Blood Cultures in the Evaluation of Children With Cellulitis

Karin Berger Sadow, MD*, and James M. Chamberlain, MD‡

ABSTRACT. Objective. To evaluate the yield of blood cultures obtained from immunocompetent children admitted for cellulitis in the post-Haemophilus influenzae type b (Hib) vaccine era and to determine whether these cultures are cost-effective.

Design. Retrospective case series.

Setting. Urban pediatric emergency department.

Study Population. Patients 2 days to 22 years of age admitted with cellulitis from 1994 through 1995.

Measurements and Results. Of 381 patients identified, 266 (70%) had blood cultures and 243 of these children were enrolled. Data recorded include demographics, immunization status, initial clinical appearance, antibiotic pretreatment, preexisting illness, location and precipitating cause of cellulitis, white blood cell count, and band-to-neutrophil ratio (BNR). Blood cultures were categorized as positive, negative, or contaminant. Five cultures (2%) were positive, and 13 (5.4%) were contaminants. The positive blood cultures grew streptococcus and staphylococcus organisms, and none of the children were bacteremic with H influenzae. All patients with group A β-hemolytic streptococcus had active varicella. The mean age was lower (26 vs 75 months) in those with a positive blood culture, and mean BNR was higher (0.32 vs 0.07). Patient management did not change for bacteremic patients with uncomplicated cellulitis. All repeat cultures were negative. The cumulative charge for all blood cultures was $50 986.

Conclusions. Blood cultures are not cost-effective and are more frequently contaminated than positive in the evaluation of a patient with uncomplicated cellulitis. Since introduction of the H influenzae type b vaccine, the most common organisms are streptococci. Using a BNR = 0.20 as a threshold for sending blood cultures, we would have missed one positive culture, but would have avoided blood cultures in 213 patients (88%) with an estimated savings of $42 850. Pediatrics 1998;101(3). URL: http://www.pediatrics.org/cgi/content/full/101/3/e4; cellulitis, bacteremia, health care costs.

ABBREVIATIONS. Hib, Haemophilus influenzae type b; ED, emergency department; WBC, white blood cell; BNR, band-to-neutrophil ratio; GABHS, group A β-hemolytic streptococcus; CI, confidence interval.

From the Departments of Pediatrics and Emergency Medicine, George Washington University School of Medicine and Health Sciences and Children’s Hospital, Washington, DC.

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Reprint requests to (K.B.S.) Children’s National Medical Center, 111 Michigan Ave, NW, Suite 1450, Washington, DC 20010.


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Cellulitis is a common soft-tissue infection in pediatric patients. Children are prone to develop cellulitis because they frequently sustain minor traumatic injuries such as insect or animal bites, lacerations, and abrasions. Blood cultures are commonly performed on children admitted for cellulitis, despite previous literature suggesting a low yield except in cases of Haemophilus influenzae. 1-3 Blood cultures have been advocated because of the high rate of bacteremia with H influenzae, 1 but the prevalence of this pathogen has dramatically decreased since the introduction of the H influenzae type b (Hib) vaccine in 1985. 2 The purpose of this study was to determine the yield of blood cultures obtained from children admitted for cellulitis in the post-Hib vaccine era. Our hypothesis was that blood cultures are not cost-effective in the management of immunocompetent patients admitted for cellulitis. A secondary aim of the study was to investigate clinical factors associated with positive blood cultures.

METHODS

Study Design and Population

This retrospective case series was conducted at an urban university-affiliated pediatric referral center. The annual emergency department (ED) census is 50 000, with a 14% admission rate. ED patients are evaluated by housestaff in pediatrics, emergency medicine, and family medicine. Supervision is provided by pediatric emergency medicine attending physicians and fellows.

Eligible patients were identified by a computer search of patients admitted after evaluation in the ED from January 1, 1994 to December 31, 1995 with a diagnosis of cellulitis. Hospital records were reviewed, and patients were excluded if records could not be located or if the patient developed cellulitis after hospital admission.

The billable charges associated with performing blood cultures were obtained from the Department of Laboratory Medicine and included the following: aerobic culture, $128; anaerobic culture, $71; and sensitivity for positive blood culture, $65. During the study period, obtaining blood cultures included aerobic and anaerobic cultures.

The following risk factors for bacteremia were abstracted from the medical record: age, sex, race, immunization status, toxic appearance, antibiotic pretreatment, preexisting illness, location and precipitating cause of cellulitis, maximum temperature, white blood cell (WBC) count, and band-to-neutrophil ratio (BNR). Blood cultures were defined as positive if they grew Staphylococcus aureus, group A β-hemolytic streptococcus (GABHS), Streptococcus pneumoniae, or H influenzae, and defined as contaminated if they grew Staphylococcus epidermidis, Streptococcus viridans, or micrococcus species. Cultures were considered negative if no organism was found. The inpatient records of those patients with positive and contaminated cultures were reviewed to determine whether there was a change in hospital management, defined as a change in antibiotic therapy or the performing of additional diagnostic tests, including repeat blood cultures. The mean length of hospital stay was compared in the positive and negative/contaminated blood culture groups.
Analysis
Statistical analysis was performed using Kwikstat and Epistat statistical software. Descriptive statistics are reported as means (±SD) and medians with ranges. The association of categorical variables with bacteremia was tested using the chi-squared test, and the association of continuous variables with bacteremia was tested with the t test and analysis of variance. A critical α of 0.05 was considered statistically significant.

