CONCISE COMMUNICATION

Vancomycin-Resistant Enterococcus (VRE) Transmission and Risk Factors in Contacts of VRE Carriers

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During a 2-year period, the vancomycin-resistant enterococcus (VRE) acquisition rate was 10.9% (40/368) in patients who had shared a room with a newly detected VRE carrier. Exposure to vancomycin and to anti-anaerobic antibiotics were identified as independent risk factors for VRE acquisition. Sensitivity of the first rectal VRE screening was less than 50%.

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Vancomycin-resistant enterococci (VRE) have emerged worldwide as significant healthcare-associated (HA) pathogens. Patients colonized with VRE may develop subsequent infection due to VRE, which is associated with a higher risk of death as compared with vancomycin-susceptible enterococci.[1] Therefore, VRE is regarded as an epidemiologically important pathogen, and current guidelines recommend contact precautions for VRE carriers to prevent spread.[2]

Individual risk factors for VRE acquisition include prolonged hospitalization; comorbidities; surgery; and use of antibiotics, antacids, or steroids.[3-5] However, exposure to a patient colonized with VRE in the hospital setting likely is the most important risk factor,[6-8] with acquisition rates in the range of 21%–33%.[8,9] We aimed to estimate transmission rates in the endemic situation and to identify risk factors for VRE acquisition for roommates of newly identified HA-VRE carriers.

METHODS

The study was conducted at 2 adult tertiary acute care teaching hospitals in Hamilton, Ontario, Canada. All patients with detection of HA-VRE (index patients) and their contacts from January 2010 to December 2011 were retrospectively reviewed. The study was approved by the local research ethics board.

As per hospital protocol, all admitted patients with risk factors for antimicrobial-resistant organisms were screened for rectal VRE carriage and carriage of other antimicrobial-resistant organisms. In addition, point prevalence screening for rectal VRE carriage was performed on patients in the same unit when a new HA-VRE (defined by detection of VRE at least 48 hours after admission) was identified. Known VRE carriers as well as contacts of newly identified carriers were put on contact precautions, preferentially in private rooms or rooms shared with another VRE-positive patient. The contact precautions were discontinued in contacts when 2 negative VRE screening results were obtained at a minimum of 7 days apart.

Index patients were presumed to be VRE carriers since admission or since the last negative VRE screening results, whichever was later. Contacts were roommates of index patients during this time period. In the absence of a positive VRE screening during follow-up, contacts were deemed having not acquired VRE. An outbreak on a ward was declared when 3 or more new HA-VRE cases in nonroommates occurred within 7 days or 5 cases within 30 days.

VRE was identified by using the combination of VRE chromogenic selective medium (Dalynn Colorex VRE) for screening and polymerase chain reaction for *van*A and *van*B genes for confirmation. The sensitivity of VRE swabs was calculated by dividing the number of positive contacts detected after 1 or 2 swabs by the total number of known positive contacts, that is, after 3 or more swabs.

A χ^2 analysis was conducted, and odds ratios (ORs) and 95% confidence intervals (CIs) were reported. Variables with $P < .1$ were included in multivariate logistic regression analysis. All analyses were performed with PASW 18 (SPSS).

RESULTS

There were a total of 53,123 admissions and 41,697 screenings for rectal VRE colonization during the study period (Figure 1). A total of 254 index patients were identified, including 15 patients who acquired VRE as roommates of index patients. Of these, 163 (64.2%) were sharing a room prior to detection with at least 1 of a total of 368 contacts. Among the 368 contacts, 40 (10.9%) were found to be VRE positive. The majority (37/40 [92.5%]) screened negative at admission. Assuming that 10.9% reflects the true transmission rate and an acquisition rate of 0 without exposure to a VRE index patient, 92 contacts of index cases would need to be isolated to prevent 1 additional secondary case.

Among the negative contacts, at least 1 negative screening result was available in 314/328 (95.7%), at least 2 in 235 (71.6%), and at least 3 in 145 (44.2%) patients. Among the 40 positive contacts, sensitivity of 1 and 2 swabs was 42.5% and 80%, respectively. Eight patients were detected after only 3 or 4 rectal swabs.

