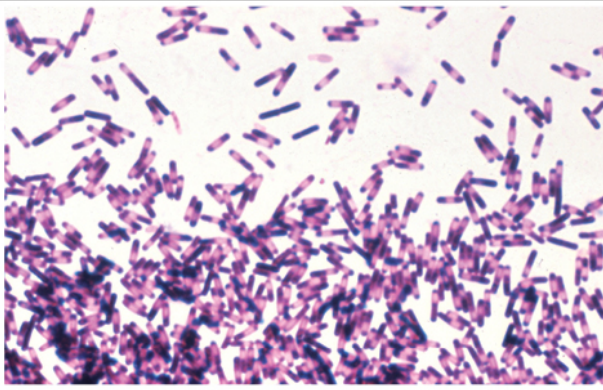
Central Venous Catheter-Associated Blood Stream Infections in Intensive Care Units in Canadian Acute-Care Hospitals

SURVEILLANCE REPORT JANUARY 1, 2006 TO DECEMBER 31, 2006 and JANUARY 1, 2009 TO DECEMBER 31, 2011



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Acknowledgments: National level Central Venous Catheter-Associated Blood Stream Infections (CVC-BSI) surveillance is possible as a result of hospitals participating in, and setting directives for, CVC-BSI surveillance. Accordingly, the Public Health Agency of Canada acknowledges the participating hospitals for providing the non-nominal confidential data that enables this report to be published. Without their close collaboration and participation in CVC-BSI surveillance, the publication of this report would not have been possible. A complete listing of these contributors is available in Appendix 4.

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Information to the reader of *CVC-BSI in Canada*

This report entitled *Central Venous Catheter-Associated Blood Stream Infections in Intensive Care units in Canadian Acute-Care Hospitals: Surveillance Report January 1, 2006 to December 31, 2006 and January 1, 2009 to December 31, 2011* was produced by the Centre for Communicable Diseases and Infection Control of the Public Health Agency of Canada (Agency). The report provides a review of central venous catheter-associated blood stream infections (CVC-BSI) surveillance data in Canada.

The Centre for Communicable Diseases and Infection Control (CCDIC) is responsible for the data collection, management, analysis and report production related to this CVC-BSI surveillance report. CCDIC supports the use of these data to inform public health and policy action. In addition, CCDIC supports the Agency's ongoing commitment to improving data quality, defining and setting surveillance standards.

The Agency collects national data on various healthcare-associated infections, including CVC-BSI through the Canadian Nosocomial Infection Surveillance Program (CNISP), a collaborative effort of the Canadian Hospital Epidemiology Committee (CHEC) which is a subcommittee of the Association of Medical Microbiology and Infectious Disease Canada (AMMI), the Centre for Communicable Diseases and Infection Control and the National Microbiology Laboratory. CNISP conducts surveillance in 54 large, university-affiliated tertiary care hospitals (i.e., major acute-care hospitals that offer a range of specialist services and to which patients are often 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. In addition, if carried out in a uniform manner, surveillance provides a measure of the burden of illness, establishes benchmark rates for internal and external comparison, identifies potential risk factors, and allows assessment of specific interventions. Surveillance for CVC-associated BSI (CVC-BSI) is considered an important measure of the quality of patient care.

Highlights of the findings are outlined in the section entitled 'At a Glance' while the main findings of the surveillance data are outlined in the section entitled 'Results'. Data sources and references are available in the Appendices.

The publication of this report would not be possible without the submission of CVC-BSI surveillance data from all participating hospitals, which are listed in Appendix 4. Their ongoing contributions to national CVC-BSI surveillance are gratefully acknowledged.

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At a Glance

Adult Intensive Care Units (ICUs)

- Among all adult ICUs, national CVC-BSI rates have significantly decreased since 2006
- Regionally, western CVC-BSI rates among all adult ICUs are relatively unchanged since 2006 while central and eastern rates have decreased
- Catheter utilization rates among all adult ICUs have shown a slight increase since 2006 in the west and central regions while the east has shown a slight decrease
- Among medical, surgical and mixed adult ICUs, CVC-BSI rates have significantly decreased since 2006
- Catheter utilization rates among medical, surgical and mixed adult ICUs are relatively unchanged since 2006 with the central region showing an increase and the east a decrease
- Among adult cardiovascular surgery ICUs national CVC-BSI rates increased since 2006 along with catheter utilization rates
- Coagulase negative staphylococcus (CONS) remains the predominant microorganism identified from CVC-BSI in adult ICUs. Other microorganisms have remained relatively unchanged except VRE which has increased from 0 in 2006 to 4% in 2011.
- The majority of microorganisms identified in adult ICUs are Gram positive (63% in 2011) and there has been no significant change in the proportions identified since 2006 (70%)
- Most patients (71% in 2011) in adult ICUs are alive at 30 days after onset of CVC-BSI and there has been no significant change in this proportion since 2006 (74%)
- The decreasing CVC-BSI rates and proportion of CONS identified from CVC-BSI in these Canadian adult ICU data are similar to trends observed internationally

Pediatric Intensive Care Units (PICUs)

- Among all PICUs, national CVC-BSI rates have significantly decreased since 2006
- Catheter utilization rates among PICUs have varied over time and an upward trend is seen since 2006
- Coagulase negative staphylococcus (CONS) remains the predominant microorganism identified from CVC-BSI in PICUs. Other microorganisms have remained relatively unchanged except Enterococcus which has increased from 3% in 2006 to 21% in 2011
- The majority of microorganisms identified in PICUs are Gram positive (68% in 2011) and there has been no significant change in the proportions identified since 2006 (68%)
- The majority of patients (88% in 2011) in PICUs are alive at 30 days after onset of CVC-BSI and there has been no significant change in this proportion since 2006 (91%)
- The decreasing CVC-BSI rates in these Canadian PICU data are similar to trends observed internationally

Neonatal Intensive Care Units (NICUs)

- Among all NICUs, national CVC-BSI rates have significantly decreased overall and by birth weight and type of catheter since 2006
- Catheter utilization rates overall and by birth weight in NICUs have remained relatively unchanged since 2006
- Coagulase negative staphylococcus (CONS) remains the predominant microorganism identified from CVC-BSI in NICUs. Other microorganisms have remained relatively unchanged except the proportion of Escherichia coli which increased from 2% in 2006 to 10% in 2011
- The majority of microorganisms identified in NICUs are Gram positive (70% in 2011)
- The majority of patients (93% in 2011) in NICUs are alive at 30 days after onset of CVC-BSI and there has been no change in this proportion since 2006 (92%)
- The decreasing CVC-BSI rates and proportion of CONS identified from CVC-BSI in these Canadian NICU data are similar to trends observed internationally

Background

The majority of healthcare-associated blood stream infections (BSIs) are associated with the use of a central venous catheter (CVC). These devices have become essential to the care of patients with complex severe illnesses, especially those in intensive care units (ICUs). Highest CVC-BSI rates are reported by the National Healthcare Safety Network (USA) in neonatal, pediatric, adult medical (major teaching hospitals), trauma and burn ICUs.[1-4] Risk factors for BSI include type of catheter used, catheter insertion site, catheter insertion and care practices, products administered through the line, frequency of manipulation, age group, underlying disease, and severity of illness.[5,6]

The skin is the main source of microorganisms causing CVC-BSI. Infection may occur as a result of migration of microorganisms from the insertion site along the percutaneous tract. This may occur during insertion or later, especially if the catheter is manipulated. Microorganisms may also be introduced into the catheter lumen from the external surface of the catheter or administration tubing at junction sites, especially when these are disconnected, or through cracks in the external portion of the catheter or some component of the administration set. The catheter hub is an important source of infection in tunnelled catheters in place for more than 30 days.[5,6]

The types of microorganisms most frequently involved in CVC-BSI are coagulase negative staphylococci (CONS), *Staphylococcus aureus*, enterococci, *Candida spp* and Gram negative bacilli. Antibiotic-resistant strains are frequently encountered.[6]

In the United States, it is estimated that approximately 16,000 CVC-BSI occur in ICUs and 500 to 4,000 patients die annually from CVC-BSI.[7] In addition, several studies have demonstrated that CVC-BSIs are associated with significant increases in length of hospital stay and medical costs.[8] It is estimated that the cost of a CVC-BSI ranges from US$34,000 to $56,000 and the annual cost of caring for patients with CVC-BSI is $60 million to $460 million.[5,7] There are no equivalent Canadian figures.[9]

The literature suggests that performance of surveillance for BSI and feedback of data results in the reduction in infection rates.[10] Standardized collection of data on infection rates also permits national benchmarking of CVC-BSI rates and provides data for the implementation of prevention and control efforts.

Objective

The objective of CVC-BSI surveillance in ICUs participating in the CNISP hospital network is to provide ongoing national benchmark rates that hospitals can use for external comparison

A secondary objective is to reduce the rates of CVC-BSI in Canadian ICUs. The literature suggests that the performance of surveillance for BSI and feedback of data results in the reduction in infection rates.[5,10] Routine standardized collection of data on infection rates also permits individual centres to evaluate specific infection prevention and control interventions.

Methodology

Surveillance network

The Public Health Agency of Canada (Agency) collates and analyzes data on patients in intensive care units with CVC-BSI in Canadian acute-care hospitals.

Surveillance for CVC-BSI 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 CVC-BSI working group comprised of Canadian Hospital Epidemiology Committee (CHEC) members and Infection Control Professionals (ICPs) from participating CNISP hospitals and an Agency epidemiologist is responsible for developing and regularly updating the surveillance protocol that includes standardized data collection forms and a data dictionary. In-service sessions are organised and delivered at the beginning of each surveillance year by the Agency staff for all participating CNISP hospitals. The purpose of the in-service sessions is to provide training on how to use the surveillance protocol and data collection forms to ensure data are comparable between hospitals, provinces and regions within the CNISP network.

Case definition

ONLY CVC[1]-associated BSIs related to an ICU[2] admission are reported. A case of CVC-BSI is defined using the following criteria:

BSI case definition:
Criterion 1: Recognized pathogen cultured from at least one blood culture, unrelated to infection at another site.

OR

Criterion 2: At least one of: fever (>38°C), chills, hypotension (if aged < 1 yr: fever, hypothermia, apnea, or bradycardia) or signs of infection of insertion site or catheter tunnel AND common skin contaminant[3] cultured from ≥ 2 blood cultures drawn on separate occasions and positive laboratory results are unrelated to infection at another site.

OR

Criterion 3: At least one of: fever >38°C, chills, hypotension (if aged < 1 yr: one of fever >38°C, hypothermia, apnea, or bradycardia), or signs of infection of catheter insertion site, tunnel or pocket AND common skin contaminant (as above) cultured from one blood culture and positive laboratory results are unrelated to infection at another site AND the physician institutes appropriate antimicrobial therapy. **NOTE: This criterion was used from January 1, 2006 – March 31, 2011. This criterion was removed from the definition starting on April 1, 2011[4].**

The case-definition was changed to maintain consistency with the CDC-National Healthcare Safety Network (NHSN) methodology used in the United States and consequently in many other countries that follow the NHSN criteria. The NHSN began using the revised definition in January 2008. The main rationale for the revised definition (removal of criterion 3) was to reduce over reporting of coagulase negative staphylococcal infections, some of which were not true infections.

*NOTE: There is no minimum period of time that the central line must be in place in order for the BSI to be considered central line associated (*CDC 2012*)*

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[1] CVC is a venous access device that terminates at or close to the heart or in one of the great vessels (aorta, pulmonary artery, inferior and/or superior vena cava, brachiocephalic, internal jugular, subclavian, external iliac, common iliac, femoral veins, and umbilical artery and vein). CVC include non-tunnelled (standard) CVC, whether coated or not, peripherally inserted CVC (PICC), tunnelled devices (e.g. Broviac, Hickman, tunnelled haemodialysis line, etc) umbilical artery and vein catheters and implanted catheters (including ports). Pulmonary artery catheters are included as these are inserted via a central vein. Other arterial catheters are NOT included. Pacemaker leads and other non-infusion devices (ECMO, IABP) inserted into central blood vessels or the heart are NOT included (*CDC,2012)*

[2] ICU is defined as a nursing care area in an acute care hospital that provides intensive observation, diagnostic and supportive care to critically ill patients including, but not limited to, invasive intravascular hemodynamic monitoring, endotracheal intubation and mechanical ventilation. The type of ICU is determined by the service designation of the majority (e.g. >80%) of patients cared for by the unit. Bone marrow transplant units and units that provide step-down care, intermediate care or telemetry only are excluded *(CDC, 2012).*

[3] Diphtheroids, *Corynebacterium* spp., *Bacillus* spp, *Propionibacterium* spp., coagulase-negative staphylococci, (including *S. epidermidis*) viridans group streptococci, *Aerococcus* spp., *Micrococcus* spp.(CDC, 2012)

[4] CNISP BSI case definition was changed because of change in CDC NHSN CLABSI definition.

In addition to meeting the above criteria for a blood stream infection (BSI), a central venous catheter must have been in place at the onset of the BSI or within the 48 hours before onset and the BSI infection must have occurred during an ICU stay or within 48 hours of leaving the ICU (CDC 2012). The CVC-BSI case is excluded if the infection is already present on admission to an ICU or if it occurred in a neonate that is <48 hours old, unless epidemiologic evidence indicated acquisition in the neonatal ICU (e.g., procedure-associated or known endemic neonatal ICU strain).

A CVC-BSI is considered to be a relapse and NOT reported if the same microorganism (as best as could be determined by the data available (e.g. species, antibiotic sensitivity, etc.)) is isolated from a subsequent blood culture less than 10 days from a negative culture or less than 10 days from completion of appropriate antibiotic therapy.

Laboratory analysis

The positive blood culture is identified by the hospital's laboratory

Data collection and submission

When a positive blood culture is identified by the hospital's microbiology laboratory, the Infection Control Professional (ICP) determines if the patient is in an ICU or was in an ICU within the 48 hours prior to the time of the positive blood culture. If yes, the patient's chart is reviewed to determine if a CVC was present at the time the specimen was obtained or within the preceding 48 hours, thereby meeting the case definition for CVC-BSI. A standardized patient questionnaire is completed through concurrent or retrospective chart review by an ICP. The questionnaire includes patient demographics and clinical information including type of ICU (Adult ICU, PICU or NICU), microorganism(s) isolated, antibiotic resistance and 30 day outcome.

Data are submitted by paper forms (fax or mail) or electronically (PDF or excel spreadsheet) by participating hospitals to the Centre for Communicable Diseases and Infection Control of the Agency for data entry, validation, statistical analysis and storage.

Denominator data

Participating hospitals provide the number of CVC line-days[5] and the number of specified ICU patients-days[6] for the corresponding surveillance year. These denominator data are ICU specific and are used to calculate the annual rates presented in this report.

[5] CVC-days = Number of patients with one or more CVC in place each day in the specified ICU during a surveillance year

[6] Patient-days = Total number of days that each patient was in the specified ICU during a surveillance year.

All ICUs

- CVC-days: The total number of patients in the specified ICUs[7] each day with one or more CVC. Only one CVC day per patient is counted even if the patient has more than one CVC.
- Patient-days: The total number of patients in the specified ICUs[9] each day.