RESULTS
During the 2-year study period, 381 inpatients were identified with a hospital discharge diagnosis of cellulitis. In 266 (70%) of these patients, blood cultures were obtained. Twenty-three patients were excluded (19 charts were unavailable, and 4 patients developed cellulitis after hospitalization). The remaining 243 comprised the study sample. During the same period, there were 108 patients with other infections having International Classification of Diseases, 9th ed, codes other than cellulitis who were not included in our study (4 patients with erysipelas, 22 with impetigo, and 82 with chickenpox with other complication).

The mean age of patients was 6.2 ± 5.0 years, and 57% were female. Sixty-seven percent were African-American, 16% white, and 11% Hispanic. Immunizations were current for 94% of patients, and only 22% were pretreated with antibiotics before admission (47 oral, 5 intramuscular, and 1 intravenous). The majority (91%) of patients had either no or noncontributory underlying disease. None of the patients with positive blood cultures were pretreated or had an underlying medical condition.

A total of 236 patients (97%) were described as nontoxic, 1 was described as toxic, and 1 was in shock. The toxic-appearing patient had cellulitis after pin removal for slipped capital femoral epiphysis, and the second patient was a hypotensive 15-year-old with a trunk cellulitis of unknown etiology. Both of these patients had negative blood cultures, although 1 was pretreated with intramuscular cefazolin.

The location and precipitating cause of cellulitis are depicted in Figs 1 and 2. Thirty percent of patients had cellulitis involving an extremity. Most cases of cellulitis (72%) were uncomplicated, but 60 (25%) of the patients had an abscess, 3 (1.2%) had osteomyelitis, 1 had a septic joint and osteomyelitis, 1 had a septic joint and psoas abscess, 1 had mastoiditis, 1 had tenosynovitis, and 1 had a thigh abscess and compartment syndrome.

Blood cultures were positive in 5 patients (2.1%; 95% confidence interval [CI]: 0.67, 4.74) and contaminated in 13 (5.4%; 95% CI: 2.88, 8.97). The positive blood cultures grew streptococcus (n = 4) and staphylococcus organisms (n = 1). The characteristics of these bacteremic patients are shown in Table 1. All patients bacteremic with GABHS had active infection with varicella. The patient with S aureus had a cellulitis complicated by a septic elbow and osteomyelitis, and the patient with S pneumoniae had a septic hip and psoas abscess. There were no positive blood cultures in the 53 pretreated patients (0%; 95% CI: 0, 6.7) and 5 positive blood cultures in 290 patients who were not pretreated (2.6%; 95% CI: 0.86, 6.0).

The mean age was lower (26 vs 75 months; P = .01) in those with a positive blood culture, and the mean BNR was higher (0.32 vs 0.07; P < .001). The mean temperature was 39.3°C in bacteremic patients and 38.0°C in nonbacteremic patients (P = .018). The mean WBC count for bacteremic patients was 23 600 ± 19 950/μL, and for nonbacteremic patients 14 870 ± 14 850/μL (P = .386).

For those patients with a positive culture and uncomplicated cellulitis, patient management did not change other than obtaining a repeat culture for every positive and contaminated culture. All repeat cultures were negative. The only change in antibiotic therapy was for a patient with a septic hip and psoas abscess; vancomycin was added to
the initial therapy of oxacillin and cefotaxime after the blood and abscess cultures grew S pneumoniae.

The length of stay for the bacteremic patients was $14.6 \pm 9.8$ days, and for the nonbacteremic patients, $4.5 \pm 4.2$ days ($P < .001$). For the patients with uncomplicated cellulitis and positive blood cultures ($n = 2$), the lengths of stay were 3 and 11 days, similar to the mean length of stay in the negative/contaminated group. For the three bacteremic patients with associated diseases (one abscess and compartment syndrome, one osteomyelitis and septic arthritis, and one septic arthritis and psoas abscess), the lengths of stay were 19, 11, and 29 days.

The charge to patients associated with negative blood cultures was $44,775 (\$128 per aerobic culture + \$71 per anaerobic culture \times 225 cultures). The charge for positive blood cultures was $1320 ([\$128 + \$71 + \$65 for sensitivities] \times 5$) and contaminated cultures $2587 ([\$128 + \$71] \times 13). The charge for repeat cultures was $2304 (\$128 \times 18). The cumulative charge associated with obtaining blood cultures was $50,986.