Acquisition rates differed between hospitals (Table 1). Exposure to vancomycin (OR, 4.24 [95% CI, 2.16–8.34]), flu-

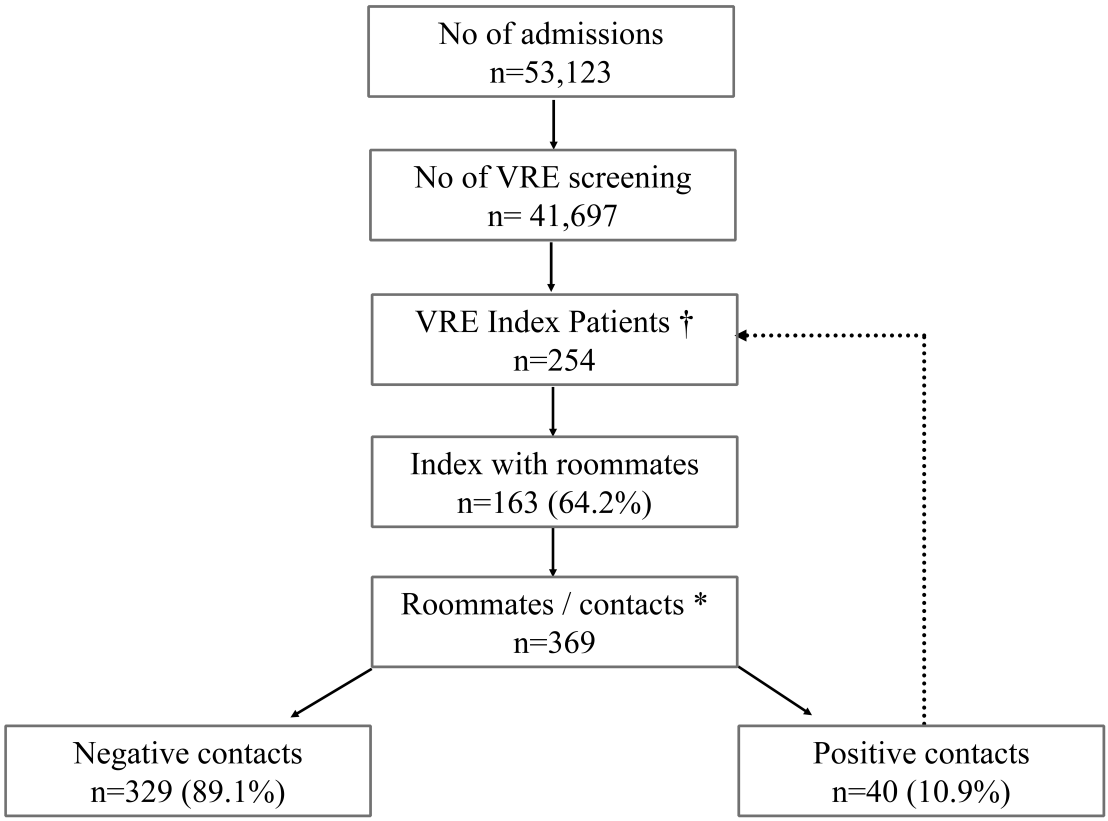

FIGURE 1. Study flow chart. Dagger indicates index patient (hospital-acquired vancomycin-resistant enterococcus [VRE] colonization). Asterisk indicates contacts (patients who shared a room with an index patient).

oroquinolones (OR, 2.33 [95% CI, 1.19–4.55]), and antibiotics with anti-anaerobic activity (OR, 2.78 [95% CI, 1.42–4.43) within 30 days were associated with VRE acquisition. There was no association with diarrhea in the index patient or age and comorbidities in contacts. In multivariate analysis, exposure to vancomycin (OR, 2.58 [95% CI, 1.22–5.47]) and antibiotics with anti-anaerobic activity (OR, 2.25 [95% CI, 1.09–4.65]) were identified as independent risk factors.

DISCUSSION

Our 3 key findings were that (1) 10.9% of roommates of newly detected HA-VRE carriers acquired VRE; (2) independent risk factors for VRE acquisition included previous exposure to vancomycin and anti-anaerobic antibiotics; and (3) sensitivity of the first screening was less than 50%, emphasizing the need for multiple screenings following VRE exposure.

