



Practice Patterns of Providers for the Management of *Staphylococcus aureus* Bacteremia in Children: Results of an Emerging Infections Network Survey

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We conducted a survey of pediatric infectious diseases providers in the Emerging Infections Network regarding the workup and treatment of children with *Staphylococcus aureus* bacteremia (SAB). We found significant practice variation in the management of children with SAB. These findings emphasize the need for further research to guide best practices.

Keywords. bacteremia; children; *Staphylococcus aureus*.

Staphylococcus aureus is a leading cause of bacteremia in children; however, optimal management of these patients remains unclear [1, 2]. The Infectious Diseases Society of America (IDSA) guidelines for the treatment of methicillin-resistant *S aureus* (MRSA) bacteremia recommend vancomycin therapy for up to 6 weeks, depending on the source and clinical response [3]. Guidelines for the treatment of methicillin-susceptible *S aureus* (MSSA) bacteremia recommend nafcillin as first-line therapy, with cefazolin as an alternative [4].

Despite these recommendations, the application of broad guidelines to specific scenarios encountered in the management of *S aureus* bacteremia (SAB) in children remains difficult. Recent literature has challenged long-held notions regarding

optimal management of SAB associated with osteoarticular infections [5, 6]; however, there remains a paucity of evidence to guide management in several other common scenarios including the following: nonpersistent SAB without a source, prolonged MRSA bacteremia, and central-line associated SAB. Given the complexity in the management of children with SAB, we sought to describe practice patterns and clinical decision making among pediatric infectious diseases (PID) providers.

METHODS

From January to February 2017, we distributed a 7-question, electronic, vignette-based survey (Supplementary Data, <https://ein.idsociety.org/surveys/survey/100/>) of clinical scenarios related to the management of SAB in children to PID providers in the Emerging Infections Network of the Infectious Diseases Society of America (IDSA EIN).

The survey questions explored diagnostic and treatment practices of providers for patients with osteomyelitis-associated SAB, nonpersistent SAB (<48 h), persistent MRSA bacteremia, peripherally inserted central catheter (PICC)-associated thrombosis with SAB, and parenteral treatment of choice for MSSA bacteremia.

Demographic information regarding practice region, experience, and employment was collected by EIN membership profile. Similar to previous EIN surveys, the response rate was calculated from PID EIN members who had ever responded to a survey [7, 8]. Descriptive statistics were calculated as percentages for each response category.

RESULTS

Two hundred twenty-three of 334 (67%) clinicians with a PID practice responded from the United States and Canada, most (37%) having 5–14 years of clinical experience, and the majority practicing at a university hospital (62%). Fourteen (6%) providers do not manage children with SAB and were excluded from the analysis.

Osteomyelitis-Associated *Staphylococcus aureus* Bacteremia

For children with osteomyelitis-associated SAB showing clinical improvement shortly after initiation of antibiotics, almost all (97%) providers routinely repeat blood cultures until negative, whereas a minority routinely image the heart (29%), abdomen (3%), retina (6%), or vasculature (eg, Doppler ultrasound, 12%) (Figure 1A). Figure 1B shows the various treatment approaches taken by pediatric providers, with half (50%) treating intravenously only for those with persistent bacteremia (>48–72 hours), whereas 28% treat almost all patients with 10–14 days of intravenous (IV) antibiotics and 22% treat with oral antibiotics

