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Factors Associated with Antibiotics for Inpatient Pediatric Pneumonia

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Abstract

Background—Antibiotics are frequently used for community-acquired pneumonia (CAP), even though viral etiologies predominate. We sought to determine factors associated with antibiotic use among children hospitalized with suspected CAP.

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Contributor Statements:

Dr. Cotter conceptualized and designed the study, coordinated the analysis, drafted the initial manuscript, and reviewed and revised the manuscript.

Drs. Florin and Ambroggio conceptualized and designed the original parent study, coordinated and supervised all data collection, supervised with conceptualizing and designing the current study, supervised and assisted with the current analysis and interpretation of data, and reviewed and revised the manuscript.

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Drs. Shah and Ruddy were involved in the conceptualization and design of the original parent study, supervised all data collection, and reviewed and revised the manuscript.

All authors approved the final manuscript as submitted and agree to be accountable for all aspects of work.

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Methods—We conducted a prospective cohort study of children who presented to the ED and were hospitalized for suspected CAP. We estimated risk factors associated with receipt of ≥1 dose of inpatient antibiotics and a full treatment course using multivariable Poisson regression with an interaction term between chest radiograph (CXR) findings and ED antibiotic use. We performed a subgroup analysis of children with non-radiographic CAP.

Results—Among 477 children, 60% received inpatient antibiotics and 53% received a full course. Factors associated with inpatient antibiotics included antibiotic receipt in the ED (RR4.33 [95% CI, 2.63,7.13]), fever (1.66 [1.22,2.27]), and use of supplemental oxygen (1.29 [1.11,1.50]). Children with radiographic CAP and equivocal CXRs had an increased risk of inpatient antibiotics compared to those with normal CXRs, but the increased risk was modest when antibiotics were given in the ED. Factors associated with a full course were similar. Among patients with non-radiographic CAP, 29% received inpatient antibiotics, 21% received a full course, and ED antibiotics increased the risk of inpatient antibiotics.

Conclusions—Inpatient antibiotic utilization was associated with ED antibiotic decisions, CXR findings, and clinical factors. Nearly a third of children with non-radiographic CAP received antibiotics, highlighting the need to reduce likely overuse. Antibiotic decisions in the ED were strongly associated with decisions in the inpatient setting, representing a modifiable target for future interventions.

Table of Contents Summary:

This study evaluated factors associated with antibiotic administration for children hospitalized with suspected pneumonia.

Introduction

Community-acquired pneumonia (CAP) ranks among the most prevalent and costly reasons for pediatric hospitalizations in the U.S.[1] There is no widely accepted gold standard for diagnosing CAP, but it is often diagnosed using a combination of history, physical examination findings, and diagnostic tests, such as chest radiograph (CXR).[2–4] While most CAP in hospitalized children is viral,[5] no real-time test can reliably differentiate bacterial CAP, which requires antibiotics, from viral CAP, which does not.[6] Due to the inability to exclude bacterial causes, antibiotics are frequently initiated.[5] Antibiotics prescribed for viral infections unnecessarily expose children to antibiotic-associated side effects, such as diarrhea and *Clostridioides difficile* colitis, and promote antimicrobial resistance.[7–9] Therefore, there is a need to decrease unnecessary antibiotic exposure in children hospitalized with CAP.[10]

Given the lack of clear criteria for diagnosing bacterial CAP,[2] the decision to prescribe antibiotics for children with suspected CAP may be influenced by multiple factors such as patient demographics, clinical presentation, ancillary diagnostics, and preceding treatment decisions. One prospective study noted that CXRs have a high negative predictive value, suggesting that most children without evidence of pneumonia on CXR do not subsequently develop pneumonia and therefore do not require antibiotics.[11] Understanding factors associated with antibiotic prescribing, particularly in children at low risk for bacterial CAP (e.g., non-radiographic CAP), may identify modifiable targets for stewardship.[11, 12] Thus,

the objectives of this study were to 1) determine demographic and clinical factors associated with inpatient antibiotic administration among children hospitalized with suspected CAP, and 2) evaluate factors in the subgroup of children with non-radiographic CAP.

Methods

Study Design.

This was a secondary analysis of a prospective cohort study (Catalyzing Ambulatory Research in Pneumonia Etiology and Diagnostic Innovations in Emergency Medicine" [CARPE DIEM]) of children with suspected CAP who presented to a tertiary-care pediatric Emergency Department (ED).[13–15] The study was approved by the hospital's Institutional Review Board. Informed consent was obtained from all legal guardians and assent was obtained from children ≥11 years of age.

