RESEARCH BRIEFS

Secular Trends in Nosocomial Vancomycin-Resistant Enterococcal Bloodstream Infections Among United States Veterans Affairs Hospitals, Fiscal Years 2004 through 2014

Nosocomial bloodstream infections (BSI) due to vancomycin-resistant enterococci (VRE) represent an important infection control issue, as the burden of VRE infections has increased dramatically over the last few decades.[1] In a study of United States hospitals, the incidence of hospitalizations due to VRE doubled from 2000–2003 to 2003–2006.[2] Among Canadian hospitals, the prevalence of VRE infections tripled from 2007 to 2013.[3] Other studies have reported similar increases in the incidence of VRE-BSI.[4–6] Although these collective data suggest an increase in the burden of VRE infection, more current data from a national sample are needed. In this study, we aimed to quantify and evaluate trends in the incidence of nosocomial VRE-BSI in the Veterans Affairs (VA) healthcare system.

We conducted a national retrospective study of adult hospitalized patients admitted to any VA hospital between fiscal years (FY) 2004 and 2014 (ie, October 1, 2003, through September 30, 2014). Microbiologically confirmed cases were identified from inpatient clinical data from the VA Corporate Data Warehouse and were defined as (1) having ≥1 blood culture positive for an *Enterococcus* species demonstrating resistance to vancomycin as reported by institutional susceptibility testing results obtained during routine clinical care and (2) hospital admission ≥48 hours at the time of first positive blood culture. Additional data collected included patient demographics (eg, age, gender) and setting of onset (ie, intensive care unit [ICU] vs non-ICU). Age-specific hospitalization estimates were derived from Veterans Health Administration Support Service Center data. Cases from non–acute-care admissions were excluded from analysis. Age-specific incidences (per 10,000 hospitalizations and per 10,000 patient days) were computed per fiscal year and were analyzed over time by linear regression. Statistical analysis was performed using Prism version 7 software (GraphPad, La Jolla, California); $P < .05$ was considered statistically significant. The Kansas City VA institutional review board approved this study.

Over the study period, 4,572 cases of nosocomial VRE-BSI were observed over 7,269,927 hospitalizations (6.29 per 10,000 hospitalizations) and 46,732,419 patient days (0.98 per 10,000 patient days). In total, 114 hospitals across all 50 United States, the District of Columbia, and Puerto Rico contributed cases. Among these cases, 3,658 (80.0%) were due to *Enterococcus faecium*, 388 (8.5%) were due to *Enterococcus faecalis*, and 526 (11.5%) were due to other *Enterococcus* or unspecified species. Most cases occurred in a non-ICU setting ($n = 2{,}755$; 60.3%). The median age was 65 years (interquartile range, 59–76 years) and 4,455 (97.4%) were male.

We detected notable differences in yearly age-specific incidence rates of nosocomial VRE-BSI over the study period (Table 1). Overall incidence increased during the first 5 years of study, peaking in FY2007–2008 (8.95 per 10,000 hospitalizations; 1.29 per 10,000 patient days; slope for linear trend for FY2004–2008, 0.06; $r^2 = 0.79$). The incidence of VRE-BSI steadily declined over the remainder of the study period and the lowest rates were observed in FY2014 (2.84 per 10,000 hospitalizations; 0.52 per 10,000 patient days; slope for linear trend for FY2008–2014, −0.12; $r^2 = 0.9$). Overall, the incidence density of nosocomial VRE-BSI significantly decreased over the study period (slope for linear trend for FY2004–2014, −0.07; 95% confidence interval, −0.10 to −0.03; $r^2 = 0.69$; $P = .002$). Similar year-by-year trends in incidence rates were observed consistently across all age groups, with the highest incidence observed in those aged 75–84 years.

In this national retrospective study of VA hospitals, we noted significant changes in the epidemiology of nosocomial VRE-BSI from FY2004 to FY2014. Consistent with previous data, we observed increasing incidence rates of VRE-BSI in the first few years of study.[2–7] However, we report a marked decrease in the burden of nosocomial VRE-BSI over the last 5 years of study. The epidemiology of VRE infections was recently reviewed in a meta-analysis of multicenter studies.[1] In contrast to the present analysis, most studies reported increasing incidences of VRE infections, including BSI.[1] However, most of these investigations did not include data more recent than 2011.

