BRIEF REPORT

Clinical Risk Factors for Revisits for Children With Community-Acquired Pneumonia

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ABSTRACT

BACKGROUND: Children discharged from the emergency department (ED) with community-acquired pneumonia (CAP) revisit for several reasons, including disease progression or treatment failure. Understanding factors associated with revisits may assist clinicians in preventing subsequent visits.

METHODS: Children aged 3 months to 18 years with an *International Classification of Diseases, Ninth Revision* diagnosis of CAP between December 1, 2009 and April 31, 2013 were eligible. The primary outcome was a CAP-related ED visit or hospitalization within 30 days of the index visit. The secondary outcome was a CAP-related ED visit within 48 hours of discharge from the index visit. The association between clinical variables and an ED revisit for children with CAP was assessed by using multivariable logistic regression models.

RESULTS: Of the 3304 index ED visits by patients with CAP, 148 (4.5%) revisited the ED. Children with complex chronic conditions (CCCs) were 2.23 times as likely to revisit the ED as those without a CCC (95% confidence interval: 1.29–3.86). Children admitted and those who received aminopenicillins at the index visit were less likely (63% and 49%, respectively) to revisit the ED (95% confidence interval: 0.24–0.56 and 0.30–0.85, respectively).

CONCLUSIONS: Although children with CAP have a relatively low revisit rate to the ED, patients who received aminopenicillins at their index visit were statistically less likely to revisit when adjusting for markers of severity (eg, age, CCCs, and disposition at index visit). Clinical factors alone, however, may not be the only indicators of revisits, and additional factors may need to be considered in future studies.

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Community-acquired pneumonia (CAP) is 1 of the most frequent reasons children visit the emergency department (ED) and is the fifth most prevalent and the second costliest reason for hospitalization among children in the United States.[1] Minimizing unnecessary revisits is a priority for health care systems to provide high-value health care while minimizing excessive costs.[2] Return visits after a diagnosis of CAP increase total hospital costs, may result in unnecessary hospitalizations, and contribute to overall health care burden.[1,3] Additionally, potential episode-based care models in medicine increase the attention of hospitals on reuse after discharge because hospitals are more likely to be "penalized" for a revisit.[4,5]

Among hospitalized children with CAP, ~8% are readmitted within 30 days, with readmissions accounting for 16% of total hospital costs of all pneumonia hospitalizations.[6] Risk factors for hospital readmissions have included being <1 year of age, having a previous hospitalization, a longer index hospitalization, and complicated pneumonia.[6] Although risks of pneumonia-related hospitalization have been examined, the factors associated with ED revisits for patients with CAP are not well described. Identified risk factors associated with ED revisits may improve management for higher-risk children that need admission to the hospital for continued care. The downstream effects include reducing costs, addressing parental anxiety, and focusing ED resource use. Thus, the objective of this study was to identify the temporal and clinical factors associated with ED revisits for patients with CAP. Our hypothesis was that a small proportion of children diagnosed with CAP who presented with certain clinical risk factors (eg, <92% oxygen saturation) would revisit the ED within 7 days.

METHODS

Study Design and Data Source

In this retrospective cohort study, we included children who visited the ED at an urban, tertiary care children's hospital and were diagnosed with CAP. Chart review from the Epic Electronic Health Record (Epic Systems Corporation, Verona, WI) was used for all ED visits and hospitalizations. This study was approved by the institutional review board at our institution with a waiver of informed consent.

Study Subjects

Children ages 3 months to 18 years old who visited the ED between December 1, 2009 and April 31, 2013 and had an initial diagnosis of CAP were eligible for inclusion regardless of index visit disposition. An episode of CAP was defined as being within 30 days of the index diagnosis of CAP; thus, it was possible for a child to have >1 episode of CAP within the study period. Diagnosis of CAP was defined (by using a previously validated algorithm) as an *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9-CM) diagnosis code of the following: (1) the primary billing diagnosis of pneumonia (480–486, 487.0), empyema (510), or pleurisy (511.0, 511.1, 511.9); or (2) the primary diagnosis of pneumonia-related symptoms (Supplemental Table 4) with a billing diagnosis of pneumonia (480–486, 487.0), empyema (510), or pleurisy (511.0, 511.1, 511.9) in any other diagnosis position.[7]

Children who visited the ED 14 days before the index ED visit were excluded to decrease the potential for including children with hospital-acquired pneumonia.