Study Population.

Children 3 months to 18 years of age with signs and symptoms of a lower respiratory tract infection (LRTI) who received a CXR in the ED for suspected CAP between July 2013 and December 2017 were eligible to be enrolled. Signs and symptoms of an LRTI included one or more of the following: cough, sputum, chest pain, shortness of breath, tachypnea, or abnormal lung findings (e.g., crackles, wheezing) on physical examination.[5, 14] We did not include fever in the inclusion criteria, similar to prior pneumonia literature,[11] because both fever in the ED and fever at home have limitations - children may have already received an antipyretic prior to presentation, and parents may have different definitions of fever and methods for checking for one.[5] To be inclusive of all patients with suspected CAP, children who met all inclusion criteria and may have had a potential asthma exacerbation were not specifically excluded. As the study was intended to investigate CAP in otherwise healthy children, patients were excluded if they had complex chronic conditions (e.g., congenital heart disease, tracheostomy-dependent, chronic lung disease, neuromuscular disease, sickle cell disease, immunodeficiency), history of aspiration pneumonia,[16] hospitalization within the prior 14 days, or prior study enrollment within the last 30 days. Additionally for this analysis, children who received more than two days of antibiotics prior to ED visit and those discharged from the ED were excluded. Thus, this analysis only included children who presented to the ED and were ultimately hospitalized, including patients admitted to the inpatient ward or intensive care unit (ICU).

Data acquisition.

Patient demographics, medical history, current symptoms, and ED clinicians' physical examination findings were prospectively collected by trained research coordinators. Imaging results, antibiotic therapy, and medical interventions were extracted from the electronic health record and reviewed for accuracy by two investigators. Respiratory viral testing was not included in this analysis because testing as a part of clinical care was uncommon, and prior studies have demonstrated that viral testing was not associated with antibiotic decisions.[17]

Outcome.

The primary outcome was receipt of inpatient antibiotics, defined as at least one dose of antibiotics at any time during the hospitalization, after transfer out of the ED. Our goal was to evaluate risk factors associated with any inpatient antibiotic use, regardless of the number of doses, as prior literature demonstrated that each additional day of antibiotics was associated with measurable antibiotic harm.[18] Because some patients may receive just one dose of antibiotics in the inpatient setting prior to discontinuation, our secondary outcome was receipt of a full course of antibiotics, defined as ≥5 days of antibiotics[19] during the admission or antibiotic prescription at discharge.

CXR classification.

All CXRs were interpreted based on a pediatric radiologist's impression as part of clinical care and manually categorized (T.A.F) into one of the four mutually exclusive groups: 1) radiographic CAP (findings such as "infiltrate", "consolidation" or "pneumonia"), 2) equivocal ("atelectasis vs pneumonia"), 3) atelectasis ("atelectasis" without mention of terms that meet criteria for radiographic CAP), and 4) normal (CXRs that did not meet criteria for prior categories and included findings such as "normal", "peribronchial thickening" or "airway disease"). We focused on these four categories because there are many abnormal CXR findings, and we aimed to evaluate the association between antibiotic use and CXR findings across the spectrum of abnormal results. Additionally, prior studies also separated equivocal CXR findings and radiographic CAP.[12, 20] Similar to prior literature, we defined non-radiographic CAP as any CXR that did not meet criteria for radiographic CAP or equivocal CXR (i.e., normal CXRs or those with atelectasis).[15]

Data analysis.

Descriptive statistics were computed overall, and by inpatient antibiotic use groups. Continuous and categorical variables were compared using the Wilcoxon Rank Sum test and Pearson's chi-squared test, respectively. We performed univariable and multivariable Poisson regression with robust error variance to determine the association between risk factors and inpatient antibiotic use.[21] This approach allows us to estimate the relative risk (RR) directly, which is recommended over odds ratios for prospective studies with a non-rare binary outcome.[21, 22] In multivariable models, we adjusted for risk factors identified in two ways: those determined *a priori* to be clinically relevant, including age, history of fever, history of asthma (including reactive airways disease), receipt of at least one dose of antibiotics in the ED, CXR findings, and severe illness in the ED, and those with $p<0.01$ in bivariable analysis (i.e., days of illness, wheeze, focal crackles, and focal decreased breath sounds in the ED, and receipt of supplemental oxygen in the inpatient setting). Severe illness in the ED was defined as receipt of supplemental oxygen, positive-pressure ventilation, or vasopressors in the ED, diagnosis of sepsis,[23] or transfer directly from the ED to the ICU.[24, 25] An interaction term was included to assess how the receipt of antibiotics in the ED modifies the effect of CXR findings on inpatient antibiotic prescribing. This was decided *a priori* as ED antibiotic decisions may differentially affect how CXR findings influence inpatient antibiotic prescribing. We performed a subgroup analysis to examine risk factors among children with non-radiographic CAP as they are low risk for bacterial disease.[11] Statistical tests were