The etiology for the decline we observed in nosocomial VRE-BSI incidence is uncertain. Similar reductions in methicillin-resistant *Staphylococcus aureus* (MRSA) and gram-negative bacillus BSI rates have recently been described in the VA population; they have been attributed to an expanded MRSA infection prevention initiative implemented across the healthcare system in early 2007.[8,9] This infection control program featured a number of horizontal infection control interventions that could have potentially reduced the incidence of other hospital-acquired infections.[8] Complete implementation of this initiative was mandated for all VA hospitals by FY2008, and the program details have been previously reviewed.[8] Consistent with this theory, a significant reduction in voluntary reporting of VRE infections was noted from 2007 to 2010 in 33 VA hospitals following the implementation of this infection control program.[8]

Although the use of a national sample and microbiological confirmation of cases represent significant strengths of this study, the study had several limitations. This was a study of the

https://doi.org/10.1017/ice.2017.125 Published online by Cambridge University Press

TABLE 1. Age-Specific Incidence Rates of Nosocomial Vancomycin-Resistant *Enterococcus* (VRE) Bloodstream Infections Among United States Veterans Affairs Hospitals, Fiscal Years 2004–2014

	Fiscal Year										
Incidence by Age Group	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Per 10,000 hospitalizations											
18–34 years	0.83	2.35	3.01	3.21	3.33	0.50	0.85	1.16	1.75	0.00	0.36
35–44 years	3.16	5.19	4.84	3.95	3.70	4.62	1.69	1.02	1.33	0.67	0.11
45–54 years	5.56	6.06	5.88	5.32	6.91	4.23	2.82	3.59	3.19	2.11	1.92
55–64 years	6.57	9.52	8.87	9.63	9.39	7.97	6.02	5.38	5.46	4.01	3.60
65–74 years	8.90	10.02	10.35	10.90	11.25	7.32	6.27	6.00	5.18	3.70	3.68
75–84 years	11.56	9.67	11.31	11.64	8.52	7.85	7.42	7.02	5.13	4.29	3.18
≥85 years	6.95	8.63	8.43	7.30	7.09	7.43	5.23	5.86	3.14	2.47	1.89
All	7.57	8.59	8.64	8.95	8.62	6.81	5.39	5.22	4.54	3.30	2.84
Per 10,000 patient days											
18–34 years	0.11	0.29	0.40	0.41	0.52	0.10	0.12	0.17	0.26	0.00	0.05
35–44 years	0.44	0.77	0.72	0.60	0.57	0.75	0.27	0.17	0.23	0.12	0.19
45–54 years	0.72	0.84	0.82	0.76	1.01	0.68	0.43	0.57	0.53	0.35	0.32
55–64 years	0.88	1.32	1.24	1.37	1.39	1.29	0.95	0.87	0.91	0.67	0.61
65–74 years	1.21	1.46	1.52	1.61	1.71	1.21	1.01	0.99	0.90	0.65	0.66
75–84 years	1.53	1.33	1.61	1.69	1.27	1.26	1.29	1.15	0.87	0.73	0.56
≥85 years	0.91	1.19	1.49	1.47	1.09	1.22	0.87	1.00	0.55	0.44	0.34
All	1.01	1.20	1.20	1.29	1.28	1.11	0.85	0.84	0.77	0.56	0.52

VA population, which consists largely of Caucasian males of advanced age with a high comorbidity burden and poorer health than the general population.[10] Therefore, the results of this study may not be generalizable to dissimilar populations. This study was not designed to evaluate potential etiologies for the changing epidemiology observed and further study is warranted.

In summary, we report a significant decrease in the national incidence of nosocomial VRE-BSI in recent years. This finding contrasts with older data suggesting that the incidence of VRE infection has been increasing. Whether the incidence of nosocomial VRE-BSI outside the VA system is similarly decreasing warrants further study.

ACKNOWLEDGMENTS

The authors sincerely thank Mary Oehlert for providing institutional support and study coordination and Allen Faler for his expertise and assistance in database management. The authors also thank the VA Microbiology and Antimicrobial Data Work Group for their thoughtful advice on data extraction. The contents of this report do not represent the views of the Department of Veterans Affairs or the United States Government.

Financial support: This material is the result of work supported with resources and the use of facilities at the Dwight D. Eisenhower VA Medical Center, Leavenworth, Kansas.

Potential conflicts of interest: All authors report no conflicts of interest relevant to this article.

