ORIGINAL ARTICLE

Central Line–Associated Bloodstream Infection Surveillance outside the Intensive Care Unit: A Multicenter Survey

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OBJECTIVE. The success of central line–associated bloodstream infection (CLABSI) prevention programs in intensive care units (ICUs) has led to the expansion of surveillance at many hospitals. We sought to compare non-ICU CLABSI (nCLABSI) rates with national reports and describe methods of surveillance at several participating US institutions.

DESIGN AND SETTING. An electronic survey of several medical centers about infection surveillance practices and rate data for non-ICU patients.

PARTICIPANTS. Ten tertiary care hospitals.

METHODS. In March 2011, a survey was sent to 10 medical centers. The survey consisted of 12 questions regarding demographics and CLABSI surveillance methodology for non-ICU patients at each center. Participants were also asked to provide available rate and device utilization data.

RESULTS. Hospitals ranged in size from 238 to 1,400 total beds (median, 815). All hospitals reported using Centers for Disease Control and Prevention (CDC) definitions. Denominators were collected by different means: counting patients with central lines every day (5 hospitals), indirectly estimating on the basis of electronic orders ($n = 4$), or another automated method ($n = 1$). Rates of nCLABSI ranged from 0.2 to 4.2 infections per 1,000 catheter-days (median, 2.5). The national rate reported by the CDC using 2009 data from the National Healthcare Surveillance Network was 1.14 infections per 1,000 catheter-days.

CONCLUSIONS. Only 2 hospitals were below the pooled CLABSI rate for inpatient wards; all others exceeded this rate. Possible explanations include differences in average central line utilization or hospital size in the impact of certain clinical risk factors notably absent from the definition and in interpretation and reporting practices. Further investigation is necessary to determine whether the national benchmarks are low or whether the hospitals surveyed here represent a selection of outliers.

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Each year, an estimated 250,000 bloodstream infections occur throughout hospitals in the United States, more than half of which occur in patients outside of the intensive care unit (ICU).[1] These infections cause substantial morbidity and are possibly an independent cause of mortality.[2] The economic costs also pose a considerable burden. Although reports vary, the direct attributable medical cost of a single central line–associated bloodstream infection (CLABSI) has been placed at up to $29,156 per patient[3] and the cost to the US healthcare system at $2.3 billion annually.[4] Furthermore, because the Centers for Medicare and Medicaid Services no longer reimburses hospitals for follow-up care related to hospital-acquired CLABSIs,[5] these infections are likely to have an even greater direct financial impact on hospitals in years to come.

Surveillance of CLABSIs acquired in ICUs has been routinely performed in many hospitals for years. Data collection and the reporting of infection rates are necessary for establishing baseline incidence in a patient population and quantifying the effectiveness of prevention efforts. Several studies

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suggest that the combination of surveillance and simple interventions can dramatically reduce the incidence of CLABSIs acquired in the ICU.[4,6,7]

The success of CLABSI prevention programs in ICUs has led regulatory agencies and public health experts to call for an expansion of efforts beyond the ICU setting to the inpatient wards.[8] The US Department of Health and Human Services has included a 50% reduction in CLABSI rates, both in the ICU and on inpatient wards, as one of its 5-year national prevention targets.[9] Furthermore, starting in 2008, under National Patient Safety Goal 07.04.01, the Joint Commission began requiring hospitals to provide data on "short- and long-term central venous catheters and peripherally inserted central catheter lines,"[10] effectively broadening surveillance to include all inpatient settings, where most of the nontemporary and peripherally inserted central catheter lines are found.

While the lessons learned from years of ICU surveillance have helped structure similar programs for CLABSI outside the ICU (non-ICU CLABSI [nCLABSI]), the development of a strategy that can be applied across entire hospitals requires more than simply recapitulating those methods.

To determine current surveillance practices and rates for nCLABSI, we conducted a voluntary survey to compile the experiences of 10 hospitals that are collecting CLABSI data outside their ICUs. In addition to providing the hospitals' rates, we also describe some of the ways in which non-ICU surveillance methodology may differ as well as the difficulties of using nCLABSI rates for interhospital comparison.