two-sided with a significance level of 0.05. Analyses were performed using SAS (version 9.4, Cary, NC).

Results

Description of Cohort.

Of 1142 children enrolled, 477 met the inclusion criteria for the current study (Supplemental Figure 1). The median age was 2.8 years (IQR, 1.2, 5.8). Most children reported having fever (86%) and cough or rhinorrhea (82%) (Table 1). Half of the patients (51%) had radiographic CAP or equivocal CXR and 49% had non-radiographic CAP.

Antibiotics in the Inpatient Setting and a Full Antibiotic Course.

In total, 285 (60%) patients received at least one dose of antibiotics in the inpatient setting, and 254 (53%) received a full antibiotic course. Children who received antibiotics in the inpatient setting were older (3.3 vs 2.2 years), had a longer fever duration (3 vs 2 days), and more often had radiographic CAP (47% vs 3%) and abnormal lung findings in the ED (Table 1).

Antibiotic Use and CXR Findings.

Of the children with radiographic CAP, 96% received of inpatient antibiotics and 91% received a full antibiotic course. Of the 232 children with non-radiographic CAP, 29% received inpatient antibiotics and 21% received a full course. Children with non-radiographic CAP represented 24% of all children who were given inpatient antibiotics and 21% who were given a full antibiotic course.

Antibiotic Use Across Spectrum of Care: Overall and Non-Radiographic CAP.

Most patients who received antibiotics in the ED also received them in the inpatient setting (90%) and most children who received antibiotics in the inpatient setting went on to receive a full course (89%). For those with non-radiographic CAP, most who received antibiotics in the ED had antibiotics continued in the inpatient setting (71%) and most who received antibiotics in the inpatient setting completed a full course (72%).

Risk Factors for Inpatient Antibiotic Use.

In adjusted analyses, receipt of antibiotics in the ED, history of fever, and receipt of supplemental oxygen in the inpatient setting were associated with an increased risk of inpatient antibiotic use (Table 2; Supplemental Table 1 for unadjusted analyses). The association between CXR findings and inpatient antibiotics was modified by receipt of antibiotics in the ED ($p<0.001$; Table 3). Children with radiographic CAP and equivocal CXR had an increased risk of receiving inpatient antibiotics compared to those with normal CXRs, but the increased risk was modest when antibiotics were given in the ED (RR 1.35 [1.06,1.71] and 1.36 [1.06,1.74], respectively) and much greater when ED antibiotics were not given (RR 6.07 [3.86, 9.54] and 3.67 [2.09, 6.44], respectively). Additionally, when antibiotics were given in the ED, there was no difference in the risk of inpatient antibiotic use between those with equivocal and radiographic CAP. Among children who did not

receive ED antibiotics, those with atelectasis had an increased risk of receiving inpatient antibiotics compared with those with a normal CXR (RR 2.03 [1.09, 3.76]).

Risk Factors for Inpatient Antibiotic Use in Non-Radiographic CAP.

There were 232 children with non-radiographic CAP, and in the adjusted model, those who received antibiotics in the ED had an increased risk (RR 2.83 [1.87,4.28]) of receiving inpatient antibiotics (Supplemental Tables 2–3). History of fever, focal crackles, and receipt of supplemental oxygen in the inpatient setting also increased the risk of inpatient antibiotic use in this cohort.

Risk Factors for a Full Course of Antibiotics.

We found similar risk factors for a full course of antibiotics as we did in our primary analysis (Supplemental Tables 4–5).

