Antibiotic and Diagnostic Discordance Between ED Physicians and Hospitalists for Pediatric Respiratory Illness

AUTHORS
Eric R. Coon, MD,[a] Christopher G. Maloney, MD, PhD,[a] Mark W. Shen, MD[b]

[a]*Division of Inpatient Medicine, Department of Pediatrics, University of Utah School of Medicine, Primary Children's Hospital, Salt Lake City, Utah; and*
[b]*University of Texas Southwestern, Dell Children's Hospital, Austin, Texas*

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ABBREVIATIONS
CAP: community-acquired pneumonia
ED: emergency department
IMC: intermediate care unit

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Address correspondence to Eric Coon, MD, Department of Pediatrics, Division of Inpatient Medicine, University of Utah School of Medicine, Primary Children's Hospital, 100 North Mario Capecchi Dr, Salt Lake City, UT 84113. E-mail: eric.coon@hsc.utah.edu

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abstract

BACKGROUND AND OBJECTIVE: Imperfect diagnostic tools make it difficult to know the extent to which a bacterial process is contributing to respiratory illness, complicating the decision to prescribe antibiotics. We sought to quantify diagnostic and antibiotic prescribing disagreements between emergency department (ED) and pediatric hospitalist physicians for children admitted with respiratory illness.

METHODS: Manual chart review was used to identify testing, diagnostic, and antibiotic prescribing decisions for consecutive children admitted for respiratory illness in a winter (starting February 20, 2012) and a summer (starting August 20, 2012) season to a tertiary, freestanding children's hospital. Respiratory illness diagnoses were grouped into 3 categories: bacterial, viral, and asthma.

RESULTS: A total of 181 children admitted for respiratory illness were studied. Diagnostic discordance was significant for all 3 types of respiratory illness but greatest for bacterial ($P < .001$). Antibiotic prescribing discordance was significant ($P < .001$), with pediatric hospitalists changing therapy for 93% of patients prescribed antibiotics in the ED, including stopping antibiotics altogether for 62% of patients.

CONCLUSIONS: Significant diagnostic and antibiotic discordance between ED and pediatric hospitalist physicians exists for children admitted to the hospital for respiratory illness.

Respiratory illnesses are the most common pediatric diagnoses necessitating hospitalization.[1,2] Antibiotics are often prescribed for respiratory illness,[3,4] yet a significant portion of antibiotic use may be unnecessary.[5–9] The first aim listed by the American Academy of Pediatrics Choosing Wisely campaign targets overuse of antibiotics for respiratory illness.[10]

Antibiotics prescribed in the setting of respiratory illness are intended to treat bacterial pathogens. However, radiologic,[11–13] laboratory,[14,15] and clinical findings[16,17] are all unreliable in distinguishing bacterial from viral lower respiratory tract illness. In fact, viral pathogens can be isolated from 45% to 83% of children hospitalized for respiratory illness, including community-acquired pneumonia (CAP).[18–23]

Given this diagnostic challenge, the tremendous amount of testing and treatment variation that exists for respiratory illness may not be surprising.[24–27] However, the degree to which different types of providers in dissimilar practice environments contribute to this variation by disagreeing on the diagnosis is less clear. Diagnostic discordance for respiratory illness between emergency department

(ED) physicians and hospitalists is documented in the adult literature, but it has not been described in pediatrics.[28–32] Antibiotic discordance between ED and hospitalist physicians for respiratory illness at admission has not been measured in any age group. Our study sought to quantify the diagnostic and antibiotic discordance between ED physicians and pediatric hospitalists for children admitted to the hospital for respiratory illness.

METHODS

Setting

We conducted a cohort study at Dell Children's, a tertiary care, freestanding children's hospital. Approximately 80% of ED shifts are covered by pediatric-trained providers, and the remaining shifts are covered by adult-trained providers. Resident teams were the sole admitting teams, and all admissions were staffed by pediatric hospitalists providing 24/7 direct supervision.

Inclusion Criteria

Patients were eligible for inclusion if they were admitted through the Dell Children's ED or directly from an outside clinic, urgent care clinic, or ED with a respiratory illness. Physicians used the resident triage admission list, a prospectively recorded list of all patients transferred or admitted to the inpatient pediatric ward teams, which included an intermediate care unit (IMC). Descriptions suggesting respiratory illness included pneumonia, asthma, increased work of breathing, respiratory distress, bronchiolitis, croup, stridor, infiltrate, aspiration, hypoxia, upper respiratory tract infection, cough, respiratory syncytial virus, and flu. Consecutive patients were included through the day in which 100 patients with respiratory illness were obtained in a winter season (starting February 20, 2012) and a summer season (starting August 20, 2012). More than 100 patients were obtained in both seasons because enrollment continued until midnight on the day in which the enrollment goal was reached. Enrollment was conducted in both winter and summer seasons to provide greater generalizability, given seasonal fluctuations in the relative contribution of pathogens and allergens to respiratory illness.