Potential Risk Factors

Potential risk factors included age, sex, race, ethnicity, insurance, complex chronic conditions (CCCs),[8] asthma and pneumonia history, the season, triage level (ie, 1–5, with level 1 indicating a more serious case necessitating immediate attention), fever (≥38°C), hypoxia (oxygen saturation ≤92%), tachycardia, tachypnea, whether a chest radiograph was performed, the collection of the blood culture or complete blood count, the receipt of intravenous fluids or antibiotics, and disposition at index visit (ie, hospitalized versus discharged from the hospital). Tachycardia and tachypnea were classified by using the Pediatric Advanced Life Support (PALS) age-specific criteria.[9] Tachycardia (90% for age per PALS criteria), tachypnea (90% for age per PALS), hypoxia, or fever were documented as being present if they occurred at any point during the ED visit. Patients were considered to have asthma if they had an asthma diagnosis (493.×) at the time of the index visit or if they had a medical history of asthma documented in their electronic health record (EHR).

Outcome Measures

The primary outcome measure was a pneumonia-related ED revisit defined as a revisit or hospital readmission within 30 days with (1) an ICD-9-CM discharge diagnosis code for pneumonia in a principal or subsequent position, or (2) a primary ICD-9-CM discharge diagnosis code classified under the Pediatric Emergency Care Applied Research Network ICD-Based Diagnosis Grouping System subgroup "Infectious Respiratory Diseases" (Supplemental Table 4).[10] The time to a revisit to the ED was calculated as the date and time of arrival to the ED revisit subtracted from the date and time of discharge from the index ED visit. As a secondary outcome, we evaluated risk factors associated with ED revisits within 48 hours after being discharged from the ED or from being discharged from the hospital.

Data Analysis

Patient-level characteristics were described by using median and interquartile ranges for non-normally distributed continuous variables and frequencies and percentages for categorical variables. Analysis was performed on patients with individual episodes of pneumonia and was not necessarily unique to patients; thus, it was possible for the characteristics of the same child to be included multiple times in the analysis. Pneumonia-related revisits were compared with patients with either no revisit or a nonpneumonia revisit (labeled "no pneumonia revisit") by using the Wilcoxon rank test for continuous variables and χ^2 or Fisher's exact tests for categorical variables as appropriate. Incidence of pneumonia-related revisits was calculated as the number of pneumonia-related ED revisits divided by the total number of index visits.

To determine risk factors associated with a pneumonia-related ED revisit, a

multivariable logistic regression was performed and presented as odds ratios (ORs) and 95% confidence intervals (CIs). Risk factors with $P \leq .1$ in the univariable analyses were included in a multivariable model and remained in the final model if they were statistically significant at $P = .05$.[11] Etiology and overall management of pneumonia is highly dependent on age and the presence of CCCs. Thus, they were determined a priori as strong confounders because young children and children with CCCs are more likely to revisit the ED, resulting in a readmission to the hospital.[12] Age and CCCs were therefore included in the final multivariable logistic regression model regardless of statistical significance.[8] All analyses were performed by using SAS version 9.3 (SAS Institute, Inc, Cary, NC).

RESULTS

Study Population

The study cohort consisted of 3062 children diagnosed with 3304 episodes of CAP, 1448 (43.8%) of whom were admitted to the hospital at the index visit (Table 1). After discharge from the ED or the hospital, there were 148 (4.5%) revisits to the ED within 30 days due to pneumonia and 70 (2.1%) hospitalizations at the revisit (Fig 1). When compared with pneumonia episodes that resulted in being discharged from the hospital from the index ED visit, significantly less episodes resulted in revisits to the ED because of CAP if the children were initially hospitalized (5.7% vs 2.9%, respectively; $P \leq .01$). Most episodes of CAP (61%) resulted in revisits to the ED within 4 days (Supplemental Fig 2).