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Received April 2, 2017; accepted May 21, 2017; electronically published July 11, 2017

Infect Control Hosp Epidemiol 2017;38:1114–1116

 0899-823X/2017/3809-0018. DOI: 10.1017/ice.2017.125

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The Effect of Ultraviolet Light on *Clostridium difficile* Spore Recovery Versus Bleach Alone

In 2014, 101,074 cases of hospital-acquired *Clostridium difficile* infections were reported to the National Healthcare Safety Network (NHSN) by acute-care hospitals.[1] Environmental contamination is a risk factor for hospital-onset *C. difficile*.[2] Ways to decrease environmental contamination include frequent hand hygiene and adequate environmental cleaning with sporicidal agents[3]; however, both methods are subject to human error. *Clostridium difficile* spores can persist in hospital environments for up to 5 months.[4] In multiple studies, an additional step of no-touch disinfection using ultraviolet light at 254 nanometers (UV-C) has eradicated *C. difficile* spores in hospital environments.[5,6]

Our aim was to evaluate the effectiveness of manual cleaning and subsequent UV-C treatment on inpatient hospital room surfaces of patients with confirmed *C. difficile* infections (CDIs). We measured colony-forming units (CFUs) of *C. difficile* on high-touch surfaces.

The Surfacide system (Waukesha, WI) produces UV-C light and is composed of 3 towers that work together or individually. The towers are placed around the bed in a triangle to focus on high-touch surfaces and to minimize shadowing. This system utilizes a laser to measure the space and calculate the required disinfection cycle time using a prespecified algorithm while rotating 360°. The system is equipped with a motion sensor to trigger a machine shut down to protect patients and staff. At our 308-bed comprehensive cancer center, we have trained staff to operate the emitters.

Our study focused on patient rooms of occupants with confirmed CDI via positive toxin B gene (*tcdB*) polymerase chain reaction (PCR) testing results. These patients are placed in enteric contact isolation, which mandates daily room cleaning with bleach and daily bathroom UV-C disinfection, but the latter does not necessarily occur immediately after manual cleaning. One emitter is used in the bathroom with the door closed, while the patient may be present in the room. Upon discharge, the bathroom and room are terminally cleaned with bleach and are immediately disinfected with UV-C. One emitter typically runs for 10 minutes in a bathroom, then the 3 emitters run for 45 minutes in the patient room.

After bleach cleaning, prior to UV-C disinfection, 2–3 high-touch surfaces were sampled by vigorously swabbing the right side of each high-touch surface with a urethane sponge (4 cm × 3.5 cm) moistened with neutralizing buffer (World Bioproducts EZ-10NB PUR). After UV-C disinfection, the same site was sampled, but on the left side of each high-touch surface. The 9 sample sites included over-bed table, toilet seat, computer keyboard, bathroom doorknob, bathroom faucet handles, bed side rails, bedside commode, recliner chair table, and call light (Table 1). Each swab was placed in a sterile bag, and 9.9 mL of 0.1% peptone buffer was added to each bag in the lab. The sponge was mechanically stomached to release recovered microorganisms into the buffer. Samples were dilution plated onto liver veal agar plates and incubated anaerobically at 37°C for 2 days. Sample cutoffs are reported as <10 CFUs as the lower limit of detection, meaning 9 to 0 colonies on the plate. Results are not reported between 0 and 9 CFUs due to addition of buffer, which releases organisms from swabs and dilutes the sample. Descriptive statistics for surfaces sampled prior to UV-C implementation were calculated using a dichotomous outcome of 10 CFUs. An overall comparison of UV-C treatment by ≥10 CFUs and <10 CFUs was assessed using the Fisher exact test. All statistical procedures were performed in SAS version 9.3 software (SAS Institute, Cary, NC). Values were considered significant at $P < .05$.

Over 4 months, 476 sites were cultured: 186 were in bathrooms and 290 were in the patient rooms. Overall, prior to UV-C treatment, 32 of 238 (13%) were positive after bleach cleaning for *C. difficile* at ≥10 CFU. In the bathrooms, 5 of 88 high-touch surfaces (6%) were *C. difficile* positive; in the patient rooms, 27 of 118 high-touch surfaces (23%) were *C. difficile* positive, respectively. The toilet seat and the over-bed table were the 2 most commonly positive sites (Table 1).

Among all sites, after UV-C treatment, only 1 of 238 high-touch surfaces (0.4%) was positive: 1 computer keyboard had 10 CFUs. We observed a statistically significant decrease in the

https://doi.org/10.1017/ice.2017.125 Published online by Cambridge University Press