Exclusion Criteria

Patients were excluded if they carried a nonrespiratory diagnosis often treated with antibiotics (otitis media, urinary tract infection, and strep pharyngitis) or were actively completing an antibiotic course prescribed before admission to the hospital. The only comorbidities for which patients were excluded were cystic fibrosis and cancer, because these conditions have protocoled antibiotic treatment decisions.

Diagnosis

Diagnoses, including nonrespiratory diagnoses often treated with antibiotics, were determined by descriptors and phrases from the impression portions of ED and hospitalist charting at the time of admission. In cases where the resident and attending impressions differed, the attending impression was used. Discharge diagnosis was based on descriptors and phrases in the discharge narrative. Respiratory illness was categorized into 3 groups. Descriptors such as pneumonia and atypical pneumonia were included in the bacterial group. Any description implying a viral respiratory illness, such as viral pneumonia, lower respiratory tract infection, upper respiratory tract infection, bronchiolitis, or croup, was included in the viral respiratory illness group. Phrases such as reactive airway disease, reversible bronchospasm, and asthma were included in the asthma group. An individual patient could have none or all 3 (bacterial, viral, asthma) diagnoses depending on physician descriptions. Coded and billing diagnoses were ignored, given their inaccuracy for pediatric CAP.[33]

Antibiotic Prescription

ED physicians' decision to treat was based on their written orders immediately after their diagnostic impression. The admitting team's decision about antibiotic therapy was determined by review of the documented plan on admission by the resident and attending, with the attending plan trumping any discrepancies with the resident plan. In some cases when the plan was unclear, the medication administration record was queried.

Chest Radiograph

Chest radiograph findings were based on the final report by the radiologist and were subdivided according to a previously published ranking of radiographic pneumonia: definite, equivocal, or normal.[34] Findings with descriptors such as consolidation, infiltrate, and pneumonia were considered definite, whereas those with phrases such as consolidation versus atelectasis or worrisome for superimposed bacterial pneumonia were labeled equivocal.[34] Our study added an abnormal category for reports using terms such as perihilar, peribronchial thickening, reactive airway disease, hyperinflation, or viral. Only radiographs ordered by the ED physician at the time of admission were included for analysis.

Statistical Analysis

Analysis was performed by using Stata, version 13 (Stata Corp, College Station, TX). We compared baseline dichotomous, ordinal, and continuous variables by using χ^2, Wilcoxon–Mann–Whitney, and *t* tests, respectively. We compared the amounts of diagnostic and antibiotic disagreement between ED and hospitalist physicians by using the McNemar test for correlated samples (ED and hospitalist physicians were making decisions on the same patients) and adjusted for multiple comparisons by using the Holm procedure.[35] We compared mean length of stay for patients with antibiotics continued and discontinued by pediatric hospitalists by using linear regression and adjusting for age and season.

RESULTS

One hundred three patients met inclusion criteria between February 20 and February 29, 2012, and 104 patents met inclusion criteria between August 20 and September 11, 2012. Twenty-six patients were excluded because they were diagnosed with a nonrespiratory diagnosis often treated with antibiotics ($n = 13$) or were actively completing an antibiotic course prescribed before presentation ($n = 13$). Nineteen patients were excluded from the winter season, and 7 patients were excluded from the summer season. Patients were seen by 22 different pediatric hospitalists. Four patients were directly admitted from outside clinics.

Table 1 describes characteristics of 181 patients included in the study. Patients admitted in the winter season were younger, less likely to have a comorbidity, more likely to receive viral testing, and less likely to have a normal chest radiograph.

