ORIGINAL ARTICLE

Development of a Modified Surveillance Definition of Central Line–Associated Bloodstream Infections for Patients with Hematologic Malignancies

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OBJECTIVE. To develop a modified surveillance definition of central line–associated bloodstream infection (mCLABSI) specific for our population of patients with hematologic malignancies to better support ongoing improvement efforts at our hospital.

DESIGN. Retrospective cohort study.

PATIENTS. Hematologic malignancies population in a 1,200-bed tertiary care hospital on a 22-bed bone marrow transplant (BMT) unit and a 22-bed leukemia unit.

METHODS. An mCLABSI definition was developed, and pathogens and rates were compared against those determined using the National Healthcare Safety Network (NHSN) definition.

RESULTS. By the NHSN definition the CLABSI rate on the BMT unit was 6.0 per 1,000 central line–days, and by the mCLABSI definition the rate was 2.0 per 1,000 line-days ($P < .001$). On the leukemia unit, the NHSN CLABSI rate was 14.4 per 1,000 line-days, and the mCLABSI rate was 8.2 per 1,000 line-days ($P = .009$). The top 3 CLABSI pathogens by the NHSN definition were *Enterococcus* species, *Klebsiella* species, and *Escherichia coli*. The top 3 CLABSI pathogens by the mCLABSI definition were coagulase-negative *Staphylococcus* (CONS), *Pseudomonas aeruginosa*, and *Staphylococcus aureus*. The difference in the incidence of CONS as a cause of CLABSI under the 2 definitions was statistically significant ($P < .001$).

CONCLUSIONS. A modified surveillance definition of CLABSI was associated with an increase in the identification of staphylococci as the cause of CLABSIs, as opposed to enteric pathogens, and a decrease in CLABSI rates.

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Hospital-acquired bloodstream infection (HABSI) surveillance is a core function of infection prevention programs. Application of National Health and Safety Network (NHSN) methodology identifies bloodstream infections that can be defined as central line–associated bloodstream infections (CLABSIs).[1] The purposes of CLABSI surveillance include trending data, serving as a metric for improvement projects to decrease infection rates and increasingly as an objective measure of the quality of care delivered for interhospital comparison.

The NHSN CLABSI definition, which was originally intended for a general medical-surgical population, is problematic when applied to patients with hematologic malignancies, who by definition have dysfunctional immune systems. Bone marrow transplant (BMT) recipients and leukemia patients undergoing treatment have inherent risks for HABSI as a result of intensive conditioning regimens and chemotherapy that result in profound and lengthy neutropenia with resultant mucous membrane disruption and risk of bacteria translocation.[2,3] Furthermore, BMT recipients require immunosuppressive therapy to prevent graft-versus-host disease.[4] There is additional risk for HABSI due to the frequent and prolonged need for a central venous catheter (CVC). The NHSN definition does not take into account these factors, and to attribute the HABSI to a secondary source specific criteria must be met that do not include translocation.

The misclassification of HABSI as CLABSI by definition does not allow infection prevention surveillance to provide credible, actionable data to care teams invested in process improvement and also may have unintended negative consequences in an era of increasing public reporting of infection rates and resultant institutional pressure to decrease CLABSI

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TABLE 1. Primary and Secondary Bloodstream Infection (BSI) Rates for the Bone Marrow Transplant (BMT) and Leukemia Units by National Healthcare Safety Network (NHSN) and Modified Central Line–Associated BSI Definitions

	NHSN	Modified	*P*
Primary BSI rate			
BMT unit	5.6	1.9	<.001
Leukemia unit	10.3	3.6	<.001
Secondary BSI rate			
BMT unit	0.6	4.2	<.001
Leukemia unit	1.4	8.1	<.001

NOTE. Rates are given as cases per 1,000 patient-days.

rates.[5] We developed a modified surveillance definition of CLABSI (mCLABSI) specific for our population of patients with hematologic malignancies to better support ongoing improvement efforts at our hospital. In this report, we describe our experience and compare CLABSI rates and attributed causal pathogens using this modified definition and the standard NHSN definition.

METHODS

Cleveland Clinic is a 1,200-bed tertiary care hospital in Cleveland, Ohio, that houses a 22-bed BMT unit and a 22-bed leukemia unit. In July 2010, a multidisciplinary task force was formed with its goal being to decrease infection rates in these units as part of an institution-wide campaign to decrease CLABSI rates. Efforts included a comprehensive education campaign, changes to central line maintenance practices with random audits to ensure best practice, introduction of new technology, and short-cycle e-mail notification of CLABSI events to bedside caregivers.

