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Major article

Single-center study of interrater agreement in the identification of central line–associated bloodstream infection

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Background: Interrater reliability of central line–associated bloodstream infection (CLABSI) determination has not been well studied. The present study evaluated interrater reliability between infection preventionists (IPs) for CLABSI- and other bloodstream infection (BSI)-related factors and examined whether any nurse characteristics are associated with interrater reliability.

Methods: A total of 165 blood cultures were reviewed by 2 IPs assigned at random. Reliability outcomes were CLABSI, infection type (hospital- or community-acquired), presence of a central line, primary versus secondary BSI, secondary source of BSI, and IP-determined source of BSI (primary, secondary, or indeterminate). Kappa coefficients were calculated. Logistic regression was used to evaluate associations between IP characteristics and agreement on diagnosis of CLABSI.

Results: CLABSI agreement was moderate in IP pairs ($\kappa = 0.562 \pm 0.080$) and not associated with IP characteristics. After controlling for IP characteristics associated with secondary outcomes, agreement regarding secondary source was more likely in pairs with a larger absolute difference in years employed ($P = .013$), and agreement regarding infection source was more likely in pairs with larger differences in years employed and duration of certification ($P = .025$).

Conclusions: The rate of IP agreement regarding CLABSI was moderate and not associated with IP characteristics, reflecting adequate training. Education and reassessment of definitions may promote higher rates of agreement between IPs.

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Infection preventionists (IPs) are trained professionals who follow standardized Centers for Disease Control and Prevention (CDC) guidelines for surveillance of hospital-acquired infections (HAIs), including central line–associated bloodstream infections (CLABSI). By the CDC definition, CLABSI is a laboratory-confirmed bloodstream infection (BSI) occurring with a central line in place and not secondary to an infection at another body site.[1] Clinical and laboratory reports and results of other diagnostic tests are used to identify CLABSI; however, the definition of CLABSI does not allow for an unknown or indeterminate conclusion.

CLABSIs are high-risk HAIs associated with significant patient morbidity[2] and mortality[3] and increased hospital costs.[4] To prevent or reduce the incidence of CLABSI, best practice recommendations and prevention bundles from the Institute for Healthcare Improvement and others have become the standard of care.[3-6]

The CDC's definition of CLABSI was published in 1988 and has been validated over time. Revisions were made based on opinions from experts in surveillance, prevention, and control of HAI. The CDC's definition was originally intended for epidemiologic purposes to look for significant trends, identify outbreaks of infection, and calculate infection rates; however, CLABSI has become an important metric of hospital infection prevention activities in recent years. The CDC's definition has high sensitivity but low specificity, thereby capturing all potential CLABSI cases but also including cases that might not be CLABSI from a clinical standpoint.

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The definition was not intended for clinical, diagnostic, or reimbursement purposes.

The incidence of CLABSI has repercussions for hospitals and IPs. Joint Commission National Patient Safety Goal 7 requires implementation of evidence-based guidelines to prevent CLABSI and measure CLABSI rates.[7] Furthermore, as a result of the Deficit Reduction Act of 2005, hospitals that participate in the inpatient prospective payment system do not receive maximum payment for cases of CLABSI (one of the selected conditions) acquired during hospitalization.[8] Interhospital and intrahospital comparisons of CLABSI rates led to increased clinician and health care organization scrutiny of IPs' CLABSI diagnoses and questions about the accuracy of data interpretation. There are few reports in the literature of retrospective assessment of HAIs for sensitivity and specificity by IPs[9-11] and multiple reports of interobserver assessment of wounds and X-rays for infection-related outcomes[12-18]; however, we have found no research reports on the variability of IP interrater reliability for CLABSI determination. Given that the CDC definition of CLABSI is used for public reporting and hospital reimbursement, variability in interpretation of CLABSI should be minimal when determinations are completed by trained IPs.

The primary purpose of this study was to evaluate CLABSI interrater reliability among 8 IPs. Secondary purposes were to determine interrater reliability among the IPs for infection type (hospital- or community-acquired), presence of a central line, primary versus secondary BSI, BSI secondary source type (urinary tract or lower respiratory tract infection), and IP-determined BSI source: primary or secondary, based on CDC definitions. In addition, IPs reassessed the BSI source using 3 options: primary, secondary, or "indeterminate," the latter used to describe cases that did not clearly fit the CDC criteria. We also evaluated whether reliability differences were based on IP characteristics.

