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Identifying Potentially Unnecessary Hospitalizations in Children With Pneumonia

Sriram Ramgopal, MD[a], **Douglas Lorenz, PhD**[b], **Lilliam Ambroggio, PhD**[c,d], **Nidhya Navanandan, MD**[c], **Jillian M. Cotter, MD, MSCS**[d], **Todd A. Florin, MD, MSCE**[a]

[a]Division of Emergency Medicine, Ann & Robert H. Lurie Children's Hospital of Chicago, Northwestern University Feinberg School of Medicine, Chicago, Illinois

[b]Department of Bioinformatics and Biostatistics, University of Louisville, Louisville, Kentucky

[c]Section of Pediatric Emergency Medicine, Children's Hospital Colorado, Department of Pediatrics, University of Colorado, Aurora, Colorado

[d]Section of Pediatric Hospital Medicine, Children's Hospital Colorado, Department of Pediatrics, University of Colorado, Aurora, Colorado

Abstract

OBJECTIVE: To characterize the outcomes of children with community acquired pneumonia (CAP) across 41 United States hospitals and evaluate factors associated with potentially unnecessary admissions.

METHODS: We performed a cross-sectional study of patients with CAP from 41 United States pediatric hospitals and evaluated clinical outcomes using a composite ordinal severity outcome: mild-discharged (discharged from the emergency department), mild-admitted (hospitalized without other interventions), moderate (provision of intravenous fluids, supplemental oxygen, broadening of antibiotics, complicated pneumonia, and presumed sepsis) or severe (ICU, positive-pressure ventilation, vasoactive infusion, chest drainage, extracorporeal membrane oxygenation, severe sepsis, or death). Our primary outcome was potentially unnecessary admissions (ie, mild-admitted). Among mild-discharged and mild-admitted patients, we constructed a generalized linear mixed model for mild-admitted severity and assessed the role of fixed (demographics and clinical testing) and random effects (institution) on this outcome.

RESULTS: Of 125 180 children, 68.3% were classified as mild-discharged, 6.6% as mild-admitted, 20.6% as moderate and 4.5% as severe. Among admitted patients (n = 39 692), 8321 (21%) were in the mild-admitted group, with substantial variability in this group across hospitals (median 19.1%, interquartile range 12.8%–28.4%). In generalized linear mixed models comparing

Address correspondence to Sriram Ramgopal, MD, Division of Pediatric Emergency Medicine, Department of Pediatrics, Ann & Robert H. Lurie Children's Hospital of Chicago, 225 E Chicago Ave, Box 62, Chicago, IL 60611. sramgopal@luriechildrens.org.

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mild-admitted and mild-discharge severity groups, hospital had the greatest contribution to model variability compared to all other variables.

CONCLUSIONS: One in 5 hospitalized children with CAP do not receive significant interventions. Among patients with mild disease, institutional variation is the most important contributor to predict potentially unnecessary admissions. Improved prognostic tools are needed to reduce potentially unnecessary hospitalization of children with CAP.

Pediatric community-acquired pneumonia (CAP) is among the most common infectious diseases worldwide. In resource-rich countries, pediatric CAP occurs in ~1.5 per 1000 children annually.[1] CAP is the fifth most common and second most costly reason for pediatric hospitalization in the United States.[2] Approximately one-half of children <5 years of age with CAP are hospitalized.[3]

Studies of pediatric CAP often use outcomes such as hospital length of stay (LOS) or revisit to medical care that are multifaceted and lack granularity and objectivity.[4–6] Hospitalization, for example, represents individual and institutional norms, in addition to clinical features, and may overestimate disease severity among children with CAP.[7] However, factors influencing LOS may be more related to institutional practice patterns or social determinants and unrelated to severity.[8–10] Without objective, clinically meaningful outcome measures, studies of pediatric CAP can be difficult to interpret, limiting their generalizability and applicability. As such, the 2011 Infectious Diseases Society of America or Pediatric Infectious Diseases Society pediatric CAP guideline emphasizes the need for objective outcome measures that can be “standardized, measured, and compared” as a key area for future research.[11]

The use of a standardized, interventions-based, outcome measure for pediatric CAP may provide opportunities to better describe and identify groups that require further investigation. In particular, some children who are admitted with CAP, particularly those not receiving any major medical interventions, may not substantially benefit from hospitalization. In a single-center prospective cohort study of 1142 children presenting to the emergency department (ED) with suspected CAP, 40% of those hospitalized were discharged within 24 hours.[12] Of those, 72% did not require oxygen, 85% did not require intravenous fluids, and none required more invasive respiratory support. Hospitalization may, therefore, be unwarranted for many children, exposing them to nosocomial infections, unnecessary testing and treatment, medical errors, time lost from school or work, anxiety, and cost.[13,14] Given the risks associated with hospitalization, greater efforts are needed to identify potentially unnecessary hospitalizations for CAP in which children require few, or no, meaningful interventions. The use of an objective, outcomes-based severity measure may be beneficial to identify children who do not require admission and are amenable to earlier deescalation of care and less testing and interventions.

