**Practice forum**

**Horizontal infection prevention measures and a risk-managed approach to vancomycin-resistant enterococci: An evaluation**

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Key Words:
Vancomycin-resistant enterococci
Risk management

**Background:** The use of infection control measures in the management of vancomycin-resistant enterococci (VRE) is hotly debated. A risk-managed approach to VRE control after the introduction of 2 horizontal infection prevention measures—an environmental cleaning (EC) and an antimicrobial stewardship (AMS) program—was assessed.

**Methods:** Routine screening for VRE was discontinued 6 and 4 months after introduction of the EC and AMS programs, respectively. Only 4 units (intensive care, burns-trauma, solid organ transplant, and bone marrow transplant units) where patients were deemed to be at increased risk for VRE infection continued screening and contact precautions. Cost avoidance and value-added benefits were monitored by the hospital finance department. VRE monitoring on these high-risk units and facility-wide comprehensive bacteremia surveillance continued as per established protocols. Surveillance for methicillin-resistant Staphylococcus aureus (MRSA) and Clostridium difficile infection (CDI) remained unchanged.

**Results:** VRE bacteremia rates did not increase with the change to the VRE risk-managed approach. The number of patients requiring VRE isolation in all areas of the hospital decreased from an average of 32 to 6 beds per day. Statistically significant reductions in CDI and MRSA rates were observed possibly related to the aggressive decluttering, equipment cleaning, and AMS program elements.

**Conclusion:** A risk-managed approach to VRE can be implemented without adverse consequences and potentially with significant benefits to a facility.

The effectiveness of control measures and whether they should be applied to vancomycin-resistant enterococci (VRE) is a subject of intense debate.1-4 The cost of maintaining a VRE control program varies, largely reflecting the inconsistencies in the intensity of screening and infection control policies aimed at identifying and managing this antimicrobial-resistant organism.5 Despite intensive efforts at containment, VRE colonization has increased in Canada and internationally.6-8 More recently, the increased use of horizontal infection prevention strategies that target all health care—associated pathogens has been promoted as a more sustainable way to address antimicrobial resistance.9

In 2010-2011, Vancouver Coastal Health performed approximately 17,000 surveillance admission screens for VRE (consistent with our hospital admission screening algorithm) and spent $5.2 million to isolate 612 incident cases of VRE ($8,465/case).10 Only 37 (6%) cases represented infections, of which 13 (2%) were from sterile sites or considered serious in nature. Incident VRE colonization rates at Vancouver General Hospital (VGH) increased significantly from 10.9 per 10,000 (95% confidence interval [CI], 9.6-12.4) patient days in 2008-2009 to 16.0 (95% CI, 13.5-16.7) in 2012-2013 (P < .001). In contrast, VRE incident infections remained stable at 1.3 and 1.6 per 10,000 patient days (P = .50) for 2008-2009 and 2012-2013, respectively. In light of the increasing burden of VRE, the difficulties of sustaining the
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program economically and logistically, and the relatively low number of infections, the infection prevention and control (IPAC) program proposed a risk-managed approach to VRE control after the introduction of 2 horizontal infection prevention measures—an environmental cleaning (EC) and an antimicrobial stewardship (AMS) program. The results of this approach and how it was managed financially at the largest facility (VGH) are detailed herein.

METHODOLOGY

Approach

Vancouver Coastal Health is a regional health authority comprising 9 acute care facilities, numerous long-term care centers, and a rehabilitation hospital. VGH is the 728-bed adult tertiary care center and is the provincial referral center for transplantation, burns, specialty intensive care, and trauma. It was the first of the facilities to pilot a combined horizontal infection control program with EC and AMS components followed by a risk-managed approach to VRE. The EC element began in August 2012, and the AMS initiative began in November 2012. The risk-managed approach to VRE then began on March 1, 2013.

The EC program addressed facility clutter and hoarding, identified roles and responsibilities for cleaning each piece of equipment, and provided dedicated staff to clean both mobile and patient-specific equipment, all in an effort to decrease microbial bioburden. Unit-specific equipment cleaning and storage depots were established with par levels of all essential items and with the assurance that depots would be checked multiple times during the day to ensure that supplies did not fall below established baselines. All mobile equipment was bar-coded to facilitate regular inspection and repairs through a centralized maintenance program. As well, a green means clean sticker program identified cleaned equipment for end users (Fig 1).

The AMS program focused on prescriber education, use of clinical pathways and algorithms for patient care, audit and feedback of broad-spectrum antimicrobials on target units, de-escalation of antimicrobial therapy where indicated, development of clinical resources and tools for clinicians, drug utilization evaluation based on hospital-wide prescribing patterns, embedding of microbiology laboratory—based prescribing and infection prevention messaging, and establishment of an AMS committee.

