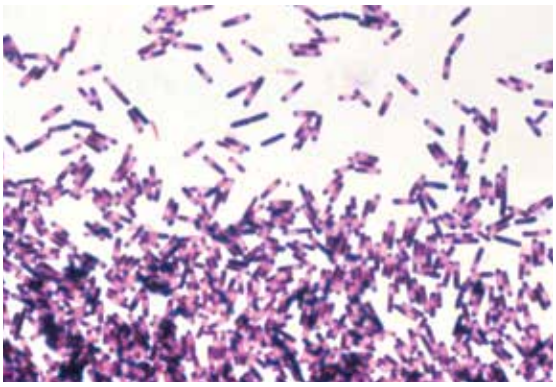
# VANCOMYCIN-RESISTANT ENTEROCOCCI INFECTIONS IN CANADIAN ACUTE-CARE HOSPITALS

## SURVEILLANCE REPORT JANUARY 1, 1999 TO DECEMBER 31, 2011





Public Health Agency of Canada
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Vancomycin-resistant enterococci infections in Canadian acute-care hospitals:
Surveillance Report January 1, 1999 to December 31, 2011
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Rapport de surveillance du 1er janvier 1999 au 31 décembre 2011

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**Acknowledgments:** National level Vancomycin-Resistant Enterococci (VRE) surveillance is possible as a result of hospitals participating in, and helping to set directives for, VRE surveillance. Accordingly, the Public Health Agency of Canada acknowledges the participating hospitals for providing the non-nominal confidential data that enable this report to be published. Without their close collaboration and participation in VRE surveillance, the publication of this report would not have been possible. A complete listing of these contributors is available in Appendix 2.

**N.B.** This document must be cited as the source for any information extracted and used from it.

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# INFORMATION TO THE READER OF *VRE IN CANADA*

On behalf of the Public Health Agency of Canada, we would like to present you with a report entitled *Vancomycin-resistant enterococci infections in Canadian acute-care hospitals: Surveillance Report January 1, 1999 to December 31, 2011*. This is the first report providing a review of available vancomycin-resistant enterococci (VRE) surveillance data in Canada.

The Public Health Agency of Canada is responsible for the data collection and management, analysis and report production related to this *Vancomycin-resistant enterococci infections in Canadian acute-care hospitals* report. In addition, we continue to improve data quality, define and set surveillance standards, as well as support the use of these data to inform public health and policy action.

The Public Health Agency of Canada collects national data on various healthcare-associated infections, including VRE through the Canadian Nosocomial Infection Surveillance Program (CNISP), a collaborative effort of the Centre for Communicable Diseases and Infection Control, the National Microbiology Laboratory and sentinel hospitals across Canada who participate as members of the Canadian Hospital Epidemiology Committee (a subcommittee of the Association of Medical Microbiology and Infectious Disease Canada). CNISP conducts surveillance in 54 largely, university-affiliated tertiary care hospitals (i.e., major hospitals that offer a range of specialist services such as burn units, transplant units, trauma centres, specialized cardiac surgery etc. to which patients are referred from smaller hospitals). CNISP surveillance provides key information that informs the development of federal, provincial and territorial infection prevention and control programs and policies.

The main findings of the surveillance data are outlined in the results section, and this is followed by a series of tables summarizing the underlying data. The results of an audit of the 2008 VRE data are available in the Section 4.

The publication of this report would not be possible without the submission of VRE surveillance data from all participating hospitals, which are listed in Appendix 2. Their ongoing contribution to national VRE surveillance is gratefully acknowledged.

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# AT A GLANCE

The Public Health Agency of Canada (Agency) has collected data on hospitalized patients with vancomycin-resistant enterococci (VRE) infections in Canadian acute-care hospitals through the Canadian Nosocomial Infection Surveillance Program (CNISP) since 1999. This report describes the epidemiology and microbiology of VRE infections in Canada from 1999 to 2011. The following are highlights of this surveillance report.

- The majority (93%) of VRE infections are healthcare-associated.
- VRE affects an older hospitalized population; 52% of VRE infections are among patients aged 65 years or older.
- Most (77%) VRE infections are associated with a recent hospitalization.
- VRE infection rates remain low but have been rapidly increasing since 2008.
- VRE infection rates are the highest among large hospitals in the Central and Western regions of Canada and lowest in Eastern Canada.
- Urinary tract infections are the most commonly reported type of VRE infection (51%).
- *E. faecium vanA* is the predominant resistance gene among VRE bloodstream infections.

# BACKGROUND

Enterococci are bacteria that live in the human intestine, in the female genital tract and are often found in the environment. Generally these bacteria do not cause illness. Vancomycin-resistant enterococci (VRE) are strains of enterococci that are resistant to the antibiotic vancomycin. A person with VRE who has symptoms (e.g. an infection of the urinary tract or bloodstream) is infected with VRE.

VRE infections occur most commonly among people in hospitals with weakened immune systems; those who have been previously treated with vancomycin or other antibiotics for long periods of time; those who have undergone surgical procedures and those with medical devices such as urinary catheters are at a higher risk of becoming infected with VRE.

VRE is usually spread from person to person by direct contact or by contact with contaminated surfaces. VRE can be present on environmental surfaces or on the hands of caregivers after contact with other people with VRE or after touching surfaces or objects contaminated with VRE (e.g. toilet seats, bedrails, door handles, soiled linens, stethoscopes etc.)

To diagnose a VRE infection, a sample is taken from the patient. Once the sample has been taken, the organism must be allowed to grow in the laboratory. If the organism tests positive for VRE, it is then tested to determine which antibiotics may be effective for treating the infection. VRE infections can be treated with antibiotics other than vancomycin. Laboratory testing of the VRE strain can determine which antibiotics will work.

In order to prevent these infections, it is important to practise good hand hygiene. Thorough hand washing is important after using the bathroom, before preparing food or after contact with a person who has VRE. Wash with soap and water or use alcohol-based hand rubs. VRE can survive for weeks on surfaces and objects so regularly clean areas such as bathrooms and frequently touched surfaces (e.g. door handles).

# METHODS

## SURVEILLANCE NETWORK

The Public Health Agency of Canada (Agency) collects data on hospitalized patients with vancomycin-resistant enterococci (VRE) in Canadian acute-care hospitals through the Canadian Nosocomial Infection Surveillance Program (CNISP). Surveillance of VRE at participating hospitals is considered to be within the mandate of hospital infection prevention and control programs and does not constitute human research. Therefore in participating hospitals this surveillance activity does not require Institutional Review Board (IRB) review.

A VRE working group comprised of seven Canadian Hospital Epidemiology Committee members from participating hospitals, an Agency epidemiologist and NML representatives, is responsible for developing and regularly updating the surveillance protocol which includes standardized data collection forms and a data dictionary. In-service sessions are organised at the beginning of each surveillance year by the Agency for all participating hospitals. The purpose of the in-service sessions are to provide training to Infection Control Practitioners (ICPS) on how to follow the surveillance protocol and complete the data collection forms, and to ensure consistency across the participating hospitals in the understanding of each question on the data collection forms. This ensures that the data are comparable between the participating hospitals and between the provinces and regions.

## CASE DEFINITIONS

A case of VRE is defined as any inpatient[a] from whom *Enterococcus faecium* or *Enterococcus faecalis* having a minimum inhibitory concentration of vancomycin of $\geq$ 8 µg/mL was isolated from a clinical[b] specimen. It is important to note that individuals who are in outpatient settings such as emergency departments and clinics are not considered admitted to the hospital and are therefore not included in the surveillance. The collected specimens are sent to the hospital's laboratory to determine if the inpatient is positive for VRE.

Cases are classified based on where VRE was likely acquired (e.g. either in the community or in the hospital). A community-associated case is defined as an individual with VRE who has been hospitalized for less than 48 hours with no previous history of VRE, no prior hospital or long-term care admission in the previous 12 months, and no reported use of medical devices. A healthcare-associated case is defined as an individual with VRE originating from exposure to any healthcare setting including long-term care facilities or clinics in the previous 12 months and/or has been hospitalized for greater than 48 hours. This assessment is determined based on information available in the patient chart at the time of data collection.

## DATA COLLECTION AND SUBMISSION

When a VRE case is identified by the hospital's laboratory, a standardized patient questionnaire is completed through concurrent or retrospective chart review by an ICP. The questionnaire includes patient demographics and clinical information, previous hospitalization within the past 12 months, site of positive culture, where VRE was presumed to have been acquired (either in the community or in the hospital), and whether the patient had concurrent infection with methicillin-resistant *Staphylococcus aureus* (MRSA).