In this study, we sought to describe outcomes of pediatric CAP outcomes among children admitted to pediatric hospitals and to evaluate the role of institutional variation of care among patients with CAP having potentially unnecessary hospitalizations, defined as hospitalizations without the receipt of major medical interventions.

METHODS

Data Source

We performed a multicenter cross-sectional study using data abstracted from the Pediatric Health Information System (PHIS), an administrative database that contains ED, inpatient, ambulatory surgery, and observation data from geographically diverse children's hospitals in the United States affiliated with the Children's Hospital Association (Overland Park, KS). Data are deidentified, but unique patient identifiers facilitate longitudinal tracking.[15] The Children's Hospital Association and member hospitals jointly ensure data quality and integrity.[16] We included 41 hospitals with complete data during the studied timeframe. The study was designated as exempt by our institutional review board.

Patient Inclusion

We included children 90 days to 18 years of age with a diagnosis of CAP who presented to a PHIS hospital ED from January 1, 2016 to March 31, 2020. Consistent with previous studies of pediatric CAP, we used 90 days as the lower limit of age to avoid including neonatal pneumonia, which may be because of distinct organisms and have a different management approach compared with older infants.[12,17] For similar reasons, we did not include direct admissions to the hospital. We identified patients with a diagnosis of CAP using a previously validated algorithm of primary International Classification of Disease (ICD) discharge diagnosis codes,[18] which we cross-walked to ICD, 10th Revision, Clinical Modification codes (ICD-10-CM) using general equivalence mappings[19] (Supplementary Table 4). The validity of using general equivalence mappings to convert diagnosis codes for pneumonia has been previously demonstrated in pneumonia research with high accuracy.[20] The present list of diagnosis codes has been previously used in research on pediatric complicated pneumonia[21] and chest radiography use.[22] We excluded clinic, ambulatory surgery, or 'other' encounters, and patients with complex chronic conditions (CCC). CCC were defined as medical conditions expected to last >12 months and to require specialty pediatric care and/or hospitalization in a tertiary care center by using encounter-level diagnoses.[23] The CCC algorithm uses all available diagnosis and procedure codes to identify those with medical complexity and includes conditions such as tracheostomy status and cystic fibrosis. Because the goal of our investigation was to evaluate CAP outcomes in mostly healthy children, we excluded patients with CCCs given the distinct risk factors, predisposition, and microbiology of pneumonia in many of these patients.[24]

Data Acquisition

For each encounter, demographics included age at admission, sex, race, ethnicity, day of presentation, geographic region by United States census region, and primary payer status. Race and ethnicity was classified as a composite variable of White non-Hispanic, Black non-Hispanic, Hispanic, and Asian (including multiracial).[25,26] Day of presentation was classified as end of week (Friday and Saturday) versus all other days. We used this definition to identify potential differences in care related to primary care physician follow up. Diagnostic testing included performance of blood culture, complete blood count, C-reactive protein, procalcitonin, respiratory pathogen panel, respiratory culture, chest radiography, chest ultrasound, or chest computed tomography on the first day (defined

as day 0 or 1 within PHIS) of hospital encounter. Procalcitonin was assessed using orders for calcitonin (which included procalcitonin). Medication information included use of intravenous fluids (including electrolyte solutions with or without dextrose, Ringers' lactate, and hyperalimentation) and use and timing (ie, day of administration) of antibiotics. Antibiotic prescribing data in PHIS is only available for orders placed during hospitalization (ED or inpatient) and not for outpatient visits. Interventions examined included endotracheal intubation, oxygen administration, positive-pressure ventilation including noninvasive (ie, high-flow nasal cannula [HFNC], continuous positive airway pressure, or bilevel positive airway pressure) and invasive (ie, mechanical ventilation), and extracorporeal membrane oxygenation. Additionally, we acquired diagnosis codes, procedure codes, disposition status (admission, ICU admission, or ED discharge), revisits, and in-hospital mortality.