METHODS

Data collection for this prospective, cross-sectional, comparative study was completed within a 4-month period in 2011. The study was approved by the hospital's Institutional Review Board.

Setting and sample

The study was conducted within the Department of Infection Prevention at a 1200+-bed quaternary care medical center in northeast Ohio. In 2009, the Department documented a total of 705 HAI BSIs, of which 519 (74%) were CLABSI. All 8 IPs whose primary responsibilities included CLABSI surveillance volunteered to participate in the study by reviewing laboratory-determined positive blood cultures collected from hospitalized inpatients for CLABSI determination.

Power analyses were used to determine the number of BSI samples required to show a moderate agreement among IPs in CLABSI determination ($\kappa > 0.4$) and to examine agreement based on IP characteristics. A sample size of 165 cases, reviewed by 2 IPs, were required to provide 80% power for $\kappa > 0.4$ if the true κ was ≥ 0.6. Calculations were performed using formulas of Donner and Eliasziw[19] in R version 2.11 (R Project for Statistical Computing, Vienna, Austria). For measuring associations between agreement and other characteristics, if 25% of raters had the characteristic of interest and there was moderate correlation among responses from the IP pairs ($r = 0.5$), then there would be 80% power to detect an odds ratio (OR) of ≥ 2.30 as statistically significant. These calculations were based on use of logistic regression with generalized estimating equations using methods described by Liu and Liang,[20] assuming 5 samples per IP pair, and were performed with R version 2.11 software.

Outcomes and measurement

IP characteristics were assessed using a 6-item investigator-developed questionnaire that included years of IP experience, years of clinically based registered nurse employment, years employed at the hospital, highest degree, certification in infection prevention (yes/no), and number of times recertified (to reflect duration of certification). Items used fill-in-the-blank and check-box formats. To maintain IP confidentiality, study numbers were assigned to each of the 8 IPs using a random number generator. The principal investigator was the sole person who could match an IP's name and study number and the sole person who knew the blood culture assignments for each IP pair.

CLABSI agreement by paired IPs was assessed by randomly selecting 2 blood cultures each day from the batch of blood cultures, based on numbers derived from the random number generator. Excluded from the study were those organisms defined as contaminants according to the CDC definition[1] (ie, single-positive coagulase-negative staphylococci, diptheroids, *Bacillus*, *Propionibacterium* spp, viridans group streptococci, *Aerococcus* spp, and *Micrococcus* spp). Blood cultures drawn within 48 hours of admission were excluded in an attempt to eliminate community-onset BSI, although complete elimination was not possible using this method. When a positive blood culture met the exclusion criteria, the principal investigator noted the reason for exclusion and selected a new blood culture, using the next random number on the list, until 2 acceptable cultures were obtained.

Blood culture data were captured on an investigator-developed 5-question case report form that used a check-box format: (1) infection type (hospital- or community-acquired), (2) central line presence or absence, (3) primary or secondary BSI, (4) source of secondary BSI (eg, urine, wound, lower respiratory tract infection; based on CDC definitions), and (5) BSI source (primary, secondary, or indeterminate, based on study definitions). An indeterminate BSI was defined as a BSI that the IP suspected was not a CLABSI, but that met the CDC criteria nonetheless. In addition, IP reported the time spent evaluating the blood culture for CLABSI.

Data collection

After selecting positive blood cultures each day, the principal investigator assigned 2 IPs to evaluate each culture using a list of random numbers generated from the online random number generator. The 2 paired IPs independently reviewed the clinical information from an electronic medical record to identify CLABSI and completed the 5-question case report form. The IPs were instructed not to consult with one another. If discussion was required, then the culture was removed from the study and a replaced with another randomly assigned culture the next day. Completed study cultures were placed in an envelope for the principal investigator.

Statistical analysis

Continuous IP-related factors were summarized using median and interquartile range (IQR). Categorical IP-related factors were summarized using frequency and percent. Comparisons of categorical IP-related factors between blood cultures in which the paired IPs agreed or disagreed regarding CLABSI were performed using the χ^2 test or Fisher exact test, when necessary. Comparisons of pair differences in continuous IP-related factors were performed using Wilcoxon's rank-sum test. Overall percent agreement on CLABSI among IP raters was calculated. The κ statistic that measured IP agreement beyond chance was calculated using methods specifically derived for nominal scales and assuming that

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