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Hospital and community characteristics associated with pediatric direct admission to hospital

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Abstract

Objectives—One-quarter of pediatric hospitalizations begin as direct admissions, defined as hospitalization without receiving care in the hospital's emergency department (ED). Direct admission rates are highly variable across hospitals, yet previous studies have not examined reasons for this variation. We aimed to determine the relationships between hospital and community factors and pediatric direct admission rates, and evaluate the degree to which these characteristics explain variation in risk-adjusted direct admission rates.

Methods—We conducted a cross-sectional study of the Healthcare Cost and Utilization Project's Kids Inpatient Database, American Hospital Association Database, and Area Health Resource File, including children <18 years of age who were admitted for a medical hospitalization in states contributing data to all datasets. Using hierarchical generalized linear modeling we generated risk-adjusted direct admission rates and used generalized linear models to assess the association of hospital and community characteristics with these risk-adjusted rates.

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Results—We included 211,458 children discharged from 933 hospitals and 26 states; 20.2% were admitted directly. One-fifth of the variance in risk-adjusted direct admission rates was attributed to observed hospital and community factors. The greatest proportion of this explained variance was related to ED volume (37%), volume of pediatric hospitalizations (27%), and size of the pediatrician workforce (12%).

Conclusions—Direct admission rates were associated with several hospital and community characteristics, but the majority of variation in hospitals' direct admission rates was not explained by these factors. These findings suggest opportunities for diverse hospital types to develop the infrastructure and communication systems necessary to support pediatric direct admissions.

Keywords

hospitalization; direct admission; pediatric; care coordination

Introduction

Emergency department (ED) crowding has been described by the Institute of Medicine as a “national epidemic,” with numerous studies illustrating associations between ED crowding and patient mortality, treatment delays and patient dissatisfaction.^{1–3} One factor contributing to ED crowding is the substantial proportion of hospitalizations that begin in EDs, which has increased considerably since the 1990s.^{4,5} In contrast, the proportion of direct admissions - defined as hospital admission without first receiving care in the hospital's ED - has decreased.⁵

One-in-four unplanned pediatric hospitalizations originate as direct admissions. A national survey of inpatient pediatric medical directors suggests several benefits of this admission approach, including improved patient satisfaction, reduced risk of nosocomial infection, earlier patient access to pediatric-specific care in general hospitals that lack pediatric EDs, and decreased healthcare costs.^{6,7} Comparative effectiveness research has shown that pediatric direct admission is associated with substantially lower costs and no appreciable differences in adverse outcomes relative to admission through EDs.^{6,8,9}

Despite potential benefits for patients and health systems, pediatric direct admission rates are highly variable across hospitals and patient characteristics. Past work has shown that children who are privately insured and who report white race are more likely to be directly admitted than racial/ethnic minorities and children who are publically insured, which may reflect differences in access to ambulatory care.^{6,8} However, these differences may also be related to the characteristics of hospitals, health systems and their communities, such as the local physician workforce, the presence of hospitalists to provide inpatient care, and ED volumes. To our knowledge, no previous studies have examined these factors. Healthcare administrative structures, such as joint ventures between hospitals and physicians may also increase direct admission rates through physician-hospital integration. Finally, variation in direct admission rates may be influenced by physician and hospital preferences, with some hospitals formalizing direct admission programs and implementing communication systems to optimize handoffs between referring (outpatient) and accepting (inpatient) healthcare providers.⁷

We hypothesized that community and health system factors would contribute to the variation in pediatric direct admission rates across hospitals. More specifically, we hypothesized that factors associated with limited access to ambulatory care (i.e. child poverty, residence in a health professional shortage area), and factors that may limit relationships and communication between referring and accepting healthcare providers (i.e. large pediatric workforce, hospitalists providing inpatient care) would be negatively associated with hospitals' direct admission rates. In contrast, we hypothesized that factors facilitating relationships between referring and accepting physicians (i.e. physician-hospital integration) would be associated with higher direct admission rates. To evaluate these hypotheses, our objectives were twofold: (i) to determine the relationships between hospital and community factors and direct admission rates for common pediatric reasons for hospitalization, and (ii) to evaluate the degree to which these characteristics explain variation in risk-adjusted pediatric direct admission rates.

Methods

Study Design and Eligibility

We conducted a retrospective study of non-elective hospitalizations in children and adolescents (hereafter called children) less than 18 years of age, excluding in-hospital births, hospitalizations without documentation of the admission source, hospitalizations originating from court or law enforcement, and inter-facility transfers. Hospitals without EDs were excluded, so as to include only hospitals where both direct and ED admissions were possible. Given our interest in understanding patterns of care at hospitals with general pediatrics services, hospitals that admitted only adolescents greater than twelve years of age or infants less than 6 months of age were excluded. To limit heterogeneity at the patient level, we only included children with a principal diagnosis of one of nine common pediatric medical conditions, identified using the pediatric diagnostic grouper by Keren et al.¹⁰ This grouper uses International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) codes to group common and costly principal diagnoses into distinct conditions (for example, pneumonia), excluding children with ICD-9-CM principal procedure codes unlikely related to their principal diagnosis (for example, appendectomy for a child with a principal diagnosis of pneumonia). Finally, to allow for stable estimates of direct admission rates, we included only hospitals with ≥ 25 pediatric hospitalizations during the study year.