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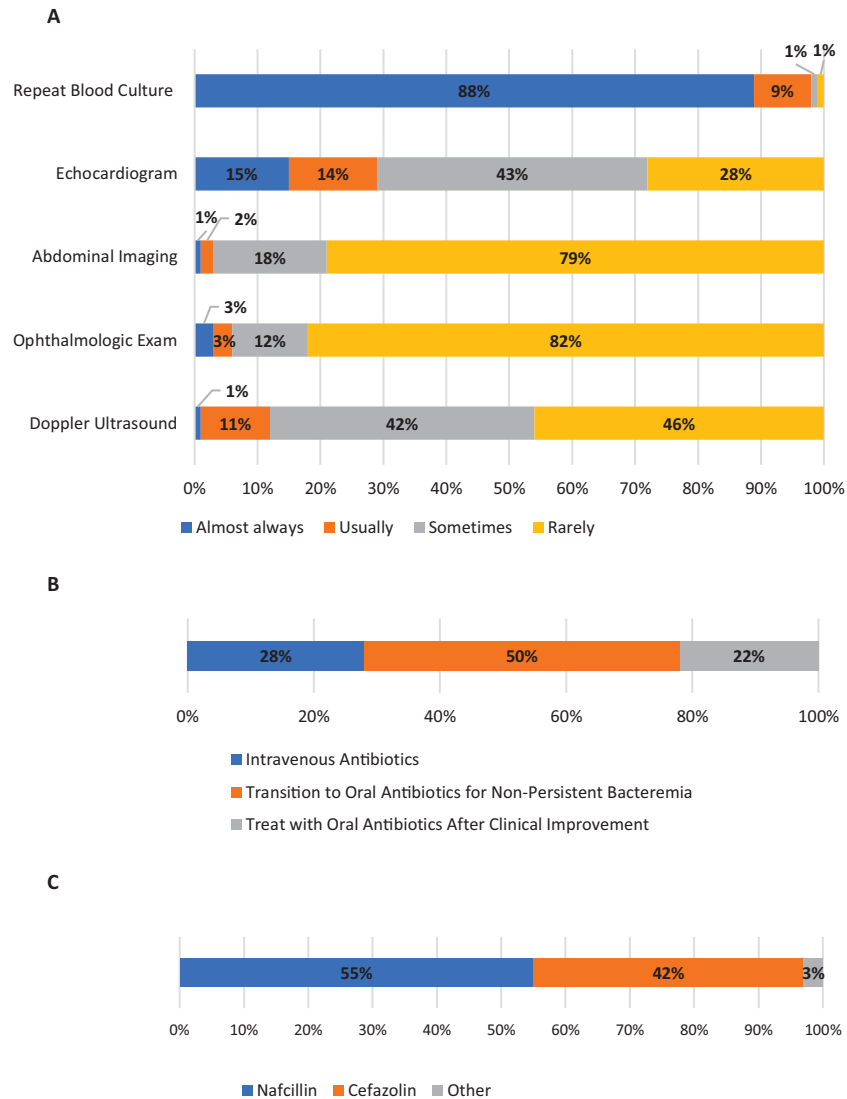


Figure 1. Practice patterns among providers for the workup and treatment of osteomyelitis-associated *Staphylococcus aureus* bacteremia (SAB). (A) Diagnostic workup for a child with osteomyelitis-associated SAB that is improving shortly after antibiotic initiation. Almost all providers repeat blood cultures until negative; however, the minority will routinely look for other foci of infection. (B) For the treatment of osteomyelitis-associated SAB, 50% of providers will switch to an oral regimen for nonpersistent bacteremia. Twenty-eight percent and 22% will treat with all intravenous antibiotics or treat with oral antibiotics after clinical improvement, respectively. (C) For the treatment methicillin-susceptible *Staphylococcus aureus* bacteremia with osteomyelitis, 55% of clinicians use nafcillin, 42% use cefazolin, and 3% use an alternative agent.

once they have clinically improved (ie, no minimum duration of parenteral therapy). For those with MSSA bacteremia, nafcillin and cefazolin are used similarly (Figure 1C).

Nonpersistent *Staphylococcus aureus* Bacteremia

For febrile, well appearing children with only 1 *S aureus* blood culture, no clear source of infection, and subsequent negative cultures before antibiotics, 54% of providers treat with oral antibiotics after empiric vancomycin; 25% complete therapy with IV antibiotics, and 17% discontinue antibiotics, assuming that *S aureus* is a contaminant. A small proportion (4%) of providers chose an alternative management strategy, including evaluating for a source of infection (3%).

Persistent Methicillin-Resistant *Staphylococcus aureus* Bacteremia

For the treatment of children with persistent MRSA bacteremia despite adequate vancomycin levels, 37% continue vancomycin and add a second agent, most commonly rifampin. A minority (12%) continue vancomycin monotherapy, whereas 43% change to other agents, most commonly daptomycin; 8% of providers chose an alternative management strategy.