Severity Outcome

We classified encounters using an ordinal pneumonia severity measure derived from previous prospective work.[12,17] Severity tiers were labeled as mild-discharged, mild-admitted, moderate, and severe (Table 1).[12] Mild-discharged patients were discharged from the ED and did not have any readmission within 7 days. Mild-admitted patients were admitted on the index visit or a revisit within 7 days but did not have any additional indicators of severity contained within the moderate or severe groups. Patients with moderate disease were hospitalized and required intravenous fluid, oxygen, broadening of antibiotics, had a complicated pneumonia, or presumed sepsis. Patients with severe disease required the ICU, positive-pressure ventilation, vasoactive infusion, chest drainage, extracorporeal membrane oxygenation, had severe sepsis, or in-hospital mortality. We used discharge ICD diagnosis codes to identify patients with complicated CAP, mechanical ventilation, systemic inflammatory response syndrome or sepsis, and severe sepsis.[27] HFNC has substantial variability in application, lack of clear indications for use, and limited delivery of positive pressure to the lower airways; therefore, we did not include HFNC as a positive-pressure modality in our outcome measure. Additionally, it was not used in the original risk stratification criteria which we adapted here.[12,17] Diagnosis and procedure codes used to identify interventions and clinical testing are provided in Supplemental Tables 4–6. We also evaluated revisits within 7 days of the index visit. For final category designation, encounters were assigned to the highest level of severity for which criteria were met.

Statistical Analysis

As our aim was to identify children potentially not requiring hospitalization, our primary outcome of interest was the mild-admitted subgroup, representing children hospitalized but not receiving any major medical interventions or meeting moderate or severe criteria. We evaluated the proportion of patients in each severity stratum by hospital.

To evaluate hospital-level effects associated with variation in care for patients with mild-admitted CAP among patients with mild disease severity, we limited our analysis to patients with mild-discharged and mild-admitted severity. We constructed a generalized linear mixed model for an outcome of mild-admitted disease, considering clinical testing (including blood testing and chest radiography) and demographics (such as payor status and age) with

hospital as a random effect. From the random-effects model, we calculated χ^2 statistics for the fixed and random effects to identify their relative importance to the model. This model was fit in 3 ways: first, including clinical tests as individual binary variables (performance of procalcitonin, C-reactive protein, blood culture, payor status, respiratory viral panel, chest radiography, and complete blood count); second, including a single binary variable representing the performance of any of the tests; and third, including the count of the number of tests performed. For the model with the best fit (defined as the maximal negative log-likelihood ratio), we evaluated the contribution of each hospitals' individual intercept against a fixed intercept of the logistic model. Analyses were performed by using the *lme4* package in R, version 4.1.0 (R Foundation for Statistical Computing, Vienna, Austria).

RESULTS

We identified 125 180 patients during the 51 month period (Fig 1). The median age was 3.8 years (interquartile range [IQR]; 1.9–7.0 years), and 52% of patients were males (Table 2). Most patients (82%) received a chest radiograph, and 19% had a blood culture obtained. When limited to hospitalized patients, 87% received antibiotics, and the median LOS was 3 days (IQR 1–4 days). Antibiotic use among admitted patients by principal diagnosis is provided in Supplemental Table 7.

By using the ordinal severity outcome, 85 488 patients (68.3%) were classified as mild-discharged, 8321 (6.6%) as mild-admitted, 25 781 (20.6%) as moderate, and 5590 (4.5%) as severe. Demographics by severity tier are provided in Supplemental Table 8. Among patients with moderate CAP, 17 434 (67.6%) had 1 moderate criterion, 7550 (29.3%) had 2 criteria, 751 (2.9%) had 3, and 46 (0.2%) had 4. Of these, intravenous fluid use was the only defining criteria in 44.3%, followed by supplemental oxygen in 20.0% (Table 3).

Role of Institution in Potentially Unnecessary Hospitalizations

Twenty-one percent of hospitalized patients were classified with 'mild-admitted' severity. There was substantial variability in the proportion of children with mild-admitted CAP among the 41 PHIS hospitals (median 19.1%, IQR 12.8% to 28.4%; Fig 2). When evaluating the association of laboratory testing and demographic factors with mild-admitted CAP in the cohort limited to mild-admitted and mild-discharged patients, the largest amount of variability in the model was attributed to the random intercepts per hospital. The model including binary indicators for each individual test provided the best fit (smallest log-likelihood) (Fig 3). When inspecting this model, we identified the greatest random variability was in the intercept term, indicating that within-hospital variability had the greatest contribution toward mild-admitted CAP (Supplemental Fig 4). The model including the number of tests exhibited the same variation in the intercept term, but additionally exhibited substantial random variation across hospitals in the effect of the number of tests on the likelihood of mild-admitted CAP. For nearly all hospitals, more tests corresponded with a higher likelihood of admission, but the magnitude of this effect varied considerably.

DISCUSSION

In this multicenter cross-sectional study of administrative data, we describe the distribution of severity among children with CAP presenting to pediatric hospitals and identify institutional variation in the prevalence of patients with mild-admitted disease. Most (70%) children presenting to the ED with CAP have mild disease. One in 5 (21%) hospitalized children met criteria for mild-admitted CAP, not receiving major medical interventions (eg, intravenous fluids, supplemental oxygen) or having diagnoses requiring hospitalization (eg, septic shock). Although concerns of low-value care may exist across the severity spectrum, it is likely that some in the mild-admitted CAP group may represent potentially unnecessary hospitalizations. Among admitted patients, institutional factors had the greatest contribution to our outcome of mild-admitted disease severity.