Data are submitted electronically through a web based information management system by each participating hospital to the Agency for further statistical analysis and storage.

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[a] Inpatient = Individual who has been admitted to the hospital.

[b] Clinical specimen (e.g. stool specimen) = A specimen that is collected because of clinical indication or suspicion of infection for the purpose of patient diagnosis.

## LABORATORY ANALYSIS

Participating hospitals send all specimens of VRE infected cases to the National Microbiology Laboratory (NML) for molecular testing. All *E.faecium* and *E. faecalis* clinical specimens from 1999 to 2010 were tested by polymerase chain reaction (PCR) to determine the presence of vancomycin resistant genes *vanA, B, C, D, E, G* and *L*. Multilocus sequence typing (MLST) and broth microdilution using Gram-Positive Sensititre panels were completed only for bloodstream infection specimens from 1999 to 2010 to determine genetic relatedness and antimicrobial susceptibilities, respectively.

The NML submits the laboratory results to the Agency through the same web based information management system used by the hospitals for the submission of the patient questionnaire data. Both the laboratory results and the patient questionnaires are linked using a unique patient identifier.

## DENOMINATOR DATA

Participating hospitals also provide the Agency with the number of patient-admissions[c] and the number of patients-days[d] for the corresponding surveillance year. These denominator data are used to calculate the annual incidence rates presented in this report.

## DATA ANALYSIS

Data submitted to the Agency both by participating hospitals (patients' clinical and demographic data) and the NML (results of laboratory analysis) are extracted, validated and statistically analysed as appropriate.

Annual incidence rates are calculated using patient admissions and patient-days. For reporting purposes and to ensure confidentiality, the provinces are grouped into three regions: Western (British Columbia, Alberta, Saskatchewan and Manitoba), Central (Ontario and Quebec), and Eastern (Nova Scotia, New Brunswick, Prince Edward Island and Newfoundland and Labrador). The territories do not currently submit data to the Agency and Prince Edward Island only began submitting data in 2011. To further explore the variation in rates, hospitals are categorized based on the number of inpatient beds in their facility. Categories are as follows: $\leq$ 200 beds (small), 201–500 beds (intermediate) and >501 beds (large). Stratified rates based on these categories are calculated.

VRE infection incidence rates are presented from 1999 to 2011. These rates are further stratified by region and bed size. Demographic data (age and sex) and clinical data (site of infection and concurrent MRSA infection) from 2006 to 2011 are presented. Data on place of acquisition and previous hospitalization are available from 2006 to 2010.

[c] Patient-admissions = Number of patients hospitalized during a surveillance year.

[d] Patient-days = Cumulative total number of days that each patient was hospitalized for during a surveillance year.

# RESULTS

Since reporting began in 1999, a cumulative total of 1,241 VRE infected cases were reported to the Public Health Agency of Canada (Agency) through December 31, 2011.

## ANNUAL VRE INFECTION TRENDS

Figure 1 illustrates the trend in annual VRE infected cases since 1999. The number of VRE infected cases is quite low but has been rapidly rising since 2008. Section 1 provides the number of infected cases and rates by year.

**FIGURE 1:** National VRE infection incidence rates per 1,000 patient admissions, 1999–2011 (n=1,241)

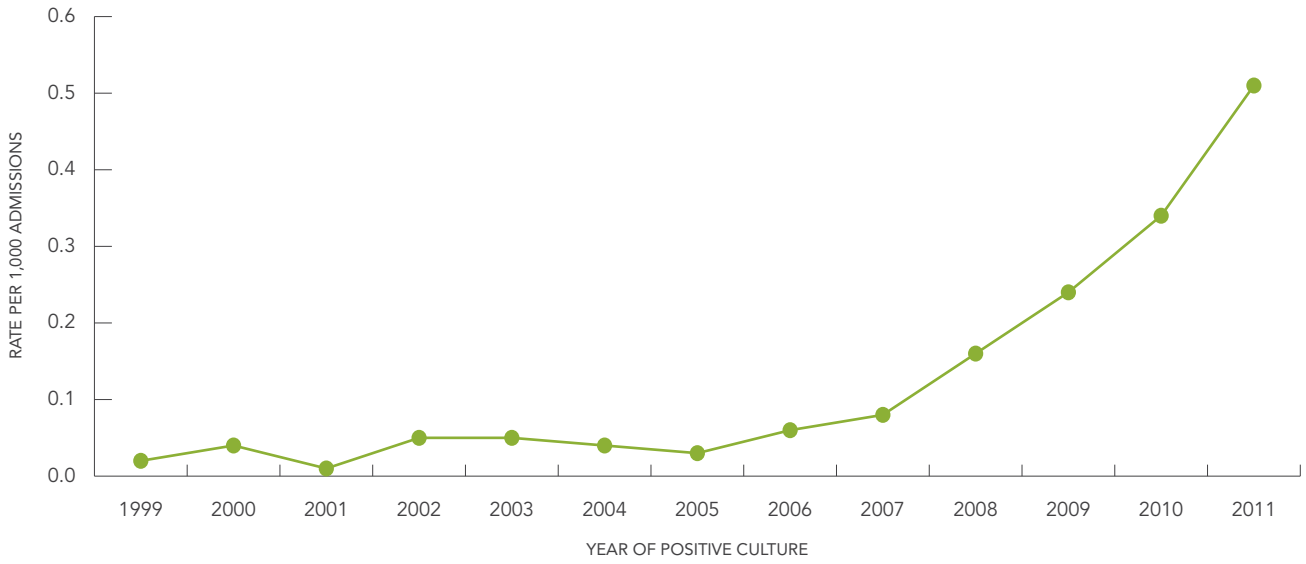


Figure 2 highlights the regional variation in VRE infection rates from 1999 to 2011. While VRE infection rates in the Eastern provinces remain consistently low, infection rates in the Central region declined slightly in 2010 but rose significantly in 2011. VRE infection rates in the West have been steadily increasing since 2008. Section 2 provides the number of infections and rates by year and region.

Typically, larger hospitals provide care to complex patients who are characterized as higher risk (e.g. individuals with chronic conditions such as renal failure and cancer as well as patients with longer hospital stay). They also provide specialized services such as burn units, transplant units, trauma centers, specialized cardiac surgery etc. Additionally, larger hospitals often act as referral centres for smaller hospitals. The size of a hospital is determined by the number of inpatient beds.