The business case for the new EC and AMS programs was funded with the proviso by the senior executive team that the program be revenue neutral through cost avoidance measures by year 3. As mentioned, the combined horizontal program was established first and the VRE risk-managed approach was implemented several months later. From that point on, only patients in intensive care units (ICUs), burn-trauma (BT) units, and bone marrow and solid organ transplantation (BMSOT) units—those units whose patients are at greatest risk of a VRE infection (high-risk units)—had admission and weekly VRE screening and isolation if specimens were positive. Importantly, the weekly VRE point prevalence and admission screening to these units continued unchanged from previous years to monitor the impact of the VRE risk-managed approach. Figure 2 shows the hospital-wide VRE bacteremia rates did not increase after implementation of the risk-managed approach. Figure 2 shows the hospital-wide nosocomial VRE bacteremia rates for both high-risk and other units from 2007-2008 to 2014-2015. There were no statistically significant differences in the rates over time for the other units. In 2012-2013 there was a spike in the rate for the high-risk units, with a total of 16 VRE bacteremias, of which 14 were acquired prior to implementation of the risk-managed approach on March 1, 2013. The VRE bacteremia rates for the high-risk units declined after the peak in 2012-2013, with the rate in 2014-2015 being statistically significantly lower than the rate in 2012-2013 (P = .009). For 2014-2015, the rates for high-risk and other units are not statistically significantly different from each other (P = .057), with the rate for the high-risk units at their lowest since 2007-2008.

Importantly the number of patients requiring VRE isolation in all areas of the hospital (including ICU, BMSOT, and BT) decreased from an average of 32 (new and readmitted patients) to 6 beds per day despite a ≥100% occupancy rate during this period. The aggressive decluttering, equipment cleaning, and AMS program elements have likely contributed to the dramatic decrease in cases of CDI by >55.8%, falling from 12.0 (95% CI, 10.7-13.5) in 2011-2012 to 9.9 (95% CI, 8.7-11.2) in 2012-2013 to 6.6 (95% CI, 5.6-7.6) in 2013-2014 to 5.3 cases per 10,000 (95% CI, 3.9-6.0) patient days in 2015, the rates for high-risk and other units are not statistically significantly different from each other (P = .057), with the rate for the high-risk units at their lowest since 2007-2008.

RESULTS

VRE bacteremia rates did not increase after implementation of the risk-managed approach. Figure 2 shows the hospital-wide nosocomial VRE bacteremia rates for both high-risk and other units from 2007-2008 to 2014-2015. There were no statistically significant differences in the rates over time for the other units. In 2012-2013 there was a spike in the rate for the high-risk units, with a total of 16 VRE bacteremias, of which 14 were acquired prior to implementation of the risk-managed approach on March 1, 2013. The VRE bacteremia rates for the high-risk units declined after the peak in 2012-2013, with the rate in 2014-2015 being statistically significantly lower than the rate in 2012-2013 (P = .009). For 2014-2015, the rates for high-risk and other units are not statistically significantly different from each other (P = .057), with the rate for the high-risk units at their lowest since 2007-2008.

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Economic evaluation

Two financial advisors were assigned to the project to track cost avoidance and any unexpected costs. Laboratory savings were based on the reduction of VRE surveillance cultures and focused mainly on reagent savings rather than on technologist time. Cost avoidance in laundry, personal protective equipment, and isolation supplies was obtained from Logistics and Business Initiatives Shared Services (who monitor the external contractors). A previous in-house economic analysis of the costs of managing CDIs was used to estimate cost recovery from a reduction in these cases. Antibiotic utilization was calculated from pharmacy data and based on defined daily dose as described by the World Health Organization.

The financial advisors provided quarterly budget summaries listing 1-time expenses, ongoing operating expenses, and savings as previously listed. The net project costs-savings were summarized at the end of each fiscal year and reviewed by the senior executive team.
the year-to-date (quarter 3 of 2014-2015). CDI rates declined 46% from 2012-2013 at the time of implementation of the VRE risk-managed approach to 2014-2015; the difference is statistically significant ($P < .001$). MRSA rates have also declined but not as dramatically. Rates increased from 5.3 (95% CI, 4.8-7.5) in 2011-2012 to 8.9 (95% CI, 7.8-10.1) in 2012-2013, but they declined

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**Fig 1.** Environmental program. (1A) Before and (1B) after decluttering campaign and purchase of standardized isolation carts; (2) color-coded cleaning carts and microfiber cloths; (3) barcoded and green means clean tagged equipment; and (4) equipment depot.
post-implementation to 8.1 (95% CI, 7.1-9.3) in 2013-2014 and 6.7 (95% CI, 5.6-8.1) in the year-to-date (quarter 3) of 2014-2015. The reduction in MRSA rates from 2012-2013 prior to implementation of the risk-managed approach to VRE and 2014-2015 (25% reduction) is statistically significant ($P = .02$).