The distribution of disease severity described in this study is similar to other work evaluating pneumonia severity in children. In our study, 21% of admitted patients were classified in the mild-admitted category of our ordinal outcome. Although factors driving admission for this subgroup are likely multifaceted and include physical examination features, diagnostic testing results, or social factors, some of these hospitalizations may have been potentially unnecessary. Additionally, some admitted patients initially with mild disease may have progressed to more severe disease states during their hospitalization. In the previous single-center prospective study that first used the ordinal severity outcome, 62.9% of 1128 patients had mild disease, 32.9% developed moderate disease (equivalent to mild-admitted and moderate in this study), and 4.3% severe disease.[12] Among hospitalized patients in this study, 40% had an admission without major medical interventions (equivalent to the mild-admitted group in this study), suggesting a potentially unnecessary hospitalization. Given the variability demonstrated between institutions in these potentially unnecessary admissions, it is not surprising that we found differences in our multicenter study compared to that single-site study. Our reported prevalence of severe CAP is consistent with data from a 2006 nationally representative study of hospitalized children with CAP, which reported that 2.7% to 4.8% of patients with CAP had local complications, such as empyema, and 3.1% to 3.4% of patients experienced systemic complications, such as acute respiratory failure.[28] Another 3-site prospective cohort study from 2010 to 2012 found that mechanical ventilation, shock, or death occurred among 7.6% of children hospitalized with CAP.[29] The low rate of mortality observed in our study corresponds with longitudinal United States data suggesting a gradually decreasing rate of mortality from pediatric pneumonia over time.[30]

We found that certain outcomes within each severity class occurred more frequently than others. Because some of the outcomes included in the moderate severity category may be arbitrary (eg, intravenous fluids), our findings may underestimate the prevalence of potentially unnecessary hospitalizations as there are likely patients in this group who received these interventions but did not require them. Use of intravenous fluid was the largest driver of moderate classification, followed by use of oxygen. However, there is considerable debate about the role of intravenous fluids in patients with mild dehydration, with concerns of its minimal benefit, and in some cases risks of iatrogenic harm from hypotonic fluids, and resultant interventions (such unnecessary laboratory testing and correction of their abnormalities) that are representative of low-value care.[31] As such, it

is possible that our moderate severity class includes some patients who may not have truly required intravenous fluids and would otherwise be classified as ‘mild-admitted.’

Most children who present to the ED with CAP can likely be managed at home, with almost 70% of children in this multicenter cohort discharged without a return visit warranting hospitalization. Overall rates of revisit for pneumonia were low (6%) similar to previous single-center work demonstrating a rate of 4.5%,[32] with fewer than one-half of revisits in our study requiring admission. As such, our findings confirm that few children with CAP managed in the outpatient setting undergo clinical deterioration and that most can be safely cared for in the community.

An important and concerning finding was the extensive variability in the proportion of patients identified to have mild-admitted severity (ie, hospitalization without major interventions) across hospitals. Further work is needed to identify the reasons for admission for this group and identify the reasons for this variation (eg, concern for deterioration, results of diagnostic testing, or social factors), because there is likely opportunity to decrease hospital use for this large group of children. In conjunction with improved prediction models for disease severity, additional work is necessary to improve implementation, as suggested by the broad variability between patients meeting mild-admitted disease severity criteria within each institution. For example, although greater testing was associated with a lower odd of classification into mild-admitted disease severity, there was substantial variability at the hospital-level intercepts for these outcomes, suggesting broad institutional differences with respect to testing that may be suitable for targeted multiinstitutional quality improvement efforts.

Among patients admitted to the hospital, severe outcomes of CAP were infrequent in previously healthy children (3.5% overall, or 14.1% of admitted patients). The relatively low proportion of patients with severe disease in our study is consistent with previous work.[28–30] Because severe outcomes are rare but high stakes for children with CAP, there is a need for predictive tools to help identify these “needles in the haystack” without overuse of medical resources, which also has associated harms. There are several examples of successful risk models for other high-stakes conditions, such as traumatic brain injury,[33] intraabdominal injury,[34] and appendicitis,[35] that identify patients at low risk of severe disease to limit unnecessary diagnostic testing and hospitalization. Similarly, models to risk stratify patients with CAP could identify patients at low risk of severe outcomes to allow for targeted use of diagnostic testing and treatment to better identify the cohort of patients who may not require hospitalization.