The data sources for this analysis included the Healthcare Cost and Utilization Project's (HCUP) 2009 Kids' Inpatient Database (KID), the 2009 US Department of Health and Human Services' Area Health Resource File (AHRF), and the American Hospital Association (AHA) database (2009). The KID is a publicly available, nationally representative database developed to study pediatric hospitalizations and includes an 80% sample of non-inborn pediatric discharges from all community, non-rehabilitation hospitals from participating states.¹¹ It contains information on all patients, regardless of payer, and includes both hospital-level and patient-level variables, including demographic characteristics, charges, and other clinical and resource use data available from discharge abstracts. The 2009 KID was used because it is the most recent data set that contains hospital identifiers that can be linked to other national data sources. The AHRF aggregates

county-level data from several sources and includes data related to health facilities, health status, and socioeconomic and environmental characteristics at the county level. The AHA database provides a comprehensive census of hospitals in the United States, including detailed characteristics about hospital resources, infrastructure and staffing.¹² Because the datasets do not contain identifiable information, the Institutional Review Board at Baystate Medical Center determined that our study did not constitute human subjects research.

Descriptor variables

A priori, we identified variables at the patient, hospital and community levels that we hypothesized would be associated with pediatric direct admission rates. At the patient level, we examined age, gender, race/ethnicity, expected primary payer, medical complexity and disease severity. Medical complexity was categorized as (i) non-chronic disease, (ii) complex chronic disease or (iii) non-complex chronic disease, using the previously validated Pediatric Medical Complexity Algorithm (PMCA) based on ICD-9-CM codes.¹³ Disease severity was classified based on all patient refined-diagnosis related group (APR-DRG) severity of illness coding, which classifies illnesses severity as minor, moderate, major or extreme.¹⁴

Hospital characteristics derived from the KID included geographic region, defined according to census classifications; teaching status based on membership in the Council of Teaching Hospitals of the Association of American Medical Colleges; urban/rural location; hospital ownership, classified as public, private non-profit and private investor-owned; hospital type, classified as general hospital or children's hospital; and total volume of pediatric hospitalizations, categorized as low (<185 hospitalizations), medium (186–986 hospitalizations) and high volume (>986 hospitalizations) based on national data of pediatric hospitalizations.¹⁵ From the AHA database we determine annual total ED volume; presence of hospitalists to provide patient care; presence of a pediatric intensive care unit; hospitals' participation in joint venture arrangements with physicians or physician groups; and level of hospital-physician integration, categorized as low or high according to a previously published algorithm.¹⁶ These variables were pediatric-specific for freestanding children's hospitals only.

Community characteristics, reported in the AHRF at the county-level included sociodemographic variables (percent of children living in poverty, percent of adults >25 years of age with four or more years of college education), and healthcare resource variables (number of short-term general hospital beds per 100,000 population [bed supply], pediatrician and emergency medicine workforce per 100,000 population, and designation as a health professional shortage area).

Statistical analysis

We categorized each hospitalization as a direct admission or ED admission and calculated patient-level summary statistics, assessing differences between direct and ED admissions using chi-square tests for categorical variables and Wilcoxon rank sum tests for continuous variables. We then calculated median direct admission rates associated with each hospital and community characteristic.

Because our primary aim was to evaluate community and health system factors associated with direct admission rates, we developed hospital-specific risk-adjusted direct admission rates (RADARs). A hospital's RADAR reflects the proportion of children directly admitted to a hospital, adjusting for the case-mix admitted to that hospital, where the case-mix is defined by patient age, gender, race/ethnicity, primary payor, disease severity, medical complexity and reason for hospitalization (Table 1). We then used the RADAR as the primary outcome in multivariable models, allowing us to evaluate how community and health system factors were associated with direct admission rates that had been adjusted for patient characteristics. To calculate RADARs, we used a hierarchical generalized linear model (HGLM) that included the above-described patient characteristics as well as a random intercept for hospital, applying methods analogous to those used by the Centers for Medicare and Medicaid Services to calculate risk-standardized outcomes.^{17,18} For each hospital, we estimated a *predicted direct admission rate* as the direct admission rate for that hospital's case-mix while incorporating the hospital-specific random intercept. We then calculated an *expected direct admission rate* for each hospital as the direct admission rate for the same case-mix, but incorporating the average hospital intercept. The ratio of predicted to expected rates for each hospital provides a measure of whether the hospital has a higher (ratio > 1) or lower (ratio < 1) direct admission rate than average, while accounting for the hospital's particular case mix. Finally, RADARs for each hospital were calculated as the product of the unadjusted overall mean direct admission rate and the ratio of the predicted to expected direct admission rate. Variation across RADARs should reflect factors beyond the case-mix of patients admitted to the hospital.

Following calculation of our RADARs, we developed generalized linear models (GLMs) at the hospital level to assess the association of hospital and community characteristics with these rates. We used backward stepwise regression modeling, keeping factors with $p < 0.10$, and forcing 'hospitalist care' into the model. Regression diagnostics did not indicate problems with multicollinearity among community and hospital factors in the final model.