Table 1 summarizes the July 2014 budget and includes information on start-up capital costs, on-going operating expenses (largely personnel), and cost avoidance achieved through (1) reduction in VRE isolations and subsequent decrease in CDI cases with the horizontal program; (2) decreased laboratory reagent consumption; and (3) antimicrobial cost savings. Isolation cost savings included an across-the-board 15% decrease in linens, isolation gowns, and gloves; a reduction in cleaning supply costs and supply waste from isolation rooms; and recovered revenue generation from an increase in available private rooms.

Table 1

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<tbody>
<tr>
<td>One-time expenses</td>
<td>548,817</td>
<td>50,000</td>
<td>0</td>
<td>For consultant fees, renovation costs for equipment rooms, isolation carts, cleaning carts and color-coded microfiber cloths, AMS software</td>
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<td>Ongoing operational expenses</td>
<td>466,418</td>
<td>1,079,362</td>
<td>1,079,362</td>
<td>For part-time AMS physician, pharmacist, and analyst salaries with the addition of mobile equipment cleaning personnel from 2013-2014 onward</td>
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<td>Total expenses</td>
<td>1,015,235</td>
<td>1,129,362</td>
<td>1,079,362</td>
<td>Antibiotic reduction (average $355,000/y last 2 y), laboratory savings (average $65,000/y last 2 years), decreases in laundry, cleaning supplies, PPE (average $325,000/y last 2 y), and private room savings through decreased VRE and CD isolation (average $330,000/y last 2 y)</td>
</tr>
<tr>
<td>Total savings</td>
<td>1,005,533</td>
<td>(1,054,955)</td>
<td>(1,094,017)</td>
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<tr>
<td>Net project costs/(savings)</td>
<td>914,702</td>
<td>74,407</td>
<td>(14,655)</td>
<td>AMS, antimicrobial stewardship; CD, Clostridium difficile; PPE, personal protective equipment.</td>
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*Modest savings were achieved in 2012-2013, but they were not included by finance in the average estimates of cost reduction noted in the comments section.

DISCUSSION

VRE management varies widely. Large-scale screening and isolation is costly, but most facilities continue to maintain these intensive (and expensive) vertical measures believing that patients colonized with VRE perpetuate more exposures and more infections. Others have abolished VRE control programs arguing that they are not applied consistently, control programs are not cost-effective, infections are few, and tolerating some increase in VRE colonization or infections is acceptable.4,15 The IPAC team at VGH performed a careful risk assessment and concluded that only patients at the highest risk of acquiring a serious VRE infection (ICU, BT, and BMSOT units) would continue to have an astounding 97% reduction in blood and body fluid exposures reported by the maintenance staff responsible for bed repair from an average of 1 report per week to 2 annually. Additionally, staff who repair general equipment did not record any soft tissue injuries for an 18-month period once the central equipment repair bays with automatic hoists were installed. There is now no waiting time for equipment at the unit level.

**Table 2**

Hospital-wide nosocomial VRE bacteremia cases and rates: high-risk versus other units. The 2014-2015 data are current through January 29, 2015. Fiscal years run from April 1-March 31 (eg, 2008-2009 runs from April 1, 2008-March 31, 2009). Risk-managed approach to VRE was implemented on March 1, 2013, and surveillance on all units (except for the high-risk units) was discontinued. Beginning January 2009, all stool samples submitted to the laboratory for CDI testing were screened for VRE. This change in laboratory testing increased VRE detection, with 35% of all newly identified VRE detected through a CDI screen (data from January 1, 2009-March 31, 2010). Testing of CDI stools for VRE was discontinued November 19, 2012. In 2012-2013, a total of 16 VRE bacteremias were acquired on the high-risk units. All but 2 were acquired prior to implementation of the risk-managed approach on March 2, 2013. CDI, Clostridium difficile infection; VRE, vancomycin-resistant enterococci.