Our findings are subject to limitations. First, in our efforts to adapt the ordinal outcome to the PHIS data set, certain modifications were made to fit with the constraints of available data, such as an inability to distinguish between bolus versus continuous intravenous fluids. The rationale behind treatment decisions or LOS cannot be ascertained within the PHIS data set. Similarly, our outcome of interest was potentially unnecessary admissions, but a more granular evaluation of patient records beyond what may be performed from an administrative data set would be needed to definitively identify such encounters. For example, the identification of children admitted for intravenous antibiotics because of failure

of outpatient therapy or intolerance to oral antibiotics would be identified in this study as a failure of outpatient antibiotics. A more accurate classification of this patient, however, would require in-depth chart review. Importantly, PHIS does not have vital signs (such as respiratory rate) or laboratory results. This may explain some of the study findings, because patients may have been admitted for observation because of tachypnea or respiratory distress without need for further intervention. However, if these patients did not require escalation of care, which can be deduced from our results, this identifies a population for improved prognostic tools to assist ED clinicians in making admission decisions. Similarly, we were unable to identify potential social factors associated with hospitalization, such as presence of primary care physician and distance to the hospital from this data set. Institutional factors (such as the routine administration of broad-spectrum antibiotics) may have had some impact on severity classification, although the number of patients for whom broadening of antibiotics occurred as the sole factor moderate severity group was low (1.0%). With respect to clinical testing performed in the ED, we did not have detailed information with respect to the exact timing of events, because PHIS only provides the date of each service. Finally, our population was derived from previous work identifying ICD-9 diagnosis codes for CAP; however, work in other disease states has suggested that the conversion of ICD-9 to ICD-10 codes can sometimes be incomplete.[36] Finally, our inclusion was based on ICD-10 codes that were converted from previously validated ICD-9 codes. Previous work has corroborated the validity of this type of inclusion, as does the high rate of antibiotic use among children with suspected bacterial pneumonia among those admitted to the hospital.[20]

CONCLUSIONS

In this multicenter cross-sectional study, we modified a previously developed composite outcome and applied it to a multicenter data set to identify cohorts of children with CAP. These outcomes suggest that a large proportion children admitted with CAP have mild disease and do not require any intravenous fluids or supplemental oxygen. A portion of these patients may, therefore, not require hospitalization. There was broad institutional-level variation with respect to the association of testing, demonstrating the need for improved quality improvement methods to reduce this potentially unnecessary variation in care. Given the uncommon occurrence of severe outcomes, predictive models to risk stratify patients with CAP could allow for targeted use of diagnostic testing and treatment of those that are at most risk, while minimizing potentially unnecessary hospitalizations and resource use in those at low risk.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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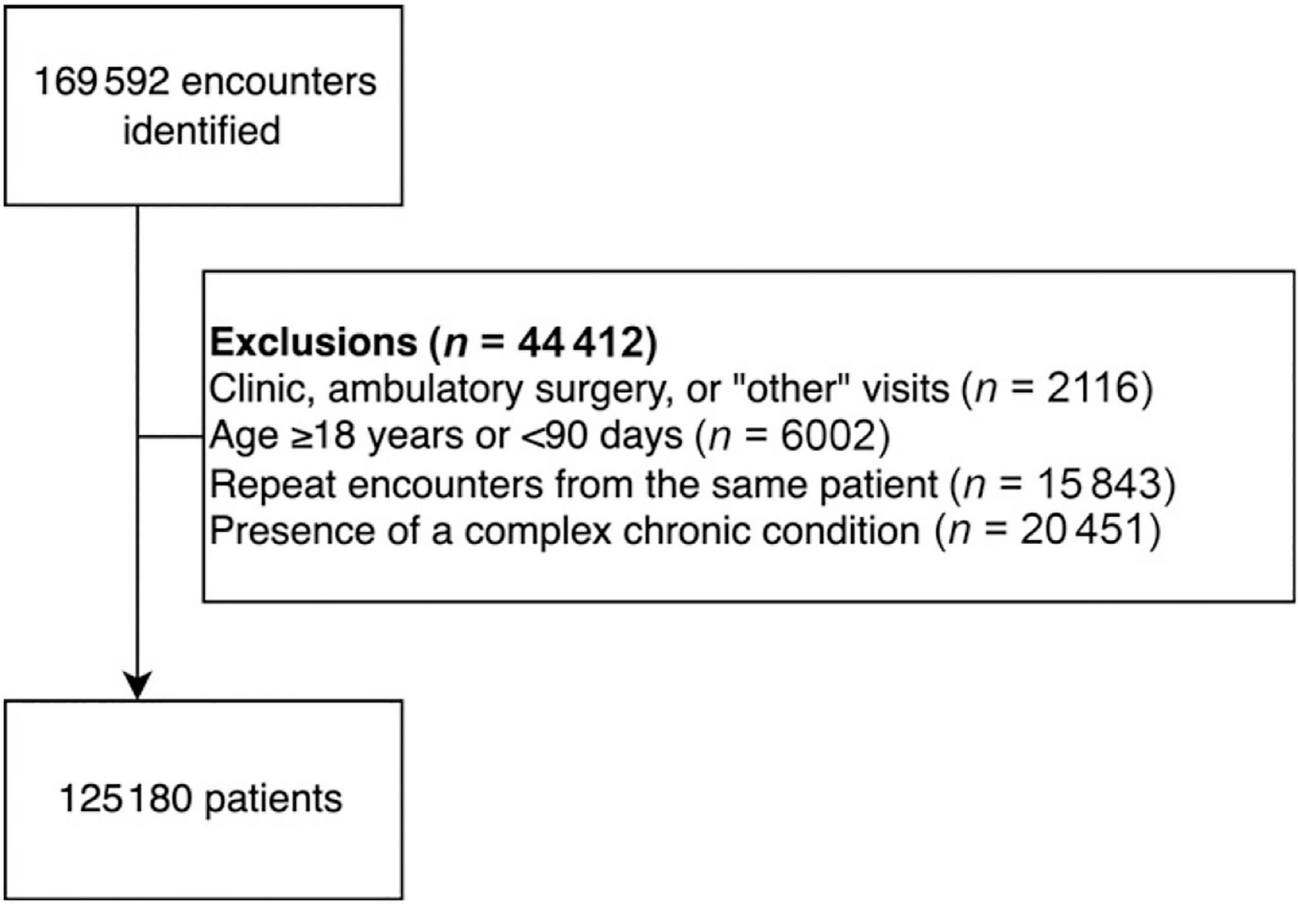