Discussion

In this prospective cohort study of children hospitalized with suspected CAP, antibiotic use in the ED, abnormal CXR findings, fever, and use of supplemental oxygen were associated with receipt of antibiotics in the inpatient setting and a full treatment course. Antibiotics initiated in the ED were frequently continued in the inpatient setting (90%) and those who received a dose in inpatient setting often completed a full course (89%). Despite evidence that most children with non-radiographic CAP are low risk for bacterial CAP,[11] nearly 1 in 3 received inpatient antibiotics and 1 in 4 received a full treatment course. In this subgroup, inpatient antibiotic use was associated with antibiotics in the ED, fever, focal crackles, and use of supplemental oxygen.

Even though antibiotics are not beneficial for most children with non-radiographic CAP,[11] 21% of those who received a full antibiotic course had non-radiographic CAP. Our findings are supported by prior studies demonstrating that 22–36% of children in the ED who received antibiotics had non-radiographic CAP.[11, 12] While clinicians may be concerned that CXR findings consistent with pneumonia can be absent early on or in patients with dehydration, there are no pediatric data to support this, and a prior study highlighted the high (98%) negative predictive value of CXRs.[11, 26, 27] While CXRs are imperfect (particularly their inability to differentiate viral vs bacterial and infectious vs non-infectious causes when infiltrates are present), clinicians can harness their negative predictive value to identify those who likely have a non-bacterial respiratory illness (e.g., viral pneumonia, bronchiolitis, asthma) and would not benefit from antibiotics.[11, 28, 29] Our work highlights the great potential for reducing unnecessary antibiotics by targeting children with non-radiographic CAP.

When evaluating the impact of CXRs across the spectrum of findings, we found that children with atelectasis who did not receive antibiotics in the ED had more than a two-fold increased risk of receiving inpatient antibiotics and a full treatment course compared to those with normal CXRs. Few studies have explored the association between antibiotic use and atelectasis. Our finding suggests that despite atelectasis being a non-specific sign on many pediatric CXRs, atelectasis increased the risk of antibiotic use.[30] Additionally,

among children who received antibiotics in the ED, there was no difference in the risk of inpatient antibiotics between those with equivocal CXRs or radiographic CAP even though the term “equivocal” suggests uncertainty regarding the presence of radiographic CAP. Similarly, prior studies demonstrate high antibiotic rates for equivocal CXRs.[12] While acknowledging the subjectivity of CXR interpretations,[31] our results suggest that optimizing decision making in the context of nuanced CXR findings may help promote antibiotic stewardship.

Most children who received antibiotics in the ED had antibiotics continued in the inpatient setting and received a full treatment course, even among those with non-radiographic CAP. Additionally, when antibiotics were given in the ED, children with abnormal CXR findings had only a modest increased risk of inpatient antibiotic use compared to those with normal CXRs. The inpatient setting provides a unique opportunity for clinicians to make therapeutic decisions based on an evolving clinical picture rather than one point in time.[32] However, our data suggest that inpatient antibiotic decisions were rarely modified and were strongly influenced by ED treatment decisions. A single-center study of 181 children noted only 38% of those who received antibiotics in the ED continued antibiotics in the inpatient setting.[33] These results may differ from ours due to varied hospital practices or patient populations, as our study included children with suspected CAP who had a CXR, whereas the other study included a higher proportion (54%) of children with asthma and 19% without a CXR. Similar to our findings, a scenarios based-survey in adults found that hospitalists were more likely to continue both inappropriate and overly broad antibiotic therapy when initiated by ED clinicians.[34]

The influence of ED antibiotic prescribing on inpatient treatment decisions may relate to the concept of therapeutic momentum (a term used, at times, synonymously with clinical inertia and therapeutic inertia).[35–39] Therapeutic momentum is the failure of clinicians to initiate or intensify therapy when therapeutic goals are not reached or to stop or reduce therapy that is no longer needed.[35–39] Based on prior literature, there exists a very strong norm for noninterference, where clinicians do whatever they can to avoid altering another prescriber’s decisions, and this may play a role in therapeutic momentum in pediatric CAP.[40] The desire to continue treatment for a patient that is improving and overestimate the potential benefits of antibiotics, particularly in the context of simultaneously receiving many other ED interventions (e.g., intravenous fluids) that improve a child’s clinical appearance, may also be a contributing factor.[41] Additionally, clinician perceptions of parental pressure or expectations with regard to antibiotics, similar to the its role in antibiotic decision making in the ambulatory setting,[42] may contribute in the inpatient setting, particularly once antibiotics have already been started. Therapeutic momentum is a recognized barrier to appropriate escalation or de-escalation of medications for adults and children with chronic conditions such as diabetes and hypertension.[43,44] Less is known about therapeutic momentum in the acute care setting, as patients transition from the ED to inpatient wards or its role as a modifiable barrier to antibiotic stewardship, making our study a novel contribution with important implications.

