Published in final edited form as:
J Hosp Med. 2015 January ; 10(1): 13–18. doi:10.1002/jhm.2265.

Hospital outcomes associated with guideline recommended antibiotic therapy for pediatric pneumonia

Joanna Thomson, MD, MPH[a], **Lilliam Ambroggio, PhD, MPH**[a,b], **Eileen Murtagh Kurowski, MD, MS**[b,c], **Angela Statile, MD, MEd**[a,b], **Camille Graham, MD**[b,d], **Joshua D. Courter, PharmD**[e], **Brieanne Sheehan, MGS**[a], **Srikant Iyer, MD, MPH**[b,c,f], **Christine M. White, MD, MAT**[a,b,f], and **Samir S. Shah, MD, MSCE**[a,b,g]

[a]Division of Hospital Medicine, Cincinnati Children's Hospital Medical Center

[b]Department of Pediatrics, University of Cincinnati College of Medicine

[c]Division of Emergency Medicine, Cincinnati Children's Hospital Medical Center

[d]Division of General and Community Pediatrics, Cincinnati Children's Hospital Medical Center

[e]Division of Pharmacy, Cincinnati Children's Hospital Medical Center

[f]James M. Anderson Center for Health Systems Excellence, Cincinnati Children's Hospital Medical Center

[g]Division of Infectious Diseases, Cincinnati Children's Hospital Medical Center

Abstract

Background—Recent national guidelines recommend use of narrow spectrum antibiotic therapy as empiric treatment for children hospitalized with community-acquired pneumonia. However, clinical outcomes associated with adoption of this recommendation have not been studied.

Methods—This retrospective cohort study included children 3 months -18 years, hospitalized with CAP from May 2, 2011 through July 30, 2012. Primary exposure of interest was empiric antibiotic therapy, classified as guideline recommended or not. Primary outcomes were length of stay (LOS), total hospital costs, and inpatient pharmacy costs. Secondary outcomes included broadened antibiotic therapy, emergency department revisits, and readmissions. Multivariable linear regression and Fisher's exact test were performed to determine the association of guideline recommended antibiotic therapy on outcomes.

Results—Empiric guideline recommended therapy was prescribed to 168 (76%) of 220 patients. Median hospital LOS was 1.3 days (IQR: 0.9-1.9 days); median total costs of index hospitalization were $4,097 (IQR: $2,657-$6,054); median inpatient pharmacy costs were $91 (IQR: $40-$183). Between patients who did and did not receive guideline recommended therapy, there were no differences in LOS (adjusted −5.8% change; 95% CI: −22.1, 12.8), total costs (adjusted −10.9% change; 95% CI: −27.4, 9.4), or inpatient pharmacy costs (adjusted 14.8% change; 95% CI: −43.4,

Address for Correspondence: Joanna Thomson, MD, Division of Hospital Medicine, Cincinnati Children's Hospital Medical Center, 3333 Burnet Avenue, ML 9016, Cincinnati, OH, 45220; Telephone: 513-803-8092; Fax: 513-803-9244; joanna.thomson@cchmc.org.

The authors report no conflicts of interest.

27.1). Secondary outcomes were rare with no difference in unadjusted analysis between patients who did and did not receive guideline recommended therapy.

Conclusions—Use of guideline recommended antibiotic therapy was not associated with unintended negative consequences; there were no changes in LOS, total costs, or inpatient pharmacy costs.

Keywords

pediatric; pneumonia; community-acquired pneumonia; guidelines; antibiotics

INTRODUCTION

Community-acquired pneumonia (CAP) is a common and serious infection in children. With more than 150,000 children requiring hospitalization annually, CAP is the fifth most prevalent and the second most costly diagnosis of all pediatric hospitalizations in the United States.[1-3]

In August 2011, the Pediatric Infectious Diseases Society (PIDS) and the Infectious Diseases Society of America (IDSA) published an evidence-based guideline for the management of CAP in children. This guideline recommended that fully immunized children without underlying complications who require hospitalization receive an aminopenicillin as first-line antibiotic therapy.[4] Additionally, the guideline recommends empirically adding a macrolide to an aminopenicillin when atypical pneumonia is a diagnostic consideration.