FIGURE 1.
Flow diagram of study cohort.

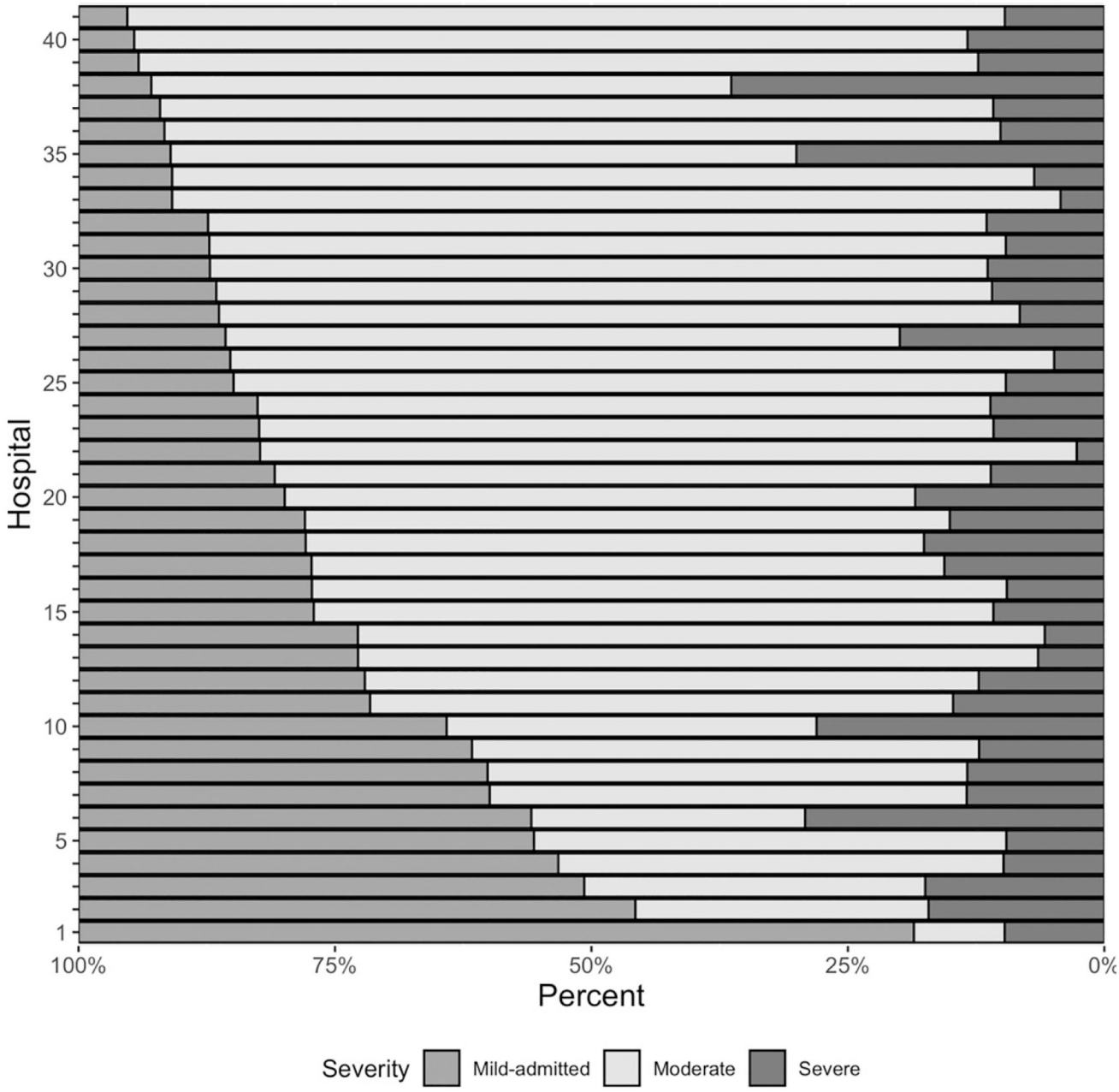

FIGURE 2.
Institutional variability of disease severity classification among 41 included hospitals. Hospitals are ordered on the basis of the proportion of patients meeting “mild-admitted” severity criteria.

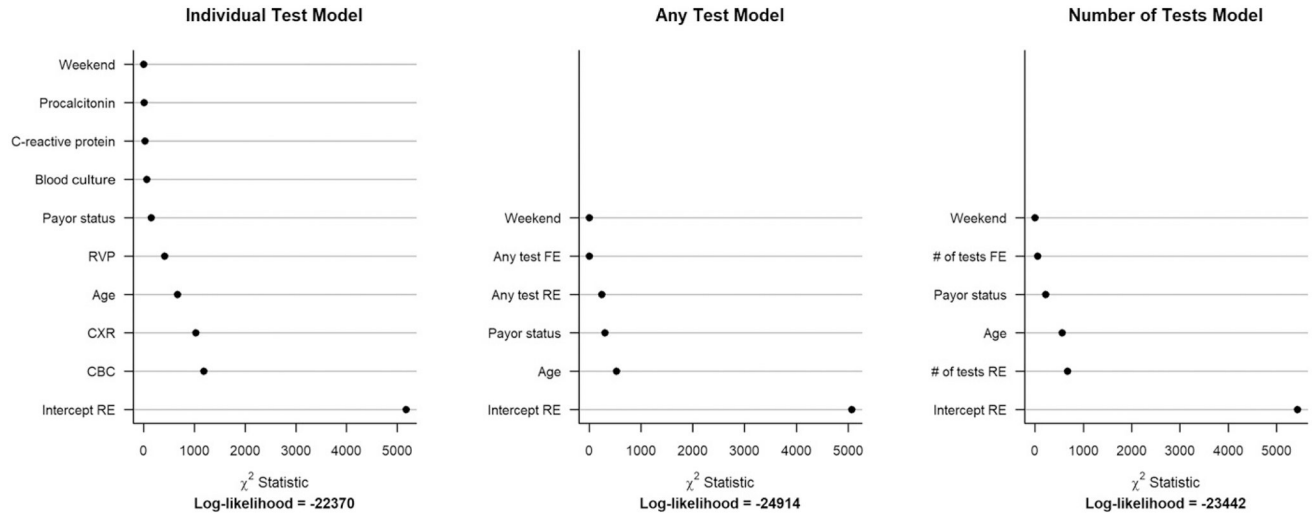

FIGURE 3.

Relative importance of variables in random effects models (assessed by the χ^2 test for fixed and random effects) which incorporate (A) individual tests, (B) a dichotomous variable of "any" test, and (C) an integer value of the number of effects among the cohort of patients with mild-admitted and mild-discharged disease severity. χ^2: Relative importance of variables in mixed effects logistic regression models, as measured by χ^2 test statistics. The models include as fixed effects either binary indicators for each test ("individual test" model), a binary variable indicating administration of any test ("any test" model), or the number of tests administered ("number of tests" model). FE, fixed effect; RE, random effect.

TABLE 1

Application of the Ordinal Pneumonia Severity Measure to PHIS Database

Criteria	Criteria Adaptation to PHIS
Mild-Discharged	
Discharged from ED	No admission, and No revisit leading to readmission <7 d from index visit
Mild-Admitted	
Hospitalized but not meeting any further criteria	Admitted from index visit, or Admitted from revisit and No additional criteria met from the moderate or severe groups
Moderate	