Neonatal ICUs

- Birth weight is collected and used to stratify risk for CVC-BSI. Neonatal ICU CVC-BSI rates are stratified by 5 birth weight (grams) groups (< 750g, 751 -1000g, 1001-1500g, 1501-2500g, >2500g) and by type of catheter (CVC or umbilical catheter (UC)). In 2006, those of birth weight < 1000 g were not stratified further. This group was divided into birth weight of < 750 g and 751-1000 g from 2009 onwards because of NHSN stratification changes.
- Rates are also stratified by type of catheter (CVC or UC).
- In 2006, catheter-days were not stratified by CVC and UC. Stratification was begun in 2009 because the NHSN had started reporting separate CVC and UC rates in NICU.

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- **CVC-days and UC-days in NICU:** The total number of patients of each birth weight group in the NICU each day with one or more CVC or UC. Only one CVC day or UC day per patient is counted even if the patient has more than one CVC or UC. A patient with both an UC and a CVC, is counted only as an UC day. If a site is unable to stratify CVC-days and UC-days, total CVC-UC days are reported.

- **Patient days:** the total number of patients of each birth weight group in the NICU each day.

Data analysis

Data submitted to the Agency by participating hospitals (patient's clinical, demographic and laboratory data) are extracted, validated and statistically analysed as appropriate.

Annual incidence rates are calculated using CVC-days. Patient-days are used to calculate the rate of catheter utilization per ICU.

[7] Type of adult ICUs collecting data in are identified - e.g. Adult medical ICU, Adult coronary ICU, Adult mixed ICUs (any combination of patients e.g., medical/surgical; medical/neurological; surgical/trauma; med/surg/trauma etc.).

Rate Calculations:

$$\text{Infection rate: CVC-BSI rate} = \frac{\text{Number of CVC-BSIs}}{\text{Number of ICU CVC-days}} \times 1000$$

$$\text{Catheter utilization rate: Catheter utilization rate} = \frac{\text{Number of ICU CVC-days}}{\text{Number of ICU patient-days}}$$

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, and Newfoundland and Labrador) for adult and neonatal ICU rates. Currently, only eight pediatric hospitals that participate in CVC-BSI surveillance are able to provide denominator data that is separated from the rest of the adult hospital population. As a result, rates are not calculated at the regional level to ensure confidentiality.

For 2006 and from 2009-2011, overall Adult ICU, Adult medical, surgical and mixed (medical/surgical) ICU, Adult Cardiovascular Surgery ICU, Pediatric ICU (PICU) and Neonatal ICU (NICU) CVC-BSI rates are presented. For adult ICUs the rates are stratified by region. For neonatal ICUs the rates are stratified by birth weight and type of catheter (CVC and umbilical catheter). 95% CIs are provided for all rates and 2006 rates were compared to 2011 rates to identify any significant changes.

Demographic (age and sex) and microorganism data for adult, pediatric and neonatal ICUs are presented. The proportions of microorganisms identified in 2006 were compared to 2011 to identify any significant changes.

Results

The following sections of this report outline CVC-BSI surveillance data and provide a description of hospitalized ICU patients who have been diagnosed with a CVC-BSI. Surveillance for CVC-BSI in adult ICUs, PICUs and NICUs was initiated in 2006 as a Canadian Patient Safety Institute (CPSI) and CNISP co-funded research study in participating hospitals, resumed in 2009 (voluntary participation by hospitals) and became a core (mandatory participation by hospitals) CNISP surveillance project in 2010. CVC-BSI surveillance data are presented for 2006 and from 2009-2011.

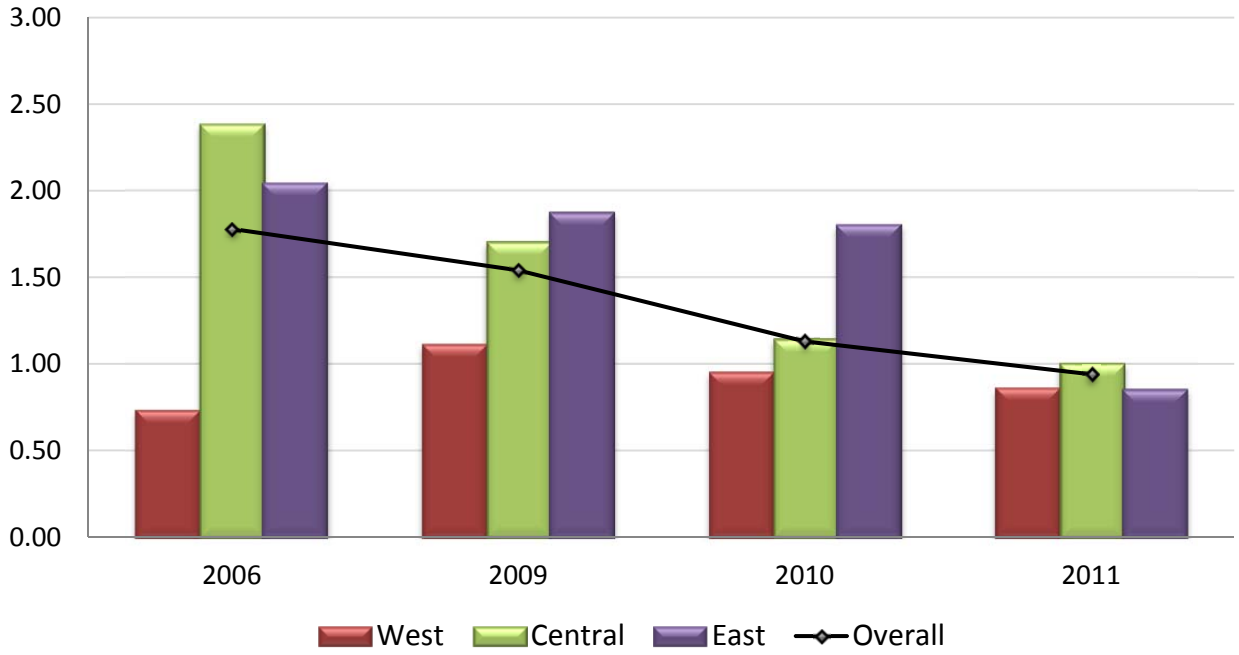
Section 1: CVC-BSI in Adult Intensive Care Units (ICUs) in Canada: National Surveillance from January 1, 2006 to December 31, 2006 and from January 1 2009 to December 31 2011

Annual CVC-BSI trends in Adult ICUs

Figure 1 illustrates the 2006 baseline CVC-BSI rate in all adult ICUs[8] and the trend in annual CVC-BSI rates from 2009 – 2011. National rates have been steadily declining. Regionally, western rates have declined since 2009 while central and eastern rates have declined since 2006.[9]

Figure 1

National and Regional CVC-BSI rate per 1,000 CVC-days in Adult ICUs 2006, 2009-2011



[8] Adult ICUs = Mixed (medical/surgical), medical, surgical, cardiovascular surgery, coronary and neurological

[9] In 2011, the BSI case definition changed – criterion 3 was removed - some of the decrease in 2011 may be attributed to this change in BSI case definition

Table 1 provides the number of cases and rates per CVC-days with 95% CIs by year for all adult ICUs and the number of ICUs that provided both cases and denominator data. The rates for 2006 and 2011 were compared.

Table 1 National and Regional CVC-BSI rates in Adult ICUs

Adult ICUs[§]	2006	2009	2010	2011	*p*[10]
National all CVC-BSI reported	264	291	192	159	
CVC-BSI eligible* (CVC-days)	210 (117,706)	223 (145,028)	158 (139,952)	142 (150,655)	
Rate per 1,000 CVC-days (95%CI)	1.78 (1.54, 2.03)	1.54 (1.34, 1.74)	1.13 (0.95, 1.30)	0.94 (0.79, 1.10)	0.04
Number of ICUs[†]	36	37	40	41	
West all CVC-BSI reported	58	54	43	41	
CVC-BSI eligible (CVC-days)	29 (39,973)	50 (45,177)	42 (44,333)	39 (45,095)	
Rate per 1,000 CVC-days (95% CI)	0.73 (0.46, 0.99)	1.11 (0.80, 1.41)	0.95 (0.66, 1.23)	0.86 (0.59, 1.14)	*ns*
Number of ICUs	13	14	17	13	
Central all CVC-BSI reported	180	190	131	98	
CVC-BSI eligible (CVC-days)	155 (65,017)	141 (82,722)	98 (85,637)	88 (87,939)	
Rate per 1,000 CVC-days (95% CI)	2.38 (2.01, 2.76)	1.70 (1.42, 1.99)	1.14 (0.92, 1.37)	1.00 (0.79, 1.21)	<0.001
Number of ICUs	17	16	17	18	
East all CVC-BSI reported	26	47	18	20	
CVC-BSI eligible (CVC-days)	26 (12,716)	32 (17,129)	18 (9,982)	15 (17,622)	
Rate per 1,000 CVC-days (95% CI)	2.04 (1.26, 2.83)	1.87 (1.22, 2.52)	1.80 (0.97, 2.64)	0.85 (0.42, 1.28)	0.03
Number of ICUs	6	7	6	10	

[§] Adult ICUs = Mixed (medical/surgical), medical, surgical, cardiovascular surgery, coronary and neurological

*Rates are calculated using only eligible data = hospitals that supplied cases and denominator data, rates are per 1,000 CVC-days

[†] Number of participating ICUs varies due to eligible data submitted

Table 2 reports the national and regional catheter utilization rates by year for all adult ICUs. Catheter utilization rates among all adult ICUs have shown an increase since 2006 specifically in the west and central regions while the east has shown a slight decrease.

Table 2 National and Regional Catheter Utilization Rates (CURs)[11] for Adult ICUs

Adult	2006	2009	2010	2011
Overall CUR	0.66	0.80	0.72	0.75
West CUR	0.68	0.69	0.63	0.70
Central CUR	0.66	0.85	0.80	0.84
East CUR	0.61	0.58	0.56	0.57

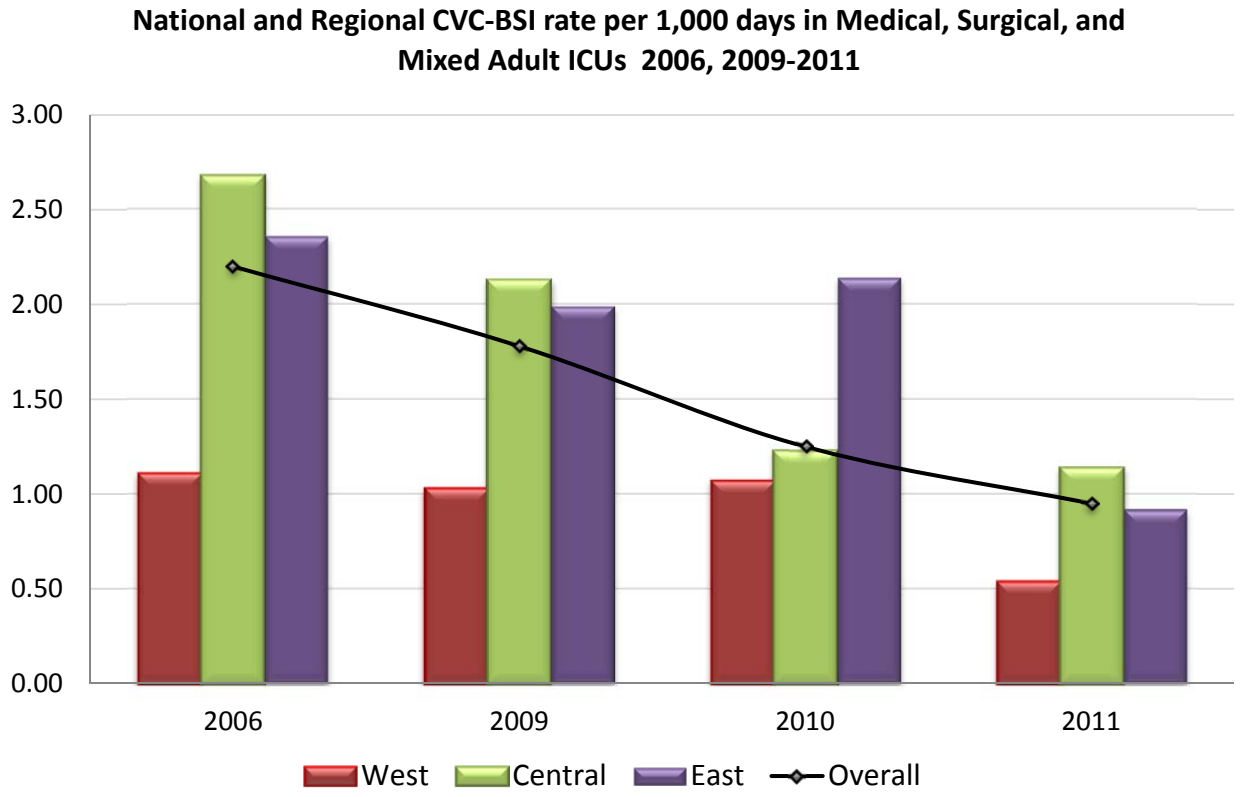
[10] Significance test compares 2006 CVC-BSI rate to 2011 CVC-BSI rate

[11] Catheter utilization rate = $\frac{\text{Number of ICU CVC-days}}{\text{Number of ICU patient-days}}$

Annual CVC-BSI trends in medical, surgical and mixed (medical/surgical) Adult ICUs

Figure 2 illustrates the 2006 baseline CVC-BSI rate in medical, surgical and mixed adult ICUs and the trend in annual CVC-BSI rates from 2009 – 2011. National and regional rates have been steadily declining[12].

Figure 2



[12] In 2011, the BSI case definition changed – criterion 3 was removed - some of the decrease in 2011 may be attributed to this change in BSI case definition

Table 3 provides the number of cases and rates per CVC-days with 95% CIs by year and the number of ICUs that provided both cases and denominator data. The rates for 2006 and 2011 were compared.

Table 3 National and Regional CVC-BSI rates in Medical, Surgical and Mixed Adult ICUs

Adult Medical, Surgical and Mixed ICUs	2006	2009	2010	2011	*p*[13]
National CVC-BSI reported	234	233	164	121	
CVC-BSI eligible* (CVC-days)	202 (91,978)	191 (107,030)	137 (109,827)	112 (118,462)	
Rate per 1,000 CVC-days (95% CI)	2.20 (1.89, 2.50)	1.78 (1.53, 2.04)	1.25 (1.04, 1.46)	0.95 (0.77, 1,12)	0.002
Number of ICUs†	22	23	27	28	
West all CVC-BSI reported	56	37	33	19	
CVC-BSI eligible (CVC-days)	29 (26,127)	33 (32,009)	33 (30,908)	18 (33,470)	
Rate per 1,000 CVC-days (95% CI)	1.11 (0.71, 1.51)	1.03 (0.68, 1.38)	1.07 (0.70, 1.43)	0.54 (0.29, 0.79)	0.01
Number of ICUs	7	8	11	8	
Central all CVC-BSI reported	152	168	114	87	
CVC-BSI eligible (CVC-days)	147 (54,814)	131 (61,461)	87 (70,963)	83 (73,097)	
Rate per 1,000 CVC-days (95% CI)	2.68 (2.25, 3.12)	2.13 (1.77, 2.50)	1.23 (0.97, 1.48)	1.14 (0.89, 1.38)	<0.001
Number of ICUs	12	11	13	14	
East all CVC-BSI reported	26	28	17	15	
CVC-BSI eligible (CVC-days)	26 (11,037)	27 (13,561)	17 (7,956)	11 (11,895)	
Rate per 1,000 CVC-days (95% CI)	2.36 (1.45, 3.26)	1.99 (1.24, 2.74)	2.14 (1.12, 3.15)	0.92 (0.38, 1.47)	0.04
Number of ICUs	3	4	3	6	

*Rates are calculated using only eligible data = hospitals that supplied cases and denominator data, rates are per 1,000 CVC-days

† Number of participating ICUs varies due to eligible data submitted

Table 4 reports the national and regional catheter utilization rates by year for medical, surgical and mixed adult ICUs. National catheter utilization rates have shown an increase since 2006 and regionally specifically in the west and central regions while the east has shown a decrease.

