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Patient contact is the main risk factor for vancomycin-resistant *Enterococcus* contamination of healthcare workers' gloves and gowns in the intensive care unit

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Abstract

Objective: To determine which healthcare worker (HCW) roles and patient care activities are associated with acquisition of vancomycin-resistant *Enterococcus* (VRE) on HCW gloves or gowns after patient care, as a surrogate for transmission to other patients.

Design: Prospective cohort study.

Setting: Medical and surgical intensive care units at a tertiary-care academic institution.

Participants: VRE-colonized patients on Contact Precautions and their HCWs.

Methods: Overall, 94 VRE-colonized patients and 469 HCW–patient interactions were observed. Research staff recorded patient care activities and cultured HCW gloves and gowns for VRE before doffing and exiting patient room.

Results: VRE were isolated from 71 of 469 HCWs' gloves or gowns (15%) following patient care. Occupational/physical therapists, patient care technicians, nurses, and physicians were more likely than environmental services workers and other HCWs to have contaminated gloves or gowns. Compared to touching the environment alone, the odds ratio (OR) for VRE contamination associated with touching both the patient (or objects in the immediate vicinity of the patient) and environment was 2.78 (95% confidence interval [CI], 0.99–0.77) and the OR associated with touching only the patient (or objects in the immediate vicinity) was 3.65 (95% CI, 1.17–11.41). Independent risk factors for transmission of VRE to HCWs were touching the patient's skin (OR, 2.18; 95% CI, 1.15–4.13) and transferring the patient into or out of bed (OR, 2.66; 95% CI, 1.15–6.43).

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Conflicts of interest. All authors reported no conflicts of interest.

Conclusion: Patient contact is a major risk factor for HCW contamination and subsequent transmission. Interventions should prioritize contact precautions and hand hygiene for HCWs whose activities involve touching the patient.

Vancomycin-resistant *Enterococcus* (VRE) is responsible for bacteremia, surgical site infections, and urinary tract infections, resulting in ~ 1,300 deaths in the United States annually.[1] The incidence is increasing across the United States and > 80% of *Enterococcus faecium* are now vancomycin resistant.[2,3] Approximately 7%–11% of patients in intensive care units (ICUs) are VRE colonized.[4] Patients with VRE bacteremia have 2.5-fold greater odds of death than patients with vancomycin-susceptible enterococcal infections.[5]

Healthcare workers (HCWs) serve as intermediate vectors for VRE transmission from patient to patient in the ICU. Previous research has implicated both the ICU room environment[6–8] and direct patient contact in VRE acquisition among HCWs.[9,10] However, these studies were either too small or examined a number of multidrug-resistant organisms so that specific care activities related to VRE transmission could not be identified.

Understanding risk factors for VRE contamination and subsequent transmission is useful for infection prevention teams in determining how barrier precautions will be implemented. In addition, it is useful for future researchers in developing and studying novel infection prevention strategies. In this study, we sought to determine the frequency of VRE transmission to HCWs' gowns or gloves during routine patient care in the ICU and to identify the care activities most associated with HCW contamination with VRE.

Methods

Study design and participants

We performed a prospective cohort study to determine which HCW types and patient care activities are risk factors for VRE transmission to HCWs' gloves or gowns, a surrogate for transmission to other patients in the ICU. Between January 1, 2017, and November 15, 2017, 100 VRE-colonized patients from the medical and surgical ICUs were enrolled at the University of Maryland Medical Center. The medical ICU is a 29-bed unit providing medical care to adult patients with acute or life-threatening conditions, while the surgical ICU is a 24-bed unit which cares for adult surgical patients. These ICUs screen for VRE on admission, discharge, and once weekly as part of the VRE infection prevention active surveillance program. On each study day, e-mail alerts associated with the hospital microbiology laboratory notified research staff of recent (within 72 hours) VRE positive cultures. Patients with positive rectal surveillance cultures and 5 HCWs per patient were eligible for enrollment in the study. The Institutional Review Board of the University of Maryland, Baltimore, granted approval for the study and waived consent of participants.