TABLE 1 Patient Characteristics by Season

	Winter (%), $N = 84$	Summer (%), $N = 97$	*P*
Age			
0–2 mo	11	1	<.01[a]
2 mo–2 yr	54	33	
2–6 yr	24	48	
6–18 yr	12	18	
Gender			
Male	55	63	.70[b]
Comorbidity			
Present	37	54	.03[b]
Chest radiograph			
Normal	15	21	.02[a]
Abnormal	40	32	
Equivocal	24	14	
Definite	7	7	
Not performed	11	23	
Unknown	2	3	
Viral testing[c]			
Positive	26	1	<.01[b]
Negative	33	5	
Not performed	40	94	
Location at admit			
Floor	86	79	.27[b]
IMC	14	21	
Length of stay, avg h			
	58	42	.10[d]
Diagnosis[e]			
Emergency physician			
Bacterial	52	57	.56[b]
Viral	57	19	<.01
Asthma	24	57	<.01
Hospitalist[f]			
Bacterial	12	10	.73
Viral	74	42	<.01
Asthma	35	64	<.01

[a] Wilcoxon–Mann–Whitney.
[b] χ^2.
[c] Rapid respiratory syncytial virus or influenza testing.
[d] *t* test.
[e] Column percentages can sum to >100% because patients could have >1 diagnosis.
[f] Hospitalist diagnosis at the time of admission.

Diagnosis

ED and admitting hospitalist team diagnoses were compared for each individual patient at the time of admission (Table 2). We found that ED physicians and hospitalists had statistically significant discordance for all 3 respiratory illness groups. The greatest amount of discordance occurred for the diagnosis of bacterial respiratory illness, a difference that persisted after stratification by season and antibiotic prescription. A sensitivity analysis using hospitalist discharge diagnosis instead of hospitalist admission diagnosis did not appreciably change the total amount of diagnostic discordance for bacterial respiratory illness (47% using admission, 46% using discharge).

Antibiotic Prescription

Twenty-eight patients during the winter season and 20 patients during the summer season received antibiotics from an ED or hospitalist physician at the time of admission.

TABLE 2 Diagnostic Disagreement Between ED Physicians and Hospitalists at the Time of Admission

Diagnosis	Agreement		Disagreement		*P*, Unadjusted	*P*, Adjusted
	ED Yes, Hospitalist Yes, %	ED No, Hospitalist No, %	ED Yes, Hospitalist No, %	ED No, Hospitalist Yes, %		
Total ($n = 181$)						
Bacterial	9	44	45	2	<.001[a]	<.001[b]
Viral	31	38	5	25	<.001	<.001
Asthma	36	45	5	14	.006	.03
Winter ($n = 84$)						
Bacterial	10	45	43	2	<.001	<.001
Viral	51	20	6	23	.004	.03
Asthma	20	62	4	14	.02	.08
Summer ($n = 97$)						
Bacterial	9	42	47	1	<.001	<.001
Viral	14	54	4	28	<.001	<.001
Asthma	51	30	6	13	.11	.22
Received antibiotics ($n = 48$)						
Bacterial	33	8	55	4	<.001	<.001
Viral	20	43	0	37	<.001	<.001
Asthma	18	59	6	16	.13	.22
No antibiotics ($n = 133$)						
Bacterial	1	57	42	1	<.001	<.001
Viral	36	36	7	21	.002	.01
Asthma	43	39	5	13	.02	.08

Measuring statistical significance for comparisons across rows (eg, total disagreement of bacterial versus viral and asthma) is not possible because the McNemar test could be biased by prevalence in these comparisons.
[a] Paired-sample McNemar test comparing the 2 disagreement percentages, 45% vs 2% for this particular row.
[b] Adjusted for 15 comparisons by using Holm.[35]

We found statistically significant discordance between ED and pediatric hospitalist physicians regarding antibiotic prescription (Table 3), more so in the winter than the summer. ED physicians started antibiotic therapy on 45 patients admitted for respiratory illness. Hospitalists made 1 of 5 decisions about antibiotic treatment in these patients at the time of admission: continue the same antibiotic as prescribed by the ED (3/45), narrow antibiotic coverage (9/45, most often from ceftriaxone to ampicillin), broaden antibiotic coverage (4/45, addition of an antibiotic in all cases), change antibiotic class (1/45, ceftriaxone to trimethoprim–sulfamethoxazole), or discontinue antibiotic therapy (28/45).

Of the 136 patients who did not have antibiotics started by the ED physician, 2 patients in the summer and 1 in the winter were started on antibiotics by the hospitalist at the time of admission. Thus, there was 98% agreement when antibiotics were not prescribed in the ED.