Table 4 National and Regional Catheter Utilization Rates (CURs)[14] for Medical, Surgical and Mixed Adult ICUs

Adult Medical, Surgical and Mixed ICUs	2006	2009	2010	2011
Overall CUR	0.74	0.82	0.73	0.77
West CUR	0.70	0.84	0.62	0.74
Central CUR	0.67	0.83	0.79	0.83
East CUR	0.76	0.66	0.70	0.58

[13] Significance test compares 2006 CVC-BSI rate to 2011 CVC-BSI rate

[14] Catheter utilization rate = $\frac{\text{Number of ICU CVC-days}}{\text{Number of ICU patient-days}}$

Annual CVC-BSI trends in Cardiovascular Surgery Adult ICUs

Figure 3 illustrates the 2006 baseline CVC-BSI rate in cardiovascular surgery adult ICUs and the trend in annual CVC-BSI rates from 2009 – 2011. National and regional rates have significantly increased between 2006 and 2011. However, when comparing the rates between 2009 and 2011, there is no significant increase.

Figure 3

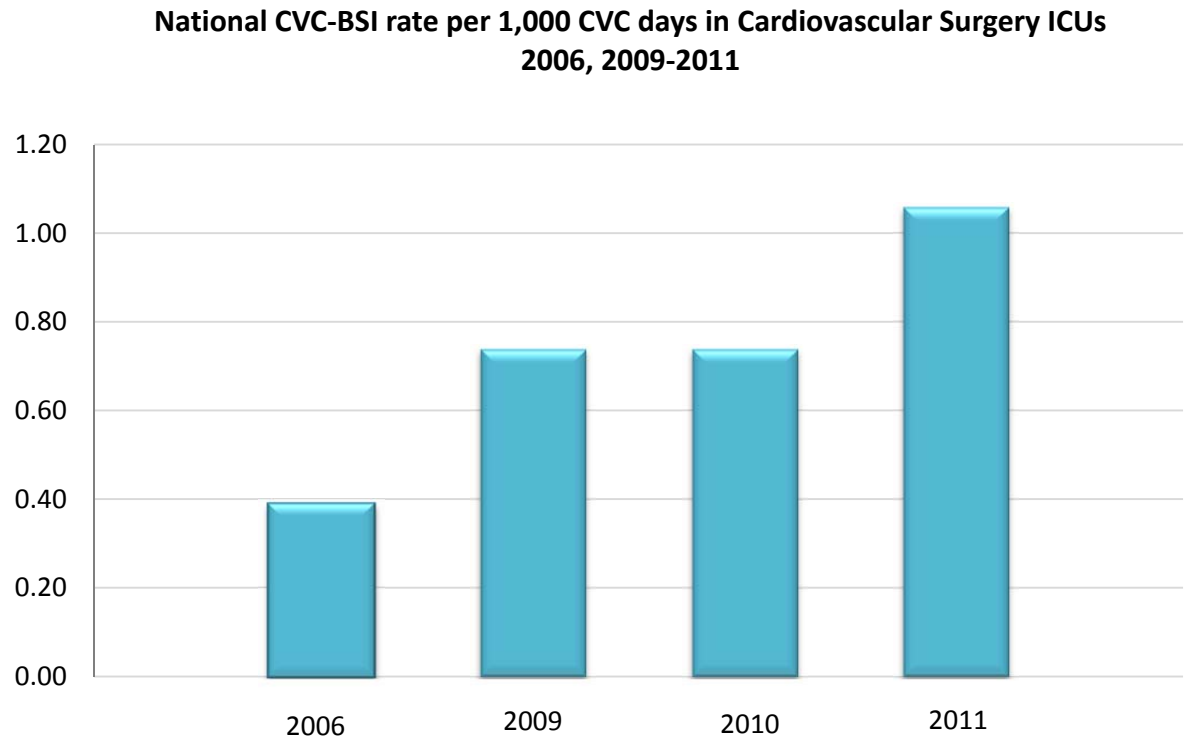


Table 5 provides the number of cases and rates per CVC-days with 95% CIs by year and the number of cardiovascular surgery ICUs that provided both cases and denominator data. The rates for 2006 and 2011 were compared.

Table 5 National CVC-BSI rates in Cardiovascular Surgery Adult ICUs

Adult CV surgery	2006	2009	2010	2011	*p*[15]	
National all CVC-BSI reported	8	37	20	30		
CVC-BSI eligible* (CVC-days)	8 (20,524)	23 (30,974)	18 (24,200)	28 (26,474)		0.007
Rate per 1,000 CVC-days (95% CI)	0.39 (0.12, 0.66)	0.74 (0.44, 1.05)	0.74 (0.40, 1.09)	1.06 (0.67, 1.45)		
Number of ICUs†	6	7	6	6		

*Rates are calculated using only eligible data = hospitals that supplied cases and denominator data, rates are per 1,000 CVC-days

† Number of participating ICUs varies due to eligible data submitted

Table 6 reports the national catheter utilization rates by year for cardiovascular surgery ICUs. National catheter utilization rates have shown an increase since 2006.

Table 6 National Catheter Utilization Rates (CURs)[16] for Cardiovascular Surgery Adult ICUs

Adult CV Surgery	2006	2009	2010	2011
Overall CUR	0.82	0.94	0.97	0.98

[15] Significance test compares 2006 CVC-BSI rate to 2011 CVC-BSI rate

[16] Catheter utilization rate = $\frac{\text{Number of ICU CVC-days}}{\text{Number of ICU patient-days}}$

Laboratory results

Figure 4 illustrates the proportion of microorganisms identified in CVC-BSI from adult ICU cases categorized as Gram positive, Gram negative bacteria and fungal in 2006 and the trend in the annual proportion of microorganisms from 2009 – 2011. The proportion of microorganisms identified as Gram positive, Gram negative and fungal has not significantly changed since 2006.

Figure 4 Proportion of Microorganisms found in CVC-BSI in Adult ICUs

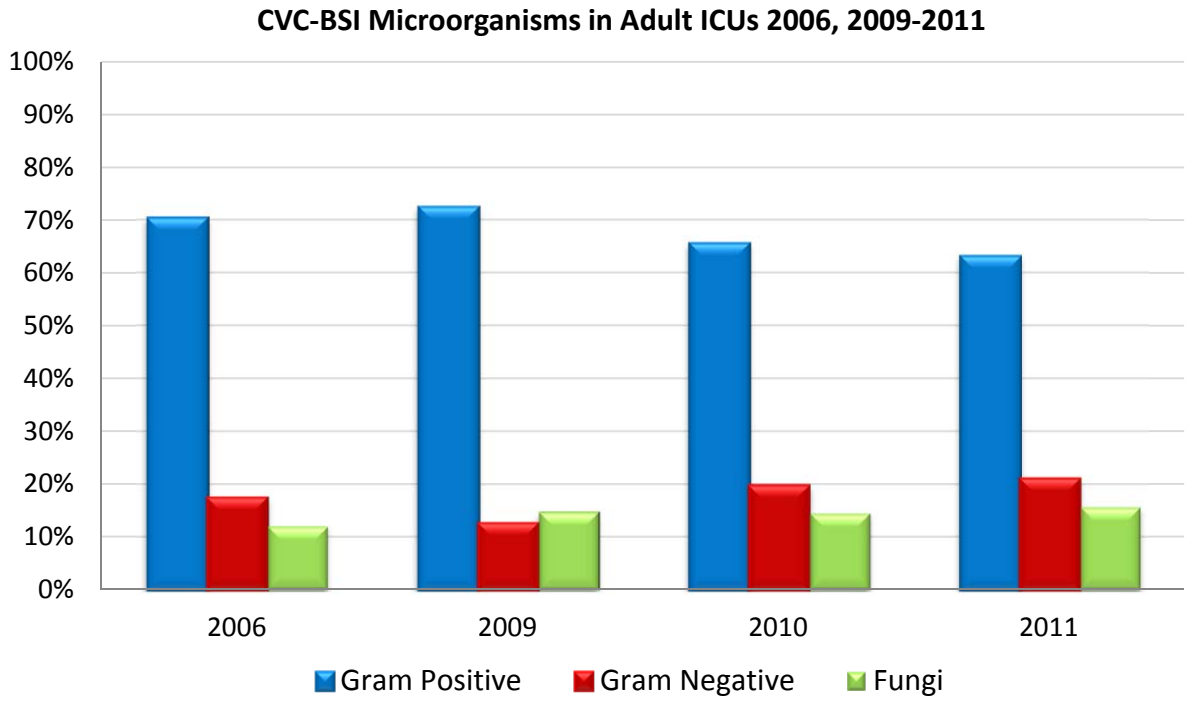


Table 7 provides the number and proportions of microorganisms by year. The proportions of microorganisms for 2006 and 2011 were compared.

Table 7 Microorganisms identified in CVC-BSI in Adult Intensive Care Units

Microorganism	2006 N (%)	2009 N (%)	2010 N (%)	2011 N (%)	*p*[17]
Gram positive	209 (70.4)	206 (72.5)	149 (65.6)	105 (63.2)	*n/s*
Gram negative	52 (17.5)	36 (12.7)	45 (19.8)	35 (21.1)	*n/s*
Fungi	36 (12.1)	42 (14.8)	33 (14.5)	26 (15.7)	*n/s*
Total*	**297**	**284**	**227**	**166**	

[17] Significance test compares proportion of microorganisms in 2006 to proportion identified in 2011

*Number of microorganisms may exceed number of cases reported per year as multiple microorganisms identified per case. However, in some years, cases were reported aggregately with no clinical or laboratory information. Therefore, the number of microorganisms may be less than the number of cases.

Table 8 provides more detail relating to the microorganisms identified in CVC-BSI from adult ICU cases in 2006 and the trend in the annual proportion of microorganisms identified from 2009–2011. The proportions of microorganisms for 2006 and 2011 were compared. Coagulase negative staphylococcus (CONS) remains the predominant organism identified from CVC-BSI in adult ICUs however, the proportion of CONS identified significantly decreased in 2011 when the definition of CVC-BSI changed[18]. All other microorganisms remain relatively unchanged except VRE which has increased since 2006.

Table 8 Proportion of Microorganisms identified in CVC-BSI in Adult ICUs by year

Microorganism	2006 N (%)	2009 N (%)	2010 N (%)	2011 N (%)	*p*[19]
Gram positive bacteria:					
CONS[20]	132 (44.4)	128 (45.1)	89 (39.2)	52 (31.3)	0.007
Enterococcus	37 (12.5)	51 (18.0)	31 (13.3)	32 (19.3)	*n/s*
VRE[21]	0	9 (3.2)	6 (2.6)	6 (3.6)	0.004
MSSA[22]	21 (7.1)	5 (1.8)	9 (3.9)	4 (2.4)	*n/s*
MRSA[23]	4 (1.4)	5 (1.8)	3 (1.3)	4 (2.4)	*n/s*
Streptococcus	10 (3.4)	4 (1.4)	6 (2.6)	3 (1.8)	*n/s*
Bacillus	1 (0.3)	2 (0.7)	2 (0.9)	0	*n/s*
Clostridium spp	1 (0.3)	0	0	2 (1.2)	*n/s*
Other Gram positive [24]	3 (1.0)	2 (0.7)	3 (1.3)	2 (1.2)	*n/s*
Gram negative bacteria					
Klebsiella	14 (4.7)	10 (3.5)	10 (4.3)	11 (6.6)	*n/s*
Enterobacter	7 (2.4)	3 (1.1)	8 (3.4)	8 (4.8)	*n/s*
Pseudomonas	11 (3.7)	2 (0.7)	8 (3.4)	4 (2.4)	*n/s*
Serratia	8 (2.7)	6 (2.1)	6 (2.6)	5 (3.0)	*n/s*
Escherichia coli	4 (1.4)	6 (2.1)	6 (2.6)	3 (1.8)	*n/s*
Other Gram negative[25]	8 (2.7)	9 (3.2)	7 (3.0)	4 (2.4)	*n/s*
Fungi					
Candida albicans	23 (7.7)	22 (7.8)	10 (4.3)	15 (9.0)	*n/s*
Candida spp[26]	13 (4.4)	19 (6.7)	22 (9.4)	11 (6.6)	*n/s*
Other fungi[27]	0	1 (0.4)	1 (0.4)	0	*n/s*
Total *	**297**	**284**	**227**	**166**	

[18] In 2011, the BSI case definition changed – criterion 3 was removed - some of the decrease in 2011 may be attributed to this change in BSI case definition
[19] Significance test compares proportion of microorganisms in 2006 to proportion identified in 2011
[20] Coagulase negative staphylococcus
[21] Vancomycin resistant enterococcus
[22] Methicillin susceptible *staphylococcus aureus*
[23] Methicillin resistant *staphylococcus aureus*
[24] Diptheroids, corynebacterium, Lactobacillus, Propionbacterium
[25] Proteus Mirabilis, Citrobacter, Morganella Morganii, Acinetobacter Lwoffi, Stenotrophomonas maltophilia, coliform, Hafnia Alvei, Prevotella Melaninogenica
[26] Candida non-albicans or species not determined
[27] Saccharomyces cerevisiae

*Number of microorganisms may exceed number of cases reported per year as multiple microorganisms identified per case. However, in some years, cases were reported aggregately with no clinical or laboratory information. Therefore, the number of microorganisms may be less than the number of cases.

Figure 5 illustrates the proportion of adult ICU patients alive 30 days after onset of the CVC-BSI. Almost three quarters of adult ICU patients (71% in 2011) remain alive 30 days after onset of the CVC-BSI and there has been no significant change in this proportion since 2006

Figure 5 Outcome 30 days after CVC-BSI in Adult ICUs

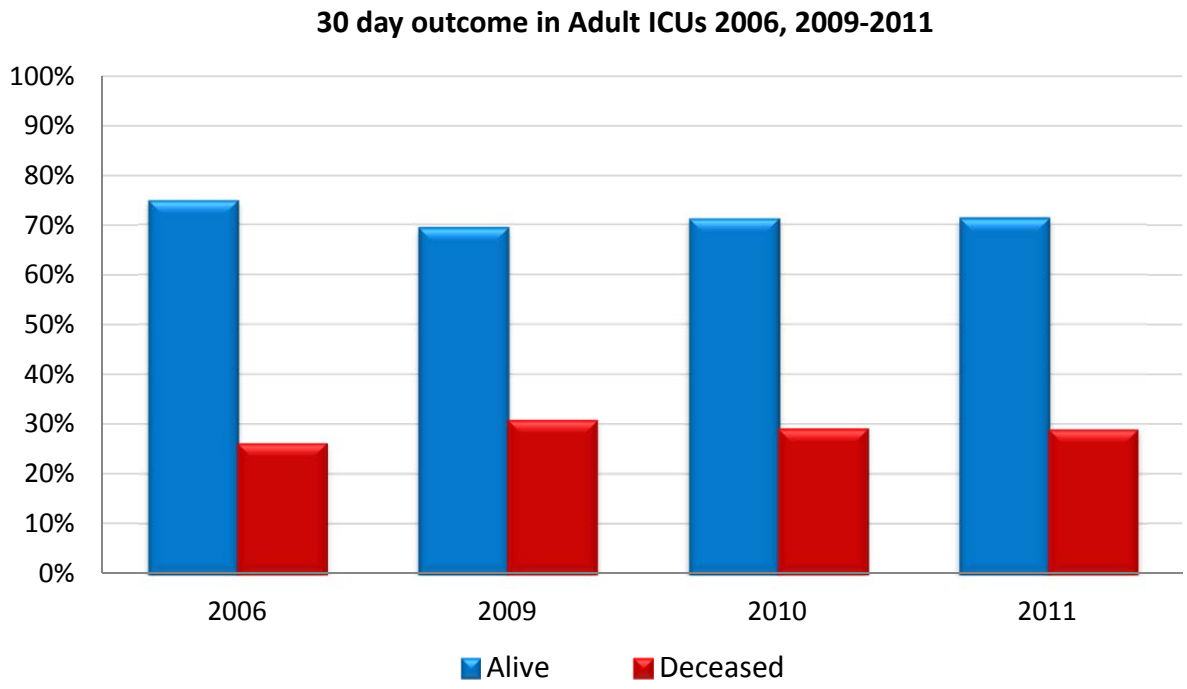


Table 9 provides the number and proportion of adult ICU patients alive or deceased 30 days after CVC-BSI by year. The proportions alive and deceased for 2006 and 2011 were compared.