This recommendation was a substantial departure from practice for hospitals nationwide, as a multicenter study of children's hospitals (2005-2010) demonstrated that <10% of patients diagnosed with CAP received aminopenicillins as empiric therapy. [5] Since publication of the PIDS/IDSA guidelines, the use of aminopenicillins has increased significantly across institutions, but the majority of hospitalized patients still receive broad spectrum cephalosporin therapy for CAP.[6]

At baseline, 30% of patients hospitalized with CAP received guideline recommended antibiotic therapy at our institution. Through the use of quality improvement methods, the proportion of patients receiving guideline recommended therapy increased to 100%.[7] The objective of this study was to ensure that there were not unintended negative consequences to guideline implementation. Specifically, we sought to identify changes in length of stay (LOS), hospital costs, and treatment failures associated with use of guideline recommended antibiotic therapy for children hospitalized with uncomplicated CAP.

METHODS

Study Design and Study Population

This retrospective cohort study included children 3 months to 18 years, hospitalized with CAP, between May 2, 2011 and July 30, 2012, at Cincinnati Children's Hospital Medical

Center (CCHMC), a 512-bed free-standing children's hospital. The CCHMC Institutional Review Board approved this study with a waiver of informed consent.

Patients were eligible for inclusion if they were admitted to the hospital for inpatient or observation level care with a primary or secondary *International Classification of Disease-9th*revision (ICD-9) discharge diagnosis code of pneumonia (480.0-2, 480.8-9, 481, 482.0, 482.30-2, 482.41-2, 482.83, 482.89-90, 483.8, 484.3, 485, 486, 487.0) or effusion/empyema (510.0, 510.9, 511.0-1, 511.8-9, 513).[8] Patients with complex chronic conditions[9] were excluded. Medical records of eligible patients (n=260) were reviewed by two members of the study team to ensure that patients fell into the purview of the guideline. Patients who did not receive antibiotics (n=11) or for whom there was documented concern for aspiration (n=1) were excluded. Additionally, patients with immunodeficiency (n=1) or who had not received age-appropriate vaccinations (n=2), and patients who required intensive care unit admission on presentation (n=17) or who had a complicated pneumonia, defined by presence of moderate or large pleural effusion at time of admission (n=8), were also excluded.[7] Finally, for patients with multiple pneumonia admissions, only the index visit was included; subsequent visits occurring within 30 days of discharge were considered readmissions.

Treatment Measure

The primary exposure of interest was empiric antibiotic therapy upon hospital admission. Antibiotic therapy was classified as guideline recommended or non-guideline recommended. Guideline recommended therapy was defined as follows:

1. For children without drug allergies: ampicillin (200 mg/kg/day intravenously) OR amoxicillin (90 mg/kg/day orally);
2. For children with penicillin allergy: ceftriaxone (50-100 mg/kg/day intravenously or intramuscularly) OR cefdinir (14mg/kg/day orally);
3. For children with penicillin and cephalosporin allergy: clindamycin (40 mg/kg/day orally or intravenously);
4. OR azithromycin (10 mg/kg/day orally or intravenously on Day 1) in combination with antibiotic category #1 or #2 or #3 above.

Outcome Measures

The primary outcomes examined were hospital LOS, total cost of hospitalization, and inpatient pharmacy costs. LOS was measured in hours and defined as the difference in time between departure from and arrival to the inpatient unit. Total cost of index hospitalization included both direct and indirect costs, obtained from the Centers for Medicare & Medicaid Services' Relative Value Units data for Current Procedural Terminology codes.[10]

Secondary outcomes included broadening of antibiotic therapy during the hospital course, pneumonia-related emergency department (ED) revisits within 30 days, and pneumonia-related inpatient readmissions within 30 days. Broadening of antibiotic therapy was defined as addition of a second antibiotic (e.g. adding azithromycin on day 3 of hospitalization) or change in empiric antibiotic to a class with broader antimicrobial activity (e.g. ampicillin to

ceftriaxone) at any time during hospitalization. As our study population included only patients with uncomplicated pneumonia at time of admission, this outcome was used to capture possible treatment failure. ED revisits and inpatient readmissions were reviewed by three investigators to identify pneumonia-related visits. To encompass all possible treatment failures, all respiratory-related complaints (e.g. wheezing, respiratory distress) were considered as pneumonia-related. Disagreements were resolved by group discussion.

