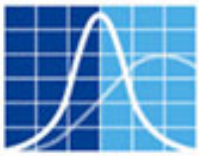

CONCISE COMMUNICATION

Clinical Impact of Blood Cultures Contaminated with Coagulase-Negative Staphylococci at an Academic Medical Center

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Of all blood cultures positive for coagulase-negative staphylococci collected in 1 year at an academic hospital, 100 were selected randomly for review and designated true positives or contaminated. For the 85 patients whose cultures were determined to be contaminated, chart abstractions revealed substantial unnecessary antibiotic administration, additional laboratory tests and procedures, and hospital readmissions.

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Blood cultures are necessary to establish the diagnosis of bloodstream infections and are useful in directing appropriate antimicrobial therapy. Contamination of blood cultures with skin flora, however, poses a substantial problem in the evaluation and management of patients[1] and may result in unnecessary antibiotic use and laboratory assessments as well as adverse reactions to administered antimicrobials and prolonged hospital stays.[2-4] We assessed and quantified such events related to blood cultures contaminated by coagulase-negative staphylococci (CoNS) at an academic medical center.

METHODS

All CoNS-positive cultures of blood drawn from inpatients and emergency department (ED) patients between September 1, 2006, and August 31, 2007, were identified. A computer-generated random sample of 100 of these blood cultures constituted the study population. We excluded cultures that grew *Staphylococcus lugdunensis* or were repeat CoNS-positive cultures from the same patient in the 5 days after an initial CoNS-positive culture sample was drawn. Variables collected for all patients included age, gender, diagnoses received at admission, medical history, maximum and minimum temperatures, leukocyte and absolute neutrophil counts in the 24 hours before and after the initial CoNS-culture-positive sample was drawn, lowest systolic blood pressure in the 24 hours before and after the initial CoNS-positive sample was drawn, presence of prosthetic material (eg, vascular catheters, indwelling urinary catheters, cardiac pacing devices, orthopedic hardware), presence of other identified sources of infection, hospital location at the time of blood sample collection, subsequent blood samples for culture drawn within the event period, sources of all culture samples (eg, peripheral venipuncture, peripheral intravenous catheter, central vascular catheter), and perievent microbiology data (eg, urine, wound, or blood culture data not within the 5-day event period). Additional variables for patients less than 1 year of age included evaluation for apnea and bradycardia in the 24 hours before and after collection of the initial CoNS-positive culture sample.

Two infectious diseases specialists independently reviewed all data collected and designated which of the CoNS-positive blood cultures in the random sample represented contaminants. A third infectious diseases specialist adjudicated the classifications that were not agreed on by the first two specialists. For episodes determined to have involved contaminated blood culture specimens, further data concerning otherwise unnecessary testing or treatment possibly related to the contaminated culture were abstracted. These included antibiotic treatment (including type, duration, and any subsequent adverse drug reactions), collection of additional blood culture samples or serum antibiotic levels, placement or removal of central vascular catheters, and any subsequent testing or actions taken, including hospital admission, readmission, and ED evaluation. These events were attributed to a contaminant event only if explicit description by the clinical caregivers linked these actions to such an event (eg, "central line removed due to gram-positive cocci in blood cultures").

The deidentified, abstracted data were entered into a secured database, and a descriptive analysis was performed. The frequencies of contamination and of each of the attributable events in the original sample were extrapolated to 1 year from the total number of CoNS-positive blood cultures during the study year; confidence intervals were computed using a nonparametric bootstrap with 1,000 repetitions (R statistical software, ver. 2.11.1; www.r-project.org). The study was approved by the Vanderbilt University Medical Center Institutional Review Board.

RESULTS

A total of 1,655 (4%) blood cultures were positive for CoNS out of 40,287 blood samples cultured during the study year. The two infectious diseases specialists initially determined that 74 (74%) and 87 (87%) of the 100 randomly selected episodes represented contaminants; they subsequently agreed that 73 of the cultures were contaminated and 12 were not. A third specialist adjudicated the 15 discrepant designations and determined that 12 represented contaminants, leading to the conclusion that 85 (85%) of the 100 blood cultures were contaminated. The mean age of these patients was 50.5 years, and 48 (56%) of the patients were male. Contaminated specimens were most frequently collected in the adult ED (39/85 [46%]), the adult medical intensive care unit (8/85 [9%]), and the adult trauma intensive care unit (8/85 [9%]).