Table 9 Outcome 30 days after CVC-BSI in Adult ICUs

Outcome	2006 N (%)	2009 N (%)	2010 N (%)	2011 N (%)	p^{28}
Alive	194 (74.0)	167 (69.3)	133 (71.1)	99 (71.2)	*n/s*
Deceased	68 (26.0)	74 (30.7)	54 (28.9)	40 (28.8)	*n/s*
Total	**262**	**241**	**187**	**139**	

[28] Significance test compares proportion of deaths in 2006 to proportion identified in 2011

Demographics of Adult ICU patients with CVC-BSI

Tables 10 and 11 provide the age and gender of adult ICU patients with a CVC-BSI by year. The average age and proportions of men and women have remained relatively unchanged since 2006.

Table 10 Age distribution of patients with CVC-BSI in Adult ICUs

Age (years)	2006	2009	2010	2011
Mean	62.7	58,2	60.8	60.3
Median	65.0	60.1	63.7	60.3
Min - Max	17 – 91	17 – 90	16 – 90	15 - 93
Total # cases*	263	223	169	125

*Total number of cases with age available are fewer than the total number of cases reported due to missing data

Table 11 Proportion of patients with CVC-BSI by Gender in Adult ICUs

	2006	2009	2010	2011
Gender	N (%)	N (%)	N (%)	N (%)
Male	175 (67)	173 (70)	114 (60)	98 (69)
Female	86 (33)	75 (30)	75 (40)	44 (31)
Total # cases*	261	248	189	142

*Total number of cases with gender available are fewer than the total number of cases reported due to missing data

Discussion

Adult ICUs

The surveillance data for CVC-BSI in all adult ICUs (medical, surgical, mixed, cardiovascular surgery, coronary and neurological) shows in 2011, 69% of cases were reported in men with an average age of 60 years. Age ranged from 15 – 93 years. Almost three-quarters of CVC-BSI cases (71% in 2011) remain alive 30 days after onset of CVC-BSI. There has been minimal change in the distribution of age, proportion of CVC-BSI's by gender and outcome (alive) since 2006.

Overall adult ICU CVC-BSI rates per 1,000 CVC-days and medical, surgical and mixed adult ICUs have declined since 2006 from 1.78 to 0.94 in 2011 and from 2.20 to 0.95 respectively. It is important to note that in 2011, the CNISP BSI case definition changed, criterion 3 was removed and therefore subsequently excluded bacteremias for which there was only one culture positive for a microorganism typically considered a contaminant. Some of the rate decrease in 2011 may be attributed to this change in BSI case definition. However, the downward trend in rates is seen in 2010 prior to the change in case definition. The CNISP case definition was changed to maintain consistency with that of the CDC NHSN in order to continue to be able to compare CNISP CVC-BSI rates to CDC NHSN CVC-BSI rates. Although our case definition did not change till 2011 and the NHSN definition came into effect in January 2008, the CNISP overall adult CVC-BSI rates per 1,000 CVC-days have been consistently comparable to the NHSN rates for similar types of adult ICUs (Summary Table 1).[1-4] Similarly NHSN medical, surgical or mixed adult ICU CVC-BSI rates have also declined from 2.31 (2006) to 1.27 (2011) per 1,000 CVC days[1,4] while CNISP rates declined from 2.10 in 2006 to 1.25 in 2010.

Data from the Victorian Hospital Acquired Infection Surveillance System (VICNISS) in Australia have also reported decreasing CVC-BSI rates in their adult ICUs from 5.6 per 1,000 CVC-days in 2006 to 1.9 in 2010 (Summary Table 1).[11,12] The VICNISS BSI case definition was changed in 2008 to reflect the NHSN change. The VICNISS system acknowledges that their rates could be lower due to the change in case definition.[13]

The National Health Service Scotland surveillance for CVC-BSI reported CVC-BSI rates for general adult ICUs in 2010 at 0.8 per 1,000 CVC days decreasing to 0.6 in 2011.[14,15] Scotland follows the 'Hospitals in Europe Link for Infection Control through Surveillance (HELICS)' protocol case definition for CVC-BSI.[16] The HELICS protocol removed criterion 3 from their case definition starting with their 2010 surveillance in order to continue to compare with NHSN rates.[16] However, due to the nature of Scotland's data collection system, they have continued to include criterion 3 in their 2010 & 2011 case definitions despite the change in the HELICS protocol. [14,15]

Summary Table 1 Adult ICU CVC-BSI rates per 1,000 CVC-days

Surveillance network	2006	2009	2010	2011
CNISP (Canada)	1.78	1.54	1.13	0.94*
NHSN (U.S.)	2.06	1.68*	1.32	1.11
VICNISS (Australia)	5.6	2.6*	1.9	Not available
NHSS (Scotland)			0.8	0.6

*Year CVC-BSI case definition changed, criterion 3 removed

In addition to the change in criterion as a potential explanation for decreasing CVC-BSI rates, clinical practice bundles specifically designed to reduce CVC-BSI infections have been developed. In 2009, the Canadian Patient Safety Institute developed two evidence-based 'bundles': the Central Line Insertion Bundle and the Central Line Care Bundle which are part of the Safer Healthcare Now! campaign. The goal of this campaign is to prevent CVC-BSI by encouraging hospitals to implement these bundles as part of their care for patients with central venous catheters.[9] Similar campaigns have been initiated in the US (5 million Lives Campaign, The On the Cusp: Stop BSI project) and other countries including Spain (Bacteremia Zero Project), Brazil (Hospital Israelita Program to Prevent CLABSIs) and Switzerland (University of Geneva Hospital Intervention) resulting in marked decreases in CVC-BSI rates.[17]

Cardiovascular surgery adult ICU CVC-BSI per 1,000 CVC-days rates have increased from 0.39 in 2006 to 1.06 in 2011 however, they remain comparable to US NHSN data where the 2011 rate was reported at 0.82 per 1,000 CVC-days.[4]

Catheter utilization rates (CURs) which indicate CVC use vary by type of ICU and region and are dependent on many factors such as hospital size, type of service, patient acuity, funding and financial budgets. Overall CURs have remained relatively unchanged over time with a sustained increase seen in cardiovascular surgery ICUs since 2006. Adult ICU CURs are higher in Canada (0.75 in 2011) compared to those reported by the US NHSN (0.51 in 2011).[4] However, the structure (funding) of healthcare systems are quite different which may affect the use of CVCs. CURs in Canadian adult ICUs appear more similar to those reported in European countries. The CUR in Canadian adult ICUs was 0.66 in 2006 and 0.80 in 2009 similar to CURs reported by the European Centre for Disease Prevention and Control (ECDC) ranging from 0.56 in Luxembourg to 0.87 in Austria in 2007.[18]

Regional differences in adult ICU CVC-BSI rates were observed across Canada however all regions have experienced a decline in rates since 2006. Central Canada remains the region reporting the highest rate but the differences between regions are minimal. For the most part public reporting of provincial CVC-BSI rates in Canada is not common practice. The NHSN does not report CVC-BSI rates by region nor to our knowledge do other surveillance networks.

There have been no significant changes in the proportions of Gram negative and Gram positive microorganisms or fungi identified in CVC-BSI since 2006. Although the proportion of coagulase negative staphylococcus (CONS) has significantly decreased from 44% in 2006 to 31% in 2011 it

remains the most prevalent organism identified in adult ICUs. As mentioned previously the decrease in 2011 may in part be attributed to the change in case definition (removal of criterion 3). This downward trend has also been reported by the VICNISS system where the proportion of CONS identified in CVC-BSI in 2006 was 34% decreasing to 13% by 2010.[11,12] They attributed much of this decrease to their change in BSI case definition in 2008.[11] CONS has been reported as the most prevalent microorganism identified in CVC-BSI in adult ICUs representing 39% of the total microorganisms identified from 8 countries participating in the 2007 ECDC surveillance.[18]

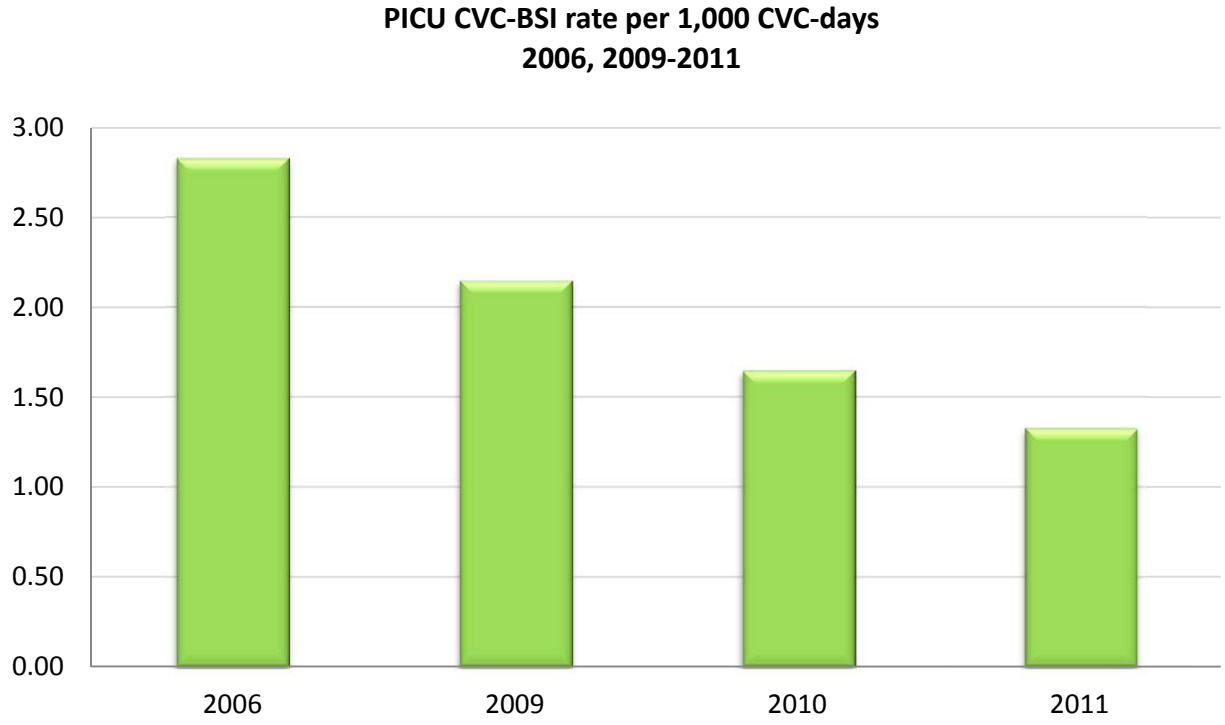
In conclusion, CVC-BSI rates and the proportion of CONS microorganisms identified in CVC-BSIs in adult ICUs are decreasing. From the limited international data available, these decreasing trends both regionally and over time are similar to trends reported in the United States, Australia and other European countries. Surveillance of CVC-BSI enables the Agency to continue to monitor the burden of CVC-BSI in Canadian adult ICUs located in acute-care hospitals and provide ongoing national benchmark rates that hospitals and provinces can use for comparison.

SECTION 2 CVC-BSI in Pediatric Intensive Care Units (PICUs) in Canada: National Surveillance from January 1, 2006 to December 31, 2006 and from January 1 2009 to December 31 2011

Annual CVC-BSI trends in Pediatric ICUs

Figure 6 illustrates the 2006 baseline CVC-BSI rate in PICUs and the trend in annual CVC-BSI rates from 2009 – 2011. National rates have been steadily declining. The 2011 CVC-BSI rate has significantly decreased from 2006.[29]

Figure 6



[29] In 2011, the BSI case definition changed – criterion 3 was removed - some of the decrease in 2011 may be attributed to this change in BSI case definition

Table 12 provides the number of cases and rates per CVC-days with 95% CIs by year and the number of ICUs that provided both cases and denominator data. The rates for 2006 and 2011 were compared.

Table 12 CVC-BSI in PICUs

PICU	2006	2009	2010	2011	*p*[30]
National all reported CVC-BSI	57	40	35	35	
All eligible* CVC-BSI (CVC-days)	57 (20,120)	34 (15,807)	17 (10,316)	30 (22,575)	
Rate per 1,000 CVC-days (95% CI)	2.83 (2.10, 3.57)	2.15 (1.43, 2.87)	1.65 (0.86, 2.43)	1.33 (0.85, 1.80)	0.03
Number of ICUs	11	5	7	9	

*Rates are calculated using only eligible data = hospitals that supplied cases and denominator data, rates are per 1,000 CVC-days

† Number of participating ICUs varies due to eligible data submitted

Table 13 reports the national catheter utilization rates by year PICUs. National catheter utilization rates have varied by year but have shown an increase since 2006.

Table 13 National Catheter Utilization Rate (CUR)[31] for PICUs

PICUs	2006	2009	2010	2011
Overall CUR	0.39	0.71	0.45	0.74

[30] Significance test compares 2006 CVC-BSI rate to 2011 CVC-BSI rate

[31] Catheter utilization rate = $\frac{\text{Number of ICU CVC-days}}{\text{Number of ICU patient-days}}$

Laboratory results

Figure 7 illustrates the proportion of microorganisms identified in CVC-BSI from PICU cases categorized as Gram positive bacteria, Gram negative and fungal in 2006 and the trend in the annual proportion of microorganisms from 2009 – 2011. The proportion of microorganisms identified as Gram positive has not significantly changed since 2006.