Data collection

All HCW–patient activities were recorded by research staff on a standardized data collection form. All HCW activities were categorized into 2 domains: interactions with the patient (patient domain) or the patient's environment (environmental domain). The patient domain included direct contact with the patient (eg, bathing/hygiene, wound dressing, or physical

examination) or contact with the objects in direct contact with a patient (eg, bed rail, bedding, catheter or drain, artificial airway, vital signs, giving oral meds, IV tubing or IV meds, or rectal tube or bag). The environmental domain included contact with items in the ICU room environment (eg, the sink, bedside table, supply cart, lift, curtain, trash, computer medical equipment, and room furniture; see online appendix for the complete list). These patient care activities and interactions were chosen based on prior literature showing that these interactions were associated with increased transmission of several types of multidrug-resistant organisms.[9,11–13]

Following patient care, but prior to doffing, the gloves and gown of each HCW were sampled for the presence of VRE with BBL dual Culturettes (BBL, Becton Dickinson, Sparks, MD). With a twirling motion, the swab was rubbed along each finger and the palms of both gloved hands. All HCW gowns were sampled twice along both forearms and then in a "W" pattern along the beltline using a twirling motion.

Patient demographics including age, sex, and race were abstracted form the electronic medical record. The Elixhauser Index, a validated comorbidity score used for hospitalized patients,[14,15] was calculated using diagnostic codes from the *International Classification of Diseases*, *Tenth Revision*. Study researchers conferred with the nursing staff to obtain clinical characteristics including the presence or absence of invasive devices, including an artificial airway (endotracheal or tracheostomy tube), Foley catheter, central venous catheter (central line), chest tube, surgical drain, rectal tube, nasogastric tube, and whether the patient had diarrhea or wounds. To quantify VRE burden, we cultured each patient's perianal area by gently rubbing ESwabs (Copan Diagnostics, Murrieta, CA) on the skin immediately around the anus.

Laboratory procedures

All HCW gown and glove swabs were placed into tryptic soy broth with 6.5% NaCl and were incubated for 24 hours at 35 ± 2°C. After incubation, 50 μL from each broth tube was inoculated onto a Bile Esculin Azide Agar with 6 μg/mL vancomycin plate (Remel, Lenexa, KS) and was incubated aerobically at 35 ± 2°C for 48 hours. The isolates were frozen in tryptic soy broth with 15% glycerol and stored at −80°C. A 1-mL aliquot of each patient perianal sample was serially diluted using Butterfield buffer. The agar plate was inoculated with 100 μL of each serial dilution and distributed evenly onto each agar plate using a cell spreader. Next, 100 μL of the original sample was inoculated into tryptic soy broth with 6.5% NaCl. The plates and broth tubes were incubated for 48 hours aerobically at 35 ± 2°C, after which the number of bacterial colonies was counted. If there was no growth on the inoculated plates, 100 μL from the previously inoculated tryptic soy broth with 6.5% NaCl tubes was inoculated onto a plate. If there was growth on the agar after 48 hours at 35 ± 2°C, a count of 1 colony-forming unit (CFU) was given. The colonies were subcultured and identified to the species level using VITEK II (BioMérieux, Marcy-l'Étoile, France). Antimicrobial susceptibility testing was conducted according to the Clinical Laboratory Standards Institute guidelines using the Kirby-Bauer disk diffusion method.

Statistical analysis

Frequencies, proportions, means, and standard deviations were calculated to describe patient demographics and clinical characteristics. Patient bacterial burden (x + 1) was log transformed and expressed in $\log_{10}$ CFU per milliliter (CFU/mL). We estimated the following associations with HCW glove or gown contamination: (1) HCW type (ie, physician or nurse practitioner, nurse, patient care technician, physical or occupational therapist, respiratory therapist, environmental service worker, or other) and (2) specific patient-care activities or interactions. Risk factors significant at $\alpha \leq 0.10$ in the previous analyses were considered candidate predictors for the multivariable model. All models were built using logistic regression models fit by generalized estimating equations with an exchangeable correlation matrix to consider within-patient correlation and were conducted in a stepwise fashion, where the model with the lowest QIC was chosen as the final multivariable model. Potential confounders were selected a priori for all models and included patient age, race, Elixhauser Index, invasive devices, diarrhea, bacterial burden, and duration of time the HCW spent in the room.

All analyses were conducted using SAS version 9.4 software (SAS Institute, Cary, NC).

Results

The demographics and clinical characteristics of the 94 VRE-colonized patients are presented in Table 1. The mean patient age was 61 years (standard deviation, ± 12 years), 57% were white, 50% were men, 60% were from the medical ICU, and the median Elixhauser Index was 7.2 (range, 0–14). Also, 93% of patients had at least 1 invasive device, with a mean of 3 devices (range, 0–6). The median VRE burden found on the perianal samples was 1.3 $\log_{10}$ CFU/mL (range, 0–8.5).