Relationship of Chest Radiograph and Antibiotic Decisions

Table 4 shows the number of patients with a given chest radiograph interpretation who were prescribed antibiotics by an ED physician and the admitting pediatric hospitalist's decision about whether to continue antibiotics. For 45% (5/11) of patients with definite radiographic pneumonia and 68% (13/19) with equivocal radiographic pneumonia who received antibiotics in the ED, antibiotics were

TABLE 3 Antibiotic Prescribing Discordance Between ED and Pediatric Hospitalist Physicians at the Time of Admission

	Agreement		Disagreement		*P*, Unadjusted	*P*, Adjusted
	ED Yes, Hospitalist Yes, %	ED No, Hospitalist No, %	ED Yes, Hospitalist No, %	ED no, Hospitalist yes, %		
Total ($n = 181$)	9	73	16	2	<.001[a]	<.001[b]
Winter ($n = 84$)	8	65	25	1	<.001	<.001
Summer ($n = 97$)	10	79	8	2	.06	.06

[a] Paired-sample McNemar test comparing the 2 disagreement percentages, 16% vs 2% for this particular row.
[b] Adjusted by using Holm.[35]

TABLE 4 Frequency of Pediatric Hospitalist Discontinued Antibiotics Grouped by Official Chest Radiograph Interpretation

Interpretation[a]	Winter ($n = 25$)	Summer ($n = 16$)	Total Percentage
Definite	3/5	2/6	45
Equivocal	10/11	3/8	68
Abnormal	4/6	2/2	75
Normal	2/3	0/0	67

[a] In 4 cases, the official chest radiograph interpretation was unknown (2 in each season).

stopped at the time of admission by the hospitalist. A linear trend test was not significant ($P = .17$) for continuation of antibiotics for increasingly certain radiographic pneumonia.

Readmission, Transfer to a Higher Level of Care, and Length of Stay

Overall, 7 patients were readmitted within 14 days of discharge and 15 were transferred to a higher level of care at some point during their hospitalization. Limiting analysis to the 48 patients who were prescribed antibiotics by the ED physician or hospitalist, 4 were readmitted and 3 were transferred to a higher level of care (Table 5). Two of these patients were readmitted for continued respiratory problems. One patient had antibiotics stopped initially and was readmitted for a viral lower respiratory tract infection, and the other patient had antibiotics broadened by the hospitalist team on the first admission.

For each of the 3 patients transferred to a higher level of care during hospitalization, the hospitalist team had continued the same antibiotics prescribed in the ED, with the addition of an antibiotic in 1 case. Patients for whom antibiotics were stopped by the hospitalist team had a shorter, though not statistically significant, mean length of stay compared with patients for whom antibiotics were continued (40.1 hours vs 64.6 hours, $P = .07$), after adjusting for age and season.

DISCUSSION

We found significant diagnostic and antibiotic prescribing discordance between ED and pediatric hospitalist physicians at the time of admission for respiratory illness in children. The disagreement was greatest for the diagnosis of bacterial respiratory illness and strongly predicted stopping antibiotic prescription. Pediatric hospitalists almost always agreed with ED decisions to not start antibiotics, but there was substantial discordance when ED physicians made a decision to prescribe antibiotics. Pediatric hospitalists stopped antibiotics altogether at the time of admission in 62% of cases. For patients whose antibiotics were stopped by the hospitalist team at the time of admission, none needed readmission for bacterial respiratory illness, none needed transfer to a higher level of care, and mean length of stay was not prolonged.

Diagnostic discordance for CAP between ED and adult hospitalist physicians has been studied, with ranges of discordance reported between 20% and 27%.[28,29,32] Our study found approximately twice as much (47%) diagnostic discordance. Significantly greater discordance for adult patients, ranging from 33% to 41%, has been demonstrated directly after implementation of guidelines recommending early antibiotic administration in the ED.[30,31] Initial studies suggesting that early antibiotic administration for CAP in adults improved outcomes[36–38] have more recently been contradicted.[39,40] Nevertheless, the notion that earlier antibiotic therapy could improve outcomes remains alluring and may have contributed to the discordance observed in the current study.

In addition to greater discordance, our study differs from adult studies in that we measured discordance at the time of admission and discharge. No adult studies measured discordance at the time of admission, relying almost exclusively on discharge diagnoses. Over the course of a hospitalization, patient symptoms evolve, new laboratory or imaging findings become available, and important trends emerge,

TABLE 5 Patients Readmitted Within 14 d of Discharge or Transferred to a Higher Level of Care During Their Hospitalization

ED Antibiotic	Hospitalist Antibiotic	Readmission Diagnosis
Ceftriaxone	None	Readmitted for viral lower respiratory tract infection
Piperacillin–tazobactam	Azithromycin	Readmitted for cholelithiasis
None	Azithromycin	Readmitted for vomiting
Ceftriaxone	Ceftriaxone and clindamycin	Readmitted for pneumonia
Ampicillin	Ampicillin	Transferred to PICU
Ceftriaxone	Ceftriaxone	Transferred to IMC
Ceftriaxone	Ceftriaxone and azithromycin	Transferred to IMC

all of which might increase the discordance between first and final physician impressions of patients. We were able to show that the diagnostic discordance for bacterial respiratory illness is actually present immediately at the time of admission and is not appreciably changed by the time of discharge. Finally, our study is also strengthened by the method used to ascertain diagnoses: manually reviewing physicians' diagnostic impressions rather than relying on administrative billing codes, which are known to be inaccurate.[33]