Figure 7 Proportion of Microorganisms found in CVC-BSIs in PICUs

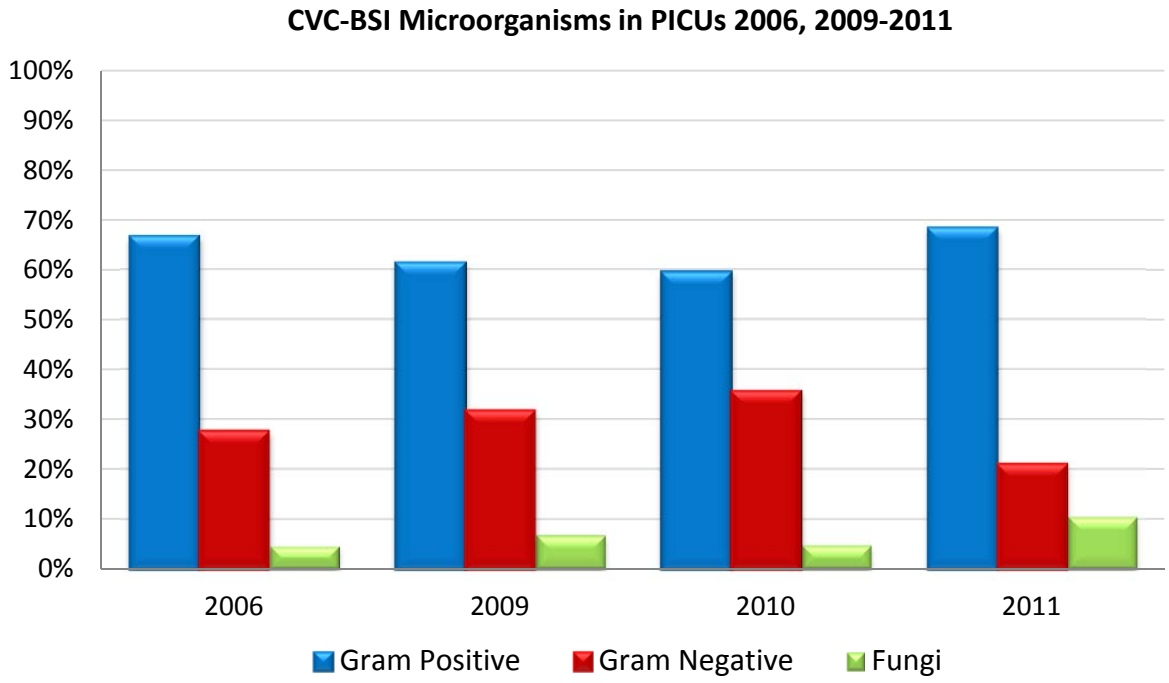


Table 14 provides the number of microorganisms and their proportions by year. The proportions of microorganisms for 2006 and 2011 were compared.

Table 14 Microorganisms identified in CVC-BSI in PICUs

PICU Total Micro	2006 N (%)	2009 N (%)	2010 N (%)	2011 N (%)	p[32]
Gram positive	44 (67.7)	27 (61.4)	25 (59.5)	26 (68.4)	*n/s*
Gram negative	18 (27.7)	14 (31.8)	15 (35.7)	8 (21.1)	*n/s*
Fungi	3 (4.6)	3 (6.8)	2 (4.8)	4 (10.5)	*n/s*
Total	65	44	42	38	

[32] Significance test compares proportion of microorganisms in 2006 to proportion identified in 2011

Table 15 provides more detail relating to the microorganisms identified in CVC-BSI from PICU cases in 2006 and the trend in the annual proportion of microorganisms identified from 2009 – 2011. The proportions of microorganisms for 2006 and 2011 were compared. Coagulase negative staphylococcus (CONS) remains the predominant organism identified from CVC-BSI in PICUs since 2006. The proportions of microorganisms have remained relatively unchanged except the proportion of Enterococcus which has significantly increased since 2006. There were no VRE reported, and only one isolate of MRSA.

Table 15 Proportion of Microorganisms identified in CVC-BSI in PICUs by year

Microorganisms	2006	2009	2010	2011	*p*[33]
Gram positive bacteria:					
CONS[34]	29 (44.6)	15 (34.1)	12 (28.6)	16 (42.1)	*n/s*
Enterococcus	2 (3.1)	7 (15.9)	9 (21.4)	8 (21.1)	0.008
VRE[35]	0	0	0	0	*n/s*
MSSA[36]	7 (10.8)	1 (2.3)	2 (4.8)	1 (2.6)	*n/s*
MRSA[37]	0	0	1 (2.40	0	*n/s*
Streptococcus	3 (4.6)	4 (9.1)	0	0	*n/s*
Bacillus	2 (3.1)	0	1 (2.4)	1 (2.6)	*n/s*
Clostridium spp	1 (1.5)	0	0	0	*n/s*
Gram negative bacteria:					
Klebsiella	6 (9.2)	2 (4.6)	5 (11.9)	4 (10.5)	*n/s*
Enterobacter	2 (3.1)	3 (6.8)	5 (11.9)	1 (2.6)	*n/s*
Pseudomonas	2 (3.1)	3 (6.8)	2 (4.8)	1 (2.6)	*n/s*
Serratia	3 (4.6)	3 (6.8)	1 (2.4)	1 (2.6)	*n/s*
Escherichia coli	5 (7.7)	0	0	0	*n/s*
Other Gram negative[38]	0	3 (6.8)	2 (4.8)	1 (2.6)	*n/s*
Fungi					
Candida albicans	1 (1.5)	1 (2.3)	1 (2.4)	2 (5.30	*n/s*
Candida spp [39]	2 (3.1)	2 (4.6)	1 (2.4)	2 (5.3)	*n/s*
Other fungi[40]	0	0	0	0	*n/s*
Total*	**65**	**44**	**42**	**38**	

*Number of microorganisms exceeds number of cases reported per year as multiple microorganisms identified per case

[33] Significance test compares proportion of microorganisms in 2006 to proportion identified in 2011
[34] Coagulase negative staphylococcus
[35] Vancomycin resistant enterococcus
[36] Methicillin susceptible *staphylococcus aureus*
[37] Methicillin resistant *staphylococcus aureus*
[38] Stenotrophomonas Maltophilia, Pantoea Agglomerans, Citrobacter Freundii
[39] Candida non-albicans or species not determined

Figure 8 illustrates the proportion of PICU patients alive at 30 days after onset of CVC-BSI. The majority of patients (88% in 2011) in PICUs are alive at 30 after CVC-BSI and there has been no significant change in this proportion since 2006

Figure 8 Outcome 30 days after CVC-BSI in PICUs

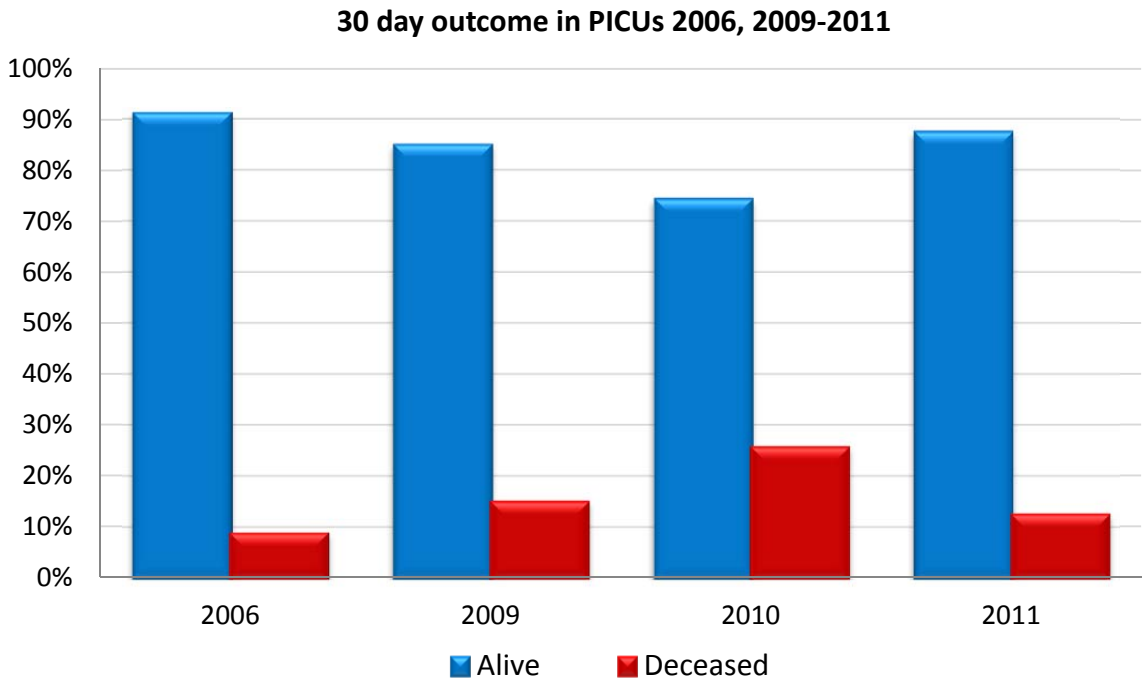


Table 16 provides the number and proportion of PICU patients alive or deceased at 30 days after onset of CVC-BSI by year. The proportions alive and deceased for 2006 and 2011 were compared.

Table 16 Outcome 30 days after CVC-BSI in PICUs

PICU Outcome	2006	2009	2010	2011	*p*[41]
Alive	52 (91.2)	34 (85.0)	26 (74.3)	28 (87.5)	*n/s*
Deceased	5 (8.8)	6 (15.0)	9 (25.7)	4 (12.5)	*n/s*
Total	57	40	35	32	

[41] Significance test compares proportion of deaths in 2006 to proportion identified in 2011

Demographics of PICU patients with CVC-BSI

Tables 17 and 18 provide the age and gender of PICU patients with a CVC-BSI by year. The average age and proportion of male and female cases have remained relatively unchanged since 2006.

Table 17 Age distribution of patients with CVC-BSI in PICUs

Age	2006	2009	2010	2011
Mean	2.6 yrs	2.1 yrs	2.7 yrs	3.1 yrs
Median	8 mths	8 mths	10 mths	5 mths
Min - Max	1 mth – 18 yrs	1 mth – 17 yrs	3 mths – 17 yrs	4 mths – 17 yrs
Total # cases*	57	39	33	33

*Total number of cases with age available are fewer than the total number of cases reported due to missing data

Table 18 Proportion of patients with CVC-BSI by Gender in PICUs

	2006	2009	2010	2011
Gender	N (%)	N (%)	N (%)	N (%)
Male	29 (51)	18 (47)	18 (55)	20 (57)
Female	28 (49)	20 (53)	15 (45)	15 (43)
Total # cases*	57	38	33	35

*Total number of cases with gender available are fewer than the total number of cases reported due to missing data

Discussion

The 2011 surveillance data reported for CVC-BSI in pediatric ICUs (PICUs) shows 57% of cases are male with an average age of 3 years. Age ranged from 4 months – 17 years. Over three-quarters of CVC-BSI cases (88% in 2011) are alive at 30 days after onset of CVC-BSI. There has been minimal change in the distribution of age, proportion of CVC-BSI's by gender and outcome (alive) since 2006.

Overall PICU CVC-BSI rates per 1,000 CVC-days have declined from 2.83 in 2006 to 1.33 in 2011. It is important to note that in 2011, the CNISP BSI case definition changed, criterion 3 was removed and therefore subsequently excluded bacteremias for which there was only one culture positive for a microorganism typically considered a contaminant. Although some of the rate decrease in 2011 may be attributed to this change in BSI case definition, PICU rates were declining prior to 2011. The CNISP case definition was changed to maintain consistency with that of the CDC NHSN in order to continue to be able to compare CNISP CVC-BSI rates to CDC NHSN CVC-BSI rates. Although our case definition did not change till 2011 and the NHSN definition came into effect in January 2008, the CNISP PICU CVC-BSI rates per 1,000 CVC-days have been consistently comparable to the NHSN rates (Summary Table 2).[1-4] NHSN rates have also shown a decline from 2.80 in 2006 to 1.72 in 2011.[1,4]

Data from a 3 year multi-institutional interventional study in the United States (US) reported decreasing PICU CVC-BSI rates from 5.2 (2004-2006) to 2.3 (2007 – 2009) per 1,000 CVC-days.[19]

A five country (Colombia, India, Mexico, Philippines, Turkey) interventional study in 11 PICUs reported decreased PICU CVC-BSI rates from 10.7 (2003) to 5.2 (2010) per 1,000 CVC days.[20]

Summary Table 2 PICU CVC-BSI rates per 1,000 CVC-days

Surveillance network	2006	2009	2010	2011
CNISP (Canada)	2.83	2.15	1.65	1.33
NHSN (U.S.)	2.80	2.28	1.84	1.72

In addition to the change in criterion as a potential explanation for decreasing CVC-BSI rates, clinical practice bundles specifically designed to reduce CVC-BSI infections have been developed. In 2009, the Canadian Patient Safety Institute developed two evidence-based 'bundles': the Central Line Insertion Bundle and the Central Line Care Bundle which are part of the Safer Healthcare Now! campaign. The goal of this campaign is to prevent CVC-BSI by encouraging hospitals to implement these bundles as part of their care for patients with central venous catheters.[9] Similar campaigns have been initiated in the US (5 million Lives Campaign, The On the Cusp: Stop BSI project) and other countries including Spain (Bacteremia Zero Project), Brazil (Hospital Israelita Program to Prevent CLABSIs) and Switzerland (University of Geneva Hospital Intervention) resulting in marked decreases in CVC-BSI rates.[17]

Catheter utilization rates (CURs) which indicate CVC use are dependent on many factors such as hospital size, type of service, patient acuity, funding and financial budgets. Overall, CURs in Canadian PICUs have varied over time and an upward trend is seen since 2006. Canadian PICU CURs are generally higher (0.74 in 2011) than those reported by the NHSN (0.49 in 2011).[4] However, the structure (funding) of healthcare systems are quite different which may affect the use of CVCs. Both the US and Canada have shown increases in PICU CURs since 2006.[1-4] No European or Australian CUR data were available for comparison.