**FIGURE 2:** Regional VRE infection incidence rates per 1,000 patient admissions, 1999–2011 (n=1,241)

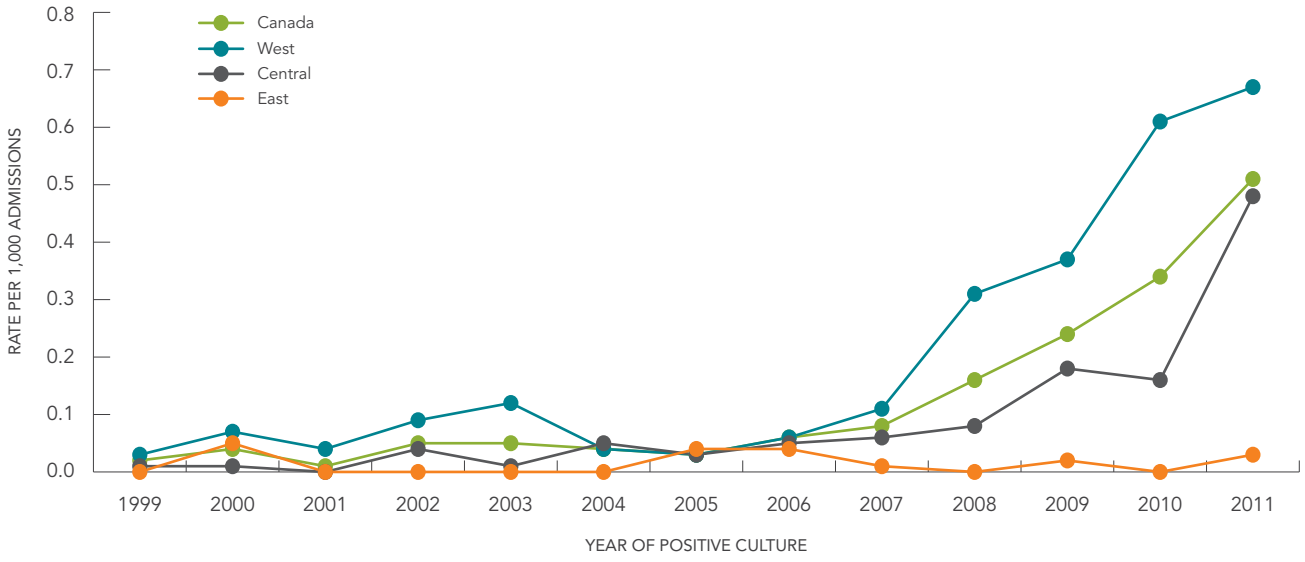
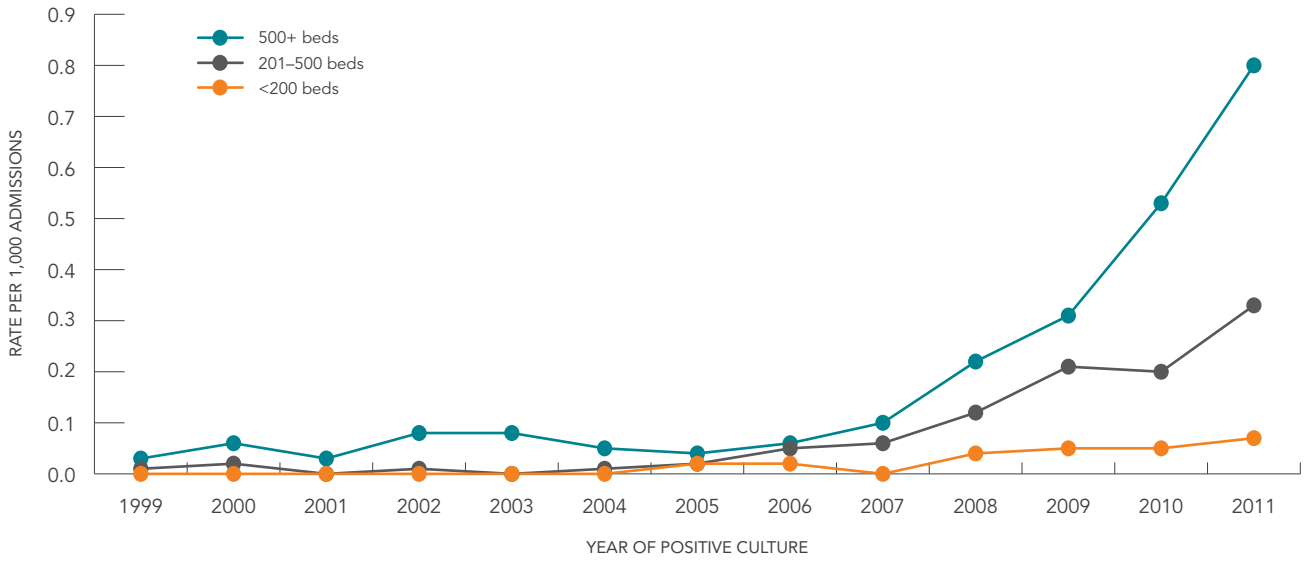


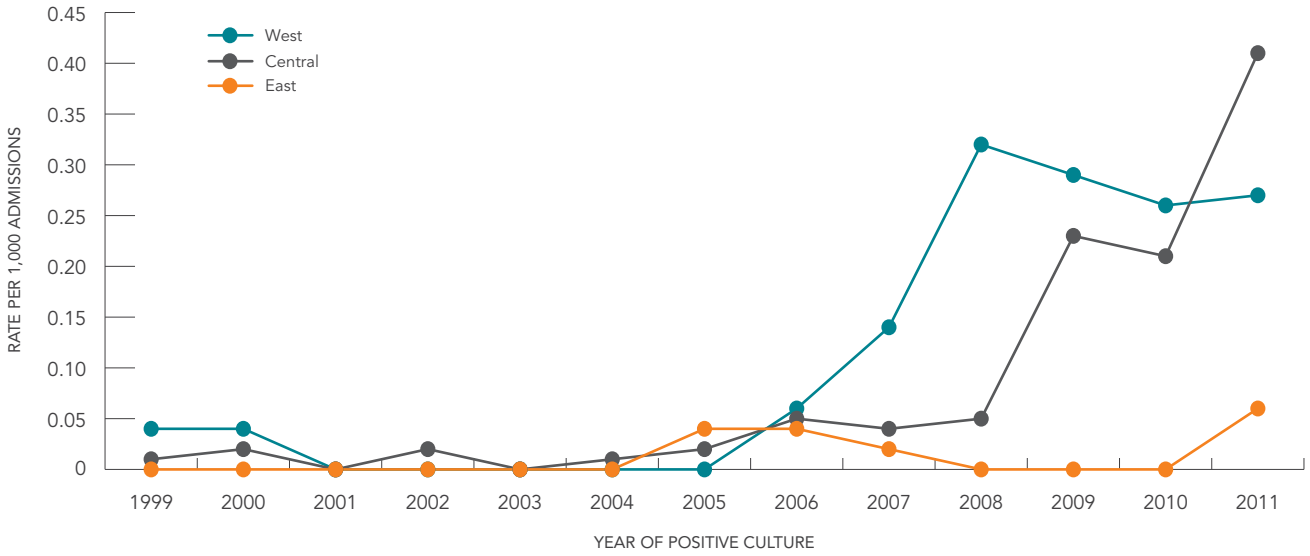
Figure 3 illustrates that VRE infection rates were similar between bed size categories from 1999 to 2006 with slightly higher rates among large hospitals (those with more than 500 beds). In 2008, large hospitals and intermediate sized hospitals (those with 201 to 500 beds) began to observe an increase in VRE infection rates. Since 2009, rates in large hospitals have significantly increased while the rates in intermediate hospitals continue to slowly increase. VRE infection rates for small hospitals (those with less than 200 beds) slightly increased in 2008 but have remained stable through to 2011.

**FIGURE 3:** VRE infection incidence rates by bed size, per 1,000 patient admissions, 1999–2011 (n=1,241)



Bed size rates were further stratified to explore regional differences. In general, infection rates for all three bed size categories remain the lowest in the East. Figure 4 illustrates that the increase in infection rates observed in 2007 and onwards was mainly driven by infection rates in large (data not shown) and intermediate hospitals in the West. As of 2009, infection rates in large (data not shown) and intermediate hospitals in the Central region also contributed to the observed increase in infection rates. Only data for hospitals with 201 to 500 beds are presented in this report due to the small number of hospitals in some regions reporting data among the small and large bed size categories.

**FIGURE 4:** VRE infection rates for hospitals with 201–500 beds by region, per 1,000 admissions (n=373)



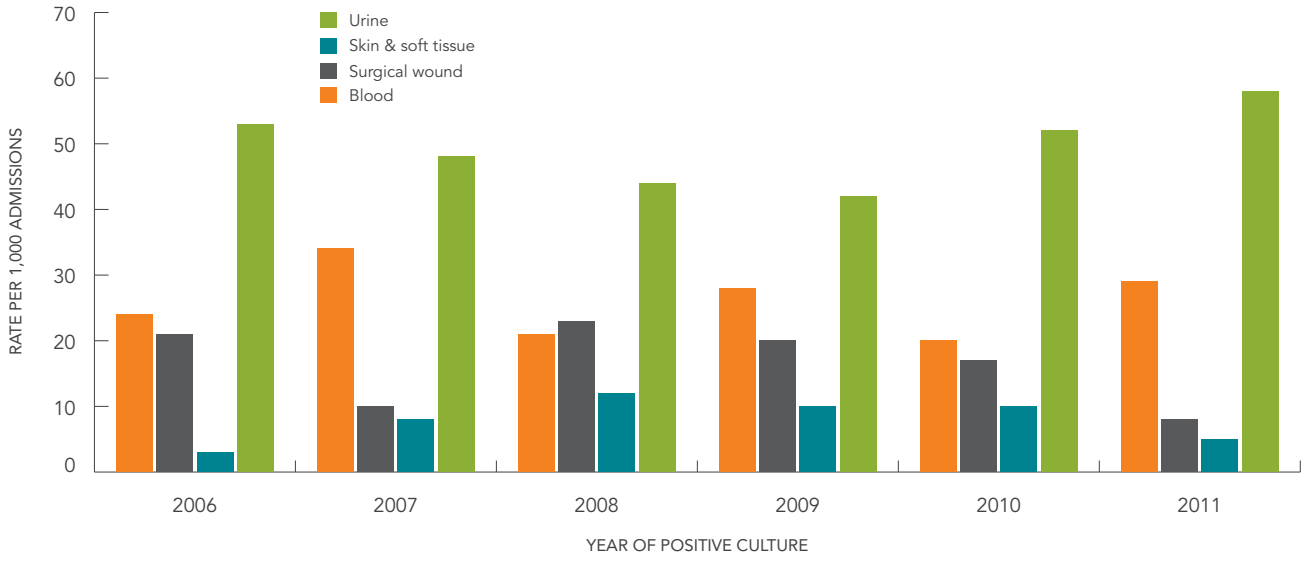
## CHARACTERISTICS OF VRE INFECTION

Demographic data are available for 1,087 (88%) VRE infected cases from 2006 to 2011. Fifty-two per cent (n=566) of hospitalized VRE infected cases were 65 years of age or older, 47% (n=509) were 18 to 64 years and 1% (n=12) were less than 18 years. Approximately half (56%, n=612) of the cases were female.

