (32)	36 (35)	
Hispanic or Latino	8 (4)	1 (1)	7 (7)	
Native Hawaiian/Other Pacific Islander	1 (1)	0 (0)	1 (1)	
White	126 (64)	62 (67)	64 (62)	
Nursing Home in				0.05
Boston	28 (14)	13 (14)	15 (14)	
Buffalo	28 (14)	18 (19)	16 (15)	
Maryland	90 (45)	39 (41)	51 (48)	
San Antonio	22 (11)	6 (6)	16 (15)	
Washington DC	26 (13)	18 (19)	8 (8)	
History of MRSA in year prior to enrollment	149 (75)	89 (95)	60 (57)	<0.01
MRSA+				
Nose (n=94)		86 (92)		
Perianal skin (n=87)		30 (34)		
Wound (n=24)		17 (71)		
Length of stay in Nursing Home prior to enrollment in days (median, IQR)	217 (45, 607)	196 (45, 587)	232 (44, 664)	0.75
Rehabilitation Care	59 (30)	23 (25)	36 (34)	0.14
Acute care hospitalization in past 3 months	60 (30)	27 (29)	33 (31)	0.71
Current antibiotic use at enrollment	34 (17)	22 (23)	12 (11)	0.02
Diabetes mellitus	60 (30)	27 (29)	33 (31)	0.50
Devices				
Indwelling urinary catheter	31 (16)	17 (18)	14 (13)	0.37
External urinary catheter	13 (7)	8 (9)	5 (5)	0.39
Ostomy	8 (4)	3 (3)	5 (5)	0.72
Feeding tube	8 (4)	6 (6)	2 (2)	0.15
Tracheostomy	6 (3)	4 (4)	2 (2)	0.42

Characteristic	Overall Population N (%) n=200	With MRSA Colonization N (%) n=94	Without MRSA Colonization N (%) n=106	p-value
PICC line	13 (7)	4 (4)	9 (9)	0.26
Dialysis catheter	7 (4)	2 (2)	5 (5)	0.45
Any wound with a dressing that is regularly changed	75 (38)	42 (45)	33 (31)	0.05
Secretions at enrollment				
Stool incontinence	27 (14)	12 (13)	15 (15)	0.66
Diarrhea	3 (2)	0 (0)	3 (3)	0.25
Heavy wound secretions	7 (4)	4 (5)	3 (3)	0.71
Heavy respiratory secretions	1 (1)	0 (0)	1 (1)	1.00

Table 2.

Odds of gown or glove transmission given type of care over odds of gown or glove transmission if that type of care was not given, adjusted for clustering within individual MRSA colonized residents

Type of care	# of interactions	% care given with other types of care	Gloves		Gowns	
			OR	p-value	OR	p-value
Hygiene	139	70%	2.53	<0.01	2.01	0.01
Any dressing change	141	33%	2.02	0.01	2.33	<0.01
Transfer of resident	164	51%	1.63	0.05	1.70	0.11
Bathing	122	59%	1.58	<0.01	2.38	<0.01
Dressing resident	119	76%	1.55	0.13	2.31	<0.01
Any device care or use	90	48%	1.54	0.19	1.68	0.17
Diaper change	127	68%	1.43	0.07	1.42	0.25
Glucose monitoring	38	47%	0.92	0.79	0.74	0.34
Glucose monitoring alone	20	0%	0.66	0.56	No transmission	
Any therapy	33	6%	0.83	0.64	0.80	0.64
Physical exam	177	18%	0.86	0.40	1.04	0.88
Toilet assist	83	58%	0.73	0.22	1.06	0.82
Any medications	384	11%	0.66	<0.05	0.59	<0.05
Any medications alone	341	0%	0.65	0.03	0.53	<0.01
Feeding	68	18%	0.49	<0.05	No transmission	
Changing linens	252	19%	0.41	0.82	1.17	0.48