There have been no significant changes in the proportions of Gram negative, Gram positive or fungal microorganisms identified in CVC-BSI since 2006. As previously mentioned, the BSI case definition changed in 2011 (removal of criterion 3) however, there has been no significant change in the proportion of CONS identified in PICUs (45% in 2006 and 42% in 2011). In contrast, a 2007 US study reported a difference in the proportion of CONS identified in PICUs using the BSI case definition with criterion 3 (29%) and without criterion 3 (17%).[21] CONS remains the most prevalent organism identified in Canadian PICUs and similarly reported in other European and American studies.[21,22] Other microorganisms identified have remained relatively unchanged except enterococcus which has significantly increased from 3% in 2006 to 21% in 2011. The 2007 US study by Niedner et al reported the proportion of enterococcus identified among PICU isolates at 20%.[21]

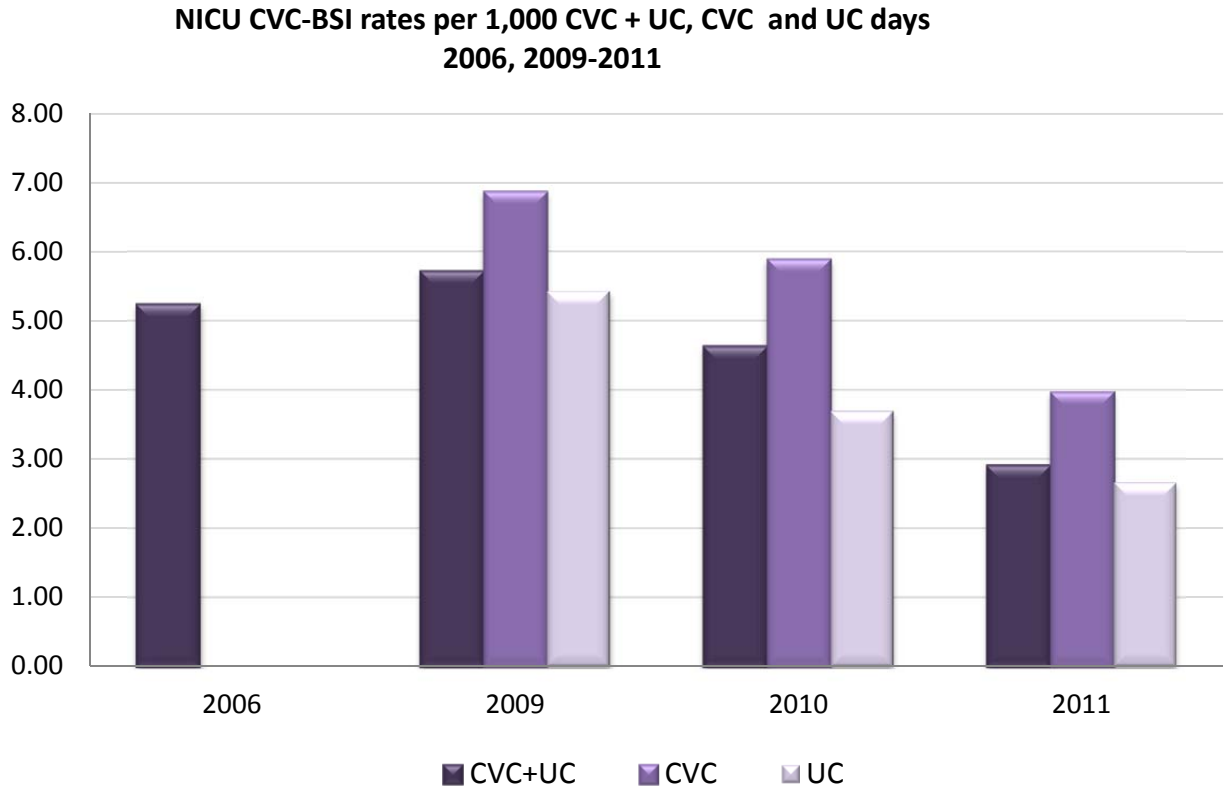
In conclusion, CVC-BSI rates in Canadian PICUs are decreasing. These decreasing trends in PICU CVC-BSI rates over time are similar to trends reported in the United States. The distribution of microorganisms identified from CVC-BSI in PICU patients has remained relatively unchanged over time except for the proportion of enterococcus. There is limited international data available for comparison on microorganisms isolated from CVC-BSI in PICU patients. Surveillance of CVC-BSI enables the Agency to continue to monitor the burden of CVC-BSI in Canadian pediatric ICUs located in acute care hospitals and provide ongoing national benchmark rates that hospitals and provinces can use for comparison.

SECTION 3 CVC-BSI in Neonatal Intensive Care Units (NICUs) in Canada: National Surveillance from January 1, 2006 to December 31, 2006 and from January 1 2009 to December 31 2011

Annual CVC-BSI trends in NICUs

Figure 9 illustrates the 2006 baseline CVC-BSI rate in NICUs by type of catheter[42] and the trend in annual CVC-BSI rates from 2009 – 2011. National NICU CVC-BSI rates have been steadily declining. The 2011 CVC-BSI rate for all types of catheters has significantly decreased from 2006.[43]

Figure 9



[42] CVC + UC = Central venous catheter and umbilical catheters combined
CVC = Central venous catheters only (Separation of cases and denominator data initiated in 2009)
UC = Umbilical catheters only (Separation of cases and denominator data initiated in 2009)

[43] In 2011, the BSI case definition changed – criterion 3 was removed - some of the decrease in 2011 may be attributed at least in part to this change in BSI case definition. This change in case definition affected NICU rates disproportionately as frequently only one blood culture is obtained in an NICU patient and CONS, a common skin contaminant, is very frequently isolated in neonatal blood cultures.

Table 19 provides the number of cases and rates per CVC + UC, CVC and UC days with 95% CIs by year and the number of ICUs that provided both cases and denominator data. The rates for 2006 and 2011 were compared for CVC+UC cases and for 2009 and 2011 for both CVC cases and UC cases.

Table 19 CVC-BSI in NICUs by type of catheter and year

NICU	2006	2009	2010	2011	*p*[44]
All reported CVC-BSI (CVC + UC)	234	208	228	115	
All eligible* CVC-BSI (CVC+UC days)	234 (44,630)	133 (23,245)	174 (37,596)	109 (37,411)	
Rate per 1,000 CVC+UC days (95% CI)	5.24 (4.57, 5.91)	5.72 (4.75, 6.69)	4.63 (3.94, 5.32)	2.91 (2.37, 5.91)	<0.001
All reported CVC-BSI (CVC)	---	138	182	93	
All eligible* CVC-BSI (CVC days)	---	75 (10,920)	110 (18,661)	92 (23,148)	
Rate per 1,000 CVC-days (95% CI)	---	6.87 (5.31, 8.42)	5.89 (4.79, 7.00)	3.97 (3.16, 4.79)	<0.001
All reported CVC-BSI (UC)	---	31	36	17	
All eligible* CVC-BSI (UC days)	---	24 (4,422)	21 (5,669)	16 (5,990)	
Rate per 1,000 UC-days (95% CI)	---	5.43 (3.26, 7.60)	3.70	2.67 (1.36, 3.98)	0.02
Number of NICUs (CVC+UC)	16	7	13	13	

*Rates are calculated using only eligible data = hospitals that supplied cases, denominator and type of catheter data
--- CVC & UC days were not separated in 2006

Table 20 reports the catheter utilization rates by year for NICUs. National catheter utilization rates have remained relatively unchanged since 2006.

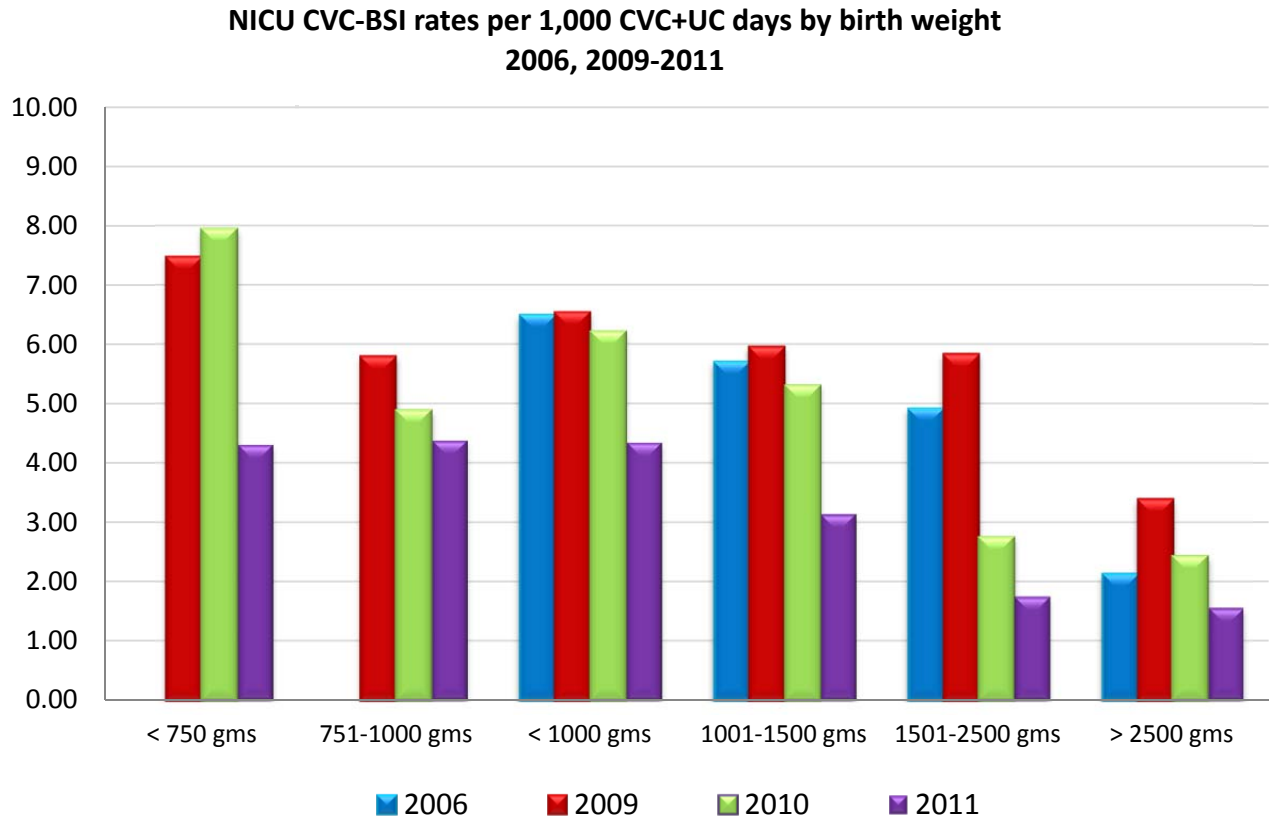
Table 20 National Catheter Utilization Rates (CURs)[45] for NICUs

NICUs	2006	2009	2010	2011
Overall CUR (CVC + UC)	0.31	0.33	0.28	0.32

[44] Significance test compares 2006 CVC-BSI rate to 2011 CVC-BSI rate
[45] Catheter utilization rate = Number of ICU CVC-days / Number of ICU patient-days

Figure 10 illustrates the 2006 baseline CVC-BSI rate for CVC+UC cases in NICUs by birth weight (≤1000 grams) and the trend in annual CVC-BSI rates by birth weight from 2009 – 2011. National NICU CVC-BSI rates by birth weight have been steadily declining. The 2011 CVC-BSI rate for most birth weights has significantly decreased from 2006.[46]

Figure 10



[46] In 2011, the BSI case definition changed – criterion 3 was removed - some of the decrease in 2011 may be attributed at least in part to this change in BSI case definition. This change in case definition affected NICU rates disproportionately as frequently only one blood culture is obtained in an NICU patient and CONS, a common skin contaminant, is very frequently isolated in neonatal blood cultures.

Table 21 provides the number of cases and rates per CVC + UC days with 95% CIs by year and birth weight. The rates for 2006 and 2011 were compared for cases with birth weight ≤1000 grams and for 2009 and 2011 for cases with birth weight ≤750 and 751-1000 grams

Table 21 CVC-BSI in NICUs by birth weight and year (for cases in both CVC & UC lines)

NICU CVC + UC cases & line days	≤750 grams	751-1000 grams	≤1000 grams	1001-1500 grams	1501-2500 grams	>2500 grams
2006 reported CVC-BSI	---	---	97	63	36	21
2006 eligible* CVC-BSI	---	---	97 (14,934)	55 (9,635)	35 (7,116)	20 (9,392)
2006 rate per 1,000 CVC+UC days (95% CI)	---	---	6.50 (5.20, 7.79)	5.71 (4.20, 7.22)	4.92 (3.29, 6.55)	2.13 (1.20, 3.06)
2009 reported CVC-BSI	53	57	110	44	27	20
2009 eligible* CVC-BSI	34 (4,546)	33 (5,686)	67 (10,232)	28 (4,696)	21 (3,595)	16 (4,723)
2009 rate per 1,000 CVC+UC days (95% CI)	7.48 (4.97, 9.99)	5.80 (3.82, 7.78)	6.55 (4.98, 8.12)	5.96 (3.75, 8.17)	5.84 (3.34, 8.34)	3.39 (1.73, 5.05)
2010 reported CVC-BSI	65	56	121	56	26	23
2010 eligible* CVC-BSI	55 (6,915)	44 (9,001)	99 (15,916)	41 (7,727)	15 (5,451)	18 (7,398)
2010 rate per 1,000 CVC+UC days (95% CI)	7.95 (5.85, 10.06)	4.89 (3.44, 6.33)	6.22 (4.99, 7.45)	5.31 (3.68, 6.93)	2.75 (1.36, 4.14)	2.43 (1.31, 3.56)
2011 reported CVC-BSI	29	32	61	26	11	16
2011 eligible* CVC-BSI	26 (6,026)	30 (6,852)	56 (12,878)	25 (7,950)	11 (6,296)	16 (10,283)
2011 rate per 1,000 CVC+UC days (95% CI)	4.31 (2.66, 5.97)	4.38 (2.81, 5.95)	4.35 (3.21, 5.49)	3.14 (1.91, 4.38)	1.75 (0.71, 2.78)	1.56 (0.79, 2.32)
p[47]	0.02	*n/s*	0.03	0.008	0.001	*n/s*

*Rates are calculated using only eligible data = hospitals that supplied cases, denominator, birth weight and type of catheter data
--- In 2006 those of birth weight < 1000 g were not stratified further. This group was divided into birth weight of < 750 g and 751-1000 g from 2009 onwards because of NHSN stratification changes; CVC & UC days were not separated in 2006

Table 22 reports the catheter utilization rates by year and birth weight for NICUs. National catheter utilization rates have decreased since 2006.

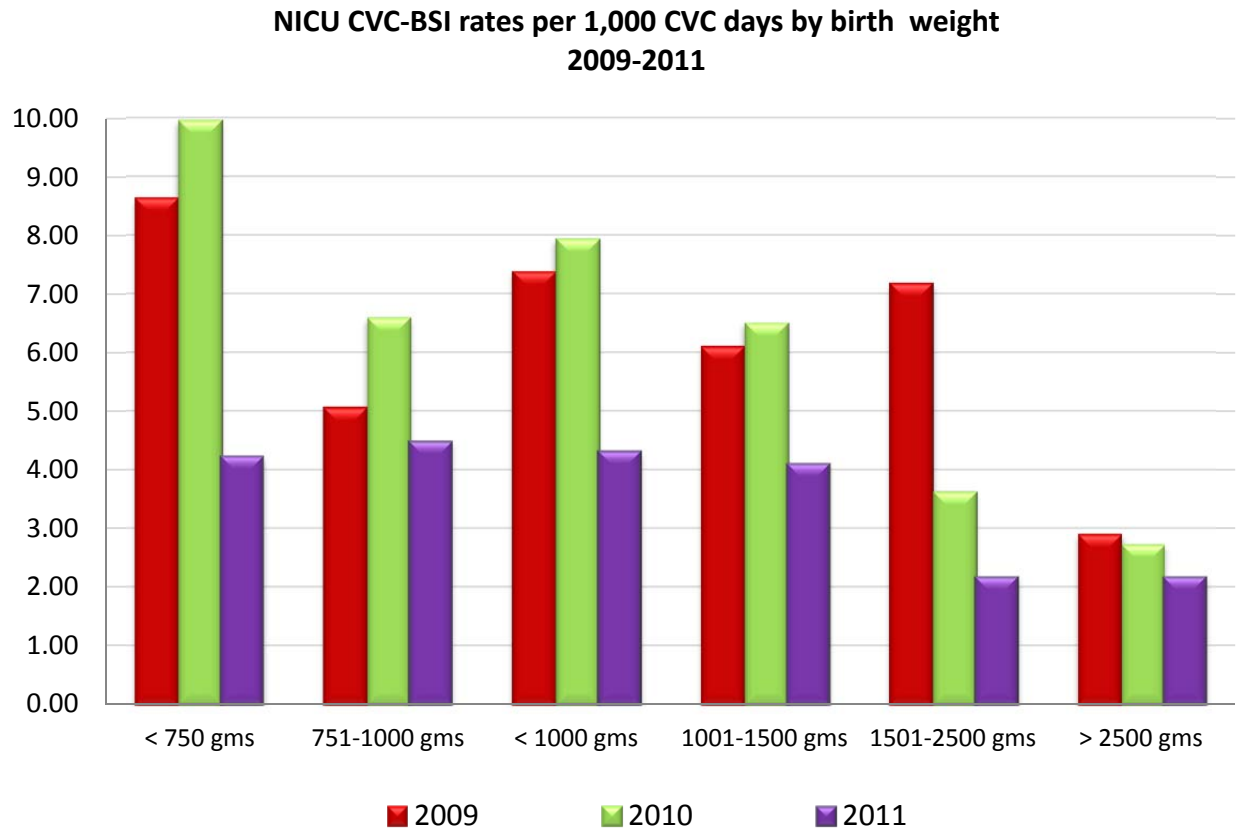
Table 22 National Catheter Utilization Rates (CURs)[48] for NICUs

