

## Things We Do For No Reason™: Routine Blood Culture Acquisition for Children Hospitalized with Community-Acquired Pneumonia

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Inspired by the ABIM Foundation's Choosing Wisely® campaign, the "Things We Do for No Reason™" (TWDFNR) series reviews practices that have become common parts of hospital care but may provide little value to our patients. Practices reviewed in the TWDFNR series do not represent "black and white" conclusions or clinical practice standards but are meant as a starting place for research and active discussions among hospitalists and patients. We invite you to be part of that discussion.

### CLINICAL SCENARIO

A 4-year-old previously healthy, fully immunized boy presented to the emergency department (ED) with three days of worsening cough, fever to 103°F, dyspnea, and decreased oral intake. In the ED, he was febrile, temperature 102.7°F, heart rate 115 beats/min, respiratory rate 30 breaths/min, and O<sub>2</sub> saturation 86%. Pertinent findings identified on examination included tachypnea, dry mucous membranes, and decreased breath sounds in the posterior right lung fields. Chest radiograph revealed a right lower lobe opacification concerning for community-acquired pneumonia (CAP). He was admitted to the hospital due to hypoxemia and dehydration. A blood culture was obtained, and treatment with ampicillin was initiated. The following morning, he was afebrile, clinically improved, and no longer hypoxemic, but the blood culture grew Gram-positive cocci. Another blood culture was performed, and he was switched to vancomycin. The next day, penicillin-susceptible *Streptococcus pneumoniae* was confirmed from the original culture, and he was discharged home on high-dose amoxicillin.

### WHY YOU MIGHT THINK A BLOOD CULTURE IS HELPFUL

CAP is a prominent cause of childhood morbidity and among the most common causes for acute childhood hospitalizations in the United States, with 124,900 hospital stays documented

in 2012.<sup>1</sup> In 2011, the Infectious Diseases Society of America (IDSA) released recommendations for pediatric CAP in immunocompetent children aged >3 months without chronic medical conditions. The recommendations clearly discourage blood cultures in the outpatient setting but are less direct in the inpatient setting. The recommendations state that providers should obtain blood cultures "in children requiring hospitalization for presumed bacterial CAP that is moderate to severe, particularly those with complicated pneumonia."<sup>2</sup> The recommendation is graded as "strong", though the IDSA acknowledged the "low" quality of supporting evidence. Although the organization provides a classification for "complicated pneumonia," it does not define what constitutes mild versus moderate or severe pneumonia.

Without clear recommendations, decisions to obtain blood cultures for hospitalized children with CAP vary among providers and institutions, with the reported hospital-to-hospital variation being as large as 0%-78.7%.<sup>3</sup> Some believe that any child hospitalized with CAP meets the definition of moderate to severe pneumonia and have implemented projects to increase blood culture acquisition for this population.<sup>4</sup> The decision to err on the side of routinely obtaining a blood culture may come from providers' prevalent worry of "missing" a diagnosis, desire to target antibacterial therapy, and assumption that it will provide additional information for patients lacking improvement.

### WHY A ROUTINE BLOOD CULTURE ON PEDIATRIC CAP ADMISSIONS IS NOT HELPFUL

Since the publication of the 2011 IDSA guidelines, new evidence has revealed a decreasing incidence of bacteremia in pediatric populations.<sup>5</sup> Moreover, viruses were the most frequently identified pathogens in children hospitalized with CAP in a large study, which were isolated in 66% of patients, whereas typical bacteria (either alone or in combination with a virus) were identified in only 7% of cases.<sup>6</sup> When blood cultures are obtained for pediatric CAP, the incidence of a true bacterial bloodstream pathogen is 1.4%-7% of patients in the United States in the conjugate vaccine era.<sup>7-11</sup> Given that the practice of obtaining blood cultures varies widely among hospitalized patients and that cultures are often obtained based on perceived severity of presentation,<sup>8,9,12</sup> the true incidence of bacteremia in children with CAP would likely be lower if blood

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TABLE. Summary of Study Types, Rates of Bacteremia in Complicated vs Uncomplicated Patients, and Study-Specific Definitions of Complicated Pneumonia.