Data on previous hospitalization are available for 603 VRE infected cases from 2006 to 2010. The majority (77%; n=462) of cases had been hospitalized within the previous 12 months. Data on place of VRE acquisition are available for 659 VRE infected cases from 2006 to 2010. For 93% (n=615) of cases, the likely place of acquisition was an acute care facility; for 15 cases (2%) it was in the community and for the remaining 29 cases (5%) the place of acquisition was unknown. Of the 615 healthcare-associated cases, most (88%, n=543) acquired VRE in the reporting hospital, 10% (n=62) in another acute care facility and 2% (n=10) acquired VRE in a long-term care facility. Tables 7 and 8 provide the number of healthcare-associated cases and rates by year.

Data on site of VRE infection are available for 857 cases from 2006 to 2011. Figure 5 illustrates that of the cases with clinical infection, VRE was recovered from urine in 51% of cases (n=434), from blood in 25% (n=218), from a surgical wound in 16% (n=133) and in 8% (n=72) from skin and soft tissue. In some cases VRE was recovered from multiple sites. Data on concurrent methicillin-resistant *Staphylococcus aureus* (MRSA) infection was available for 694 VRE infected cases. Among those, 7% (n=50) had a concurrent MRSA infection. Tables 3 and 4 provide the number of VRE bloodstream infections and rates by year.

**FIGURE 5:** Distribution of site of VRE infection, 2006–2011 (n=857)

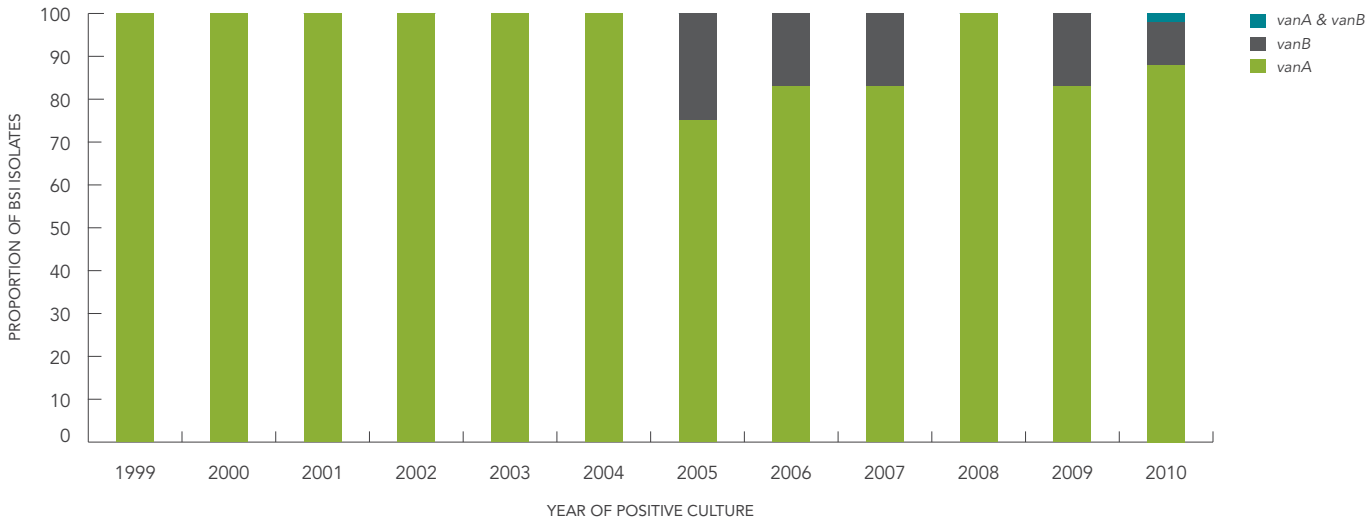


## LABORATORY RESULTS

From 1999 to 2009, of the 537 VRE infection reported, 382 (71%) specimens were received and tested by the National Microbiology Laboratory (NML). Of those, 99% (n=378) were *E.faecium* and 1% (n=4) were *E. faecalis*. The distribution of resistance genes for *E. faecium* were as follows: 93% (n=350) harboured the *vanA* gene; 7% (n=26) harboured the *vanB* gene and <1% (n=2) harboured both the *vanA* and *vanB* genes. For *E.faecalis*, three specimens were *vanA* and one was *vanB*.

The following laboratory findings focus on VRE bloodstream infections (BSI) submitted and tested from 1999 to 2010 by the NML. Of the 178 VRE BSIs reported, 123 (69%) were submitted to and tested by the NML. All 123 infections were confirmed as *E. faecium* by polymerase chain reaction (PCR). One hundred and ten infections (89%) harboured the *vanA* gene, 11 (10%) harboured the *vanB* gene and one (1%) carried both *vanA* and *vanB* genes. Figure 6 illustrates that from 1999 to 2004, the v*anA* gene was the only gene identified and even after the *vanB* gene was detected in 2005 the *vanA* gene remains the predominant gene among VRE bloodstream infections.

**FIGURE 6:** Distribution of *vanA* and *vanB* genes among VRE bloodstream infections, 1999 to 2010 (n=123)



Furthermore, multilocus sequence typing (MLST) was completed for all 123 isolates of bloodstream infections (BSIs) to help determine genetic relatedness. Figure 7 shows that in total, 19 different sequence types (STs) were found. When distributed by year a shift in sequence type in 2005 and 2006 was observed. Before 2005 only four sequence types; ST154, ST16, ST80 and ST17 were observed. Beginning in 2005 these were replaced with several other sequence types illustrated in Figure 7.

This shift in sequence type coincided with the increase in rates of BSIs in the Central and Western regions of Canada. It is unknown whether the shift in sequence type is associated with the increase in BSI rates. The regional distribution of sequence types was also examined and due to the small number of VRE BSI reported in the East the data are not presented. Laboratory analysis found that the sequence types are evenly distributed across the Central and Western regions.

**FIGURE 7:** Sequence type distribution of VRE bloodstream infections by year, 1999–2010 (n=123)

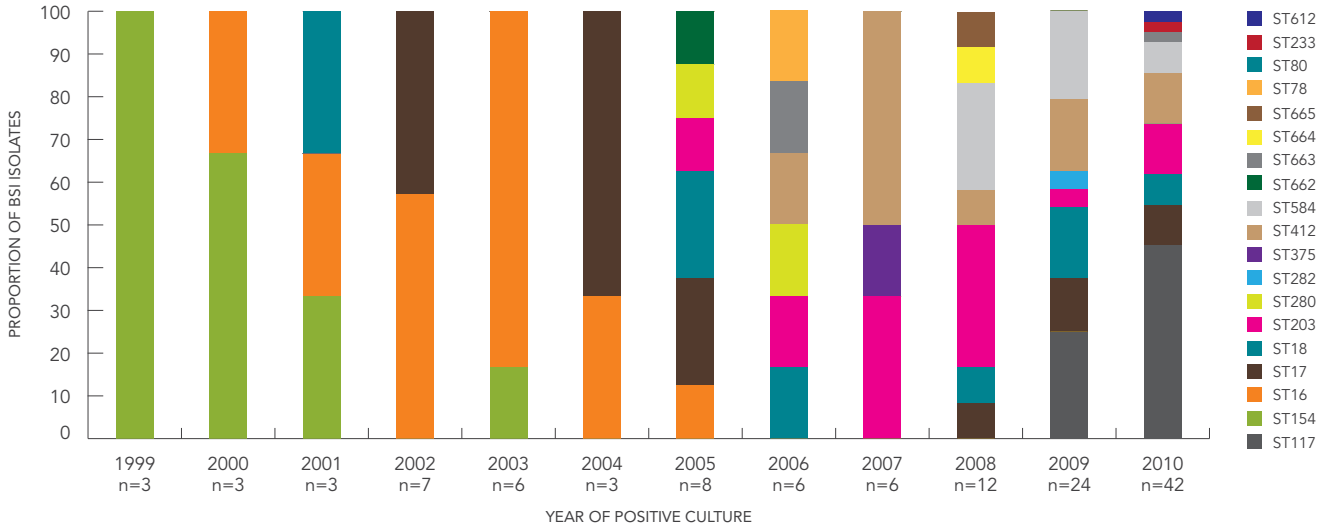


Table 1 presents the antimicrobial susceptibility data for the 123 bloodstream infection specimens. All specimens (100%) are multidrug resistant (MDR), which means that they are resistant to three or more classes of antimicrobials. There is a high prevalence of resistance to erythromycin (94%) and the fluoroquinolones (99%). Additionally, all specimens remain susceptible to daptomycin, linezolid and tigecycline and nearly all specimens are susceptible to chloramphenicol and quinupristin/dalfopristin.