NICU CVC+UC CUR	≤750 grams	751-1000 grams	≤1000 grams	1001-1500 grams	1501-2500 grams	>2500 grams
2006 CUR	---	---	0.41	0.34	0.26	0.32
2009 CUR	0.48	0.38	0.42	0.30	0.19	0.23
2010 CUR	0.44	0.33	0.37	0.27	0.18	0.32
2011 CUR	0.44	0.35	0.39	0.37	0.24	0.30

[47] Significance test compares 2006/2009 CVC-BSI rate to 2011 CVC-BSI rate
[48] Catheter utilization rate = $\frac{\text{Number of ICU CVC-days}}{\text{Number of ICU patient-days}}$

Figure 11 illustrates the 2009 baseline CVC-BSI rate for CVC cases in NICUs by birth weight and the trend in annual CVC-BSI rates by birth weight from 2010 – 2011. National NICU CVC-BSI rates by birth weight have been steadily declining. The 2011 CVC-BSI rate for most birth weights has significantly decreased from 2009.[49]

Figure 11



[49] In 2011, the BSI case definition changed – criterion 3 was removed - some of the decrease in 2011 may be attributed at least in part to this change in BSI case definition. This change in case definition affected NICU rates disproportionately as frequently only one blood culture is obtained in an NICU patient and CONS, a common skin contaminant, is very frequently isolated in neonatal blood cultures.

Table 23 provides the number of cases and rates per CVC days with 95% CIs by year and birth weight and the number of ICUs that provided both cases and denominator data. The rates for 2009 and 2011 were compared.

Table 23 CVC-BSI in NICUs by CVC catheter, birth weight and year

NICU CVC cases & line days	≤750 grams	751-1000 grams	≤1000 grams	1001-1500 grams	1501-2500 grams	>2500 grams
2006 reported CVC-BSI	---	---	---	---	---	---
2006 eligible* CVC-BSI	---	---	---	---	---	---
2006 rate per 1,000 CVC days	---	---	---	---	---	---
2009 reported CVC-BSI	40	38	78	29	18	13
2009 eligible* CVC-BSI	24 (2,780)	8 (1,583)	24 (3,255)	17 (2,790)	13 (1,813)	5 (1,730)
2009 rate per 1,000 CVC days	8.63	5.05	7.37	6.09	7.17	2.89
(95% CI)	(5.18, 12.09)	(1.55, 8.56)	(4.42, 10.32)	(3.20, 8.99)	(3.27, 11.07)	(0.36, 5.42)
2010 reported CVC-BSI	53	43	96	44	20	20
2010 eligible* CVC-BSI	31 (3,117)	31 (4,704)	62 (7,821)	25 (3,843)	12 (3,315)	10 (3,682)
2010 rate per 1,000 CVC days	9.95	6.59	7.93	6.50	3.62	2.72
(95% CI)	(6.44, 13.45)	(4.27, 8.91)	(5.95, 9.90)	(3.96, 9.06)	(1.57, 5.67)	(1.03, 4.40)
2011 reported CVC-BSI	23	25	48	23	9	13
2011 eligible* CVC-BSI	22 (5,198)	20 (4,465)	42 (9,744)	22 (5,371)	9 (4,156)	13 (5,988)
2011 rate per 1,000 CVC days	4.23	4.48	4.31	4.10	2.17	2.17
(95% CI)	(2.46, 6.00)	(2.52, 6.44)	(3.01, 5.61)	(2.38, 5.81)	(0.75, 3.58)	(0.99, 3.35)
p[50]	0.01	*n/s*	0.02	*n/s*	0.003	*n/s*

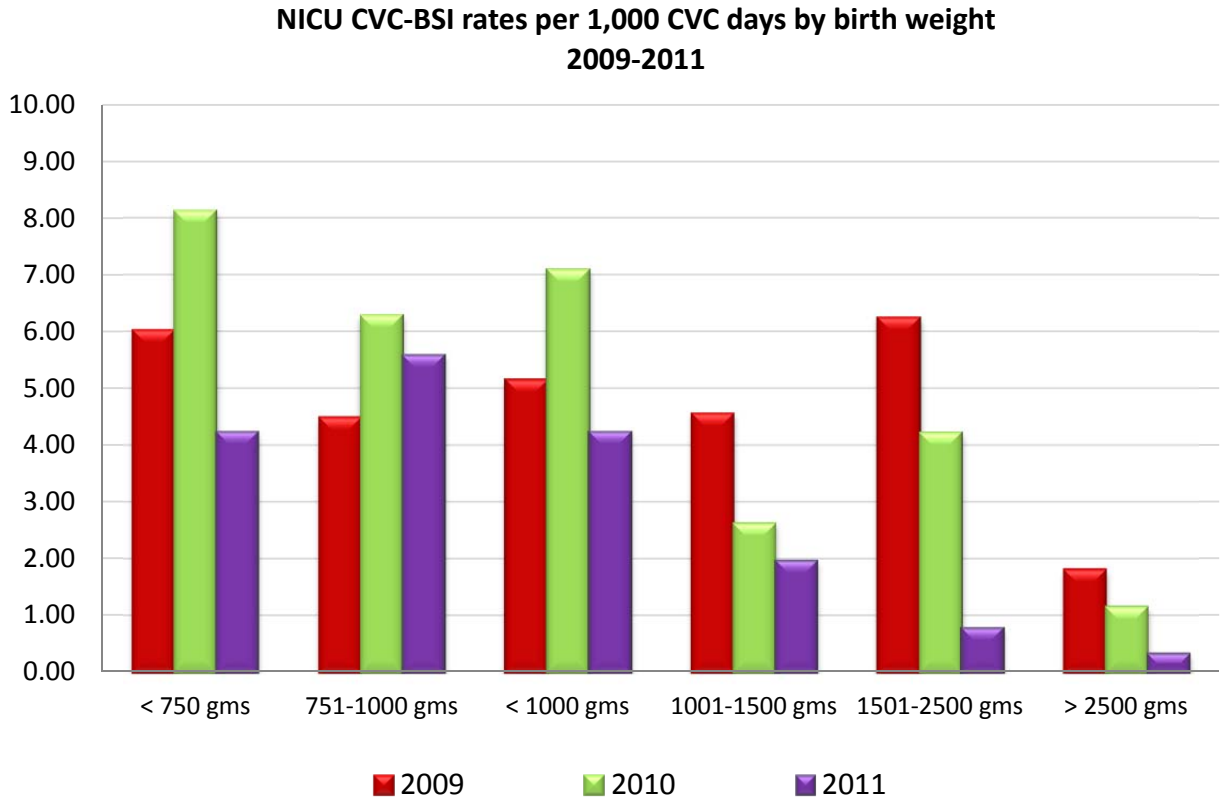
*Rates are calculated using only eligible data = hospitals that supplied cases, denominator, birth weight and type of catheter data
--- In 2006 those of birth weight < 1000 g were not stratified further. This group was divided into birth weight of < 750 g and 751-1000 g from 2009 onwards because of NHSN stratification changes; CVC & UC days were not separated in 2006

Note: CURs for type of catheter and birth weight cannot be calculated separately for CVCs as patient days stratified only by birth weight and NOT by type of catheter

[50] Significance test compares 2009 CVC-BSI rate to 2011 CVC-BSI rate

Figure 12 illustrates the 2009 baseline CVC-BSI rate for UC cases in NICUs by birth weight and the trend in annual CVC-BSI rates by birth weight from 2009 – 2011. National NICU CVC-BSI rates by birth weight have been steadily declining. The 2011 CVC-BSI rate for all birth weights has significantly decreased from 2006.[51]

Figure 12



[51] In 2011, the BSI case definition changed – criterion 3 was removed - some of the decrease in 2011 may be attributed at least in part to this change in BSI case definition. This change in case definition affected NICU rates disproportionately as frequently only one blood culture is obtained in an NICU patient and CONS, a common skin contaminant, is very frequently isolated in neonatal blood cultures

Table 24 provides the number of cases and rates per UC days with 95% CIs by year and birth weight. The rates for 2009 and 2011 were compared.

Table 24 CVC-BSI in NICUs by UC catheter and birth weight

NICU UC cases & line days	≤750 grams	751-1000 grams	≤1000 grams	1001-1500 grams	1501-2500 grams	>2500 grams
2006 reported CVC-BSI	---	---	**---**	---	---	---
2006 eligible* CVC-BSI	---	---	**---**	---	---	---
2006 rate per 1,000 UC days	---	---	**---**	---	---	---
2009 reported CVC-BSI	8	7	15	8	3	5
2009 eligible* CVC-BSI	4 (663)	3 (668)	6 (1,165)	5 (1,097)	3 (480)	2 (1,107)
2009 rate per 1,000 UC days	6.03	4.49	5.15	4.56	6.25	1.81
(95% CI)	(0.12, 11.95)	(0.59, 9.57)	(1.03, 9.27)	(0.56, 8.55)	(0.82, 3,32)	(0.70, 4.31)
2010 reported CVC-BSI	13	12	25	11	7	2
2010 eligible* CVC-BSI	6 (738)	6 (954)	12 (1,692)	3 (1,144)	4 (948)	2 (1,746)
2010 rate per 1,000 UC days	8.13	6.29	7.09	2.62	4.22	1.15
(95% CI)	(1.62, 14.64)	(1.26, 11.32)	(3.08, 11.10)	(0.00, 5.59)	(0.08, 8.35)	(0.00, 2.73)
2011 reported CVC-BSI	5	7	12	3	1	1
2011 eligible* CVC-BSI	4 (944)	7 (1.251)	11 (2,593)	3 (1,527)	1 (1,285)	1 (3,041)
2011 rate per 1,000 UC days	4.24	5.59	4.24	1.97	0.78	0.33
(95% CI)	(0.08, 8.39)	(1.45, 9.74)	(1.74, 6.75)	(0.26, 4.19)	(0.75, 2.30)	(0.32, 0.97)
p[52]	*n/s*	*n/s*	*n/s*	*n/s*	*n/s*	*n/s*

*Rates are calculated using only eligible data = hospitals that supplied cases, denominator, birth weight and type of catheter data
--- In 2006 those of birth weight < 1000 g were not stratified further. This group was divided into birth weight of < 750 g and 751-1000 g from 2009 onwards because of NHSN stratification changes; CVC & UC days were not separated in 2006

Note: CURs for type of catheter and birth weight cannot be calculated separately for UCs as patient days stratified by birth weight only and NOT by type of catheter

[52] Significance test compares 2009 CVC-BSI rate to 2011 CVC-BSI rate

Laboratory results

Figure 13 illustrates the microorganisms identified in CVC-BSI from NICU cases categorized as Gram positive bacteria, Gram negative and fungal in 2006 and the trend in the annual proportion of microorganisms identified from 2009 – 2011. The proportion of microorganisms identified as Gram positive has significantly decreased since 2006.

Figure 13 Proportion of Microorganisms found in CVC-BSIs in NICUs

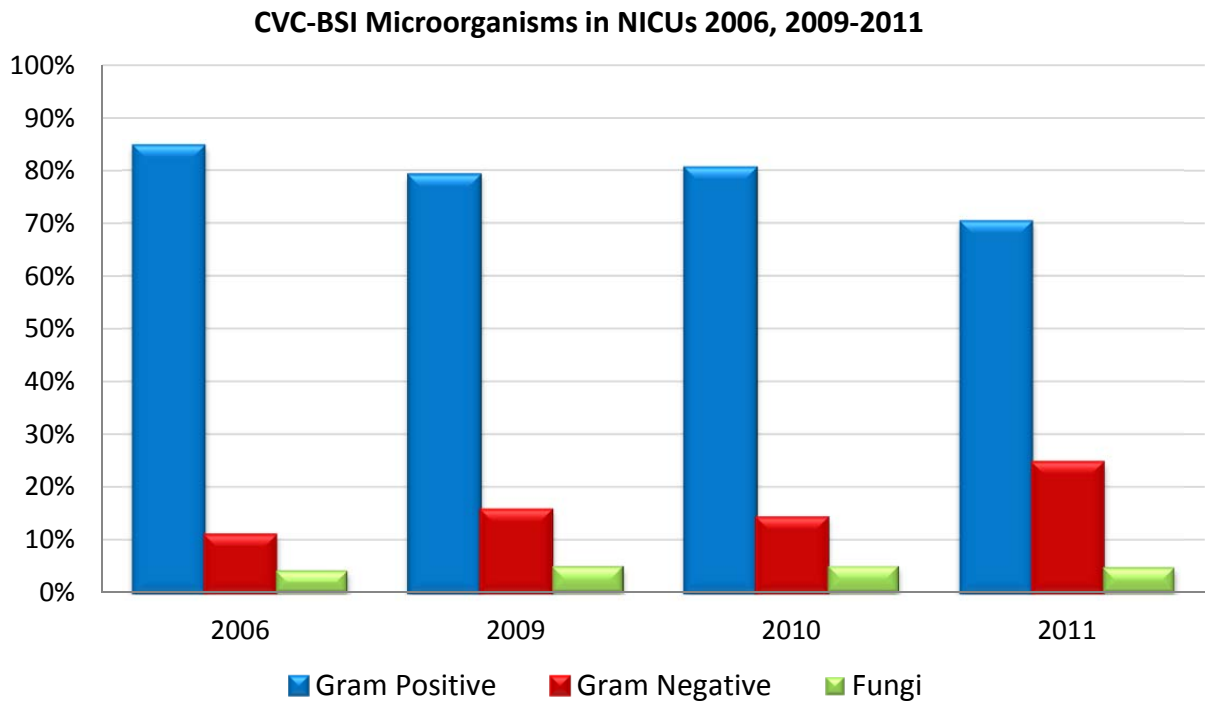


Table 25 provides the number of microorganisms and their proportions by year. The proportions of microorganisms for 2006 and 2011 were compared.