In our study, the VRE acquisition rate in contacts was lower than previously reported rates of 21%–33%.[8,9] This difference could be attributed to differences in cleaning practice, hand hygiene, antibiotic exposure, surveillance practices, or unmeasured confounders, such as patient characteristics or the overall colonization pressure.[6]

Exposures to vancomycin as well as anti-anaerobic antibiotics were independent risk factors for VRE acquisition. This is in contrast to a smaller study published by Zhou et al,[8] in which the investigators found fluoroquinolone use as a risk factor in univariate analysis.

Surprisingly, the outbreak status did not significantly affect the transmission rates. This may be related to the definition of outbreaks used during that time period, which did not take the baseline rates into account. Interestingly, more contacts were involved in an outbreak in the hospital with the higher transmission rate in univariate analysis.

We hypothesize that the low sensitivity (42.5%) of the first swab immediately after exposure may be related to a low and undetectable enteric VRE burden, as previously shown for methicillin-resistant *Staphylococcus aureus*, with a similar sensitivity of 40% with the first swab immediately after exposure.[10]

Our study has a number of limitations. (1) Because of a lack of routine typing of isolates, transmission was assumed on the basis of the epidemiological link. (2) Albeit signifi-

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TABLE 1. Characteristics and Risk Factors for Vancomycin-Resistant Enterococcus (VRE) Acquisition in 368 Contacts of VRE Patients

Characteristic	Individuals, *n*	VRE positive, *n* (%)	Crude risk OR (95% CI)	*P*	Adjusted risk OR (95% CI)	Adjusted *P*
Contacts overall	368	40 (10.9)				
Hospital						
1	154	10 (6.5)	2.35 (1.11–4.95)	**.022**	2.05 (0.89–4.76)	.093
2	214	30 (14.0)				
Outbreak						
No	267	24 (9.0)	1.91 (0.97–3.76)	.059	1.22 (0.57–2.64)	.605
Yes[a]	101	16 (15.8)				
Antibiotics[b]						
Vancomycin						
No	276	19 (6.9)	4.24 (2.16–8.34)	**<.001**	2.64 (1.27–5.51)	**.010**
Yes	88	21 (23.9)				
Ceftriaxone						
No	284	28 (9.9)	1.61 (0.78–3.34)	.194		
Yes	80	12 (15.0)				
Fluoroquinolones						
No	213	16 (7.5)	2.33 (1.19–4.55)	**.012**	1.82 (0.90–3.70)	.090
Yes	151	24 (15.9)				
Anti-anaerobic antibiotics						
No	235	17 (7.2)	2.78 (1.43–5.43)	**.002**	2.24 (1.08–4.64)	**.029**
Yes	129	23 (17.8)				

NOTE. Boldface indicates statistically significant *P* values. CI, confidence interval; OR, odds ratio.

[a] There were a total of 9 VRE outbreaks during the study period. The average duration of the outbreaks (defined as from the first to the last VRE-positive case) was 19.5 days (range, 8–31 days).

[b] As inpatients in preceding 30 days.

cantly larger than similar studies, we had only 40 positive contacts, limiting our capabilities for more extensive multivariate analyses. (3) Variables such as colonization pressure, duration of antibiotic exposure, and duration to exposure to the index patient had not been taken into account. (4) Three or more VRE screenings were available in only 44% of negative contacts, which may have resulted in false-negative findings. However, in a sensitivity analysis, when only patients with 2 or more negative swabs as true negatives were included, the acquisition rate increased only marginally (14.5%), and the conclusions from the multivariate analysis would not have changed (data not shown). (5) Finally, the lack of universal admission screening may have influenced our estimated transmission rate. However, we had negative VRE admission screenings available in more than 90% of positive contacts; thus, a significant overestimation of the acquisition rate is unlikely.

In conclusion, we estimated a transmission rate of 10.9% for patients sharing a room with newly detected VRE carriers. In light of these findings, use of contact precautions for VRE carriers may be justified to prevent transmission, but preemptive contact precautions for contacts does not seem to be warranted. Interventions to reduce the spread of VRE should be combined with antimicrobial stewardship with a focus on reducing unnecessary use of vancomycin as well as of antibiotics with anti-anaerobic coverage.

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