Routine bloodstream surveillance at Cleveland Clinic includes total HABSIs and further stratification into primary (to include CLABSIs) or secondary source per NHSN guidance.[1] HABSIs are entered and maintained in an infection prevention database. An mCLABSI definition was developed to support the task force wherein primary HABSIs that met the following criteria were no longer considered CLABSIs: (1) HABSI due to viridans group streptococci in a patient with mucositis; (2) BMT recipients with graft-versus-host disease of the gastrointestinal tract with a HABSI due to *Enterococcus, Enterobacteriaceae,* or *Candida* species; and (3) patients with neutropenia after dose-intensive chemotherapy with a HABSI due to *Enterococcus, Enterobacteriaceae,* or *Candida* species.

CLABSI rates were generated using both NHSN and mCLABSI definitions. HABSIs that met the criteria outlined above were considered secondary under the mCLABSI construct. Central line–days were manually counted per the NHSN definition, and patient-days were obtained from an administrative database. Pathogens and rates per patient-days were compared for the period January 1, 2010, through June 30, 2011. CLABSI rates for the BMT unit were compared for the period January 1, 2010, through June 30, 2011, while CLABSI rates for the leukemia unit were compared for the period September 1, 2010, through June 30, 2011 (the period when line-days were available for the leukemia unit).

The BMT database was queried to identify all admissions that occurred during the observation period for allogeneic (alloBMT) and autologous (autoBMT) recipients. CLABSIs that occurred in these specific patient populations were identified from an infection prevention database, and an attack rate was calculated.

RESULTS

During the observation period, there were 1,424 admissions comprising 18,909 patient-days. HABSI rates are shown in Table 1. There were 54 HABSIs in the BMT population, with a rate of 6.1 per 1,000 patient-days, and 118 HABSIs on the leukemia unit, with a rate of 11.7 per 1,000 patient-days. Applying the NHSN definition to the BMT unit identified a primary rate of 5.6 and a secondary rate of 0.6 per 1,000 patient-days. There was no significant difference between the total HABSI rate and the primary BSI rate. Applying the mCLABSI definition to the BMT unit identified a primary rate of 1.9 per 1,000 patient-days and a secondary rate of 4.2 per 1,000 patient-days ($P < .001$ for the comparison of the 2 primary and secondary rates).

Applying the NHSN definition to the leukemia unit identified a primary BSI rate of 10.3 per 1,000 patient-days and a secondary rate of 1.4 per 1,000 patient-days. With this definition, there was no significant difference between the total HABSI rate and the primary HABSI rate. Under the mCLABSI definition the leukemia unit's primary rate was 3.6 per 1,000 patient-days, and the secondary rate was 8.1 per 1,000 patient-days ($P < .001$ for the comparison of the 2 primary and secondary rates).

By the NHSN definition the CLABSI rate on the BMT unit was 6.0 per 1,000 line-days, and by the mCLABSI definition the rate was 2.0 per 1,000 line-days ($P < .001$). On the leukemia unit, the NHSN CLABSI rate was 14.4 per 1,000 line-days, and the mCLABSI rate was 8.2 per 1,000 line-days ($P = .009$; Table 2).

The top 3 CLABSI pathogens by the NHSN definition were *Enterococcus* species ($n = 57$), *Klebsiella* species ($n = 22$), and *Escherichia coli* ($n = 16$). The top 3 CLABSI pathogens by the mCLABSI definition were coagulase-negative *Staphylococcus* (CONS; $n = 22$), *Pseudomonas aeruginosa* ($n = 12$), and *Staphylococcus aureus* ($n = 5$). The difference in the incidence of CONS as cause of CLABSI under the 2 definitions was statistically significant ($P < .001$).

The attack rate of CLABSI was 11.6 per 100 admissions for alloBMT recipients and 4.2 per 100 admissions for autoBMT recipients by the NHSN definition. By the mCLABSI definition the alloBMT attack rate was 3.5 per 100 admissions, and the autoBMT rate was 1.9 per 100 admissions ($P = .34$; Table 2).

TABLE 2. Central Line–Associated Bloodstream Infection (CLABSI) Incidence Densities for the Bone Marrow Transplant (BMT) and Leukemia Units by National Healthcare Safety Network (NHSN) and Modified CLABSI Definitions and CLABSI Attack Rates for Allogenieic and Autologous BMT Recipients

	NHSN	Modified	*P*
Incidence density			
BMT unit	6.0	2.0	<.001
Leukemia unit[a]	14.4	8.2	.009
Attack rate			
Allogeneic BMT	11.6	3.5[b]	
Autologous BMT	4.2	1.9[b]	

NOTE. Incidence density is given as cases per 1,000 central line–days, and attack rate is given as cases per 100 admissions.

[a] Central line–days were available for the period September 1, 2010, through June 30, 2011.

[b] $P = .34$ for the comparison of the modified definition between allogeneic and autologous transplant patients.

DISCUSSION

The HABSI surveillance activity of infection prevention programs is most effective when it results in reliable, actionable data that are effectively communicated. To contribute to an ongoing improvement project aimed at reducing catheter-related bloodstream infections in patients with hematologic malignancies, we developed an mCLABSI definition to account for the inherent risk of HABSI due to translocation. Recently, Tomlinson et al[6] reported the variation in definitions used in research studies of bloodstream infections related to CVCs in patients with cancer. Their review reinforces the known difficulty in constructing a valid definition of CVC-related HABSI.

