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Major article

Epidemiology of central line–associated bloodstream infections in Quebec intensive care units: A 6-year review

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Background: The burden of central line–associated bloodstream infections (CLABSI) in Canadian intensive care units (ICUs) is not well established. The present study aimed to describe CLABSI epidemiology in Quebec ICUs during 2003-2009.

Methods: The study population was a retrospective dynamic cohort of 58 ICUs that participated in the Surveillance Provinciale des Infections Nosocomiales program during 2003-2009. We calculated annual CLABSI incidence rates (IRs), central venous catheter (CVC) utilization ratios, and case-fatality proportions, and described the pathogens involved. We analyzed data using descriptive statistics and standardized incidence ratios.

Results: A total of 891 CLABSIs were identified during 446,137 CVC-days. In 2003-2009, CLABSI IRs were 1.67 CLABSI/1,000 CVC-days in adult ICUs, 2.20 CLABSIs/1,000 CVC-days in pediatric ICUs, and 4.40 CLABSIs/1,000 CVC-days in neonatal ICUs. Since 2007, CLABSI IRs in adult, pediatric and neonatal ICUs have decreased by 11%, 50%, and 18%, respectively. Pediatric ICUs had the highest CVC utilization ratio (median, 0.61; interquartile range, 0.57-0.66). Coagulase-negative staphylococci caused 53% of the CLABSIs. The proportion of methicillin-resistant *Staphylococcus aureus* declined from 70% to <40% after 2006.

Conclusions: CLABSIs result in a considerable burden of illness in Quebec ICUs. However, CLABSI IRs have decreased since 2007, and the proportion of methicillin-resistant *S aureus* has remained <40% since 2006. Continuous surveillance is essential to determine whether these changes are sustainable.

Health care–associated infections (HAIs) are estimated to affect more than 1.4 million patients worldwide at any one time.[1] Among all HAIs, central line–associated bloodstream infections (CLABSIs) have a particularly significant impact on morbidity, mortality, and hospitalization costs. Of the 250,000 estimated cases of CLABSI reported annually in the United States, approximately 80,000 (32%) occur in intensive care units (ICUs).[2] The severe debilitation of ICU patients, many of whom have decreased immune defenses due to concurrent disease processes, along with their need for central venous catheters (CVCs) for treatment purposes and/or hemodynamic monitoring, contribute to the high incidence of CLABSI in this setting.[3-5]

Despite the clinical and public health importance of CLABSI, little has been published about its epidemiology in Canadian ICUs. A prospective cohort study carried out in 2006 described CLABSI

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incidence rates (IRs) after 1 year of surveillance in 63 university-affiliated ICUs that participated in the Canadian Nosocomial Infection Surveillance Program (CNISP).[6,7] The pooled CLABSI IRs were 2.3 cases/1,000 CVC-days for adult ICUs, 2.6 cases/1,000 CVC-days for pediatric ICUs (PICUs), and 5.7 cases/1,000 CVC-days for neonatal ICUs (NICUs). In 2003, the Institut National de Santé Publique du Québec launched the Surveillance Provinciale des Infections Nosocomiales (SPIN) program, which aimed to promote HAI surveillance and understand the epidemiology of CLABSI in ICUs in the province of Quebec.[8-10] SPIN CLABSI IRs have been used as provincial benchmarks since 2005. Given the paucity of data regarding CLABSI epidemiology in Canadian settings, and to allow Canadian ICUs to benchmark their infection rates using Canadian data, we conducted a retrospective dynamic cohort study to describe the epidemiology of CLABSI in Quebec ICUs between October 2003 and March 2009.

METHODS

SPIN program

A detailed description of the SPIN surveillance definitions and methods has been published previously.[11]

Surveillance methods

SPIN requires all participating hospitals to perform active and prospective CLABSI surveillance in their ICUs throughout the year.[8-10,12] At the time of SPIN's inception in 2003, 28 ICUs voluntarily submitted data to the program. In January 2007, the Quebec Ministry of Health mandated participation in SPIN for all Quebec ICUs with $\geq$10 beds. Currently, 62 ICUs are registered in the program, including 50 adult ICUs, 5 PICUs, and 7 NICUs. Even though their participation is not mandatory, 20 of the 62 Quebec ICUs of $<$10 beds (32%) send data to SPIN.