Hospitalized with bolus or IV fluids	Hospitalized, and Provision of any IV fluids
Hospitalized with oxygen	Hospitalized, and Provision of supplemental oxygen
Hospitalized with broadening of antibiotics from an aminopenicillin	Hospitalized, and Provision of an aminopenicillin on day 1 and Provision of any other antibiotic through the parenteral or oral route starting after day 1 OR Hospitalized, and Provision of an aminopenicillin and another oral/intravenous antibiotic on day 1 and Discontinuation of the aminopenicillin after day 1 with continuation of another oral or intravenous antibiotic after day 1
Hospitalized with a complicated pneumonia	Hospitalized, and Presence of an additional diagnosis code for that encounter (see Supplemental Table 4)
Hospitalized with presumed sepsis	Hospitalized, and Presence of a SIRS or sepsis diagnosis code (see Supplemental Table 4) Provision of any IV fluids
Severe	
ICU admission	Dedicated ICU flag within PHIS
Positive-pressure ventilation	Dedicated mechanical ventilation flag in PHIS, OR Procedure of endotracheal intubation, OR Provision of CPAP or BiPAP, OR Concomitant ICD-10 code “Z99.11” (Dependence on ventilator status)
Vasoactive infusion	Provision of any of the following parenteral medications: epinephrine, norepinephrine, dopamine, milrinone, dobutamine, phenylephrine, or ephedrine
Chest drainage	Performance of any drainage procedure of the chest, lung, pleura, bronchus or pericardium (see Supplemental Table 5)
ECMO	Dedicated ECMO flag within PHIS