**TABLE 1:** Antimicrobial susceptibility data of VRE bloodstream infections, 1999–2010 (n=123)

| ANTIMICROBIAL CLASS/ANTIMICROBIAL | %S | %I | %R | $MIC_{50}$ | $MIC_{90}$ | RANGE |
|---|---|---|---|---|---|---|
| **Penicillins** | | | | | | |
| Ampicillin | 0 | 0 | 100 | >8 | >8 | >8 |
| Penicillin | 0 | 0 | 100 | >8 | >8 | >8 |
| **Glycopeptides** | | | | | | |
| Vancomycin | 0 | 0 | 100 | >32 | >32 | 32–>32 |
| **Lipopeptides** | | | | | | |
| Daptomycin | 100 | 0 | 0 | 2 | 4 | ≤0.5–4 |
| **Macrolides** | | | | | | |
| Erythromycin | 0.8 | 4.9 | 94.3 | >4 | >4 | 1–>4 |
| **Tetracyclines** | | | | | | |
| Tetracycline | 58.5 | 0.8 | 40.7 | ≤2 | >16 | ≤2–>16 |
| **Fluoroquinolones** | | | | | | |
| Ciprofloxacin | 0.8 | 0 | 99.2 | >2 | >2 | ≤1–>2 |
| Levofloxacin | 0.8 | 0 | 99.2 | >4 | >4 | 1–>4 |
| **Nitrofurantoins** | | | | | | |
| Nitrofurantoin | 13.8 | 70.7 | 15.4 | 64 | >64 | ≤32–>64 |
| **Ansamycins** | | | | | | |
| Rifampin | 15.4 | 10.6 | 74 | >4 | >4 | ≤0.5–>4 |
| **Phenicols** | | | | | | |
| Chloramphenicol | 99.2 | 0.8 | 0 | 8 | 8 | 4–8 |
| **Streptogramins** | | | | | | |
| Quinupristin/Dalfopristin | 95.1 | 0 | 4.9 | ≤0.5 | 1 | ≤0.5–>4 |
| **Oxazolidinones** | | | | | | |
| Linezolid | 100 | 0 | 0 | 2 | 2 | ≤1–2 |
| **Aminoglycosides** | | | | | | |
| Gentamicin 500 µg/mL | 77.2 | 0 | 22.8 | ≤500 | >500 | ≤500–>500 |
| Streptomycin 1000 µg/mL | 51.2 | 0 | 48.8 | ≤1000 | >1000 | ≤1000–>1000 |
| **Glycylcycline** | | | | | | |
| Tigecycline | 100 | 0 | 0 | 0.06 | 0.12 | ≤0.03–0.5 |

NOTE: Includes all antimicrobials listed under the Clinical Laboratory Standards Institute (CLSI) guidelines for Enterococcus in addition to high-level gentamicin, streptomycin and tigecycline.

# LIMITATIONS

Several limitations should be considered when interpreting the data presented in this report. First, surveillance data understates the magnitude of VRE and subsequently does not represent the total number of inpatients infected with VRE in Canada. Surveillance data can only tell us about inpatients who have been tested and diagnosed with VRE and not those who remain untested and undiagnosed.

Second, these data only include hospitalized patients, therefore cases identified in outpatient settings such as emergency departments and clinics are not captured by this surveillance system. Furthermore, only cases who are hospitalized at participating hospitals are included.

Third, participating hospitals are representative of all Canadian hospitals. Hospitals which submit VRE data to the Agency are large, tertiary acute care centres located in major cities. VRE data from small hospitals and those in rural and northern areas are underreported.

Fourth, antibiotic prescribing practices and implementation of infection prevention and control measure may vary between hospitals, but because the Agency does not collect data regarding these factors, it was not possible to correlate them with the occurrence of VRE.

Fifth, healthcare-associated infection surveillance methodologies are not standardized across countries. For this reason, caution must be used when comparing rates between countries without knowing the details of their surveillance strategies.

Sixth, currently no data regarding the percentage of enterococcal infections resistant to vancomycin are reported to the Agency. As such, no comparisons to international data using this indicator are made in this report.

Finally, it is possible that misclassification bias may have occurred given the difficulty in interpreting whether patients with indwelling urinary bladder catheters are infected or colonized with VRE, thus possibly resulting in an overestimation of the number of infections.

# DISCUSSION

The surveillance data in this report shows that in Canada, VRE remains largely a healthcare associated organism affecting an older population with a history of previous hospitalization. The data show that there has been a significant increase in the rates of VRE infections in participating hospitals since 2008. The findings presented in this surveillance report are consistent with previously published Canadian studies.[1–2] Data reported from Canadian intensive care units (ICUs) from 2005 to 2006 found that 6.7% (11/2,555) of all enterococal specimens were resistant to vancomycin and 88.2% harboured the *vanA* gene.[3]

Studies from the United States have also reported an increase in VRE in healthcare settings over time. The National Healthcare Safety Network (NHSN) in the United States reported that the percentage of enterococcal infections resistant to vancomycin increased from 29% (1986 to 1996) to 33% in 2006-2007.[4] A study conducted in the United States using national hospitalization data found that the incidence of hospitalizations with infection due to VRE increased from 3.16 hospitalizations with VRE infection per 100,000 hospitalizations in 2000 to 6.51 hospitalizations with VRE infection per 100,000 hospitalizations in 2006.[5] Similarly, the incidence of VRE infections in Canada increased from 4.0 per 100,000 admissions in 2000 to 6.0 per 100,000 admissions in 2006. Of note the absolute rates are comparable, however the US study was based on administrative hospitalization data which included only adults (≥18 years) while the Canadian surveillance data includes inpatients of all ages. The US study captured all hospitalizations with infections due to vancomycin-resistant pathogens including VRE, vancomycin-resistant *S. aureus*, and vancomycin-intermediate *S. aureus* while the Canadian surveillance data reflects only VRE.

Several European countries have also experienced an increasing trend in VRE over time (e.g. Ireland, Germany and Greece). In an Irish centre, the number of VRE bloodstream infections (BSI) increased from 0.09 BSI per 10,000 bed-days in 2001 to 0.78 per 10,000 bed-days in 2005 ($p<0.001$). A decrease was reported in 2006 and 2007 but rates increased again to 0.46 per 10 000 bed-days[e] in 2008.[6] Among Canadian participating hospitals the rate of VRE BSI was lower than that reported by the Irish centre, however rates also increased from 0.006 per 10,000 patient-days in 2001 to 0.014 per 10,000 patient-days in 2005 to 0.039 per 10,000 patient-days in 2008. The increased incidence in 2008 reported by the large adult tertiary centre in Ireland was due in part to an outbreak of *Clostridium difficile* which limited the number of isolation rooms available for VRE. Thus the comparison of findings from one centre in Ireland to data presented in this report among a network of 54 large Canadian acute care facilities should be interpreted with caution.

