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## The impact of adherence to pediatric community-acquired pneumonia guidelines on clinical outcomes

Pui-Ying Iroh Tam, MD<sup>1</sup>, Benjamin R. Hanisch, MD<sup>1</sup>, and Michael O’Connell, BS<sup>2</sup>

<sup>1</sup>University of Minnesota Children’s Hospital, Minneapolis, MN

<sup>2</sup>Clinical and Translational Science Institute, University of Minnesota, Minneapolis, MN

### Keywords

community-acquired pneumonia; pediatric; hospitalization; antimicrobial; prescription; blood culture

Community-acquired pneumonia (CAP) accounts for over 150,000 hospitalizations annually in the United States,<sup>1</sup> and is one of the most common inpatient diagnoses.<sup>2</sup> In children, treatment for CAP is typically presumptive based on epidemiologic data specifying the most common etiologies for each age group. Guidelines from the Infectious Diseases Society of America on management of CAP in children recommend initial empiric therapy of ampicillin or penicillin G for a child who is hospitalized. In addition, the guidelines strongly recommend collection of blood cultures (BCs) in any children requiring hospitalization for presumed moderate to severe bacterial CAP.<sup>3</sup> The primary objective of our study was to evaluate how closely we adhere to guidelines on empiric therapy choices for management of pediatric CAP, including how often BCs were obtained and subsequently influenced management. Our secondary objective was to assess whether this management correlated with clinical outcomes.

### Methods

This was a multicenter retrospective study of all children between 2 months to 18 years of age hospitalized with a primary discharge diagnosis of CAP from January 2011 to December 2013 within an urban health system comprising of six hospitals. A case of pneumonia hospitalization was defined as a record with any of the following ICD-9 codes assigned as the primary diagnosis: 073.0, 481–486. We excluded patients with ICD-9 codes correlating with an underlying illness, immunocompromise or chronic condition: 87.46, 140–239, 416, 238, 585. In addition, patients hospitalized within the previous 30 days were also excluded. Medical charts were reviewed and data extracted included antimicrobials prescribed, BC collection and result, length of hospitalization, ICU admission, and therapeutic interventions such as chest tube placement and mechanical ventilation.

Address correspondence to: Pui-Ying Iroh Tam, Division of Pediatric Infectious Diseases and Immunology, 3-210 MTRF, 2001 6<sup>th</sup> St SE, Minneapolis, MN 55455; tel: 612-626-8903; fax: 612-624-8927; irohtam@umn.edu.

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Fisher's exact test were used to determine the effects of antimicrobials prescribed on hospitalization, ICU stay, and therapeutic intervention, while linear regression was used to evaluate length of hospital stay, adjusting for demographics and clinical factors. Statistical significance was set at 5%. This study was approved by the Institutional Review Board of the University of Minnesota.

## Results

One hundred and twenty-eight patients were identified, of which 90 patients were eligible. Forty-nine percent were male. Median age was 1.9 years, with a range of 2 months to 18 years (Table 1). All patients received antimicrobial therapy, of which 63 patients (72%) received a third generation cephalosporin as part of their treatment regimen. Seven patients received vancomycin, of which 43% were in the ICU, and 71% required therapeutic interventions. Only one patient received parenteral ampicillin.

Neither cephalosporins nor ampicillin were associated with a significant difference in length of hospitalization ( $p=0.06$  and  $p=0.90$  respectively), need for ICU stay ( $p=0.18$  and  $p=1.00$  respectively), or therapeutic intervention ( $p=0.33$  and  $p=1.00$  respectively). In contrast, vancomycin was significantly associated with longer hospital stay ( $p=0.0001$ ), ICU admission ( $p=0.01$ ), and therapeutic intervention ( $p=0.008$ ). After controlling for these factors with multiple linear regression, patients receiving vancomycin still had an average length of stay that was 68 hours longer than those who did not receive this antimicrobial ( $p=0.05$ ).

Blood cultures were performed in 55 patients (61%) hospitalized with CAP. Of these, only one BC was considered a true positive, which was *S. pneumoniae*. The other positive BC was micrococcus and considered a contaminant. The patient with positive BC was treated with a third generation cephalosporin and vancomycin, and vancomycin was discontinued once the profile indicated susceptibility to cephalosporins. The patient completed a course of therapy with a cephalosporin despite susceptibility of the pathogen to penicillin. Collection of BC was not associated with length of hospital stay ( $p=0.24$ ), ICU admission ( $p=0.25$ ), nor with therapeutic intervention ( $p=1.00$ ).

## Discussion

This study found that broad-spectrum antimicrobial prescribing for management of pediatric CAP remains prevalent despite national guidelines advocating narrow-spectrum therapy, and despite evidence that narrow-spectrum therapy is as effective as broad-spectrum antimicrobials with low adverse outcomes.<sup>4,5</sup> Almost three-quarters of patients in our study received broad-spectrum therapy, which indicates opportunities to educate providers and improve care. However, use of broad-spectrum antimicrobials did not lead to significantly different outcomes in hospitalized patients. Interestingly, the only statistically significant finding associated with antimicrobial usage was the increased length of hospitalization with vancomycin for the treatment of CAP. This remained statistically significant even after controlling for clinical and demographic factors, though this likely reflects its usage in patients with more severe disease, rather than its causality in severe disease.

The collection of BCs in patients hospitalized with CAP has traditionally been considered a marker of high quality care, and has been recommended by the American Thoracic Society since the 1990s as part of the initial evaluation of these patients.<sup>6,7</sup> However this practice has increasingly been questioned, particularly in adult literature where studies suggest that BC yield is low and results rarely change management.<sup>8–10</sup> In our study, BC was collected in 61% of patients. However, only 2% were positive, the result did not lead to change in management, and positivity was not associated with poor clinical outcome.

Although this was a multi-center study, the small numbers of patients receiving narrow-spectrum therapy did not provide sufficient power for robust statistical analyses. While we attempted to account for patient risk factors by excluding patients with comorbid conditions based on ICD-9 codes, and by using length of hospitalization, ICU admission, and therapeutic interventions as correlates of severity of illness, these methods may not have been sufficiently comprehensive. Larger numbers are required to more closely assess associations of antimicrobial use on clinical outcomes. Nevertheless, this study indicates that adherence to guidelines is low, and the majority of pediatric patients hospitalized with CAP were not prescribed narrow-spectrum antimicrobial therapy. Although BC was obtained in over half the patients, BC was positive in only 2% of cases and did not lead to change in antimicrobial management. Guidelines have not yet been fully adopted, and continued efforts to educate physicians, modify clinical practice, and monitor the impact on clinical outcomes, are needed.

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## Abbreviations

<b>CAP</b>	community-acquired pneumonia
<b>BC</b>	blood culture

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**Table 1**

Demographics and clinical features of pediatric patients hospitalized with CAP

Characteristic	N (%)
Hospitalized patients with CAP	90
Male	44 (49)
Age, median (range)	1.9 years (2 months – 18 years)
Length of hospital stay, median (range)	82 hours (12 hours – 24 days 17 hours)
Blood culture obtained	55 (61)
Antimicrobials prescribed	
Third-generation cephalosporin	63 (72)
Azithromycin	28 (32)
Ampicillin	1 (1)
Vancomycin	7 (8)
ICU admission	7 (8)
Therapeutic intervention	14 (16)
Mortality	0 (0)

CAP, community-acquired pneumonia

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