Peripherally Inserted Central Catheter-Associated Thrombus With *Staphylococcus aureus* Bacteremia

There was no consensus on the duration of IV therapy for children with PICC-associated thrombus and bacteremia; 34% treated for 2 weeks, 37% treated for 4 weeks, 18% treated for

6 weeks, and 11% chose an alternative treatment strategy. The majority (71%) recommend anticoagulation.

DISCUSSION

This study provides insights on the variation in the management of children with *S aureus* bacteremia. Notably, we found very little agreement in (1) the optimal route of antibiotics for children with osteomyelitis-associated SAB and nonpersistent SAB, (2) choice of antibiotic for MSSA bacteremia, (3) antibiotic approach in children with persistent MRSA bacteremia on vancomycin, and (4) optimal duration of antibiotics for PICC-associated thrombus and SAB.

These results highlight the complexity in caring for children with SAB and current gaps in consensus guidelines for the optimal management of these patients. Clinicians often encounter scenarios with little data to support treatment decisions, or they are forced to extrapolate data from adult studies. In children with SAB, however, the mortality, pathophysiology, and antibiotic pharmacokinetics are quite different than adults [3, 9–11]. The IDSA guidelines for MRSA bacteremia recommend echocardiography for all adult patients, whereas in children this is only recommended for those with congenital heart disease, persistent bacteremia (>48–72 hours), or clinical findings suggestive of endocarditis. Our results reflect this recommendation because less than one third of providers routinely obtain an echocardiogram in a clinically improving child with SAB (Figure 1A). Notably, for a vignette describing bacteremia in a child with significant atopic dermatitis, 17% of respondents chose to discontinue antibiotics, assuming that *S aureus* was a contaminant—a recommendation at odds with the Committee on Infectious Diseases recommendation that “*S. aureus* almost never is a contaminant when isolated from a blood culture” [12]. Although it is certainly biologically plausible that a positive blood culture for *S aureus* could be a result of skin contamination, particularly in atopic dermatitis with or without cutaneous *S aureus* infection, there is historic precedent to treat these children with a short course of parenteral antibiotics. Whether this is suitable in practice is thus far unstudied and merits further discussion in subsequent guideline revisions.

The optimal route of antibiotics for children with SAB is a scenario in which practice variation is high and is an area of ongoing research among PID specialists. There is a growing body of evidence, particularly in bacteremic osteoarticular infections, that an early switch to oral antibiotics is safe and does not increase the risk of treatment failure [5, 6]; however, many clinicians remain hesitant to adopt this practice due to the invasive nature of the infection and uncertainty of absorption/penetration of some oral antibiotics. This study illuminates the need for ongoing investigation in this area.

The implications of practice variation in the management of children with SAB are numerous, including unnecessary diagnostic

testing (eg, echocardiogram, visceral imaging), invasive procedures (eg, PICC line insertion), and prolonged antibiotic exposure. Moreover, this variation leads to increased healthcare costs and risk of adverse effects. Identifying areas in which these variations exist provides an opportunity to improve the value of healthcare delivery and reduce costs without compromising patient care.

CONCLUSIONS

Our study has certain limitations. The response rate, although acceptable for this type of survey, may lead to sampling bias, and it may not be generalizable to all PID providers. However, there was an equal distribution of responders throughout most regions of the United States, which may limit this bias. In addition, responses to vignette-based questions may be subject to response bias, and we recognize that vignettes may only approximate what is actually done in clinical practice. Finally, the anonymity of the survey is designed to allow responders to answer questions as accurately as possible; however, survey answers may not accurately reflect true practice patterns. Nevertheless, this study highlights the substantial variation in the management of children with SAB, can inform guidelines, and should guide our next steps in evaluating best practice patterns for this challenging pathogen.

Supplementary Data

Supplementary materials are available at *Journal of the Pediatric Infectious Diseases Society* online (<http://jpid.oxfordjournals.org>).

Notes

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