Risk Factors for Revisit

Patients who revisited the ED with pneumonia were significantly younger and less likely to receive antibiotic therapy at the index visit, specifically aminopenicillins (Table 1).

The main diagnosis code assigned at the revisit to the ED was for pneumonia, followed by fever, cough, asthma, and wheezing (Supplemental Table 3). Additionally, 93 children (63%) received a change in antibiotic at the revisit, 96 (66%)

TABLE 1 Characteristics of Cohort by Disposition

	Cohort, $N = 3304$ (%)	No Pneumonia Revisit, $n = 3156$ (95.5%)	Pneumonia Revisit, $n = 148$ (4.5%)	P
Demographics				
Age (median, IQR)	3.0 (1, 7)	3.0 (1, 7)	3.0 (1, 6)	<.01
Boys	1701 (51.5)	1616 (51.2)	85 (57.4)	.14
Race				
White	1887 (57.3)	1809 (57.6)	78 (52.7)	.70
African American	977 (29.7)	928 (29.5)	49 (33.1)	
Other	427 (13.0)	406 (12.9)	21 (14.2)	
Ethnicity				
Hispanic	222 (6.8)	214 (6.9)	8 (5.4)	.75
Non-Hispanic	3046 (93.2)	2906 (93.1)	140 (94.6)	
Unknown	2 (0.1)	2 (0.1)	0	
Insurance				
Private	1241 (37.6)	1190 (37.7)	51 (34.5)	.63
Public	1978 (59.9)	1884 (59.7)	94 (63.5)	
Self-pay and/or other	85 (2.6)	82 (2.6)	3 (2.0)	
Medical history				
CCC	418 (12.7)	396 (12.6)	22 (14.9)	.40
Asthma	658 (19.9)	634 (20.1)	24 (16.2)	.25
Medical history of asthma	803 (24.3)	770 (24.4)	33 (22.3)	.56
Medical history of pneumonia	282 (8.5)	266 (8.4)	16 (10.8)	.31
ED presentation				
Triage				
1, highest risk	8 (0.2)	7 (0.22)	1 (0.7)	.42
2	1012 (30.8)	974 (31.0)	38 (25.9)	
3	1279 (38.9)	1223 (38.9)	56 (38.1)	
4	793 (24.1)	752 (23.9)	41 (27.9)	
5, lowest risk	199 (6.1)	188 (6.0)	11 (7.5)	
Season				
Fall	694 (21)	665 (21.1)	29 (19.6)	.23
Spring	870 (26.3)	838 (26.6)	32 (21.6)	
Summer	368 (11.1)	345 (10.9)	23 (15.5)	
Winter	1372 (41.5)	1308 (41.4)	64 (43.2)	
Fever at ED presentation	1721 (53.2)	1635 (52.9)	86 (59.3)	.13
Tachycardia at 90th percentile for age	2792 (85.0)	2673 (85.1)	119 (81.5)	.23
Tachypnea 90th percentile for age	2263 (69.0)	2167 (69.1)	96 (65.8)	.39
Oxygen saturation				
>94	2055 (64.7)	1949 (64.3)	106 (73.6)	.12
92–93	664 (20.9)	639 (21.1)	25 (17.4)	
90–91	180 (5.7)	175 (5.8)	5 (3.5)	
<90	276 (8.7)	268 (8.8)	8 (5.6)	
IVFs given in ED	752 (22.8)	723 (22.9)	29 (19.6)	.35
Antibiotic given in the ED	1537 (46.6)	1481 (46.9)	56 (37.8)	.03
Cephalosporin	662 (20.0)	633 (20.1)	29 (19.6)	.89
Clindamycin	68 (2.1)	63 (2.0)	5 (3.4)	.23
Aminopenicillin	610 (18.5)	593 (18.8)	17 (11.5)	.03