METHODS

In March 2011, a brief survey was sent to a convenience sample of 10 different medical centers with 11 affiliated hospitals, 3 of which report nCLABSI data to the National Healthcare Safety Network (NHSN). In all cases, responses were provided by directors of infection prevention and hospital epidemiologists. The survey was comprised of 12 questions that began with a request for demographic information and a qualitative description of nCLABSI surveillance history and methodology at each center. It was noted whether hospitals used Centers for Disease Control and Prevention (CDC) definitions for laboratory-confirmed CLABSI and how frequently blood culture reports were received. It was also noted whether chart reviews were performed by infection preventionists or by physicians and how central line–day denominators were collected. Finally, recipients of the survey were asked to share available nCLABSI rate and central line utilization data. Minor follow-up was required with a few of the participants to clarify their qualitative descriptions. Some data extrapolation was required for annual infection rates if hospitals did not have a full year of data available at the time of the survey. Data collection was finalized by August 2011. Each hospital provided information after responding to the institutional review board and Health Insurance Portability and Accountability Act considerations at its institution.

RESULTS

Hospital Characteristics

Ten hospitals participated in the survey. All were tertiary care urban centers closely affiliated with medical schools. None were community hospitals. Data on annual admissions as well as bed size, which ranged from 238 to 1,400 (median, 815), are shown in Table 1.

Derivation of Numerator

All participants began surveillance on inpatient non-ICU wards in 2010 or earlier. Every hospital reported that they apply CDC definitions for laboratory-confirmed CLABSI[11,12] to positive blood culture reports to determine infection rate numerators. Six out of 10 hospitals obtain daily reports (Table 2). All hospitals reported that patient charts are reviewed by infection preventionists. Four indicated that hospital physician epidemiologists also review charts either as needed ($n = 2$) for particular cases requiring adjudication or on a regular basis ($n = 2$). The patient chart, radiology reports, and microbiology databases are the most frequent sources for data compiled during the review process.

Five hospitals use an electronic screening method to merge microbiology reports with reports of patients with central lines before the chart review process begins. The remaining hospitals determine the presence of a central line by searching for documentation in the patient chart.

Derivation of Denominator

The approach to deriving the denominators varied. At 5 hospitals, denominators were collected by either the ward nursing staff or a unit manager who counted patients with central

TABLE 1. Features of the 10 Participating Hospitals

	Beds			
Hospital	Total	ICU	Pediatric	Annual admissions
A	470	20	36	24,346
B	916	147	0	54,874[a]
C	238	106	238	
D	779	140	73	32,841
E	477	72	20	27,277
F	970	98	121	41,190
G	850	140	90	48,000
H	946	176	188	47,757
I	1,400	209	85	53,424
J	776	126	0	36,746

NOTE. Annual admissions include admissions to the intensive care unit (ICU). Approximately 4% of admissions are ICU admissions.

[a] Hospitals B and C are affiliated, and the total 54,874 is the combined total for both hospitals.

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TABLE 2. Surveillance Data Collection Methods

	Numerator data collection					
	Frequency of reports			Who reviews charts		
Hospital	Monthly	Weekly	Daily	IPP	MD	Denominator data collection
A	X			X		For 2010, point prevalence estimates used. Catheter-days calculated by multiplying proportion of patients with central lines by patient-days. Starting in 2011, nursing supervisors check each patient daily for lines and report number to infection prevention.
B, C			X	X		Line-day count is tied to electronic nursing documentation of line maintenance. Summary count made at midnight each night.
D			X	X		Nurses record presence of lines daily in the EMR; data are transmitted electronically to epidemiology.
E		X		X	X[a]	Unit managers check every bed each day for the presence of a line.
F	X			X		Device utilization download from analytics program that extracts these data from nursing documentation in EMR.
G			X	X	X	Collected electronically.
H			X	X		Electronic count of line-days from EMR for most units. A new EMR system was implemented in 2010. For units not yet on the new EMR, electronic algorithm used to estimate the number of line-days by looking at orders for central line maintenance and blood draws via a central line. Almost all units are now on the new EMR, with direct electronic reporting of line-days.
I			X	X	X[a]	Hand count of line-days on each individual nursing unit.
J			X	X	X	Collected manually by night shift nurse manager on each unit each evening and entered in secure electronic spreadsheet.