We observed 469 HCW–patient interactions, of which 61 of 469 (13%) led to contamination of HCWs' gloves, 29 of 469 (6%) led to contamination of HCWs' gowns, and 71 of 469 (15%) led to contamination of either HCWs' gloves or gown with VRE. Table 2 shows the associations between HCWs type and glove or gown contamination. Compared to environmental service workers and other HCWs (eg, nutritionists, dialysis technicians, etc), occupational and physical therapists had the highest odds of glove or gown contamination (odds ratio [OR], 8.66; 95% confidence interval [CI], 1.36–55.05), followed by patient care technicians (OR, 7.57; 95% CI, 1.80–31.79), nurses (OR, 4.74; 95% CI, 1.63–13.77), and physicians/nurse practitioners (OR, 4.26; 95% CI, 1.06–17.18).

The HCW observations were divided into 3 categories: interactions that involved touching the patient only (n = 50), interactions that involved touching both the patient and the environment (n = 333), and those that involved touching the environment only (n = 83). As shown in Table 3, HCW interactions that involved touching the patient only had 3.65 (95% CI, 1.17–11.41) greater odds of contaminating their gloves or gowns compared to those that touched the environment only. Interactions that involved touching both the patient and environment had 2.78 (95% CI, 0.99–7.77) greater odds of glove or gown contamination as those who touched the environment only. On average, HCWs touched 3 different items in the patient domain and 3 different items in the environmental domain. The odds of

contamination increased with the number of different patient touches (OR, 1.22; 95% CI, 1.05–1.41) and with the number of different items touched in the environment (OR, 1.07; 95% CI, 0.94–1.21).

Figures 1a and 1b show the odds ratios for HCW contamination of each patient-care activity in the environment and patient domains adjusted for VRE burden, diarrhea, nasogastric tube, and time the HCW spent in the room. Figure 1a shows that HCW gown or glove contamination was associated with touching the patient's bedding (OR, 3.36; 95% CI, 1.29–8.75), bedrail (OR, 2.83; 95% CI, 1.37–5.84), and skin (OR, 2.16; 95% CI, 1.13–4.13), and with transferring the patient into or out of bed (OR, 2.58; 95% CI, 1.11–5.99). Figure 1b shows that touching the supply cart was associated with reduced odds of contamination (OR, 0.62; 95% CI, 0.35–1.08), while touching trash (OR, 1.62; 95% CI, 0.92–2.86), was associated with increased odds. In our multivariable model, the independent predictors of HCW glove or gown contamination were touching the patient's skin (OR, 2.18; 95% CI, 1.15–4.13) and transferring the patient (OR, 2.66; 95% CI, 1.10–6.43), adjusting for patient's VRE burden, diarrhea, nasogastric tube, and time the HCW spent in the room.

Discussion

In this study, 15% of the HCW gowns or gloves became contaminated with VRE after providing patient care. Touching the patient or items touching the patient (eg, the patient's bedding and bedrail) were the greatest risk factor for HCW contamination during routine patient care. Because our patient and HCW sample sizes were nearly 5 times larger than previous studies on gown and glove contamination, we were able to identify many patient care activities associated with VRE transmission to HCWs, such as touching the patient's skin and transferring the patient into or out of bed.

We observed increased odds of glove and gown contamination among the occupational/physical therapists, patient care technicians, nurses, and physicians who were most likely to have direct contact with the patient and to perform tasks that would require them to touch or transfer the patient. The HCW interactions that involved touching the patient only conferred slightly higher odds of transmission than interactions with both the patient and the environment. Furthermore, HCWs that touched the patient only may have provided a more intense level of care than HCWs who touched both. However, these results should be interpreted with caution as these estimates may not be significantly different from one another. Odds increased 22% for each new patient contact compared with 7% increased odds for each environmental item touched. For example, the odds of glove or gown contamination is increased by 82% if the HCW had 3 different patient contacts with the patient domain (the average number of patient touches) versus an increase of 23% if the HCW had contact with 3 different environmental items.