In the United Kingdom, the prevalence of VRE among enterococcal bacteraemias has increased from 9.1% in 2001 to 12.2% in 2007.[7] Four hospitals in Germany reported an increase in VRE *faecium* infections and colonizations from 5 to 14 VRE patients per 100,000 patients.[8] German data from the European Antimicrobial Resistant Surveillance System (EARSS) reported an increase in VRE from 1% in 2001 to 11% in 2004 to 8% in 2006 rising again to 15% in 2007.[7] Rates of VRE in Greece significantly increased from <1% in 2000 to 42% in 2006, with a slight decrease reported in 2007 (37%).[7] In other European countries the prevalence of VRE is still low, for example in the Nordic countries such as the Netherlands, where the prevalence of VRE among bloodstream isolates has consistently been low (<1%) over the years.[7]

Regional differences in VRE infection rates were observed across Canada and this phenomenon has also been noted in Europe. Sweden reported an increase in VRE among healthcare facilities in three geographically separate regions. Incidence rates varied from 20.9 cases to 33.2 cases per 100,000 inhabitants in 2008. The cause of the geographic dissemination is unknown although the bacteria were genetically closely related indicating a clonal origin.[9] Data from 2005 to 2006 from 176 German ICUs found that the incidence of VRE differed significantly by region, ranging from 0.02 infections per 1,000 patient-days to 0.23 infections per 1,000 patient-days.[10] It was not until 2008 that Canada began to observe regional variations in VRE infection rates. In 2005 and 2006, the range of VRE infection rates varied nearly 12-fold across five regions in Germany while Canada observed only a 4-fold variation among three regions in 2008 (0.1 infections per 10,000 patient-days to 0.4 infections per 10,000 patient-days). It was suggested that the regional differences in VRE infection rates in German ICUs may indicate ongoing regional spread.[10]

Findings in this report show that among the participating hospitals 99% of VRE infections carry the *vanA* gene. Similarly, both Europe and the United States report *vanA* to be the most prevalent gene. In Europe, the *vanA* gene and to a lesser extent the *vanB* types are widely prevalent.[7] A study among 28 centres in the United States found the *vanA* gene to be the predominant gene as *vanA* was present in 83.8% of VRE specimens and *vanB* in 16.2% of VRE specimens.[11]

A Canadian study conducted from 1994 to 1998 found that the greater the number of beds within a facility, the greater the percentage of VRE reports. The study reported that all facilities with greater than 800 beds reported VRE compared with only 10% of facilities with less than 200 beds.[1] A similar relationship was found in this report as hospitals with more than 500 beds reported significantly higher VRE infection rates than smaller hospitals. This trend was reported in Western Canada beginning in 2007 and was later observed in the Central region of Canada in 2009. As there is only one large hospital in the East that reports data to the Agency this may contribute to the low VRE infection rate observed in this region. The relationship of larger hospitals experiencing higher VRE infection rates may be due to large hospitals serving higher risk patients (e.g. individuals with chronic conditions such as renal failure and diabetes, patient with longer hospital stay etc.), providing specialized services (e.g. transplant units) and transferring more patients between and within hospitals which, along with overcrowding, facilitates VRE transmission.

[e] NOTE: Patient-day are defined as the cumulative number of days that each patient was hospitalized for during a surveillance period. Bed-days are defined as the cumulative number of days that a bed was occupied during a surveillance period. In the context of this surveillance report the associated rates are comparable.

It has been hypothesized that an increase in the use of vancomycin to treat *Clostridium difficile* infection would lead to an increase in the incidence of VRE. However, numerous studies have reported inconsistent findings regarding the role of vancomycin use on VRE rates.[12–16] There are a number of factors can be invoked to explain the increase in VRE infection rates among Canadian acute-care hospitals. These factors, which have been demonstrated in a number of studies involving VRE and other healthcare-associated infections, include environmental contamination, prolonged hospital stay, presence of a catheter, overcrowding, transfer of patients between and within hospitals, chronic conditions such as renal failure and diabetes, liver transplantation, poor adherence with hand hygiene and infection control practices and a lack of antimicrobial stewardship.[16–20] The role of these factors in the increase in VRE rates was not assessed in this report. However, these factors have been addressed in the Public Health Agency of Canada's Infection Control Guidelines series (www.phac-aspc.gc.ca/nois-sinp/guide/pubs-eng.php).

In conclusion, the burden of VRE among Canadian acute-care hospitals remains low, yet infection rates have been rapidly increasing since 2008 with regional variation. From the limited international data that are available, the increasing VRE infection trends observed in Canada, both regionally and over time, described in this report coincides with increasing trends reported by several European countries and the United States. Surveillance of vancomycin-resistant infections will enable the Agency to continue to monitor the spread and burden of VRE in Canadian acute-care hospitals.

# SECTION 1

## VRE IN CANADA: NATIONAL VRE SURVEILLANCE FROM JANUARY 1, 1999 TO DECEMBER 31, 2011

**TABLE 1:** Number of VRE infected cases and incidence rates per 1,000 patient-admissions from January 1, 1999 to December 31, 2011 (n=1,241)

| YEAR | NO. REPORTING HOSPITALS | NO. OF INFECTIONS | INFECTION RATE |
|---|---|---|---|
| 1999 | 27 | 10 | 0.02 |
| 2000 | 27 | 22 | 0.04 |
| 2001 | 31 | 9 | 0.01 |
| 2002 | 32 | 31 | 0.05 |
| 2003 | 33 | 34 | 0.05 |
| 2004 | 33 | 26 | 0.04 |
| 2005 | 45 | 22 | 0.03 |
| 2006 | 50 | 43 | 0.06 |
| 2007 | 49 | 59 | 0.08 |
| 2008 | 47 | 111 | 0.16 |
| 2009 | 50 | 170 | 0.24 |
| 2010 | 52 | 276 | 0.34 |
| 2011 | 52 | 428 | 0.51 |

Vancomycin-resistant enterococci (VRE)

**TABLE 2:** Number of VRE infected cases and incidence rates per 10,000 patient-days from January 1, 1999 to December 31, 2011 (n=1,241)

| YEAR | NO. REPORTING HOSPITALS | NO. OF INFECTIONS | INFECTION RATE |
|---|---|---|---|
| 1999 | 27 | 10 | 0.02 |
| 2000 | 27 | 22 | 0.06 |
| 2001 | 31 | 9 | 0.02 |
| 2002 | 32 | 31 | 0.07 |
| 2003 | 33 | 34 | 0.06 |
| 2004 | 33 | 26 | 0.05 |
| 2005 | 45 | 22 | 0.04 |
| 2006 | 50 | 43 | 0.07 |
| 2007 | 49 | 59 | 0.10 |
| 2008 | 47 | 111 | 0.20 |
| 2009 | 50 | 170 | 0.32 |
| 2010 | 52 | 276 | 0.47 |
| 2011 | 52 | 428 | 0.68 |

Vancomycin-resistant enterococci (VRE)

**TABLE 3:** Number of VRE bloodstream infected (BSI) cases and incidence rates per 1,000 patient-admissions from January 1, 1999 to December 31, 2011 (n=251)

| YEAR | No. REPORTING HOSPITALS | No. OF BSIS | BSI RATE |
|---|---|---|---|
| 1999 | 27 | 3 | 0.005 |
| 2000 | 27 | 3 | 0.006 |
| 2001 | 31 | 3 | 0.005 |
| 2002 | 32 | 7 | 0.012 |
| 2003 | 33 | 6 | 0.009 |
| 2004 | 33 | 3 | 0.004 |
| 2005 | 45 | 8 | 0.011 |
| 2006 | 50 | 8 | 0.011 |
| 2007 | 49 | 17 | 0.022 |
| 2008 | 47 | 22 | 0.031 |
| 2009 | 50 | 48 | 0.068 |
| 2010 | 52 | 50 | 0.061 |
| 2011 | 52 | 73 | 0.087 |

Vancomycin-resistant enterococci (VRE)

Bloodstream infection (BSI)

**TABLE 4:** Number of VRE bloodstream infected (BSI) cases and incidence rates per 10,000 patient-days from January 1, 1999 to December 31, 2011 (n=251)

| YEAR | No. REPORTING HOSPITALS | No. OF BSIS | BSI RATE |
|---|---|---|---|
| 1999 | 27 | 3 | 0.007 |
| 2000 | 27 | 3 | 0.008 |
| 2001 | 31 | 3 | 0.006 |
| 2002 | 32 | 7 | 0.015 |
| 2003 | 33 | 6 | 0.011 |
| 2004 | 33 | 3 | 0.006 |
| 2005 | 45 | 8 | 0.014 |
| 2006 | 50 | 8 | 0.013 |
| 2007 | 49 | 17 | 0.030 |
| 2008 | 47 | 22 | 0.039 |
| 2009 | 50 | 48 | 0.089 |
| 2010 | 52 | 50 | 0.085 |
| 2011 | 52 | 73 | 0.116 |

Vancomycin-resistant enterococci (VRE)

Bloodstream infection (BSI)