Covariates

Severity of illness on presentation was evaluated using Emergency Severity Index v.4,[11] abnormal vital signs on presentation (as defined by Pediatric Advanced Life Support age-specific criteria[12]), and need for oxygen in the first 24 hours of hospitalization. Supplemental oxygen is administered for saturations < 91% per protocol at our institution. The patient's highest Pediatric Early Warning Scale (PEWS) score[13] during hospitalization was used as a proxy for disease severity. Exam findings on presentation (e.g. increased respiratory effort, rales, wheezing) were determined through chart review. Laboratory tests and radiologic imaging variables included complete blood cell count, blood culture, chest radiograph, chest ultrasound, and chest computed tomography (CT). Abnormal white blood cell (WBC) count was defined as <5,000 or >15,000 cells/mL, the defined reference range for the CCHMC clinical laboratory.

Data Analysis

Continuous variables were described using medians and interquartile ranges (IQRs) and compared across groups using Wilcoxon rank-sum test due to non-normal distributions. Categorical variables were described by counts and frequencies and compared using chi-square test.

Multivariable linear regression analysis was performed to assess the independent effect of receipt of empiric guideline recommended antibiotic therapy on outcomes of LOS and costs while adjusting for covariates. As LOS and costs were non-normally distributed, we logarithmically transformed these values to use as the dependent variables in our models. The resulting beta-coefficients were back-transformed to reflect the percent change in LOS and costs incurred between subjects who received empiric guideline therapy compared with those who did not.[14] Covariates were chosen a priori due to their clinical and biological relevance to the outcomes of LOS (e.g. wheezing on presentation and need for supplemental oxygen), total cost of hospitalization (e.g. LOS and need for repeat imaging), and inpatient pharmacy costs (e.g. LOS and wheezing on presentation) (Table 1).

Secondary outcomes of broadened antibiotic therapy, ED revisits, and hospital readmissions were assessed using Fisher's exact test. Due to the small number of events, we were unable to evaluate these associations in models adjusted for potential confounders.

All analyses were performed with SAS v.9.3 (SAS Institute, Cary, NC), and p-values < 0.05 were considered significant.

RESULTS

Of the 220 unique patients included, 122 (55%) were male. The median age was 2.9 years (IQR: 1.3, 6.3). Empiric guideline recommended therapy was prescribed to 168 (76%) patients (Table 1). Aminopenicillins were the most common guideline recommended therapy, accounting for 84% of guideline recommended antibiotics. An additional 10% of patients received the guideline recommended combination therapy with an aminopenicillin and a macrolide. Non-guideline recommended therapy included third-generation cephalosporin antibiotics (54%) and macrolide monotherapy (33%).

Those who received empiric guideline recommended antibiotic therapy were similar to those who received non-guideline recommended therapy with respect to sex, Emergency Severity Index, physical exam findings on presentation, oxygen requirement in the first 24 hours, abnormal laboratory findings, presence of effusion on chest radiograph, and need for additional imaging (Table 1). However, patients in the guideline recommended therapy group were significantly younger (median 2.5 years vs. 5.6 years, p= <0.01), more likely to have elevated respiratory rate on presentation (60.2% vs. 44.4%, p=0.04), and more likely to have an infiltrate on chest radiograph (86.3% vs. 73.6%, p= 0.03) (Table 1). Patients who received non-guideline recommended macrolide monotherapy had a median age of 7.4 years (IQR: 5.8-9.8 years).