**Fig 2.** Hospital-wide nosocomial VRE bacteremia cases and rates: high-risk versus other units. The 2014-2015 data are current through January 29, 2015. Fiscal years run from April 1-March 31 (eg, 2008-2009 runs from April 1, 2008-March 31, 2009). Risk-managed approach to VRE was implemented on March 1, 2013, and surveillance on all units (except for the high-risk units) was discontinued. Beginning January 2009, all stool samples submitted to the laboratory for CDI testing were screened for VRE. This change in laboratory testing increased VRE detection, with 35% of all newly identified VRE detected through a CDI screen (data from January 1, 2009-March 31, 2010). Testing of CDI stools for VRE was discontinued November 19, 2012. In 2012-2013, a total of 16 VRE bacteremias were acquired on the high-risk units. All but 2 were acquired prior to implementation of the risk-managed approach on March 2, 2013. CDI, Clostridium difficile infection; VRE, vancomycin-resistant enterococci.
be screened and isolated. Importantly, the team insisted that 2 critical horizontal infection control initiatives—an EC and an AMS program—would be first added to the existing IPAC interventions and monitored to ensure that they were reliably and consistently applied prior to implementing the VRE risk-managed approach. The expectation was that these generic programs (ie, targeting all organisms) would provide the infrastructure to ensure that EC and antimicrobial utilization were optimized and the bioburden from antimicrobial resistant organisms was subsequently reduced.9

The effect of the combined horizontal program and the VRE risk-managed approach was monitored by continuing the regular weekly VRE point prevalence screening of ICU, BT, and BMSOT patients, the ongoing monitoring of sterile site infections by the laboratory, and the monitoring of hospital-wide VRE bacteremia rates for which there was no change in surveillance methodology. It is gratifying that the hospital-wide VRE bacteremia rates did not increase, and in fact, rates among the high-risk units decreased significantly and are at their lowest since 2007–2008. Most remarkable was the facility-wide dramatic decrease in incident cases of C difficile and the decline in MRSA cases. The downward trend continues.

In our experience, multifaceted initiatives of the AMS program may have contributed to 2,980 avoided days of antibiotic therapy and an average cost savings of $355,000 over the last 2 fiscal years. However, these cost savings may not all be attributable to the AMS program because other factors, such as a robust clinical pharmacy program, consultation with infectious diseases and medical microbiology services, and changes in clinical practice patterns, may also be involved. It should also be noted that because the drug budget encompasses all classes of drugs (antibiotics and non-antibiotics), the cost savings achieved through antibiotic reduction may be off-set by increased costs of other agents.

Further details of the EC program in particular are worth mentioning. A program manager is crucial to the sustainment of this intervention. The program manager is responsible for ensuring that units remain uncluttered, that roles and responsibilities for cleaning equipment are updated and are adhered to, that par levels of equipment are maintained, that liaison with housekeeping supervisors occurs to ensure that EC practices are consistent and are monitored, and finally, that the budget for the program is adhered to. Adenosine triphosphate bioluminescence, ultraviolet audits, and environmental cultures have confirmed that the mobile equipment is consistently cleaned; an oversight committee monitors bed cleaning turnaround time; and independent third-party auditors inspect facility cleanliness.

There are other, more subtle benefits from the new EC approach. The cleared hallways and staff satisfaction with the well maintained and clean equipment program are 2 examples. On the bone marrow transplant unit, using a dot voting poster system, a staff satisfaction and feedback survey postimplementation indicated that 85% of staff believed that the clutter-free environment had a positive impact on their patients. Patient flow, particularly for those patients awaiting admission from the emergency department, has markedly improved, with bed access reporting that as the hospital is usually at 110% capacity “…if we were still isolating for VRE we would definitely see a back up of patients in the ED while trying to create private rooms.” There is also a perception by staff (through dot voting and poster board comments at the unit level) that there is less patient fatigue. The latter phenomenon has recently been documented to contribute to a paradoxical decrease in compliance with isolation precautions.16

Other benefits include time saved looking for clean equipment and decreased wait times for patients needing infusion pumps or other devices (maintenance now fulfills 100% of intravenous pump requests daily). Additionally, with a central equipment depot and adjacent bed repair room, there has been a 67% decrease in the wait time just for repaired beds and a 30% decrease in wait times for all mobile equipment as previously noted. We have been unable to obtain data to determine whether equipment life has been prolonged; however, the central repair area certainly affords maintenance staff the opportunity to perform full servicing on equipment as it cycles through the center. The dedicated work area customized for servicing equipment translates into improved ergonomics and productivity; there have been only 2 blood and body fluid exposures and no musculoskeletal injuries since the process has been implemented.

Although the combined horizontal program and subsequent VRE risk-management approach has been successful at our facility, it is important to emphasize that local safety culture, infrastructure, and patient population must be considered when implementing new horizontal measures. All intervention components should be objectively evaluated and adjusted using standard quality improvement methods first to ensure that there are no unintended consequences and second to foster a program that is feasible and sustainable. Antimicrobial resistant organisms continue to emerge, and health care is managed in increasingly complex settings creating an environment where vertical programs (that focus on individual organisms) are more challenging to implement and maintain. Consistent application of AMS and enhanced EC programs in combination with selective vertical approaches (where epidemiologically indicated) is a risk-managed approach that has been cost-effective, sustainable, and successful at one of Canada’s largest tertiary care facilities.

Acknowledgment

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References