# SECTION 2

## VRE IN CANADA: REGIONAL VRE SURVEILLANCE FROM JANUARY 1, 1999 TO DECEMBER 31, 2011

**TABLE 5:** Number of VRE infections and incidence rates per 1,000 patient admissions, by region, from January 1, 1999 to December 31, 2011

| | WESTERN REGION | | | CENTRAL REGION | | | EASTERN REGION | | |
|---|---|---|---|---|---|---|---|---|---|
| Year | No. reporting hospitals | No. of infections | Rate | No. reporting hospitals | No. of infections | Rate | No. reporting hospitals | No. of infections | Rate |
| 1999 | 8 | 7 | 0.03 | 13 | 3 | 0.01 | 6 | 0 | 0.00 |
| 2000 | 8 | 16 | 0.07 | 13 | 2 | 0.01 | 6 | 4 | 0.05 |
| 2001 | 8 | 8 | 0.04 | 17 | 1 | 0.00 | 6 | 0 | 0.00 |
| 2002 | 8 | 19 | 0.09 | 18 | 12 | 0.04 | 6 | 0 | 0.00 |
| 2003 | 8 | 30 | 0.12 | 19 | 4 | 0.01 | 6 | 0 | 0.00 |
| 2004 | 8 | 11 | 0.04 | 19 | 15 | 0.05 | 6 | 0 | 0.00 |
| 2005 | 15 | 9 | 0.03 | 23 | 10 | 0.03 | 6 | 3 | 0.04 |
| 2006 | 18 | 21 | 0.06 | 26 | 19 | 0.05 | 6 | 3 | 0.04 |
| 2007 | 17 | 34 | 0.11 | 26 | 24 | 0.06 | 6 | 1 | 0.01 |
| 2008 | 17 | 84 | 0.32 | 24 | 27 | 0.08 | 6 | 0 | 0.00 |
| 2009 | 17 | 107 | 0.38 | 27 | 61 | 0.18 | 6 | 2 | 0.02 |
| 2010 | 18 | 213 | 0.63 | 28 | 63 | 0.16 | 6 | 0 | 0.00 |
| 2011 | 12 | 232 | 0.69 | 28 | 193 | 0.48 | 7 | 3 | 0.03 |

Vancomycin-resistant enterococci (VRE)

Western region includes British Columbia, Alberta, Saskatchewan and Manitoba

Central region includes Ontario and Quebec

Eastern region includes New Brunswick, Newfoundland & Labrador and Nova Scotia

**TABLE 6:** Number of VRE infections and incidence rates per 10,000 patient-days, by region, from January 1, 1999 to December 31, 2011

| | WESTERN REGION | | | CENTRAL REGION | | | EASTERN REGION | | |
|---|---|---|---|---|---|---|---|---|---|
| Year | No. reporting hospitals | No. of infections | Rate | No. reporting hospitals | No. of infections | Rate | No. reporting hospitals | No. of infections | Rate |
| 1999 | 8 | 7 | 0.04 | 13 | 3 | 0.02 | 6 | 0 | 0.00 |
| 2000 | 8 | 16 | 0.11 | 13 | 2 | 0.01 | 6 | 4 | 0.05 |
| 2001 | 8 | 8 | 0.05 | 17 | 1 | 0.00 | 6 | 0 | 0.00 |
| 2002 | 8 | 19 | 0.13 | 18 | 12 | 0.05 | 6 | 0 | 0.00 |
| 2003 | 8 | 30 | 0.14 | 19 | 4 | 0.01 | 6 | 0 | 0.00 |
| 2004 | 8 | 11 | 0.06 | 19 | 15 | 0.06 | 6 | 0 | 0.00 |
| 2005 | 16 | 9 | 0.04 | 23 | 10 | 0.03 | 6 | 3 | 0.04 |
| 2006 | 18 | 21 | 0.10 | 26 | 19 | 0.06 | 6 | 3 | 0.04 |
| 2007 | 17 | 34 | 0.17 | 26 | 24 | 0.08 | 6 | 1 | 0.01 |
| 2008 | 17 | 84 | 0.40 | 24 | 27 | 0.10 | 6 | 0 | 0.00 |
| 2009 | 17 | 107 | 0.54 | 27 | 61 | 0.23 | 6 | 2 | 0.03 |
| 2010 | 18 | 213 | 0.92 | 28 | 63 | 0.23 | 6 | 0 | 0.00 |
| 2011 | 18 | 232 | 0.93 | 27 | 193 | 0.65 | 7 | 3 | 0.04 |

Vancomycin-resistant enterococci (VRE)

Western region includes British Columbia, Alberta, Saskatchewan and Manitoba

Central region includes Ontario and Quebec

Eastern region includes New Brunswick, Newfoundland & Labrador and Nova Scotia

# SECTION 3

## VRE IN CANADA: HEALTHCARE-ASSOCIATED VRE SURVEILLANCE FROM JANUARY 1, 2006 TO DECEMBER 31, 2010*

**TABLE 7:** Number of VRE healthcare-associated infections and incidence rates for the reporting facility, per 1,000 patient admissions, by region, from January 1, 2006 to December 31, 2010*

| | WESTERN REGION | | | CENTRAL REGION | | | EASTERN REGION | | |
|---|---|---|---|---|---|---|---|---|---|
| Year | No. reporting hospitals | No. of infections | Rate | No. reporting hospitals | No. of infections | Rate | No. reporting hospitals | No. of infections | Rate |
| 2006 | 18 | 15 | 0.05 | 26 | 13 | 0.03 | 6 | 1 | 0.01 |
| 2007 | 17 | 27 | 0.09 | 26 | 20 | 0.05 | 6 | 1 | 0.01 |
| 2008 | 17 | 69 | 0.26 | 24 | 21 | 0.06 | 6 | 0 | 0.00 |
| 2009 | 17 | 78 | 0.27 | 27 | 50 | 0.15 | 6 | 2 | 0.02 |
| 2010 | 18 | 188 | 0.55 | 28 | 58 | 0.15 | 6 | 0 | 0.00 |

Vancomycin-resistant enterococci (VRE)

Western region includes British Columbia, Alberta, Saskatchewan and Manitoba

Central region includes Ontario and Quebec

Eastern region includes New Brunswick, Newfoundland & Labrador and Nova Scotia

* Data on place of VRE acquisition is only available from 2006 to 2010

**TABLE 8:** Number of VRE healthcare-associated infections and incidence rates for the reporting facility, per 10,000 patient-days, by region, from January 1, 2006 to December 31, 2010*

| | WESTERN REGION | | | CENTRAL REGION | | | EASTERN REGION | | |
|---|---|---|---|---|---|---|---|---|---|
| Year | No. reporting hospitals | No. of infections | Rate | No. reporting hospitals | No. of infections | Rate | No. reporting hospitals | No. of infections | Rate |
| 2006 | 18 | 15 | 0.07 | 26 | 13 | 0.04 | 6 | 1 | 0.01 |
| 2007 | 17 | 27 | 0.14 | 26 | 20 | 0.07 | 6 | 1 | 0.01 |
| 2008 | 17 | 69 | 0.33 | 24 | 21 | 0.07 | 6 | 0 | 0.00 |
| 2009 | 17 | 78 | 0.39 | 27 | 50 | 0.19 | 6 | 2 | 0.03 |
| 2010 | 18 | 188 | 0.81 | 28 | 58 | 0.21 | 6 | 0 | 0.00 |

Vancomycin-resistant enterococci (VRE)

Western region includes British Columbia, Alberta, Saskatchewan and Manitoba

Central region includes Ontario and Quebec

Eastern region includes New Brunswick, Newfoundland & Labrador and Nova Scotia

* Data on place of VRE acquisition is only available from 2006 to 2010

# SECTION 4

## SUMMARY OF FINDINGS FROM AN AUDIT OF CANADIAN VANCOMYCIN-RESISTANT ENTEROCOCCI 2008 SURVEILLANCE DATA

## BACKGROUND

The Public Health Agency of Canada (Agency) has conducted surveillance for incident cases of Vancomycin-Resistant Enterococci (VRE) through the Canadian Nosocomial Infection Surveillance Program (CNISP) since 1999. In 2010, a reliability audit of the 2008 VRE data was conducted. This is the second reliability audit performed on CNISP data. In 2008, a reliability audit of the 2005 Methicillin-resistant *Staphylococcus aureus* (MRSA) data was performed.[1]

The principal objective of the current audit was to assess the reliability of the 2008 VRE data. Secondary objectives were to describe the type, frequency and possible causes of discordant and missing responses between original and re-abstracted data; and to make recommendations for improving data quality.