These results are consistent with those of Morgan et al,[7] who reported 13% VRE glove or gown contamination after patient encounters, and those of Duckro et al,[10] who reported 11% of VRE transmission to gloves only. Similar to our findings, Snyder et al[16] identified the presence of nasogastric feeding tubes as a patient-level risk factor for transmission of VRE to HCWs. They also found that touching the patient's skin conferred the greatest

contamination risk, specifically contact with the patient's catheter, trunk, and lower extremities.[16] Morgan et al[7] identified duration in the room, performing a physical exam, contact with the ventilator, and environmental contamination as risk factors for HCW gown and glove contamination with multidrug-resistant organisms, but VRE-specific risk factors were not examined. Hayden et al[9] reported that 62% of the 103 HCW–patient interactions resulted in glove contamination with VRE, although they were unable to distinguish between touching the patient and touching the environment because nearly all HCWs touched the environment. They did, however, detect increased transfer among those who touched both the patient and the environment compared those who touched the environment only (70% vs 52%).[9]

Our findings suggest that patient contact is the main driver of HCW contamination with VRE. In a recent investigation, McDermott et al[17] conducted environmental sampling of all ICU patients (both VRE-positive and VRE-negative) and showed that 30% of ICU patients and their bed spaces were positive for VRE.[17] Similar to our findings, McDermott et al found that high touch items closest to the patient led to increased glove contamination. In contrast to prior research,[7,10] our study did not find a strong association between touching items in the environment and HCW contamination. Despite our reasonably large sample size, no specific ICU room environmental object was associated with increased odds of HCW contamination.

This study has several limitations. First, we did not culture the entire glove or gown, though we did culture the areas of the gloves (fingers and palm) and gowns (arms and waist) most likely to come into contact with the patient and subsequent patients. Second, we did not culture the environment or collect data on time of last cleaning; therefore, we were unable to adjust for the bacterial burden of the environment. Many of the patient care activities were co-occurring, such that we may not have been able to distinguish risk between bundled care activities. Third, this study was conducted at a single site and may not be generalizable to other hospitals. Finally, we did not examine risk factors for VRE transmission to gowns only, an important component of Contact Precautions, due to small sample size. Future studies of MDRO transmission in ICUs should be powered to study this outcome.

Our results indicate that direct patient contact, as opposed to environmental contact, is the major driver for HCW glove or gown contamination with VRE, a surrogate outcome for transmission to other patients within the ICU. Most VRE-colonized patients are not known to clinicians and, as such, may not be on Contact Precautions and can thus be vectors for VRE transmission in the ICU. We were also able to estimate the association with VRE transmission for a variety of common patient care activities using a large sample size and prospective design.

In conclusion, these findings can help inform novel interventions such as "red boxes," areas in which HCWs can conduct clinical assessments without donning personal protective equipment.[18,19] However, there is a need for policies to balance customization with standardization to increase adherence to infection control practices. Our finding that 15% of HCWs are contaminated with VRE after patient care should add to the debate regarding whether or not to discontinue Contact Precautions for VRE.[20–22] Our findings contribute to

the evidence for the use of Contact Precautions and hand hygiene for HCWs whose activities involve touching the patient.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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References

1. Antibiotic resistance threats in the United States. 2013 Centers for Disease Control and Prevention website. https://www.cdc.gov/drugresistance/threat-report-2013/index.html. Accessed June 16, 2018.
2. Weiner LM, Webb AK, Walters MS, Dudeck MA, Kallen AJ. Policies for controlling multidrug-resistant organisms in US healthcare facilities reporting to the national healthcare safety network, 2014. Infect Control Hosp Epidemiol 2016;37:1105–1108. [PubMed: 27350394]
3. Seibert DJ, Speroni KG, Oh KM, DeVoe MC, Jacobsen KH. Knowledge, perceptions, and practices of methicillin-resistant Staphylococcus aureus transmission prevention among health care workers in acute-care settings. Am J Infect Control 2014;42:254–259. [PubMed: 24406259]
4. Ziakas PD, Thapa R, Rice LB, Mylonakis E. Trends and significance of VRE colonization in the ICU: a meta-analysis of published studies. PLoS ONE 2013;8:e75658. [PubMed: 24086603]
5. DiazGranados CA, Zimmer SM, Klein M, Jernigan JA. Comparison of mortality associated with vancomycin-resistant and vancomycin-susceptible enterococcal bloodstream infections: a meta-analysis. Clin Infect Dis 2005;41:327–333. [PubMed: 16007529]
6. Perugini MR, Nomi SM, Lopes GK, et al. Impact of the reduction of environmental and equipment contamination on vancomycin-resistant Enterococcus rates. Infection 2011;39:587–593. [PubMed: 21847554]
7. Morgan DJ, Rogawski E, Thom KA, et al. Transfer of multidrug-resistant bacteria to healthcare workers' gloves and gowns after patient contact increases with environmental contamination. Crit Care Med 2012;40:1045–1051. [PubMed: 22202707]
8. Drees M, Snydman DR, Schmid CH, et al. Antibiotic exposure and room contamination among patients colonized with vancomycin-resistant enterococci. Infect Control Hosp Epidemiol 2008;29:709–715. [PubMed: 18631116]
9. Hayden MK, Blom DW, Lyle EA, Moore CG, Weinstein RA. Risk of hand or glove contamination after contact with patients colonized with vancomycin-resistant Enterococcus or the colonized patients' environment. Infect Control Hosp Epidemiol 2008;29:149–154. [PubMed: 18179370]
10. Duckro AN, Blom DW, Lyle EA, Weinstein RA, Hayden MK. Transfer of vancomycin-resistant enterococci via health care worker hands. Arch Intern Med 2005;165:302–307. [PubMed: 15710793]
11. Furuno JP, Perencevich EN, Johnson JA, et al. Methicillin-resistant Staphylococcus aureus and vancomycin-resistant enterococci co-colonization. Emerg Infect Dis 2005;11:1539–1544. [PubMed: 16318693]
12. Roghmann MC, Johnson JK, Sorkin JD, et al. Transmission of methicillin-resistant Staphylococcus aureus (MRSA) to healthcare worker gowns and gloves during care of nursing home residents. Infect Control Hosp Epidemiol 2015;36:1050–1057. [PubMed: 26008727]