Median hospital LOS for the total cohort was 1.3 days (IQR: 0.9-1.9 days) (Table 2). There were no differences in LOS between patients who received and did not receive guideline recommended therapy in the unadjusted or the adjusted model (Table 3).

Median total costs of the index hospitalization for the total cohort were $4,097 (IQR: $2,657-$6,054) with median inpatient pharmacy costs of $92 (IQR: $40-$183) (Table 2). There were no differences in total or inpatient pharmacy costs for patients who received guideline recommended therapy compared with those who did not in unadjusted or adjusted analyses.

Fourteen patients (6.4%) had antibiotic therapy broadened during hospitalization, 10 were initially prescribed guideline recommended therapy and 4 were initially prescribed non-guideline recommended therapy (Table 4).

Of the 9 pneumonia-related ED revisits within 30 days of discharge, 7 occurred in patients prescribed empiric guideline recommended therapy (Table 5). No ED revisit resulted in hospital readmission or antibiotic change related to pneumonia. Two ED revisits resulted in new antibiotic prescriptions for diagnoses other than pneumonia.

Two patients were readmitted for a pneumonia-related illness within 30 days of discharge; one had received guideline recommended therapy (Table5). Both patients were directly admitted to the inpatient ward without an associated ED visit. Antibiotic class was not changed for either patient upon readmission, despite the decision to convert to intravenous form.

DISCUSSION

In this retrospective cohort study, patients who received empiric guideline recommended antibiotic therapy on admission for CAP had no difference in LOS, total cost of hospitalization, or inpatient pharmacy costs compared with those who received therapy that varied from guideline recommendations. Our study suggests that prescribing narrow spectrum therapy and, in some circumstances, combination therapy, as recommended by the 2011 PIDS/IDSA pneumonia guideline, did not result in negative unintended consequences.

In our study, children receiving guideline recommended therapy were younger, more likely to have elevated respiratory rate on presentation, and more likely to have an infiltrate on chest radiograph. We hypothesize the age difference is a reflection of common use of non-guideline macrolide monotherapy in the older, school-age child as macrolides are commonly used for coverage of *Mycoplasma pneumonia* in older children with CAP.[15] Children receiving macrolide monotherapy were older than those receiving guideline recommended therapy (median age of 7.4 years and 2.5 years respectively). We also hypothesize that some providers may prescribe macrolide monotherapy to children deemed less ill than expected for CAP (e.g. normal percutaneous oxygen saturation). This hypothesis is supported by the finding that 60% of patients who had a normal respiratory rate and received non-guideline therapy were prescribed macrolide monotherapy. We did control for the characteristics that varied between the two treatment groups in our models to eliminate potential confounding.

One prior study evaluated the effects of guideline implementation in CAP. In evaluation of a clinical practice guideline that recommended ampicillin as first line therapy for CAP, no significant difference was found following guideline introduction in the number of treatment failures (defined as the need to broaden therapy or development of complicated pneumonia within 48 hours or 30-day inpatient readmission).[16] Our study builds on these findings by directly comparing outcomes between recipients of guideline and non-guideline therapy, which was not done in the pre-post study design of prior work.[16] We believe that classifying patients based on empiric therapy received rather than timing of guideline introduction thoroughly examines the effect of following guideline recommendations. Additionally, outcomes other than treatment failures were examined in our study including LOS, costs, and ED revisits.

Our results are similar to other observational studies that compared narrow and broad spectrum antibiotics for children hospitalized with CAP. Using administrative data, Williams et al. found no significant difference in LOS or cost between narrow and broad spectrum intravenous antibiotic recipients 6 months-18 years at 43 children's hospitals.[17] Queen et al. compared narrow and broad spectrum antibiotic therapy for children ages 2 months-18 years at 4 children's hospitals.[18] Differences in average daily cost were not significant, but children who received narrow spectrum antibiotics had a significantly shorter LOS. Finally, an observational study of 319 Israeli children < 2 years of age found no significant difference in duration of oxygen requirement, LOS, or need for change in antibiotic therapy between the 66 children prescribed aminopenicillins and the 253 children prescribed cefuroxime.[19] These studies suggest that prescribing narrow spectrum

antimicrobial therapy, as per the guideline recommendations, results in similar outcomes to broad spectrum antimicrobial therapy.