TABLE 1 Continued

	Cohort, $N = 3304$ (%)	No Pneumonia Revisit, $n = 3156$ (95.5%)	Pneumonia Revisit, $n = 148$ (4.5%)	*P*
Macrolide	282 (8.5)	276 (8.8)	6 (4.1)	.05
Other[a]	45 (1.4)	44 (1.4)	1 (0.7)	.72
Laboratory and imaging tests				
CXR performed	2878 (87.1)	2751 (87.2)	127 (85.8)	.63
Effusion present on CXR	135 (4.1)	130 (4.1)	5 (3.4)	.66
Blood culture performed	804 (24.3)	776 (24.6)	28 (18.9)	.12
Blood culture positive	17 (2.1)	17 (2.1)	0	.99
CBC performed	864 (26.2)	827 (26.2)	37 (25.0)	.74
Respiratory panel performed	169 (5.1)	160 (5.1)	9 (6.1)	.59
Admitted to the hospital at index visit	1448 (43.8)	1406 (44.6)	42 (28.4)	<.01

CBC, complete blood count; CXR, chest radiograph; IQR, interquartile range; IVFs, intravenous fluids.
[a] Other antibiotics include aminoglycoside, sulfonamides, vancomycin, and linezolid.

were tachypneic, and 119 (82%) were tachycardic during their ED revisits. Children with CCCs and fever were 3.86 (95% CI: 1.39–10.71) and 2.24 (95% CI: 1.29–3.90) times as likely, respectively, to return to the ED within 48 hours as those without (Table 2). In addition, children were statistically less likely to revisit the ED within 48 hours if they were admitted at the index visit for a specific episode of CAP.

Although CCCs and dispositions remained statistically significant predictors of ED revisits within 30 days, fever did not. In addition, children who received an aminopenicillin therapy at their ED index visit were 49% (95% CI: 0.30–0.85) less likely to revisit the ED within 30 days compared with children who did not receive aminopenicillin during their CAP episodes (Table 2).

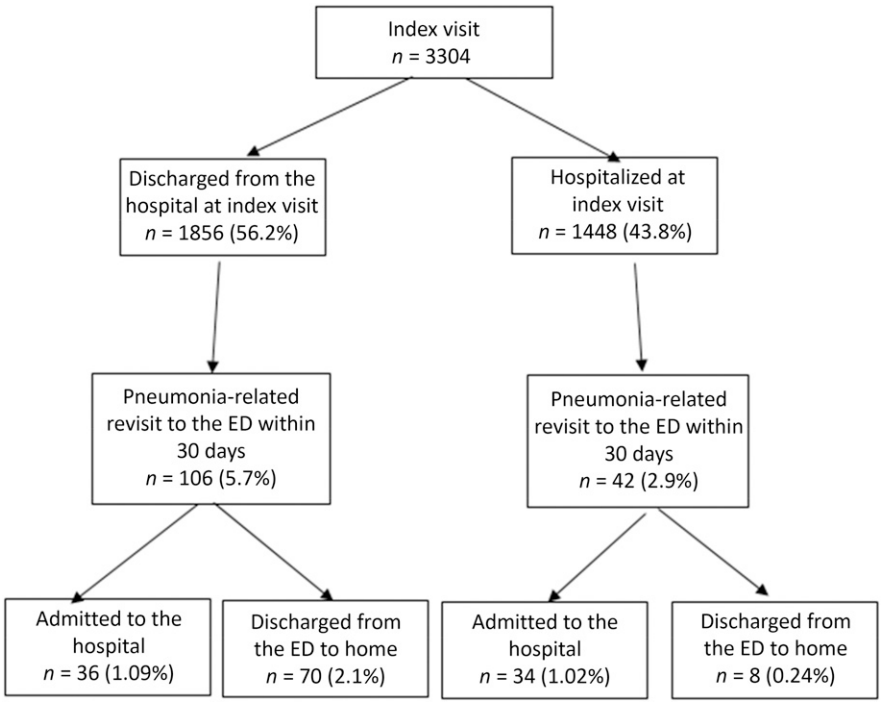

FIGURE 1 Study population.