DISCUSSION

This study is the first to define the yield of blood cultures in children admitted for all types of cellulitis in the post-Hib vaccine era. It is also the first study to attempt to determine the cost-effectiveness of routine blood cultures in the management of these patients. Many previous studies and standard textbooks advocate obtaining blood cultures in the evaluation of patients with cellulitis, but this recommendation was based historically on the high frequency of bacteremia with H influenzae.1–4

In only 5 (2%) of 243 patients did the blood culture yield a true pathogen. Four of the five isolated pathogens were of the streptococcal species. This is consistent with the observations of Schwartz et al5 in their retrospective series of periarticular cellulitis in the post-Hib vaccine era. In our study, no children were bacteremic with H influenzae.

Children with a true-positive blood culture result had a lower mean age and a higher mean BNR. Based on our data, if we would have used a BNR = 0.20 as a threshold for sending blood cultures, we would have missed one positive blood culture (a 5-year-old with active varicella and GABHS bacteremia, BNR = 0.02), but would have avoided blood cultures in 213 patients (88%). This corresponds to an estimated savings of $42,850.

The association of GABHS with varicella in this study is of interest and has been observed in previous studies.6,7 Fifteen percent of the patients in our study with varicella and cellulitis were bacteremic, and all presented on the third to fifth day of illness. As described by Doctor et al,6 invasive GABHS infections must be considered in children with varicella and fever on or beyond the third day of illness. In their study, it was noted that the average WBC count of patients with varicella and bacteremia was not elevated (11,500 ± 8400/\mu L). Two of our patients with a positive blood culture and varicella had normal WBC counts (6000 and 12,000/\mu L, respectively), whereas the other had an elevated WBC count of 25,000/\mu L. The results of both studies suggest that a normal WBC count does not preclude the possibility of bacteremia with GABHS during varicella infection.

The patients bacteremic with S aureus and S pneumoniae both had complicated cellulitis; one had a septic elbow and osteomyelitis (S aureus), and the other, a septic hip and psoas abscess. Both of these patients were <6 months of age. Because of their age and associated pathology, a blood culture was indicated as part of their complete evaluation.

Our study had several limitations. First, it is a retrospective study, thus, reports of clinical appearance and documentation of precipitating cause are limited to the patient record. Second, we may have missed some cases of bacteremia because 22% of the patients were pretreated with antibiotics before a blood culture was obtained. Finally, 30% of patients admitted did not have blood cultures performed.

Although the study design does not allow us to calculate the true incidence of bacteremia, several recommendations can be made based on this large case series. First, positive blood cultures are uncommon and were seen only in association with active varicella or underlying soft-tissue infections (osteomyelitis, septic arthritis). Second, blood cultures were twice as likely to be contaminated than positive. Third, obtaining blood culture studies involves significant costs, including financial and emotional costs (pain, etc) of repeating studies in the 5% of patients with contaminants. Finally, the small number of bacteremic patients precludes definitive statements about the prospective use of the complete blood count or BNR to predict bacteremia.

Most children with cellulitis are treated as outpatients. For children ill enough to be admitted, the associations noted with young age, high BNR, and varicella lend support to a practice of performing blood cultures in young children with any of these risk factors. However, another reasonable interpretation of our data would be not to obtain a complete blood count or blood culture unless the patient had varicella, an associated osteomyelitis or septic arthritis, or a toxic appearance.

In summary, blood cultures are not cost-effective

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TABLE 1. Characteristics of Bacteremic Patients at Presentation

<table>
<thead>
<tr>
<th>Age (Months)</th>
<th>Organism</th>
<th>Height of Fever (°C)</th>
<th>BNR</th>
<th>Location</th>
<th>Associated Pathology</th>
</tr>
</thead>
<tbody>
<tr>
<td>60</td>
<td>GABHS</td>
<td>39.3</td>
<td>0.02</td>
<td>Extremity</td>
<td>Varicella</td>
</tr>
<tr>
<td>48</td>
<td>GABHS</td>
<td>39</td>
<td>0.28</td>
<td>Extremity</td>
<td>Varicella, abscess, and compartment syndrome</td>
</tr>
<tr>
<td>12</td>
<td>GABHS</td>
<td>40.5</td>
<td>0.58</td>
<td>Trunk</td>
<td>Varicella</td>
</tr>
<tr>
<td>4</td>
<td>Streptococcus pneumoniae</td>
<td>39.4</td>
<td>0.40</td>
<td>Extremity</td>
<td>Septic hip and psoas abscess</td>
</tr>
<tr>
<td>6</td>
<td>Staphylococcus aureus</td>
<td>38.5</td>
<td>0.30</td>
<td>Extremity</td>
<td>Septic elbow and osteomyelitis</td>
</tr>
</tbody>
</table>
in the management of immunocompetent patients admitted for cellulitis. The costs associated with obtaining blood cultures are substantial, and the results do not alter therapy. In addition, iatrogenic injury may result from repeating blood cultures when initial cultures are positive or contaminated. Clinicians who wish to obtain blood cultures should limit cultures to toxic-appearing children, patients with varicella, or those with another focus of infection, such as a septic joint.

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REFERENCES
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