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Major article

Central line-associated bloodstream infections in Australian intensive care units: Time-trends in infection rates, etiology, and antimicrobial resistance using a comprehensive Victorian surveillance program, 2009-2013

Leon J. Worth MBBS, FRACP, Grad Dip Epi, PhD [a,b,*], Tim Spelman BSc, MBBS [a], Ann L. Bull PhD, MAppEpid [a], Judith A. Brett BN [a], Michael J. Richards MBBS, FRACP, MD [a,b]

[a] Victorian Healthcare Associated Infection Surveillance System Coordinating Centre, Victoria, Australia
[b] Department of Medicine, University of Melbourne, Victoria, Australia

Key Words:
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Background: The epidemiology of central line-associated bloodstream infections (CLABSI) in Australian intensive care units (ICUs) has not previously been reported. We sought to describe time-trends in CLABSI rates, infections by ICU peer-groups, etiology, and antimicrobial susceptibility of pathogens in a large cohort of Australian ICUs for the period January 1, 2009-December 31, 2013.

Methods: Using National Healthcare Safety Network methods, CLABSI surveillance in adult patients was performed by hospitals participating in the Victorian Healthcare Associated Infection Surveillance System (n = 29). Hospitals were grouped by location, sector, and teaching status.

Results: Overall, 384 CLABSI events were reported over 303,968 central venous catheter (CVC)-days, corresponding to a rate of 1.26/1,000 CVC-days (95% confidence interval, 1.14-1.40). Every 1-year increase was associated with a 26% reduction in CLABSI risk (risk ratio, 0.74, 95% confidence interval, 0.69-0.80; $P < .001$). The most frequently identified pathogens were *Enterococcus* spp (26.3%), followed by *Candida* spp (15.4%) and *Staphylococcus aureus* (13.3%). CLABSI due to *Enterococcus* spp, *S aureus,* and coagulase-negative *Staphylococcus* spp displayed significant reductions over time.

Conclusions: Internationally accepted surveillance methods have been employed in Australia, demonstrating CLABSI rates comparable to medical/surgical ICUs in the United States and a reduction in pathogen-specific infections over a 5-year period.

Central line-associated bloodstream infections (CLABSIs) in intensive care units (ICUs) result in increased morbidity, prolonged hospitalization, and greater health care expenditure.[1,2] These health care-associated infections are therefore considered key quality indicators. CLABSI events are frequently regarded as preventable, leading to the call for public reporting of infection rates,[3] zero tolerance for infection in many programs,[4] and inclusion in pay-for-performance health care funding schemes.[5]

Over the past decade, the influence of multimodal interventions (so-called bundles of care) for reduction in CLABSI rates in ICUs has been demonstrated internationally.[6,7] In Australia, however, the burden of illness has infrequently been reported, nonstandardized approaches to surveillance have previously been employed, and the uptake and influences of bundles of care for CLABSI prevention have not been evaluated. As such, CLABSI rates, etiology, and antimicrobial resistance of pathogens over time have not been formally evaluated.

CLABSI events have been monitored in Victorian hospitals since 2002.[8] In 2008, the Centers for Disease Control and Prevention/National Healthcare Safety Network (CDC/NHSN) CLABSI case definition for infection due to common commensals was significantly revised, and this change was implemented in Victorian hospitals in 2009.[9] Since this time, a consistent definition has been employed for surveillance purposes. The objectives of our study

* Address correspondence to Leon J. Worth, MBBS, FRACP, Grad Dip Epi, PhD, Victorian Healthcare Associated Infection Surveillance System Coordinating Centre, Doherty Institute, 792 Elizabeth St, Melbourne, Victoria 3000, Australia.
E-mail address: leon.worth@mh.org.au (L.J. Worth).

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were to describe time-trends for CLABSI rates, report CLABSI rates according to ICU peer groupings, and describe the etiology of CLABSI and antimicrobial susceptibility of pathogens in Victorian ICUs for the period January 1, 2009-December 31, 2013.

METHODS

The Victorian Healthcare Associated Infection Surveillance System (VICNISS) Coordinating Centre was established for the purpose of monitoring a range of health care-associated infection outcomes and relevant processes in Victorian hospitals, including CLABSI.[10] The CLABSI surveillance module is based on methods employed by the CDC/NHSN.[11,12] For our study, data collected between January 1, 2009, and December 31, 2013, were analyzed to characterize time-trends.

Participating hospitals

Victorian ICUs provide services for mixed patient populations rather than as single-specialty units.[13] During the study period, 29 hospitals participated in the VICNISS program. All large Victorian public hospitals (n = 23) participated in the program, whereas involvement by private hospitals (n = 6) was on a voluntary basis. For our study, surveillance data from adult ICUs were analyzed, excluding pediatric and neonatal ICUs.