Our study adds to prior studies that compared narrow and broad spectrum therapy by comparing outcomes associated with guideline recommended therapy to non-guideline therapy. We considered antibiotic therapy as guideline recommended if appropriately chosen per the guideline, not just by simple classification of antibiotic. For example, the use of a cephalosporin in a patient with aminopenicillin allergy was considered guideline recommended therapy. We chose to classify the exposure of empiric antibiotic therapy in this manner to reflect true clinical application of the guideline, as not all children are able to receive aminopenicillins. Additionally, as our study stemmed from our prior improvement work aimed at increasing guideline adherent therapy,[7] we have a higher frequency of narrow spectrum antibiotic use than prior studies. In our study, almost two-thirds of patients received narrow spectrum therapy, whereas narrow spectrum use in prior studies ranged from 10% to 33%.[17-19] Finally, we were able to confirm the diagnosis of pneumonia via medical record review and to adjust for severity of illness using clinical variables including vital signs, physical exam findings, and laboratory and radiologic study results.

This study must be interpreted in the context of several limitations. First, our study population was defined through discharge diagnosis codes, and therefore dependent on the accuracy of coding. However, we minimized potential for misclassification through use of a previously validated approach to identify patients with CAP and through medical record review to confirm the diagnosis. Second, we may be unable to detect very small differences in outcomes given limited power, specifically for outcomes of LOS, ED revisits, hospital readmissions, and need to broaden antibiotic therapy. Third, residual confounding may be present. Although we controlled for many clinical variables in our analyses, antibiotic prescribing practices may be influenced by unmeasured factors. The potential of system level confounding is mitigated by standardized care for patients with CAP at our institution. Prior system level changes using quality improvement science have resulted in a high level of adherence with guideline recommended antimicrobials as well as standardized medical discharge criteria.[7,20] Additionally non-medical factors may influence LOS, limiting its use as an outcome measure. This limitation was minimized in our study by standardizing medical discharge criteria. Prior work at our institution, demonstrated that the majority of patients, including those with CAP, were discharged within two hours of meeting medical discharge criteria.[20] Fourth, discharged patients who experienced adverse outcomes may have received care at a nearby adult emergency department or at their pediatrician's office. While these events would not have been captured in our electronic health record, serious complications due to treatment failure (e.g., empyema) would require hospitalization. As our hospital is the only children's hospital in the Greater Cincinnati metropolitan area, these patents would receive care at our institution. Therefore, any misclassification of revisits or readmissions is likely to be minimal. Finally, study patients were admitted to a large tertiary academic children's hospital, warranting further investigation to determine if these findings can be translated to smaller community settings.

In conclusion, receipt of guideline recommended antibiotic therapy for patients hospitalized with community-acquired pneumonia was not associated with increases in LOS, total costs

of hospitalization, or inpatient pharmacy costs. Our findings highlight the importance of changing antibiotic prescribing practices to reflect guideline recommendations, as there was no evidence of negative unintended consequences with our local practice change.

Acknowledgments

Disclosures: Dr. Ambroggio and Dr. Thomson were supported by funds from the NRSA T32HP10027-14 and Dr. Shah was supported by funds from NIAID K01A173729.

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Table 1

Characteristics of cohort.