Our study has several limitations. First, this study was conducted at a single tertiary care academic pediatric hospital, and conclusions, particularly about the influence of ED

practices on antibiotic prescribing in the inpatient setting, may not be generalizable to other settings. Second, because we only included patients in whom a CXR was obtained, the applicability of these findings for children without CXRs is unknown. However, given that 89% of patients admitted with CAP at children's hospitals in the U.S. receive CXRs, we suspect this will be applicable to many institutions.[4, 45] Third, we may have misclassified patients who also had an asthma exacerbation or reactive airway disease, which may have been disproportionally higher for those with non-radiographic CAP. This may have influenced our antibiotic risk factors, particularly for patients with non-radiographic CAP. However, children included in the study had to have a CXR performed for suspected CAP regardless of additional suspicion for asthma. Furthermore, our analysis adjusted for a history of asthma or reactive airway disease to reduce this confounder. Fourth, CXR interpretation is observer dependent.[2, 31] The aim of this study was to understand how factors in clinical practice, such as CXR results presented in real-time, influence antibiotic decision making; thus, we categorized CXR findings based on the interpretation made in clinical practice. Fifth, the original prospective cohort study was powered to differentiate severity in children with CAP[24] and because this was a secondary analysis, we report our findings as effect sizes. Finally, because we do not know the indication for antibiotic use, we cannot be certain antibiotics were prescribed for CAP rather than other suspected bacterial infections.

Conclusion

Among children hospitalized with suspected CAP, receipt of antibiotics in the ED, CXR findings, history of fever, and receipt of supplemental oxygen were strongly associated with prescribing antibiotics in the inpatient setting and receiving a full treatment course. Nearly a third of children with non-radiographic CAP received inpatient antibiotics despite having a low risk for bacterial CAP. Once antibiotics were started in the ED, they were often continued, even for patients with non-radiographic CAP. Therapeutic momentum, rather than clear rationale for continuing antibiotics, likely played a role in these findings. Targeting therapeutic momentum and implementing other antibiotic stewardship strategies, focusing particularly on children with non-radiographic CAP, could help improve judicious antibiotic use.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Abbreviations:

CAP	Community acquired pneumonia
CXR	chest radiograph
ED	Emergency Department
RR	risk ratio
IQR	interquartile range
ICU	intensive care unit

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What's Known on This Subject:

Though community-acquired pneumonia is most frequently caused by viruses, antibiotics are often prescribed. Pathogen-specific tests are lacking. Antibiotic overuse contributes to antimicrobial resistance and adverse effects, suggesting an increasing need for improved antimicrobial stewardship.

What This Study Adds:

We identified several factors associated with antibiotic prescribing for children hospitalized with suspected CAP. Children with non-radiographic pneumonia often received antibiotics. These findings help identify potential modifiable targets for future stewardship interventions.

Table 1.