Author/Year	Population/Study Type	Rate of True Bacteremia in all Patients with Blood Cultures Drawn	Rate of Bacteremia in Patients with Complicated and Uncomplicated Pneumonia	Definition of Complicated Pneumonia
IDSA, 2011 <sup>2</sup>	Guideline	Mostly 1.4%-3.4%, outlier 11.4%	13%-26.5% <sup>a</sup> of complicated CAP	Multilobar, effusion, empyema, abscess, necrosis, pneumothorax, bronchopleural fistula
Shah et al. 2011 <sup>11</sup>	Retrospective case control ED + inpatient Single center 2006-2007	2.6% (6/227)	13% of complicated CAP <sup>b</sup>	Effusion, empyema, abscess, necrosis, bronchopleural fistula
Heine et al. 2013 <sup>7</sup>	Retrospective cohort ED + inpatient Single center 2010-2011	3.2% (5/155)	17.8% (5/28) of complicated CAP 0% (no cases) of UC hospitalized	Effusion, empyema, abscess
Myers et al. 2013 <sup>8</sup>	Retrospective cohort Inpatient Four hospitals 2010	7.1% (26/369)	10% (4/40) of complicated CAP 5.8% (19/325) of UC/hospitalized	Effusion (moderate-large), abscess, necrosis, bronchopleural fistula, pleural drainage required
Neuman et al. 2017 <sup>9</sup>	Retrospective cohort Inpatient Six hospitals 2007-2011	2.5% (65/2568)	4.2% of severe or complicated 2.2% of nonsevere/UC	Pleural drainage required on hospital day 1 or 2, severe: admitted to ICU

<sup>a</sup>Outliers noted in single center study in Utah, noted to have unusually high rate of empyema and perhaps related to local strain of *S. pneumoniae*

<sup>b</sup>The authors of this report estimate a rate of bacteremia in uncomplicated pneumonia of 1% (2/195) based on the results in the manuscript.

Abbreviations: CAP, community-acquired pneumonia; ED, emergency department; ICU, intensive care unit; IDSA, Infectious Diseases Society of America; UC, uncomplicated.

cultures were performed in all patients.

Since the introduction of the first conjugated pneumococcal vaccine, the prevalence of penicillin resistance among pneumococcal isolates dramatically declined,<sup>13</sup> though with geographic variability.<sup>14</sup> Therefore, when we isolate pneumococcus strains, resistance prevalence requires that we alter treatment much less frequently in the majority of patients with CAP receiving IDSA-recommended ampicillin/amoxicillin.<sup>2</sup> In a large six-center, geographically dispersed retrospective cohort study, Neuman et al. reported a rate of true bacteremia of 2.53%; 82% of all pathogens and 92% of pneumococcal isolates were susceptible to penicillin. Therefore, the authors estimated that 667 children hospitalized with CAP would need blood cultures to identify one child requiring an antibiotic other than an aminopenicillin.<sup>9</sup> *Staphylococcus aureus* was identified only in 1% (23/2,138) of patients in the EPIC cohort; the pathogen was identified via blood culture in only 26% (6/23) of these patients.<sup>15</sup> Therefore, the concern about the possibility of *S. aureus* may be a common reason for physicians straying from IDSA-recommended therapy, but it is an uncommon cause of CAP and infrequently identified via blood culture.

Blood culture contaminants have been reported to approach the rate of true pathogens in some studies<sup>8,9,11</sup> and be equal or exceed the rates in others.<sup>7,16</sup> While awaiting bacterial speciation, antibiotic coverage is often broadened, even for contaminants,<sup>8</sup> which can result in unnecessary exposure to nephrotoxic agents such as vancomycin, cause rare adverse events such as Stevens-Johnson syndrome, contribute to an-

tibiotic resistance and unnecessary costs, and increase the length of stay and laboratory utilization.<sup>17-19</sup>

## WHEN MIGHT A BLOOD CULTURE BE HELPFUL

Given the low penicillin resistance prevalence among pneumococcal isolates in several parts of the United States, blood cultures should be used to identify patients with nonpneumococcal CAP as these patients are more likely to require antibiotics other than penicillin or aminopenicillin. Children with complicated pneumonia are more likely to have nonpneumococcal etiologies than children with uncomplicated pneumonia.<sup>2</sup> Moreover, literature published since the IDSA guidelines continues to indicate that the incidence of bacteremia in complicated pneumonia is significantly higher than that in uncomplicated pneumonia (Table). This further supports the IDSA guideline recommendation for blood culture acquisition in children with complicated pneumonia.<sup>2</sup>