Definitions

Reported CLABSIs must have been acquired while patients were admitted to or within 48 hours of discharge from an ICU. Patients also must have had a CVC in place at the time of or within the 48 hours preceding the onset of a bloodstream infection (BSI).[3] CVCs are defined as intravenous catheters that end at or near the heart, or in a great vessel close to the heart (eg, subclavian vein, internal jugular vein, femoral vein). Peripherally inserted catheters that enter the superior vena cava, tunneled catheters, totally implanted catheters, and umbilical vessel catheters are also considered CVCs.

The SPIN definition of BSI is that of the National Nosocomial Infections Surveillance (NNIS) program published in 1988.[2,13] In brief, patients must (1) have a recognized pathogen cultured from 1 or more blood cultures and the organism cultured must not be related to an infection at another site, or (2) have 1 or more of the following signs or symptoms: fever ($>$38°C), chills, hypotension (or hypothermia [$<$37°C], apnea, or bradycardia in patients aged $<$1 year), and a common skin contaminant (eg, diphtheroids, *Bacillus* spp, *Propionibacterium* spp, coagulase-negative staphylococci, viridans group streptococci or micrococci) cultured from 2 or more blood cultures or from 1 or more blood cultures if appropriate antimicrobial therapy was initiated by the treating physician and signs, symptoms, and positive laboratory results are not related to an infection at another site.

Data collection and patient eligibility

All patients who had a CVC inserted while in the ICU were followed for up to 48 hours after CVC removal or ICU discharge, whichever came first. CLABSI cases were identified by infection control practitioners (ICPs), who performed a daily search for new positive blood culture results in the ICU patients. Consequently, ICPs visited the ICUs to verify whether patients with positive blood cultures had a CVC currently or within the previous 48 hours. If the presence of a CVC was confirmed, the medical and nursing charts were reviewed to determine whether the case fulfilled the criteria for a diagnosis of CLABSI. All CLABSIs with an onset of symptoms before ICU admission were excluded. If a CLABSI case was confirmed, data on patient demographics, death at 30 days and its association with CLABSI (according to the evaluation of the hospital epidemiologist), and pathogens and antimicrobial resistance patterns were collected. Data on denominators (CVC-days and patient-days) were collected daily by a hospital-based ICP.

All ICPs involved in the surveillance process and clinical verification of the collected data were trained by the SPIN group. Rates are available on a monthly basis on the Institut National de Santé Publique du Québec Web site, and reports are produced annually to allow for benchmarking against comparable institutions.

Study population and outcomes

We analyzed the annual pooled CLABSI mean IRs, CVC utilization ratios (CVCURs), and CLABSI case-fatality proportions for ICUs that participated in SPIN for $\geq$6 months in 1 year period between 2003 and 2009. We compared our results with those reported by the National Healthcare Safety Network (NHSN) and CNISP, and described the distribution of CLABSI pathogens and their patterns of antimicrobial resistance. McGill University's Institutional Review Board approved this study and waived the requirement for informed consent.

Statistical analysis

Continuous outcomes are presented in median, percentile, and interquartile range (IQR), whereas discrete variables are presented in terms of frequency distribution. The ICU pooled CLABSI mean IRs (per 1,000 CVC-days), CVCURs, CLABSI case-fatality rates, and antimicrobial resistance proportions were calculated according to NHSN specifications using R 2.8.1.[8,14] Results were stratified by surveillance year, ICU type (adult, pediatric or neonatal), and academic profile ("teaching unit" if the hospital is part of a teaching and research program of a medical school; "nonteaching unit" otherwise). To compare CLABSI rates, we used the *t* test or standardized incidence ratio (SIR) and its 95% confidence interval (CI).

SIR is a summary measure that uses an indirect standardization method to compare rates by dividing the number of observed CLABSIs by the number of expected CLABSIs.[15,16] The number of expected CLABSIs is calculated by multiplying the CVC-days for different SPIN ICU types for a determined time period by a reference population rate (eg, NHSN or CNISP CLABSI rate) for the same ICU type and period. A SIR of 1 means that there is no difference between the observed and the expected numbers of CLABSIs, whereas a SIR of $<$1 or $>$1 means that the (SPIN) CLABSI rate is lower or higher than the rate found in the reference population, respectively.

To calculate the SIR of SPIN over NHSN, we had to estimate the NHSN CLABSI IR for adult ICUs, PICUs, and NICUs. To calculate NHSN adult ICU and PICU CLABSI rates, we combined data from all ICUs classified as adult and pediatric, respectively. When calculating the NICU rate, we combined NHSN data from level III and II/III NICUs and included CVC- and umbilical catheter–associated infections.