NOTE. EMR, electronic medical record; IPP, infection preventionist; MD, medical doctor.
[a] Hospital physician epidemiologists review only as needed for cases requiring adjudication, not all cases.

lines every day. Other hospitals indirectly estimate the number of catheter-days from electronic orders for maintenance and blood draws from the central line ($n = 4$) or from another automated method that directly captures this information ($n = 1$).

nCLABSI Rate

Total annual non-ICU central venous catheter–days ranged from 6,965 to 57,487 days (Table 3). Using reported, not extrapolated, denominators, nCLABSI rates ranged from 0.2 to 4.2 infections per 1,000 catheter-days (median, 2.4; Figure 1). There was no apparent association between hospital bed size and infection rates.

Device utilization ratios ranged from 0.12 to 0.42 in non-ICU inpatient wards compared with 0.42 to 0.77 in ICUs (Table 3). The median non-ICU device utilization ratio was 0.24, and the median ICU device utilization ratio was 0.54. In 2009, the NHSN reported that the pooled device utilization ratio was 0.50 for all ICUs combined and 0.15 for non-ICU inpatient wards combined.[13,14]

DISCUSSION

We surveyed several major academic medical centers to determine their approach to conducting surveillance of nCLABSIs as well as their nCLABSI rates and device utilization. We also compared our results with nationally published data.

At the time of the survey, it was not known whether many hospitals had successfully operationalized regulatory requirements for housewide CLABSI surveillance, especially given the high volume of patients with central lines outside of the ICU. However, we found that all participants began in 2010 or earlier. We found uniformity in numerator methodology in that all hospitals reported that they apply CDC definitions to reports of positive blood cultures to determine the number of primary infections. For derivation of the central line–day denominator, there was more variation depending on how mature electronic record systems were at the various institutions. Although several authors have reported success with using proxy measures to calculate line-days, none of our participants use these methods.[15,16]

Infection rates varied widely from hospital to hospital. Only 2 hospitals were below the pooled CLABSI rate for inpatient wards derived from 2009 NHSN data and reported by the CDC in a national summary report;[13,14] all others exceeded this rate. Our survey was not designed to definitively conclude why the majority of the hospitals surveyed here have nCLABSI rates that exceed those reported by the CDC. There are several possibilities, including the fact that these hospitals in fact have higher rates because of suboptimal central venous catheter maintenance technique.

TABLE 3. Central Line Utilization in Intensive Care Unit (ICU) and Inpatient Wards

	ICU			Inpatient wards (non-ICU)		
Hospital	Patient-days	Catheter-days	DU ratio[a]	Patient-days	Catheter-days	DU ratio[a]
A	5,799	4,444	0.77	131,212	54,525	0.42
B	42,855	23,803	0.56	121,324	28,982	0.24
C	36,142	18,629	0.52	41,764	13,898	0.33
D	32,010	18,769	0.59	156,319	44,669	0.29
E	16,151	6,827	0.42	73,634	6,965	0.09
F	27,454	13,727	0.50	183,270	21,992	0.12
G	31,163	14,253	0.46	116,498	19,399	0.17
H	50,327	29,595	0.59	218,950	57,487	0.26
I	22,317	15,973	0.72	90,863	22,301	0.25
J	49,735	25,558	0.51	209,441	51,115	0.24
Pooled mean[b]	9,186,473	4,589,378	0.50	1,593,932	10,675,140	0.15

[a] Device utilization (DU) ratio = central line–days/patient-days.
[b] National Healthcare Safety Network pooled mean for 2009.

Another explanation is that hospitals that voluntarily report their nCLABSI data are more likely to have lower rates. According to the NHSN, device utilization serves as one possible indication of infection risk.[13] In our survey, we found that central line usage at most of the participating hospitals was higher than the reported national figures (0.21 vs 0.15). In addition, NHSN participants include many smaller hospitals reporting into the system. The authors of the NHSN report note that a reduction in rate could be "related to the influx of data from smaller hospitals that generally have lower risks of healthcare-associated infection."[13]

Patient-level differences also may account for the higher rate. Several factors may place an individual patient at clinical risk for a bloodstream infection yet are not considered by the surveillance definition. At least 2 centers have reported a significant decrease in their primary CLABSI rates when modified definitions that included other factors—such as neutropenia, mucositis, graft-versus-host disease, or other comorbidities that disproportionately affect immunocompromised patient populations—were applied.[17,18]