Characteristic (n, % unless otherwise indicated)	Overall cohort (n=220)	Guideline therapy (n=166)	Non-guideline therapy (n =54)	p-value
Age (median, (IQR))	2.9 (1.3-6.3)	2.5 (1.3-5.2)	5.6 (2.3-8.8)	<0.01*
Male	122 (55.5%)	89 (53.6%)	33 (61.1%)	0.34
Emergency Severity Index				0.11
2	90 (40.9%)	73 (44.0%)	17 (31.5%)	
3	116 (52.7%)	85 (51.2%)	31 (57.4%)	
4	14 (6.4%)	8 (4.8%)	6 (11.1%)	
Abnormal Vital Signs on presentation				
Fever	99 (45.0%)	80 (48.2%)	19 (35.2%)	0.10
Tachycardia	100 (45.5%)	76 (45.8%)	24 (44.4%)	0.86
Tachypnea	124 (56.4%)	100 (60.2%)	24 (44.4%)	0.04*
Hypotension	0	0	0	-
Hypoxia	27 (12.3%)	24 (14.5%)	3 (5.6%)	0.08
Physical Exam on presentation				
Increased respiratory effort	146 (66.4%)	111 (66.9%)	35 (64.8%)	0.78
Distressed	110 (50.0%)	86 (51.8%)	24 (44.4%)	0.35
Retraction	103 (46.8%)	81 (48.8%)	22 (40.7%)	0.30
Grunting	17 (7.7%)	14 (8.4%)	3 (5.6%)	0.49
Nasal flaring	19 (8.6%)	17 (10.2%)	2 (3.7%)	0.14
Rales	135 (61.4%)	99 (59.6%)	36 (66.7%)	0.36
Wheeze	91 (41.4%)	66 (39.8%)	25 (46.3%)	0.40
Decreased breath sounds	89 (40.5%)	65 (39.2%)	24 (44.4%)	0.49
Dehydration	21 (9.6%)	13 (7.8%)	8 (14.8%)	0.13
PEWS ≥ 5 during admission	43 (19.6%)	34 (20.5%)	9 (16.7%)	0.54
Oxygen Requirement in first 24 hours	114 (51.8%)	90 (53.6%)	24 (46.2%)	0.35
Complete Blood Count Obtained	99 (45.0%)	72 (43.4%)	27 (50.0%)	0.40
Abnormal white blood cell count	35 (35.7%)	23 (32.4%)	12 (44.4%)	0.27
Blood Culture Obtained	104 (47.3%)	80 (48.2%)	24 (44.4%)	0.63
Positive	2 (1.9%)	1 (1.3%)	1 (4.2%)	0.36
Chest Radiograph Available	214 (97.3%)	161 (97.0%)	53 (98.2%)	0.65
Infiltrate	178 (83.2%)	139 (86.3%)	39 (73.6%)	0.03*
Bilateral	29 (16.3%)	20 (14.4%)	9 (23.1%)	0.19
Multilobar	46 (25.8%)	33 (23.7%)	13 (33.3%)	0.23
Effusion	24 (11.2%)	16 (9.9%)	8 (15.1%)	0.30

Characteristic (n, % unless otherwise indicated)	Overall cohort (n=220)	Guideline therapy (n=166)	Non-guideline therapy (n =54)	p-value
Additional Imaging				
Repeat Chest Radiograph	26 (11.8%)	17 (10.2%)	9 (16.7%)	0.20
Chest ultrasound	4 (1.8%)	3 (1.8%)	1 (1.9%)	0.98
Chest CT	2 (0.9%)	1 (0.6%)	1 (1.9%)	0.40
Antibiotic				<0.01*
Aminopenicillin	140 (63.6%)	140 (84.3%)	0 (0%)	
Third-generation cephalosporin	37 (16.8%)	8 (4.8%)	29 (53.7%)	
Macrolide monotherapy	18 (8.2%)	0 (0%)	18 (33.3%)	
Clindamycin	2 (0.9%)	1 (0.6%)	1 (1.9%)	
Levofloxacin	1 (0.5%)	0 (0%)	1 (1.9%)	
Aminopenicillin + Macrolide	16 (7.3%)	16 (9.6%)	0 (0%)	
Cephalosporin + Macrolide	6 (2.7%)	1 (0.6%)	5 (9.3%)	