13. Pineles L, Morgan DJ, Lydecker A, et al. Transmission of methicillin-resistant Staphylococcus aureus to health care worker gowns and gloves during care of residents in veterans affairs nursing homes. Am J Infect Control 2017;45:947–953. [PubMed: 28431853]
14. Elixhauser A, Steiner C, Harris DR, Coffey RM. Comorbidity measures for use with administrative data. Med Care 1998;36:8–27. [PubMed: 9431328]
15. Quan H, Sundararajan V, Halfon P, et al. Coding algorithms for defining comorbidities in ICD-9-CM and ICD-10 administrative data. Med Care 2005;43:1130–1139. [PubMed: 16224307]
16. Snyder GM, Thom KA, Furuno JP, et al. Detection of methicillin-resistant Staphylococcus aureus and vancomycin-resistant enterococci on the gowns and gloves of healthcare workers. Infect Control Hosp Epidemiol 2008;29:583–589. [PubMed: 18549314]
17. McDermott H, Skally M, O'Rourke J, Humphreys H, Fitzgerald-Hughes D. Vancomycin-resistant enterococci (VRE) in the intensive care unit in a nonoutbreak setting: identification of potential reservoirs and epidemio-logical associations between patient and environmental VRE. Infect Control Hosp Epidemiol 2018;39:40–45. [PubMed: 29237512]
18. Franck JN, Behan AZ, Herath PS, Mueller AC, Marhoefer KA. The red box strategy: an innovative method to improve isolation precaution compliance and reduce costs. Am J Infect Control 2011;39:E208.
19. Blomberg D Safe zone: taking the red box to the next step. Am J Infect Control 2014;42:S80–S81.
20. Russell D, Beekmann SE, Polgreen PM, Rubin Z, Uslan DZ. Routine use of contact precautions for methicillin-resistant Staphylococcus aureus and vancomycin-resistant Enterococcus: Which way is the pendulum swinging? Infect Control Hosp Epidemiol 2016;37:36–40. [PubMed: 26486272]
21. Morgan DJ, Murthy R, Munoz-Price LS, et al. Reconsidering contact precautions for endemic methicillin-resistant Staphylococcus aureus and vancomycin-resistant Enterococcus. Infect Control Hosp Epidemiol 2015;36:1163–1172. [PubMed: 26138329]
22. Rubin MA, Samore MH, Harris AD. The importance of contact precautions for endemic methicillin-resistant Staphylococcus aureus and vancomycin-resistant enterococci. JAMA 2018;319:863–864. [PubMed: 29435582]