In comparison to ICU data, non-ICU benchmarks are difficult to find. Few previous studies have reported CLABSI rates that include patients outside of the ICU, let alone focus exclusively on this population. Zingg et al[19] conducted a 4-month prospective cohort study in a Swiss hospital examining CLABSI incidence and found a rate of 3.7 infections per 1,000 line-days (2,140 total non-ICU line-days). However, this study excluded pediatric, geriatric, and long-term care patients as well as patients with implanted ports or tunneled catheters, which may explain the comparatively low device utilization ratio (0.046). Weber et al[20] performed hospital-wide surveillance and found non-ICU CLABSI rates of 3.87 (medical step-down), 2.06 (medical ward), 1.82 (surgical step-down), and 1.15 (surgical ward) in 21,902 catheter-days. However, their rates included secondary bloodstream infections, or bacteremias associated with infection at another site, whereas we reported rates that reflect primary infections only. Studies that combine rate data from multiple centers are even rarer.

The most comparable nCLABSI data from a study setting available to date were collected at a single US center by Marschall et al.[21,22] The authors performed prospective surveil-

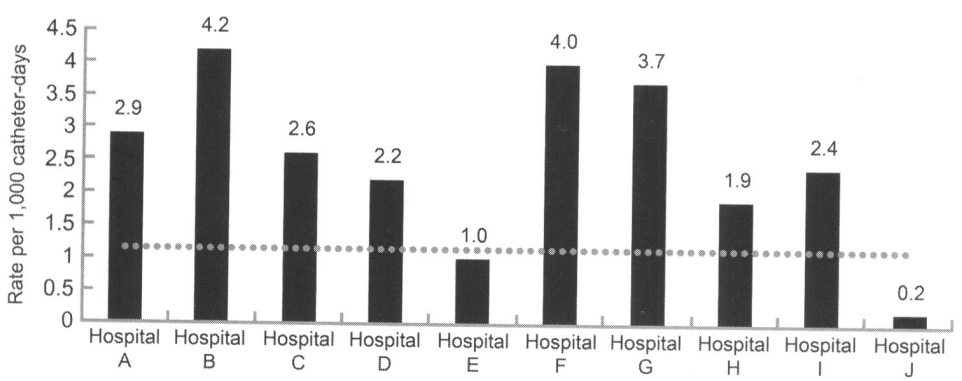

FIGURE 1. Non–intensive care unit central line–associated bloodstream infection rates. In 2009, the National Healthcare Safety Network pooled rate for inpatient wards was 1.14 per 1,000 catheter-days.[13,14]

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lance on 4 general medical wards, and they reported an overall rate of 5.7 (range, 4.3–8.0) and a device utilization ratio of 0.22. However, the data study period was in 2003, and a steady decrease in national CLABSI rates has been reported over the past few years,[14] making it difficult to use the authors' data for current benchmarking purposes. As a result, NHSN data remain the most comprehensive source of updated non-ICU data in US hospitals.

Our study has several limitations. Hospitals were not randomly selected to participate, and the sample size of 10 hospitals is small. Further study is necessary to determine whether the hospitals surveyed here are simply outliers from the national mean or whether they represent a true difference. Second, calculating one combined nCLABSI rate for each hospital conceals the diverse case mix of different unit types designated as inpatient wards. In the 2009 NHSN report, data are left stratified, and the wide ranges in both rates and device utilization—for example, from as low as 0.0 to as high as 5.4 infections per 1,000 catheter-days—are visible. We chose to follow the examples of groups that encourage the public to use CLABSI data as a quality metric and present collapsed nCLABSI rates for each of our participating hospitals.

As more healthcare centers perform nCLABSI surveillance, comparison of infection rates across different hospitals will become even more important. As of August 2011, 37 states have begun considering or have passed laws requiring healthcare facilities to report infection rate data.[23,24] Rates of vascular catheter-related infections per 1,000 discharges at hospitals participating in the Inpatient Prospective Payment System are also available on the Centers for Medicare and Medicaid Services website.[25] Because they are public domain, not only do these deidentified, hospital-specific rates appear in an annual state health department report,[26] but also they have been obtained by third-party groups and marketed as a meaningful ranking metric to paying subscribers.[27]

Recognizing the complexities of non-ICU CLABSI surveillance is important not only because it affects surveillance methodology but also because it may affect decisions on how to allocate valuable infection prevention resources. We suggest that additional data and study are necessary before hospitals can begin to understand the quality of their programs. In the day of public reporting, the only thing worse than having no baseline for comparison is subjecting hospitals, patients, and payers to an inappropriate baseline.

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