* p-value <0.05

Abbreviations: IQR, interquartile range

Table 2

Unadjusted Outcomes

Outcome	Guideline therapy (n=166)	Non-guideline therapy (n=54)	p-value
Length of stay (median days, (IQR))	1.3 (0.9-1.9)	1.3 (0.9-2.0)	0.74
Total costs (median, (IQR))	$4118 (2647-6004)	$4045 (2829-6200)	0.44
Pharmacy total costs (median, (IQR))	$84 (40-179)	$106 (58-217)	0.12
Broadened therapy (n, %)	10 (6.0%)	4 (7.4%)	0.75
Emergency Department revisit (n, %)	7 (4.2%)	2 (3.7%)	1.00
Readmission (n, %)	1 (0.6%)	1 (1.9%)	0.43

Abbreviations: IQR, interquartile range

Table 3

Univariate and multivariate analyses of receipt of empiric guideline recommended therapy with length of stay, total costs, and pharmacy costs

Outcome	Unadjusted beta-coefficient (95% CI)	Adjusted beta-coefficient (95% CI)	Adjusted percentage change in outcome (95% CI)*
Length of stay	−0.06 (−0.27,0.15)	−0.06 (−0.25, 0.12) [α]	−5.8 (−22.1, 12.8)
Total costs	−0.18 (−0.40, 0.04)	−0.11 (−0.32, 0.09) [γ]	−10.9 (−27.4, 9.4)
Pharmacy total costs	−0.44 (−0.46, −0.02)	−0.16 (−0.57, 0.24) [δ]	−14.8 (−43.4, 27.1)

*Negative adjusted percent change indicates decrease in outcome associated with guideline recommended therapy; positive adjusted percent change indicates increase in outcome associated with guideline recommended therapy.

[α]Model adjusted for age, fever on presentation, tachypnea on presentation, wheezing on presentation, need for supplemental oxygen, Pediatric Early Warning Score ≥ 5, chest radiograph findings, need for repeat imaging.

[γ]Model adjusted for age, wheezing on presentation, need for supplemental oxygen, Pediatric Early Warning Score ≥ 5, need for repeat imaging, and length of stay.

[δ]Model adjusted for age, wheezing on presentation, and length of stay. Abbreviations: CI, confidence interval

eTable 4

Clinical details of patients who had antibiotic therapy broadened during initial hospitalization

Initial Therapy	Reasons for antibiotic change identified from chart review
Guideline = 10	**Ampicillin to ceftriaxone:** - 1 patient with clinical worsening - 1 patient with coincident urinary tract infection due to resistant organism - 4 patients without evidence of clinical worsening or documentation of rationale **Addition of a macrolide:** - 3 patients without evidence of clinical worsening or documentation of rationale **Addition of clindamycin:** - 1 patient with clinical worsening
Non-guideline = 4	**Ceftriaxone to clindamycin:** - 1 patient with clinical worsening **Addition of a macrolide:** - 1 patient with clinical worsening - 1 patients without evidence of clinical worsening or documentation of rationale **Addition of clindamycin:** - 1 patient with clinical worsening

eTable 5

Clinical details of patients with an Emergency Department revisit or inpatient readmission following index hospitalization

Revisit	Initial Therapy	Day post discharge	Clinical symptoms at return visit	Clinical Diagnosis	Antibiotic prescription
ED	Guideline	3	Poor oral intake and fever	Pneumonia	Continued prior antibiotic
ED	Guideline	8	Recurrent cough and fever	Resolving pneumonia	Continued prior antibiotic
ED	Guideline	13	Follow-up	Resolved pneumonia	No further antibiotic
ED	Guideline	16	Increased work of breathing	Reactive airway disease	No antibiotic
ED	Guideline	20	Persistent cough	Viral illness	No antibiotic
ED	Guideline	22	Recurrent cough and congestion	Sinusitis	Augmentin
ED	Guideline	26	Increased work of breathing	Reactive airway disease	No antibiotic
ED	Non-guideline	16	Recurrent fever	Acute otitis media	Amoxicillin
ED	Non-guideline	20	Recurrent cough and fever	Viral illness	No antibiotic
Admission	Guideline	3	Increased work of breathing	Pneumonia	IV ampicillin
Admission	Non-guideline	9	Refusal to take oral clindamycin	Pneumonia	IV clindamycin

Abbreviations: ED, emergency department