DISCUSSION

In this study, 4.5% of children who had an episode of CAP revisited the ED. Although we evaluated a variety of clinical factors, relatively few were statistically associated with returning to the ED. The risk factors for ED revisits were CCCs, disposition, and aminopenicillin therapy at the index visit.

Authors of previous studies have found similar proportions of CAP-related ED revisits (0.9%–6.4%) and similar proportions of hospital readmissions (1.5%–5.6%).[6,13–15] Patients with CCCs with CAP have also been found to be more likely to revisit within 14 days.[6,16] In addition, only 4.5% of patients diagnosed with CAP returned within 4 days, which is consistent with the average 72-hour ED revisit rate of 5.4% across children's hospitals.[3]

The creators of the national pediatric CAP guideline recommend empirical narrow-spectrum antibiotic therapy to treat children with suspected bacterial CAP.[17] Authors of a previous study found that 2.4% of children diagnosed with CAP were treated with narrow-spectrum antibiotic therapy (ie, aminopenicillins) and were readmitted to the hospital compared with 3.2% of children treated with broad-spectrum antibiotics (ie, cephalosporins).[15] Similarly, in our study, we found that 11.5% of patients who received narrow-spectrum antibiotics compared with 19.6% of children who received broad-spectrum antibiotics revisited the ED. Although the total proportions of children who received antibiotic therapies are different, both studies reveal that more children who revisited the ED or were readmitted initially received broad-spectrum antibiotic therapy compared with those who received narrow-spectrum antibiotic therapy. Patients who received broad-spectrum antibiotics in the ED may have already failed outpatient narrow-spectrum therapy, indicating potentially increased severity or differing etiology and accounting for increased revisits in this population. However, patients who received aminopenicillins were 49% less likely to revisit the ED within 30 days in our study. This finding is consistent with the national guideline recommendation that indicates

TABLE 2 Risk Factors Associated With the Probability of Revisit to the ED

	Revisit Within 48 h[a] OR (95% CI)	Revisit Within 30 d[a] OR (95% CI)
Age, y	0.94 (0.87–1.01)	0.97 (0.93–1.02)
CCCs	3.86 (1.39–10.71)	2.23 (1.29–3.86)
Fever	2.24 (1.29–3.90)	1.35 (0.95–1.90)
Disposition[b]	0.02 (0.01–0.11)	0.37 (0.24–0.56)
Aminopenicillin received in the ED	0.51 (0.25–1.05)	0.51 (0.3–0.85)
Macrolide received in the ED	0.71 (0.21–2.34)	0.53 (0.23–1.23)

[a] Adjusted for all variables listed in the table.
[b] Discharged from the hospital at index visit.

aminopenicillins are appropriate for initial outpatient CAP treatment.

There are several limitations to this study. First, although we attempted to account for all variables associated with ED revisits, we did not have access to variables that were not routinely collected in the ED. For instance, patients with low socioeconomic statuses and those who live in a census tract with high unemployment rates have been associated with an 11 times higher rate of hospitalization for pneumonia than patients with higher socioeconomic statuses.[16] Although these factors may be important risk factors for revisits, they are not routinely collected in the EHR. In addition, most children with CAP will be managed in the outpatient setting, and a fraction will visit the ED for additional management. Our study was limited to factors documented in the EHR, and thus any discussions with the ED provider regarding a previous visit to the primary care provider for CAP, previous treatment changes, or general pre-ED visit information were not included in our analysis. Second, residual confounding because of incomplete adjustment for patient severity may exist. However, we found that admission at the index visit was protective against revisit to the ED, potentially indicating that patients with severe or complicated pneumonia were more likely to be admitted at the index visit, treated accordingly, and thus less likely to revisit.

CONCLUSIONS

Although a revisit is currently considered a quality measure of care, we suggest that revisits are uncommon, and few clinical factors (most nonmodifiable) can be used to predict a revisit at the time of the initial ED visit for pneumonia. Given this information, it would be challenging to prevent a revisit to the ED for a child diagnosed with CAP. Additional clinical and nonclinical data are needed to develop a more objective tool to assess site-of-care decisions.

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