Patient Characteristics Stratified by Inpatient Antibiotic Use

Patient Characteristics	Overall (N=477)	Inpatient Antibiotics (N=285)	No Inpatient Antibiotics (N=192)	*P*-value
Demographics				
Age in years – median (IQR)	2.8 (1.2,5.8)	3.3 (1.4,6.5)	2.2 (1.1,5.0)	0.01
Female sex	220 (46)	134 (47)	86 (45)	0.63
Non-Hispanic or Latino ethnicity	458 (96)	274 (96)	184 (96)	0.93
Insurance status				0.02
Government	243 (51)	134 (47)	109 (57)	
Private	227 (48)	149 (52)	78 (41)	
Self-pay	7 (1)	2 (1)	5 (3)	
Past Medical History				
History of pneumonia	106 (22)	64 (22)	42 (22)	0.90
History of asthma	156 (33)	76 (27)	80 (42)	<0.01
Prematurity (<37 weeks gestational age)	87 (18)	52 (18)	35 (18)	0.99
Immunizations up to date	444 (93)	267 (94)	177 (92)	0.53
History of Present Illness				
Days of illness - median (IQR)	3.0 (2.0,5.0)	4.0 (2.0,6.0)	3.0 (2.0,4.0)	<0.01
History of family reported fever	408 (86)	264 (93)	144 (75)	<0.01
Days of fever - median (IQR)	2.0 (1.0,4.0)	3.0 (2.0,5.0)	2.0 (1.0,2.0)	<0.01
Cough and/or rhinorrhea	391 (82)	228 (80)	163 (85)	0.17
Vomiting and/or diarrhea	278 (58)	178 (62)	100 (52)	0.02
ED Clinical Course				
Exam findings				
Fever >38.0°C	232 (49)	158 (56)	74 (39)	<0.01
Wheeze	189 (41)	77 (28)	112 (60)	<0.01
Focal crackles	109 (23)	94 (34)	15 (8)	<0.01
Rhonchi	185 (40)	105 (38)	80 (43)	0.29
Focal decreased breath sounds	132 (28)	97 (35)	35 (19)	<0.01
Retractions	324 (69)	175 (63)	149 (79)	<0.01
CXR findings[a]				<0.01
Radiographic pneumonia	140 (29)	135 (47)	5 (3)	
Equivocal	105 (22)	83 (29)	22 (11)	
Atelectasis	70 (15)	28 (10)	42 (22)	
Normal	162 (34)	39 (14)	123 (64)	
Receipt of antibiotics in the ED	251 (53)	225 (79)	26 (14)	<0.01
Receipt of supplemental oxygen in the ED	258 (54)	149 (52)	109 (57)	0.33
Severe illness in the ED[b]	266 (56)	151 (53)	115 (60)	0.14
Inpatient Clinical Course				
Receipt of supplemental oxygen in inpatient setting	228 (48)	159 (56)	69 (36)	<0.01

Patient Characteristics	Overall (N=477)	Inpatient Antibiotics (N=285)	No Inpatient Antibiotics (N=192)	*P*-value
Admitted or transferred to ICU	59 (12)	36 (13)	23 (12)	0.83

Values represent N(%) unless otherwise specified.

IQR, interquartile range; ED, emergency department; CXR, chest radiograph; ICU, intensive care unit.

[a]CXR findings were classified into four mutually exclusive categories based on the pediatric radiologists' interpretation as part of clinical care: 1) radiographic CAP ("infiltrate", "consolidation" or "pneumonia"), 2) equivocal ("atelectasis vs pneumonia"), 3) atelectasis, and 4) normal ("normal", "peribronchial thickening" or "airways disease")

[b]Severe illness in the ED defined as having received supplemental oxygen, positive pressure ventilation, or pressors in the ED, having sepsis in the ED, or going directly from the ED to ICU

Table 2.

Relative Risk of Inpatient Antibiotic Use

Risk Factor	Adjusted Relative Risk[a] (95% CI)
Age in years	1.01 (1.00,1.02)
History of fever at home	1.66 (1.22,2.27)
Three or more days of illness (vs <3)	1.05 (0.91,1.22)
History of asthma	0.98 (0.85,1.13)
Wheeze on exam in the ED	0.87 (0.75,1.01)
Focal crackles on exam in the ED	1.10 (0.99,1.22)
Focal decreased breath sounds on exam in the ED	0.98 (0.89,1.09)
Receipt of antibiotics in the ED[b]	4.33 (2.63,7.13)
Severe illness in the ED	0.91 (0.79,1.05)
Receipt of supplemental oxygen in inpatient setting	1.29 (1.11,1.50)
CXR findings	*See Table 3*

[a]Adjusted for all the other risk factors listed in this table and a statistically significant ($p<0.001$) interaction effect between receipt of antibiotics in the ED and CXR findings. The results of the interaction are displayed in Table 3. See supplemental Table 1 for unadjusted RRs.

[b]Among those with normal CXR (i.e., the reference group for CXR findings).

Table 3.

Adjusted Relative Risk of Inpatient Antibiotic Use by CXR Findings

CXR Finding	Adjusted Relative Risk (95% CI)[a]
No antibiotics given in the ED	
Normal	*Reference*
Radiographic CAP	6.07 (3.86, 9.54)
Equivocal	3.67 (2.09, 6.44)
Atelectasis	2.03 (1.09, 3.76)
Antibiotics given in the ED	
Normal	*Reference*
Radiographic CAP	1.35 (1.06, 1.71)
Equivocal	1.36 (1.06, 1.74)
Atelectasis	1.13 (0.81, 1.56)

[a]We used the same model as described in Table 2 to evaluate the relative risk at each categorical level of the interaction.