One difficulty in interpreting these data is that each publication used a different definition of "complicated" pneumonia, probably due to differences in data sources. Neuman et al. incorporated the narrowest definition of severe and complicated pneumonia as patients who were either admitted to an intensive care unit (ICU) or who underwent a pleural drainage procedure.<sup>9</sup> Myers' and Shah's definitions were similar to each other but much broader than that of Neuman et al. Shah et al. included lung abscess/necrosis, parapneumonic effusion/empyema, or bronchopleural fistula.<sup>11</sup> Myers et al. included the same indications but qualified their pleural fluid effusions

as “moderate-to-large” and any effusion that required pleural drainage procedure.<sup>8</sup> Myers et al. also reported bacteremia in 75% of patients with metastatic complications, including osteomyelitis.<sup>8</sup> These definitions of complicated pneumonia may at least partially explain the differences noted in the rates of bacteremia in complicated pneumonia, with the patients in the study of Myers et al. potentially representing the most severe cohort and with the highest rate of bacteremia<sup>8,9</sup> (Table).

These studies not only support the definition of complicated pneumonia put forward by the IDSA but also provide further information, though imperfect, on how to define “moderate to severe.” All the patients with bacteremia in the report of Heine et al. had complicated pneumonia and were described on chart review as either toxic-appearing or requiring ICU care.<sup>7</sup> This, in addition to the inclusion of ICU care in the definition of complicated pneumonia of Neuman et al.,<sup>9</sup> indicates that children with CAP requiring ICU care may be at higher risk of bacteremia. In fact, the British Thoracic Society guidelines do not recommend microbiological investigations of children with CAP, including blood culture, unless a child requires ICU care.<sup>20</sup>

## WHAT YOU SHOULD DO INSTEAD

Given the low rate of bacteremia in CAP, the risk of blood culture contaminants, and the small likelihood that isolation of a pathogen alters treatment for children, we recommend not using hospital admission as the determining factor for blood culture acquisition. Instead, we recommend a more targeted approach. To achieve a higher rate of true-positive bacteremia in immunocompetent children with up-to-date vaccinations, we recommend acquiring a blood culture in children with complicated pneumonia, metastatic complications, or with ICU needs. By initiating the IDSA-recommended ampicillin/amoxicillin in the remaining hospitalized patients and acquiring blood cultures for the minority of patients who do not improve, we can increase the likelihood of isolating penicillin-resistant bacteria.

Attempting to balance the importance of identifying clinically important bacteremia for children hospitalized with CAP and the inherent risks of obtaining blood cultures for all hospitalized patients, Andrews et al. created and analyzed a cost-effectiveness model. The authors compared universal acquisition of blood cultures for hospitalized children with CAP versus a targeted approach with blood cultures obtained in patients with effusion or empyema, requiring ICU care, or who are immunosuppressed. Based on this model, a targeted approach could save more than \$187 million annually, reduce the number of cultures needed to result in a meaningful change in antibiotic therapy for one patient from 122 to 42, and would “miss” only approximately one case of bacteremia resulting in treatment failure per 1,400 patients.<sup>17</sup>

## RECOMMENDATIONS

- Do not obtain blood culture routinely for children aged >3 months hospitalized for uncomplicated CAP.
- Obtain a blood culture for the following hospitalized patients with CAP:

- a. Patients with complicated CAP as defined by the IDSA, particularly those with empyema, abscess, or fistula, or metastatic complications of pneumonia (Table); or
- b. Patients with CAP requiring ICU care<sup>20</sup> for the management of shock and/or advanced respiratory support.
- c. Patients with CAP judged to need antibiotic treatment with an agent other than the IDSA-recommended ampicillin/penicillin (concern for pathogens other than penicillin-sensitive *S. pneumoniae*, immunocompromised or under-immunized status, or inadequate clinical response to empiric ampicillin therapy).

## CONCLUSION

Implementing a more targeted approach to blood culture acquisition for hospitalized children with CAP will hopefully increase the yield of true bacterial pathogens that alter management decisions. A targeted approach for the child in the opening vignette would have saved him from the pain of unnecessary phlebotomy (repeat culture), exposure to vancomycin as a nephrotoxic agent, and an additional hospital day.

*Do you think this is a low-value practice? Is this truly a “Thing We Do for No Reason?”™ Share what you do in your practice and join in the conversation online by retweeting it on Twitter (#TWDFNR) and liking it on Facebook. We invite you to propose ideas for other “Things We Do for No Reason”™ topics by e-mailing TWDFNR@hospitalmedicine.org.*

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