Events directly attributed to the 85 contaminated specimens are listed in Table 1. Of the 85 patients whose specimens

TABLE 1. Events associated with blood culture contamination

Events attributed to contaminated blood culture specimen	Study cohort[a]	1-year extrapolation (95% CI)[b]
No. of patients	85	1,308 (1,180–1,425)
Additional blood cultures collected	60	893 (613–1,241)
Antibiotic courses[c]	23	354 (230–490)
Serum vancomycin levels collected	18	293 (107–460)
Hospital admission[d]	2	31 (0–77)
Central venous catheter removal	2	31 (0–77)
Echocardiogram	2	31 (0–77)
Subspecialty consultation	2	31 (0–77)
Emergency department evaluation	1	15 (0–46)
Central venous catheter placement	1	15 (0–46)
Postponed operative procedure	1	15 (0–46)

NOTE. Data are number of events unless otherwise specified. CI, confidence interval, computed using a nonparametric bootstrap.

[a] Of 85 patients with contaminants, 49 did not have any attributable events.

[b] Extrapolation of cohort data to estimate the clinical events in 1 year of blood cultures positive for coagulase-negative staphylococci (non–*Staphylococcus lugdunensis*).

[c] Median antibiotic course, 7 days; range, 1–15 days.

[d] Length of stay was 4 days for 1 admission and 5 days for the other.

were contaminated, 36 (42%) had attributable events. Five of those who had attributable events were among the 12 whose specimens were determined by the third specialist to be contaminated. None of the attributable events that occurred only once or twice involved episodes adjudicated by the third specialist. The most common attributable event noted was having additional blood culture samples drawn. Sixty sets of additional blood cultures were distributed among 26 patients; 9 of those with additional blood cultures did not have any other attributable events. Table 1 also displays extrapolation of the data to the total number of blood cultures for the study year.

DISCUSSION

Blood culture contamination is problematic; it can lead to unnecessary and costly care, and it can complicate clinical assessments. Contaminated blood cultures in a pediatric ED were associated with substantial increased costs due to return ED visits, additional laboratory tests, additional antibiotic administration, and hospital admissions.[4] Souvenir et al.[5] estimated that blood culture contaminants resulted in excessive therapy costs of about $1,000 per adult hospitalized patient. Bates et al.[2] reported an even larger difference in total charges between hospitalized adults with false-positive blood culture results and those with negative results (median, $13,116 vs $8,731). In the same study, contaminated cultures were independently correlated with higher charges for intravenous antibiotics and laboratory testing, and the patients involved showed a tendency toward increased length of stay.[2] In a study comparing the use of dedicated phlebotomy teams and other staff on blood culture contamination rates in adults in an ED setting, Gander et al.[6] noted that patient charges were 47% higher for patients with false-positive blood culture results than for those with negative results. In our study, we sought to quantify unnecessary events attributed to CoNS-contaminated cultures and were cautious to attribute actions to contaminated cultures only when these were clearly denoted in the patient records by the provider. The substantial number of events, particularly notable when extrapolated to 1 year, may lead to adverse clinical events, increased costs, and overall patient morbidity.

There are some limitations to this study. Distinguishing contaminants from true infections remains difficult without a gold standard. Even though infectious diseases specialists made the determination of contamination, the clinical factors can be interpreted in different ways, as shown by the lack of complete concordance in the first two reviewers' decisions. Regardless, all of the specialists were blinded to the adverse outcome data at the time of contamination determination. Receipt of antibiotics after the first positive blood culture result may have affected subsequent blood culture results; this could have factored into the specialists' designation of contaminant or true positive. We demonstrated unnecessary medical care for patients with contaminated cultures, but delineating any differences between these events and those for patients with noncontaminated blood culture specimens is beyond the scope of the study. Importantly, the number of unnecessary events was likely underestimated, since only those actions that were explicitly linked to the contaminated cultures were included in the results.

Several studies have suggested methods to reduce blood culture contamination,[7] including standardization of collec-

tion technique and utilization of blood culture sample collection teams.[6,8–10] Our study suggests that substantial unnecessary interventions and possible adverse outcomes can be attributed to blood culture contamination. Implementation of known mechanisms to reduce blood culture contamination more broadly and investigation of further techniques for contamination reduction can, hopefully, prevent such events.

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