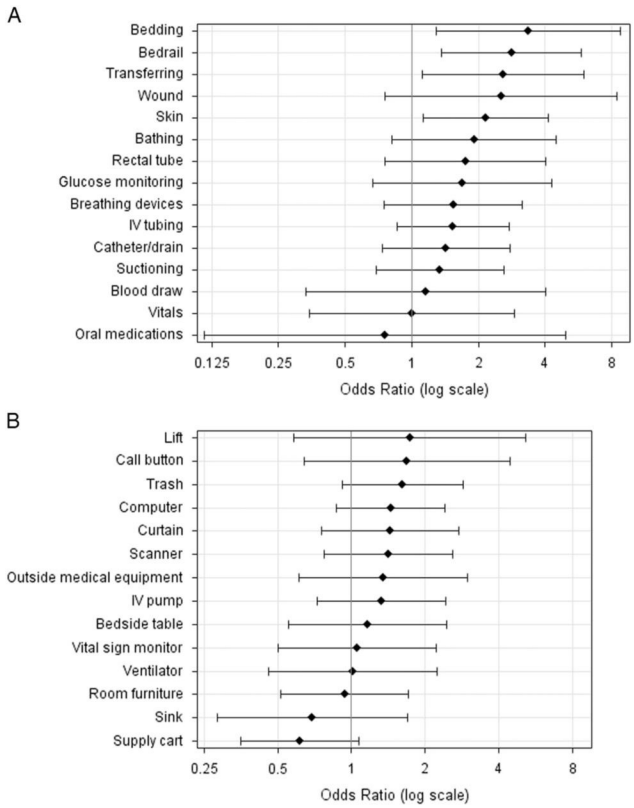

Fig. 1.

Adjusted odds ratios[a] and 95% confidence intervals of HCW glove or gown contamination for each patient care activity. (A) Patient care activities that involve touching items on or within the vicinity of the patient. (B) Patient care activities that involve touching items in the ICU room environment. [a]From a generalized estimating equation model adjusted for VRE burden, diarrhea, nasogastric tube, and time the HCW spent in the room. Abbreviations: HCW, healthcare worker and VRE, vancomycin-resistant *Enterococcus*.

Table 1.

Demographics and Clinical Characteristics of VRE Colonized ICU Patients Enrolled Between January 1, 2017, and November 15, 2017

Characteristic	Total (N = 94), No. (%)[a]
Age, mean y (SD)	60.7 (12)
Male sex	47 (50)
White race	51 (57)
Elixhauser index, median (range)	7.2 (0–14)
ICU location	
Medical ICU	56 (60)
Surgical ICU	38 (40)
Diarrhea	29 (30)
Wound	55 (59)
Endotracheal tube	48 (51)
Central line	67 (71)
Foley catheter	55 (59)
Chest tube	6 (6)
Surgical drain	25 (26)
Rectal tube	31 (33)
Nasogastric tube	52 (55)
No. of devices, median (range)	3 (0–6)
VRE burden in perianal sample (CFU/mL), median range	1.3 (0–8.5)

Note. VRE, vancomycin-resistant *Enterococcus*; ICU, intensive care unit; SD, standard deviation; CFU, colony-forming units; mL, milliliters.

[a]Unless otherwise specified.

Table 2.

Adjusted Associations Between HCW–Patient Interactions and Glove or Gown Contamination With VRE

HCW Type (N=469)	HCW-Patient Interactions, No. (%)	OR (95% CI)[a]
Nurse	236 (50)	4.74 (1.63–13.77)
MD/nurse practitioner	70 (15)	4.26 (1.06–17.18)
Respiratory technician	37 (8)	3.15 (0.64–15.54)
Patient care technician	18 (4)	7.57 (1.80–31.79)
Occupational/physical therapist	12 (3)	8.66 (1.36–55.05)
Environmental services and other[b]	96 (20)	Reference

Note. HCW, healthcare worker; VRE, vancomycin-resistant *Enterococcus*; OR, odds ratio; CI, confidence interval; MD, medical doctor.

[a]From a generalized estimating equation model adjusted for VRE burden, diarrhea, naso-gastric tube, and time HCW spent in the room.

[b]Other includes HCWs such as nutritionists, dialysis technicians, study researchers, etc.

Table 3.

Adjusted Associations Between Contact With Patient and Environmental Domains and HCW Glove or Gown Contamination With VRE

Patient Care Activity	HCW-Patient Interactions (N = 466)[a]	Interactions Resulting in Contamination, No. (%)	OR (95% CI)[b]
Touched patient domain only, no. (%)	50 (11)	10 (20)	3.65 (1.17–11.41)
Touched both patient and environmental domains, no. (%)	333 (71)	57 (17)	2.78 (0.99–7.77)
Touched environment only, no. (%)	83 (18)	4 (5)	Reference

Note. HCW, healthcare worker; OR, odds ratio; CI, confidence interval; VRE, vancomycin-resistant *Enterococcus*.

[a] Three HCWs did not touch anything in the patient room during the observation period.

[b] From a generalized estimating equation model adjusted for VRE burden, diarrhea, nasogastric tube, and HCW time spent in patient room.