Definitions

For the purposes of surveillance, a central venous catheter (CVC) was defined as an intravascular catheter terminating at or close to the heart or in 1 of the great arteries, which was used for infusion, withdrawal of blood, or hemodynamic monitoring. Consistent with CDC/NHSN criteria, CLABSI was defined when a patient had (I) a recognized pathogen cultured from 1 or more blood cultures, and the organism was not related to infection at another site, or (II) a common commensal organism cultured from 2 or more blood cultures drawn on separate occasions and 1 or more of fever (>38°C), chills or hypotension, and positive results not related to infection at another site.[12] CLABSI rates were reported using the denominator of CVC-days. The annual device utilization ratio (DUR) was calculated as the ratio of device-days to patient-days for ICU admissions within participating hospitals.[11]

Location and size of ICUs were defined according to standard criteria. ICUs were classified as metropolitan if located within the Melbourne Statistical Division and regional if located outside this Division.[14] In accordance with previous reporting in Victoria, ICUs affiliated with teaching hospitals were classified as type 1A, and those not affiliated with teaching hospitals were classified as non-1A.[9] Furthermore, ICUs were classified according to whether hospitals were situated in public or private health sectors.

Data collection and validation

Data were collected and submitted quarterly by infection prevention staff affiliated with participating health care facilities. All were trained regarding case definitions and standardized data collection by VICNISS Coordinating Centre staff. For isolated pathogens and common commensals, the organism and antibiotic susceptibilities were recorded using reported antimicrobial breakpoints (eg, susceptible, resistant, or intermediate susceptibility). All data were submitted via a uniform data collection tool, with electronic data submission available from 2010. As an internal validation measure, electronic submission precluded lodgement of incomplete or inconsistent data. Prospective monitoring was performed, with contribution from patient records and microbiology reports.

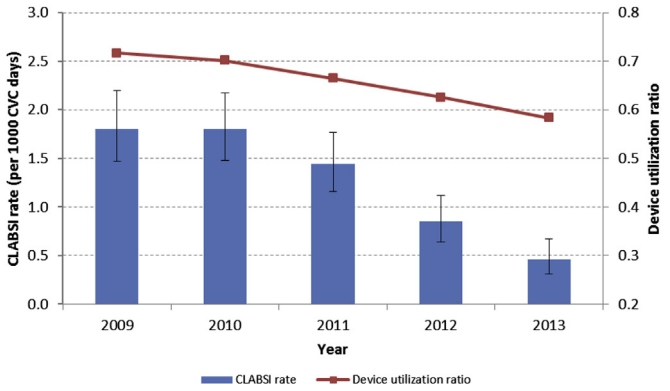

Fig 1. Annual central line-associated bloodstream infection (CLABSI) rates and device use ratios in adult intensive care units in Victoria, Australia, 2009-2013. Error bars indicate 95% confidence intervals. *CVC*, central venous catheter.

Reporting and analysis

Mixed effects Poisson regression was used to model counts of pathogen-specific CLABSIs where the aggregate number of procedures per time period formed the exposure. In the absence of explicit data regarding individual hospital characteristics (eg, case mix), the hospital identifier was modeled as a random effect to adjust for intrahospital heterogeneity. Effect size was quantified as the risk ratio (RR). Linear and nonlinear models were compared using the Akaike Information Criterion to determine which presumption (linear, quadratic, or cubic) provided the best fit for observed data.

Analysis was confined to pathogens for which sufficient annual data were available. Given a limited number of events for some pathogens, detailed analysis was restricted to the 9 most highly ranked CLABSI pathogens. In all instances, $P < .05$ was considered significant. Analysis was undertaken using Stata version 13 (StataCorp, College Station, Tex).

Ethics

No patient-identifying data were captured for the purposes of the study, and all hospital-level data were deidentified. As a quality-assurance audit without direct influence upon patient care, ethics review was not required.

RESULTS

Between January 1, 2009, and the December 31, 2013, 29 Victorian health care facilities participated in CLABSI surveillance activities. A total of 303,968 CVC-days were monitored and 384 CLABSI events were reported, corresponding to an overall rate of 1.26/1,000 CVC-days (95% confidence interval [CI], 1.14-1.40). Of patients with infection, 155 (40.4%) were women and 228 (59.4%) were men (patient sex was not recorded in 1 instance). Median age at infection was 59.9 years (interquartile range, 42.3-72.2 years).

CLABSI rates

Figure 1 demonstrates annual CLABSI rates for the period 2009-2013. Modeling demonstrated every 1-year increase across the