Although authors who have noted CAP diagnostic discordance have recognized the importance of exploring its effect on antibiotic prescribing, this has not been previously studied for CAP.[28] One study examined antibiotic prescribing discordance between the ED and the inpatient team in the first 24 hours for all infections and found that 77% of patients had their antibiotic regimen changed and 3% had their antibiotic discontinued altogether.[41] In our study, a change in antibiotic regimen occurred for 31% of patients, and complete discontinuation occurred for 62% of patients. The publication of national guidelines recommending ampicillin as first-line treatment of inpatient pediatric CAP <1 year before our data collection began probably contributed to the rate of changed antibiotics in the current study.[42]

Highly imperfect methods for distinguishing bacterial from viral lower respiratory tract processes may contribute to the discordance observed in this study. Yet these deficient diagnostic tools encumber ED and hospitalist physicians similarly, and the direction of disagreement was almost always hospitalists changing away from a bacterial diagnosis and minimizing antibiotic exposure. In our study, although hospitalists were more likely to have access to an official interpretation of the chest radiograph by a radiologist, they still discontinued antibiotic therapy for 45% and 68% of children with definite and equivocal radiographic pneumonia, respectively. Perhaps most important are ED and hospitalist physicians' distinctive practice environments, contributing to specialty-specific preference-sensitive care variation, or different values, attitudes toward risk aversion, personal experience, and interpretation of evidence.[43] For example, the fewer opportunities in the ED to assess the patient and more pressure to arrive at a timely plan of treatment and disposition presumably influence ED physician decision-making relative to hospitalist decision-making. These environmental realities may contribute to different treatment thresholds.[44] ED physicians and hospitalists may agree on the probability of bacterial pneumonia in a given patient but disagree on the specific probability at which treatment should be empirically initiated. Pediatric hospitalists may feel more comfortable with a higher treatment threshold because of their opportunity to observe the patient for an extended period of time in the hospital, a luxury not afforded to ED physicians.

It appears that clinicians' judgment may appropriately modify antibiotic prescribing for respiratory illness, even if these decisions contradict current guidelines. A similar phenomenon was demonstrated in a study of outpatient pediatricians safely identifying febrile newborns who could be spared guideline-recommended interventions such as lumbar punctures and hospital admission.[45] In the current study, almost half of patients with definite radiographic pneumonia with severe enough illness to warrant hospitalization had antibiotics stopped, a decision not supported by published guidelines.[42] Observing certain pediatric inpatients with pneumonia off antibiotics could reduce unnecessary antibiotic use, as the pediatric CAP guidelines suggest for selected outpatients.[42] One study randomly assigned children aged 1 month to 6 years hospitalized for pneumonia to antibiotic treatment or no antibiotic treatment and found no difference in outcomes for the 2 groups.[46]

The harms of diagnostic and antibiotic discordance merit additional study. Unknown is the effect on the trust and anxiety parents and patients experience after being given conflicting diagnoses by physicians hours apart at the same institution. Although single antibiotic doses have been demonstrated to increase the risk of *Clostridium difficile* colonization and disease, the effect of single antibiotic doses on individual and community-wide antibiotic resistance is incompletely understood.[47,48]

Our study has several limitations. It is possible that our single-center findings are not generalizable and that ED and pediatric hospitalist physicians at this institution have a unique and high rate of discordance for respiratory illness. Four patients included in the study were directly admitted from outside clinics and not seen in an ED before admission. Additionally, as a first attempt to quantify an anecdotal phenomenon, our study was not powered to detect a statistically significant difference

in readmission rates or transfer to a higher level of care. Finally, exploration of outcomes was limited by our review of only inpatient records at our own institution. Patients may have had antibiotic therapy added or changed after discharge by their primary care physician, another children's hospital, or another ED.

CONCLUSIONS

Significant diagnostic and antibiotic discordance between ED and pediatric hospitalist physicians was found for children admitted to the hospital for respiratory illness. Clinical judgment may appropriately modify antibiotic prescription for these patients, and greater consideration should be given to observing patients off antibiotics at the beginning of their hospitalization.

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