Criteria	Criteria Adaptation to PHIS
Severe sepsis	Presence of an additional diagnosis code for that encounter (see Supplemental Table 4)
Death	Dedicated mortality flag within PHIS

CPAP, continuous positive airway pressure; BiPAP, bilevel positive airway pressure; ECMO, extracorporeal membrane oxygenation; IV, intravenous.

TABLE 2

Demographics and clinical characteristics of study cohort

Variable	Number (%) or Median (IQR) *N* = 125 180
Demographics	
Age, years	3.8 (1.9–7.0)
Male sex	65 402 (52.2)
Race and ethnicity	
Non-Hispanic White	44 170 (35.3)
Non-Hispanic Black	25 092 (20.0)
Hispanic	35 477 (28.3)
All others	17 271 (13.8)
Missing	3170 (2.5)
Geographic region	
Midwest	29 758 (23.8)
Northeast	14 266 (11.4)
South	48 810 (39.0)
West	32 346 (25.8)
Primary source of payment	
Public	74 539 (59.5)
Private	41 834 (33.4)
Other or unknown	8807 (7.0)
Friday or Saturday encounter	33 872 (27.1)
Diagnostic testing	
Chest radiography	102 875 (82.2)
Chest computed tomography	1083 (0.9)
Chest ultrasonography	1862 (1.5)
Blood culture	23 458 (18.7)
Complete blood count	34 203 (27.3)
C-reactive protein	18 575 (14.8)
Procalcitonin	2974 (2.4)
Viral testing	21 390 (17.1)
Respiratory culture	490 (0.4)
Treatment	
Any intravenous fluid	30 042 (24.0)
Intravenous fluid for ≥2 d	11 979 (9.6)
Any supplementary oxygen	15 450 (12.3)
Supplementary oxygen for ≥2 d	1499 (7.4)
High flow nasal cannula	1411 (1.1)
CPAP or BiPAP	2901 (2.3)
Given antibiotics[a]	65 062 (52.0)
Disposition	

Variable	Number (%) or Median (IQR) *N* = 125 180
Admitted on initial visit	37 154 (29.7)
Admission length of stay, days[b]	3 (2–4)
ICU length of stay, days[c]	2 (1–3)
Any revisit	7530 (6.0)
Revisit leading to admission	2948 (2.4)

[a]Defined as ordering of oral or intravenous antibiotics at any time during encounter, not including antibiotics prescribed at discharge.

[b]Among admitted patients, taking the longer admission from the index or revisit (where applicable) per encounter.

[c]Among patients admitted to ICU, taking the longer admission from the index or revisit (where applicable) per encounter.

TABLE 3

Severity Outcomes of Included Patients With the Moderate and Severe Classification

Criteria	*N* (% of all included patients)	Only Meeting Criteria Within Group[a]
Moderate		
Hospitalized with any intravenous fluid	23 386 (18.7)	11 422 (44.3)
Hospitalized with oxygen	14741 (11.8)	5148 (20.0)
Hospitalized with broadening of antibiotics from an aminopenicillin	1760 (1.4)	249 (1.0)
Hospitalized with a complicated pneumonia	3909 (3.1)	585 (2.3)
Hospitalized with presumed sepsis	305 (0.2)	30 (0.1)
Severe		
ICU admission	3973 (3.2)	1695 (30.3)
Positive-pressure ventilation	2901 (2.3)	794 (14.2)
Vasoactive infusion	458 (0.4)	155 (2.7)
Chest drainage	923 (0.7)	595 (10.6)
ECMO	10 (0.0)	0 (0.0)
Severe sepsis	85 (0.1)	22 (0.4)
Death	8 (0.0)	0 (0.0)

Encounters in these groups may satisfy more than one criterion. In the severe group, some encounters may also satisfy criteria in the moderate group.

[a]This column represents the proportion of the population who had each outcome as the only outcome to classify them into the severity group, with proportions as a column percentage within the group.