## METHODS

The primary method used in this reliability audit was the assessment of the agreement between the original data submission (paper forms entered into a web based information management system) and re-abstracted data collected from the original source (i.e. chart). Any discrepancy between the original data submission and the re-abstracted data was identified as a discordant response. In order to evaluate the overall reliability of the 2008 VRE data, a random, systematic sample was developed to identify the audit cases which were representative of the cases reported by each hospital. The 2008 VRE database comprised 22 variables, 16 of which were selected for re-abstraction.

## RESULTS

Re-abstracted data were received from 35 out of 36 hospitals (97%), providing 97% (n=428) of the 443 case forms requested. Of these, 37% (n=157) of forms had zero discordant responses, 29% (n=126) had one discordant response, 16% (n=70) had two discordant responses while only 2 forms (0.5%) had eleven discordant responses. Discordant responses were distributed across all hospitals as ten hospitals had forms with two discordant responses, eight hospitals had forms with three discordant responses and two hospitals each had one form with eleven discordant responses.

Overall, the percentage of discordant and missing responses was 4.7%, ranging from 1.4% (n=29) for type of infection to 21.7% (n=93) for previous hospitalizations. Variables with the highest percentage of discordant and missing responses included date of birth or age (18.2%, n=77); reason for specimen collection (14.3%, n=61); patient was previously known to be a VRE carrier (13.1%, n=56); date of admission (8.4%, n=36), date of positive culture (7.2%, n=31); and location of VRE acquisition (6.8%, n=29) (Table 1). For date variables, the discrepancies largely occurred in the month and day options. It has been observed that discordant responses are more likely for variables that require interpretation and judgment or using historical data such as preceding laboratory results.

**TABLE 9:** Distribution of discordant and missing responses by variable

| VARIABLE | DATA FIELDS | DISCORDANT RESPONSES* | MISSING RESPONSES, FINALIZED | MISSING RESPONSES, REABSTRACTED | TOTAL DISCORDANT RESPONSES |
|---|---|---|---|---|---|
| | n | n (%) | n (%) | n (%) | n (%) |
| Hospital identifier | 428 | 21 (4.9) | 0 | 0 | 21 (4.9) |
| Patient identifier | 428 | 10 (2.3) | 0 | 1 (0.2) | 11 (2.6) |
| Date of birth OR Age | 428 | 77 (18.0) | 0 | 1 (0.2) | 78 (18.2) |
| Date of admission | 428 | 35 (8.2) | 0 | 1 (0.2) | 36 (8.4) |
| Sex | 428 | 5 (1.2) | 0 | 2 (0.5) | 7 (1.6) |
| Patient previously known to be VRE carrier | 428 | 53 (12.4) | 0 | 3 (0.7) | 56 (13.1) |
| Patient hospitalized in past 12 months | 428 | 90 (21.0) | 0 | 3 (0.7) | 93 (21.7) |
| Date of positive culture | 428 | 30 (7.0) | 0 | 1 (0.2) | 31 (7.2) |
| Reason for specimen collection | 428 | 60 (14.0) | 0 | 1 (0.2) | 61 (14.3) |
| Location of VRE acquisition | 428 | 28 (6.5) | 0 | 1 (0.2) | 29 (6.8) |
| Site of collected specimen | 2,568 | 66 (2.6) | 0 | 1 (0.0) | 67 (2.6) |
| Description for "other" specimen | 428 | 9 (2.1) | 0 | 0 | 9 (2.1) |
| Infection or colonization of specimen | 2,568 | 43 (1.7) | 0 | 0 | 43 (1.7) |
| Type of infection | 2,140 | 27 (1.3) | 1 (0.0) | 1 (0.0) | 29 (1.4) |
| Description for "other" infection | 428 | 15 (3.5) | 0 | 0 | 15 (3.5) |
| Infection of colonization status | 428 | 15 (3.5) | 0 | 0 | 15 (3.5) |
| **TOTAL** | **12,840** | **584 (4.5)** | **1 (0.0)** | **16 (0.1)** | **601 (4.7)** |

* Excludes missing responses.

## CONCLUSIONS

Several recommendations that were identified from the audit of the 2005 MRSA surveillance data have been implemented. A data quality framework with quality assurance practices, including ongoing auditing has been integrated into the Agency's surveillance programs. Annual in-service training and seeking input from data collectors regarding protocol development was initiated and is ongoing. The Agency continues its efforts to improve standardization and interpretation of surveillance protocols. Clearly defining variables and providing applicable response options may improve data quality, especially for those variables that require clinical judgment. The implementation of web-based reporting at the Agency has greatly reduced the overall number of discordant responses and especially errors in date variables by incorporating program logic rules that detect inconsistencies and provide immediate feedback for correction.

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# APPENDIX 1. DATA SOURCES

The following are members of the Canadian Nosocomial Infection Surveillance Program who submitted VRE data to the Public Health Agency of Canada:

**NATALIE BRIDGER,** Health Sciences Centre, St. John's, Newfoundland and Labrador

**ELIZABETH BRYCE,** Vancouver General Hospital, Vancouver, British Columbia

**JOHN CONLY,** Foothills Medical Centre, Calgary, Alberta

**ANDRE DASCAL,** SMBD-Jewish General Hospital, Montreal, Quebec

**JANICE DEHEER,** Kelowna General Hospital, Kelowna, British Columbia

**JOHN EMBIL,** Health Sciences Centre, Winnipeg, Manitoba

**JOANNE EMBREE,** Health Sciences Centre, Winnipeg, Manitoba

**GERARD EVANS,** Kingston General Hospital, Kingston, Ontario

**SARAH FORGIE,** Stollery Children's Hospital, Edmonton, Alberta

**CHARLES FRENETTE,** McGill University Health Centre, Montreal, Quebec

**GREGORY GERMAN,** Queen Elizabeth Hospital, Charlottetown, Prince Edward Island

**DAVID HALDANE,** Queen Elizabeth II Health Sciences Centre, Halifax, Nova Scotia

**DEANNA HEMBROFF,** University Hospital Northern BC, Prince George, British Columbia

**ELIZABETH HENDERSON,** Peter Lougheed Centre, Calgary, Alberta

**MICHAEL JOHN,** London Health Sciences Centre, London, Ontario

**LYNN JOHNSTON,** Queen Elizabeth II Health Sciences Centre, Halifax, Nova Scotia

**KEVIN KATZ,** North York General Hospital, Toronto, Ontario

**PAMELA KIBSEY,** Victoria General Hospital, Victoria, British Columbia

**MAGDALENA KUHN,** South East Regional Health Authority, Moncton, New Brunswick

**JOANNE LANGLEY,** IWK Health Centre, Halifax, Nova Scotia

**CAMILLE LEMIEUX,** University Health Network, Toronto, Ontario

**NICOLE LE SAUX,** Children's Hospital of Eastern Ontario, Ottawa, Ontario

**MARK LOEB,** Hamilton Health Sciences Corporation, Hamilton, Ontario

**SUSAN RICHARDSON,** Hospital for Sick Children, Toronto, Ontario

**ALLISON MCGEER,** Mount Sinai Hospital, Toronto, Ontario

**DOMINIK MERTZ,** Hamilton Health Sciences Corporation, Hamilton, Ontario

**MARK MILLER,** SMBD-Jewish General Hospital, Montreal, Quebec

**DOROTHY MOORE,** Montreal Children's Hospital, McGill University Health Centre, Montreal, Quebec

**CAROLINE QUACH,** Montreal Children's Hospital, McGill University Health Centre, Montreal, Quebec

**SUZANNE PELLETIER,** Health Sciences North, Sudbury, Ontario

**VIRGINIA ROTH,** The Ottawa Hospital, Ottawa, Ontario

**ANDREW SIMOR,** Sunnybrook Health Sciences Centre, Toronto, Ontario

**STEPHANIE SMITH,** University of Alberta Hospital, Edmonton, Alberta

**KATHRYN SUH,** The Ottawa Hospital, Ottawa, Ontario

**GEOFFREY TAYLOR,** University of Alberta Hospital, Edmonton, Alberta

**EVA THOMAS,** Children's and Women's Health Center, Vancouver, British Columbia

**NATHALIE TURGEON,** Hôtel-Dieu de Québec du CHUQ, Quebec

**MARY VEARNCOMBE,** Sunnybrook Health Sciences Centre, Toronto, Ontario

**JOSEPH VAYALUMKAL,** Alberta Children's Hospital, Calgary, Alberta

**KARL WEISS,** Maisonneuve-Rosemont Hospital, Montreal, Quebec

**ALICE WONG,** Royal University Hospital, Saskatoon, Saskatchewan

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