It is generally accepted that surveillance definitions overestimate the incidence of device-related infections.[7] Our experience confirms this, as there was no significant difference between the total HABSI rate and the primary BSI rate (a proxy for CLABSI rates) on either the BMT unit or the leukemia unit. This demonstrates a weakness of the current NHSN definition. The validity of our approach is supported by the pathogens attributed to line-related infection under our modification. Two of the pathogens identified most frequently as the cause of CLABSI by our mCLABSI definition were staphylococci, organisms commonly associated with CVC-related infection. This is in contrast to the identification of enterics as the most frequent causative pathogens by the NHSN definition, organisms associated with translocation in patients who have received chemotherapy.

The similarity in CLABSI attack rates among alloBMT recipients and autoBMT recipients further supports the validity of our mCLABSI definition. The lack of a significant difference in rates among these 2 distinct clinical populations argues that CLABSIs under the modified construct are due to factors common across patients—the presence of a CVC and the need for optimal maintenance of it—as opposed to the unique disease process and its treatment. Finally, our definition was developed in consultation with physicians involved in the care of this special patient population. A practical benefit of this internal validity is that it was accepted as a metric for an improvement project rooted in prompt event review by the treating team.

There are limitations to our approach. The mCLABSI definition was generated to avoid misclassification (or "overcalling") of HABSIs as CLABSIs that clinically most likely were not. Our modified approach runs the risk of "undercalling" CVC-related events, a trade-off of sensitivity for specificity. In addition, this was not a blinded study, raising the question as to whether there was increased documentation of mucositis. There are also limitations in the generalizability of the mCLABSI definition, as it requires an infection preventionist to have familiarity with the clinical care of this patient population, a resource that may not be available in all settings. We also did not objectively define neutropenia, mucositis, and the degree of graft-versus-host disease because it was not necessary to do so for our internal purposes. Broad application of this approach across different institutions would most likely require objective criteria to decrease variability in definition interpretation and its effect on reported rates. To a certain extent this is likely unavoidable no matter how proscriptive a definition is, as variability in surveillance results among infection preventionists has been shown with current NHSN definitions.[8]

Not unexpectedly, application of the mCLABSI definition resulted in lower CLABSI rates, a relevant finding in an era of public reporting. We estimate that application of the mCLABSI definition to our medical intensive care unit (ICU) service would affect up to 10% of our reported CLABSIs. Public reporting to the NSHN of CLABSIs occurring outside the ICU is not required at this time. If it were, under current definitions the non-ICU rate at our institution would be 40% higher than what would be found with our mCLABSI definition. Originally, surveillance constructs were applied across institutions to generate important epidemiological information and generalizable knowledge. Now, publicly reported rates are inextricably linked to hospital reimbursement and reputational risk. If surveillance definitions are to be continually used as representations of the quality of care provided, a revisiting of the methodological approach will be required.

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REFERENCES

1. Horan TC, Andrus M, Dudeck MA. CDC/NHSN surveillance definition of health care–associated infection and criteria for specific types of infections in the acute care setting. *Am J Infect Control* 2008;36:309–332.
2. Tunkel AR, Sepkowitz KA. Infections caused by viridans group streptococci in patients with neutropenia. *Clin Infect Dis* 2002; 34:1524–1529.
3. Freifield AG, Bow EJ, Sepkowitz KA, et al. Clinical practice guidelines for the use of antimicrobial agents in neutropenic patients with cancer: 2010 update by the Infectious Diseases Society of America. *Clin Infect Dis* 2011;52(4):e56–e93.
4. Poutsiaka DD, Munson D, Price LL, Chan GW, Snydman DR. Blood stream infection (BSI) and acute GVHD after hematopoietic SCT (HSCT) are associated. *Bone Marrow Transplant* 2011;46:300–307.
5. Fraser TG, Gordon SM. CLABSI rates in immunocompromised patients: a valuable patient centered outcome? *Clin Infect Dis* 2011;52:1446–1450.
6. Tomlinson D, Mermel LA, Ethier MC, Matlow A, Gillmeister B, Sung L. Defining bloodstream infections related to central venous catheters in patients with cancer: a systematic review. *Clin Infect Dis* 2011;53(7):697–710.
7. O'Grady NP, Alexander M, Burns LA, et al; Healthcare Infection Control Practices Advisory Committee. Guidelines for the prevention of intravascular catheter-related infections. *Clin Infect Dis* 2011;52(9):e162–e193.
8. Lin MY, Hota B, Khan YM, et al. Quality of traditional surveillance for public reporting of nosocomial bloodstream infection rates. *JAMA* 2010;304:2035–2041.