Table 25 Microorganisms identified in CVC-BSI in NICUs

Microorganism	2006 N (%)	2009 N (%)	2010 N (%)	2011 N (%)	*p*[53]
Gram positive	223 (84.8)	175 (79.2)	203 (80.6)	88 (70.4)	0.001
Gram negative	29 (11.0)	35 (15.8)	36 (14.3)	31 (24.8)	<0.001
Fungi	11 (4.2)	11 (5.0)	13 (5.1)	6 (4.8)	*n/s*
Total	263	221	252	125	

[53] Significance test compares proportion of microorganisms in 2006 to proportion identified in 2011

Table 26 provides more detail relating to the microorganisms identified in CVC-BSI from NICU cases in 2006 and the trend in the annual proportion of microorganisms identified from 2009 – 2011. The proportions of microorganisms for 2006 and 2011 were compared. Coagulase negative staphylococcus (CONS) remains the predominant organism identified from CVC-BSI in NICUs since 2006. The proportion of CONS has significantly decreased in 2011 however, some of the decrease in 2011 may be attributed at least in part to the change in BSI case definition (removal of criterion 3). This change in case definition affected NICU rates disproportionately as frequently only one blood culture is obtained in an NICU patient and CONS, a common skin contaminant, is very frequently isolated in neonatal blood cultures. The proportions of other microorganisms have remained relatively unchanged except the proportion of Escherichia coli which has significantly increased since 2006. There were no Clostridium, other fungi reported, and only one isolate of VRE was reported.

Table 26 Microorganisms identified in CVC-BSI in NICUs

Microorganism	2006	2009	2010	2011	p[54]
Gram positive bacteria					
CONS[55]	176 (66.9)	150 (67.9)	173 (68.7)	67 (53.6)	0.02
Enterococcus	12 (4.6)	6 (2.7)	10 (4.0)	8 (6.4)	*n/s*
VRE[56]	0	0	1 (0.4)	0	*n/s*
MSSA[57]	13 (4.9)	13 (5.9)	10 (4.0)	8 (6.4)	*n/s*
MRSA[58]	4 (1.5)	0	1 (0.4)	2 (1.6)	*n/s*
Streptococcus	7 (2.7)	2 (0.9)	3 (1.2)	1 (0.8)	*n/s*
Bacillus	6 (2.3)	5 (2.3)	6 (2.4)	0	*n/s*
Clostridium spp	0	0	0	0	*n/s*
Other Gram positive[59]	4 (1.5)	0	4 (1.6)	2 (1.6)	*n/s*
Gram negative bacteria					*n/s*
Klebsiella	12 (4.6)	14 (6.3)	9 (3.6)	9 (7.2)	*n/s*
Enterobacter	2 (0.8)	6 (2.7)	6 (2.4)	4 (3.2)	*n/s*
Pseudomonas	2 (0.8)	2 (0.9)	0	1 (0.8)	*n/s*
Serratia	6 (2.3)	3 (1.4)	4 (1.6)	0	*n/s*
Escherichia coli	5 (1.9)	8 (3.6)	10 (3.9)	13 (10.4)	<0.001
Other Gram negative[60]	3 (1.1)	1 (0.5)	2 (0.8)	4 (3.2)	*n/s*
Fungi					*n/s*
Candida albicans	7 (2.7)	5 (2.3)	5 (2.0)	4 (3.2)	*n/s*
Candida spp[61]	4 (1.5)	6 (2.7)	8 (3.2)	2 (1.6)	*n/s*
Other fungi	0	0	0	0	*n/s*
Total*	**263**	**221**	**256**	**123**	

*Number of microorganisms exceeds number of cases reported per year as multiple microorganisms identified per case

[54] Significance test compares proportion of microorganisms in 2006 to proportion identified in 2011
[55] Coagulase negative staphylococcus
[56] Vancomycin resistant enterococcus
[57] Methicillin susceptible *staphylococcus aureus*
[58] Methicillin resistant *staphylococcus aureus*
[59] Micrococcus, Kocuria Kristinae, Weissell Confusa, Heuconstoc
[60] Proteus Mirabilis, Leclercia Adecarboxylata, citrobacter, Stenotrophomonas Maltophilia
[61] Candida non-albicans or species not determined

Figure 14 illustrates the proportion of NICU patients alive 30 days after onset of CVC-BSI. In 2011, the majority of patients (93%) in NICUs are alive 30 days after CVC-BSI and there has been no significant change in this proportion since 2006

Figure 14

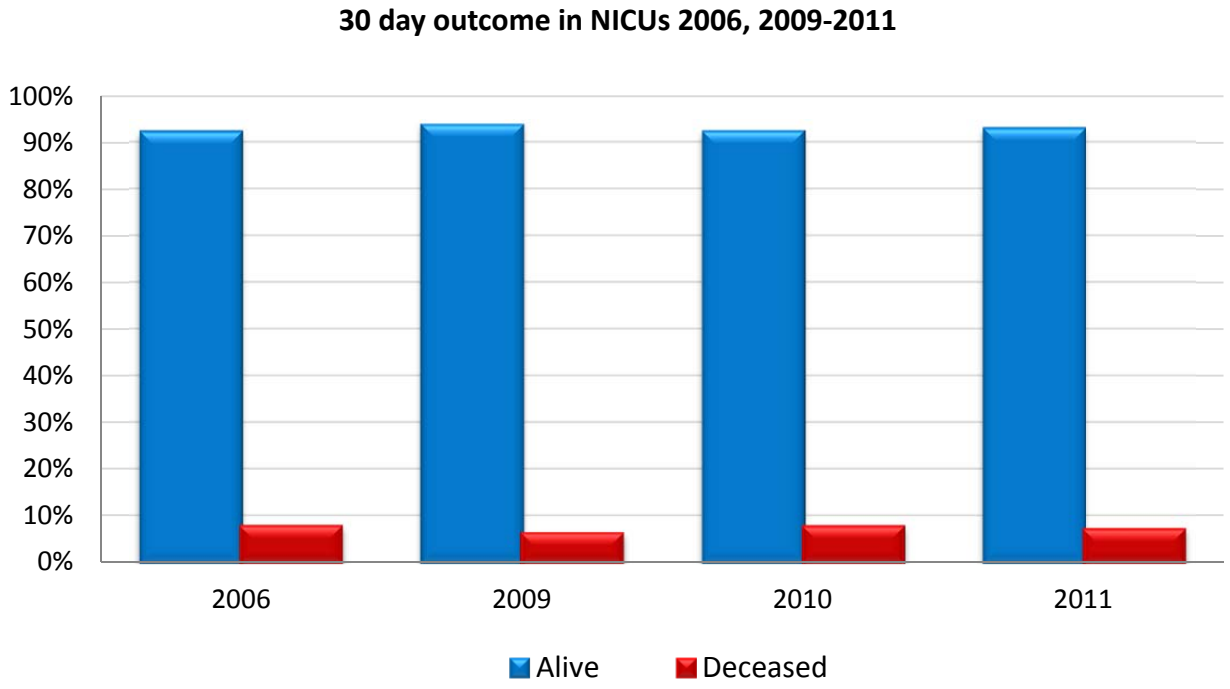


Table 27 provides the number and proportion of NICU patients alive or deceased 30 days after CVC-BSI by year. The proportions alive and deceased for 2006 and 2011 were compared.

Table 27 Outcome 30 days after CVC-BSI in NICUs

Outcome	2006	2009	2010	2011	*p*[62]
Alive	214 (92.2)	194 (93.7)	203 (92.3)	105 (92.9)	*n/s*
Deceased	18 (7.8)	13 (6.3)	17 (7.7)	8 (7.1)	*n/s*
Total	232	207	222	111	

[62] Significance test compares proportion of deaths in 2006 to proportion identified in 2011

Demographics of patients in NICUs identified with CVC-BSI

Tables 28 and 29 provide the age and gender of NICU patients identified with a CVC-BSI by year. The average age and gender proportions have both remained relatively unchanged since 2006.

Table 28 Age distribution of patients with CVC-BSI in NICUs

Age days	2006	2009	2010	2011
Mean	29 days	30 days	30 days	37 days
Median	17 days	18 days	18 days	17 days
Min - Max	1 – 395	0 – 362	2 – 365	4 – 217
Total # cases*	233	207	228	112

*Total number of cases with age available are fewer than the total number of cases reported due to missing data

Table 29 Proportion of patients with CVC-BSI by Gender in NICUs

	2006	2009	2010	2011
Gender	N (%)	N (%)	N (%)	N (%)
Male	132 (57)	111 (54)	121 (54)	70 (63)
Female	100 (43)	93 (46)	104 (46)	41 (37)
Total # cases*	232	204	225	111

*Total number of cases with gender available are fewer than the total number of cases reported due to missing data

Discussion

In 2011, the surveillance data reported for CVC-BSI in Neonatal ICUs (NICUs) shows 63% of cases are males with an average age of 37 days. However, ages ranged from 4 – 217 days. The majority (93%) of CVC-BSI cases in 2011 remained alive 30 days after onset of CVC-BSI. There has been minimal change in the distribution of age, proportion of CVC-BSI's by gender and outcome (alive) since 2006.

NICU CVC-BSI rates have declined overall and by birth weight and type of catheter since 2006. As previously mentioned, it is important to note that in 2011, the CNISP BSI case definition changed, criterion 3 was removed and therefore subsequently excluded bacteremias for which there was only one culture positive for a microorganism typically considered a contaminant. This change in case definition disproportionately affected NICU rates and the proportion of microorganisms identified as frequently only one blood culture is obtained in a NICU patient and coagulase negative staphylococcus (CONS), a common skin contaminant, is very frequently isolated in neonatal blood cultures. Although some of the rate decrease in 2011 may be attributed to this change in BSI case definition, overall NICU rates and rates in some birth weight categories were declining prior to 2011. The CNISP case definition was changed to maintain consistency with the CDC NHSN definition (changed in 2008) in order to continue to be able to compare CNISP CVC-BSI rates to CDC NHSN CVC-BSI rates. Although declining, CNISP NICU rates have been consistently higher than those reported by the NHSN in the United States.[1-4] On the other hand, CNISP NICU CVC-BSI rates by birth weight category are similar to those reported by the VICNISS in Australia.[11-13] The CNISP, NHSN and VICNISS have all reported a decrease in CVC-BSI NICU rates following the change to the BSI case definition.[1-4,11-13] The following summary table illustrates and compares the declining rates in NICUs by birth weight before and after the case definition was changed in Canada, the United States and Australia.[1-4,11-13]

Summary Table 3 NICU CVC-BSI rate per 1,000 CVC + UC days by birth weight: 2006 (CNISP, NHSN, VICNISS) vs 2010 (VICNISS) and 2011 (CNISP, NHSN)

Surveillance network	≤750 gms	751-1000 gms	1001-1500 gms	1501-2500 gms	>2500 gms
CNISP*	n/a vs 4.3	n/a vs 4.4	5.7 vs 3.1	4.9 vs 1.8	2.1 vs 1.6
VICNISS (Australia)	14.0 vs 4.2	8.8 vs 4.2	4.7 vs 3.1	4.2 vs 3.4	5.0 vs 1.5
NHSN	3.9 vs 2.5	3.2 vs 2.0	2.3 vs 1.3	2.0 vs 0.9	1.5 vs 0.9

* In 2006 those of birth weight < 1000 g in CNISP were not stratified further. This group was divided into birth weight of < 750 g and 751-1000 g from 2009 onwards because of NHSN stratification changes;

In 2010, the NHSN stopped reporting CVC-BSI rates by catheter type so no comparisons can be made to United States data.[3]

Lowest birth weight neonates in CNISP surveillance continue to report the highest CVC-BSI rates consistent with those reported by the NHSN (United States) and VICNISS (Australia) surveillance networks. [1-4,11-13]

In addition to the change in criterion as a potential explanation for decreasing CVC-BSI rates, clinical practice bundles specifically designed to reduce CVC-BSI infections have been developed. For example, in 2009, the Canadian Patient Safety Institute developed two evidence-based 'bundles': the Central Line Insertion Bundle and the Central Line Care Bundle which are part of the Safer Healthcare Now! campaign. The goal of this campaign is to prevent CVC-BSI by encouraging hospitals to implement these bundles as part of their care for patients with central venous catheters.[9] Similar campaigns have been initiated in the US (5 million Lives Campaign, The On the Cusp: Stop BSI project) and other countries including Spain (Bacteremia Zero Project), Brazil (Hospital Israelita Program to Prevent CLABSIs) and Switzerland (University of Geneva Hospital Intervention) resulting in marked decreases in CVC-BSI rates.[17]

Catheter utilization rates (CURs) which indicate CVC use overall and by birth weight in NICUs have remained relatively unchanged since 2006 and are similar to those reported by the NHSN (2011 CNISP CUR = 0.32 and NHSN = 0.28).[4]

There have been no significant changes in the proportion of fungi identified in CVC-BSI since 2006. The proportion of Gram positive microorganisms have significantly decreased since 2006 with a subsequent increase seen in Gram negative microorganisms This may in part be attributed to the change in case definition (removal of criterion 3) and the subsequent decrease seen in the proportion of coagulase negative staphylococcus (CONS) identified in CVC-BSI among neonates. The proportion of CONS has significantly decreased from 67% in 2006 to 54% in 2011, however, it remains the most prevalent organism identified in NICUs. As previously mentioned, the change in case definition disproportionately affected NICU rates and the proportion of microorganisms identified as frequently only one blood culture is obtained in a NICU patient and coagulase negative staphylococcus (CONS), a common skin contaminant, is frequently isolated in neonatal blood cultures. This downward trend in the proportion of CONS has also been reported by the VICNISS system where the proportion identified in CVC-BSI in 2006 was approximately 45% decreasing to 25% by 2010 after the change in case definition was applied.[11,12] The VICNISS attributed much of this decrease to their change in BSI case definition in 2008.[11]

In conclusion, CVC-BSI rates and the proportion of CONS microorganisms identified in CVC-BSIs in NICUs are decreasing. From the limited international data available, these decreasing trends are similar to trends reported from NICUs in the United States and Australia. Surveillance of CVC-BSI in NICUs enables the Agency to continue to monitor the burden of CVC-BSI in NICUs located in Canadian acute-care hospitals

Limitations

Several limitations should be considered when interpreting the data presented in this report. This surveillance data includes only hospitalized intensive care unit patients (Adult ICUs, PICUs & NICUs). Cases with CVC-BSI acquired while on inpatient wards (medical, surgical, orthopedic, etc.) or in emergency departments and outpatient settings, such as ambulatory care units and clinics, are not captured by this surveillance system. Therefore, these data represent only a portion of all CVC-BSI in Canada.

In addition, only cases who are hospitalized in intensive care units at participating hospitals are included. The number of reported CVC-BSI cases at any point in time is not necessarily a true reflection of the total number of ICU patients in Canada who have a CVC-BSI. Hospitals that submit CVC-BSI data to the Agency are large, tertiary acute care centres located in urban cities. CVC-BSI data from small hospitals and those in rural and northern areas are not collected by CNISP. Thus, the data in this report may not reflect rates, responsible microorganisms, or outcomes for patients hospitalized in small, rural, or northern hospitals.

The criteria for CVC-BSI changed in 2011 to exclude bacteremias for which there was only one culture positive for a microorganism typically considered a contaminant. This would have the effect of decreasing the number of reported CVC-BSIs and is likely to have contributed to the decreasing rates in 2011 and a somewhat different distribution of associated pathogens.

Implementation of infection prevention and control measures (e.g., clinical practice bundles) may vary between hospitals and as the Agency does not collect data regarding these factors, it is not possible to correlate them with the occurrence of CVC-BSI.

As with any surveillance system for which there are many participating centres, there may be inconsistencies in applying definitions and errors in recording data. CNISP attempts to decrease these errors through its in-services and data checks. It is believed that any inconsistencies and errors are random, rather than systematic, and are not likely to change the interpretation of results.

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.

Appendix 1 Data sources

The following are members of the Canadian Nosocomial Infection Surveillance Program who submitted CVC-BSI 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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