We also evaluated the proportion of variance of the RADAR attributed to these factors via partitioning of Type III sums of squares. County-level characteristics were attributed to all hospitals in that county; because the majority of counties in our sample (70%) included only one hospital, it was not feasible to develop hierarchical models with hospitals nested within counties. The initial hospital-level model included all characteristics shown in Table 2 as well as three variables to describe the pediatric case mix: percent non-white race, percent publicly insured, and percent with complex chronic medical conditions. These pediatric case-mix variables reflect the full pediatric population at each hospital during the study period, and are not limited to the children meeting our eligibility criteria. A reduced model included only those variables in the full model with p -values < 0.1 .

Three states did not report race/ethnicity data in the KID, which resulted in a substantial proportion of missing race/ethnicity data; for these cases a missing category was included for race/ethnicity.¹¹ As a sensitivity analysis, we repeated the above-described models including only hospitals for which race/ethnicity data was available (182,522 admissions across 807 hospitals).

Results

211,438 children discharged from 933 hospitals and 26 states were included in primary analyses (Figure 1). One-fifth of children (20.2%) were admitted directly, while the remainder were admitted through EDs. Children admitted directly were more likely to identify as white and less likely to identify as black or Hispanic, were less likely to be publically insured or uninsured than children admitted through EDs (Table 1). There were small but statistically significant differences between the admission groups in gender, reasons for hospitalization, medical complexity and disease severity. In our multivariable analyses the majority of these differences remained (Supplemental Table 1); gender ($p=0.73$) and age ($p=0.09$) were the only patient-level characteristics not significantly associated with direct admission rates.

Table 2 illustrates characteristics of hospitals and communities included in this analysis and their associated direct admission rates. Hospitals in the Northeast had the lowest direct admission rates (12.5%), while those in the Midwest had a median direct admission rate of 27.4%. However, within these census regions, direct admission rates varied across counties and States (Supplemental Figure 1). Direct admission rates were considerably higher at non-teaching hospitals, rural hospitals, and general hospitals than teaching, urban and children's hospitals respectively. Hospitals where hospitalists provided inpatient care had significantly lower direct admission rates than those without hospitalists. Direct admission rates also varied across hospitals with low, intermediate and high pediatric patient volumes, with the lowest direct admission rates observed at hospitals with the highest pediatric volumes. With respect to total ED volumes, hospitals with the lowest ED volumes had the highest pediatric direct admission rates; as ED volumes increased, we observed that pediatric direct admission rates decreased. There were no significant differences in direct admission rates at hospitals reporting joint ventures with physicians, but hospitals with low rates of physician-hospital integration had higher direct admission rates in our unadjusted analysis.

We also observed variation in hospitals' direct admission rates associated with the characteristics of their communities (Table 2). Direct admission rates were relatively low in communities with the lowest and highest rates of childhood poverty, and higher among the middle quartiles. In communities that had the highest number of college-educated adults, the direct admission rates were significantly lower than in communities with lower rates of college-educated adults. Communities with the lowest numbers of pediatricians and ED physicians per capita had the highest direct admission rates.

Figure 2 illustrates the variation in direct admission rates across hospitals included in our analysis, showing the distribution of both unadjusted direct admission rates and RADARs. The results of our GLM models assessing associations between hospital and community characteristics and RADARs are provided in Table 3. Variables retained in this model included percent non-white race/ethnicity, medical complexity of the pediatric hospital population, pediatric hospitalization volume, hospital ownership/control, hospitalist presence, hospital type (children's hospital or general hospital), child poverty, size of the pediatrician workforce, size of the emergency medicine physicians workforce, ED volume, and number of short-term hospital beds per 100,000 population. Of these variables,

hospitalist presence, child poverty, and hospital medical complexity case-mix were not significantly associated with RADARs while the remaining variables showed significant associations with this outcome. In this adjusted model, hospitals with the highest annual volume of pediatric hospitalization, the lowest volume of ED visits annually, and the smallest pediatrician workforce per capita had the highest RADARs.

Figure 3a illustrates the proportion of variance in the RADAR that could be attributed to hospital and community level variables; 20% of the variance was attributed to hospital and community factors while 80% was unexplained by these factors. The greatest proportion of explained variance was related to hospitals' volume of pediatric hospitalizations, annual ED volume, the size of the pediatrician workforce per 100,000 population, and the racial/ethnic composition of the hospitalized population; together these factors accounted for 83% of the explained variation in RADARs (Figure 3b).

In our sensitivity analysis that excluded the 3 states for which race/ethnicity was not included in the KID, results were essentially unchanged (data not shown).

Discussion

Combining three large national datasets we found that the community and health system characteristics included in this analysis accounted for a small proportion of the variation in risk-adjusted direct admission rates across hospitals. Several of the hospital and health system factors that we expected to be associated with RADARs – hospitalists providing inpatient care, physician-hospital integration, and joint ventures between physicians and hospitals – did not explain the variation across hospitals. Instead, the variables that accounted for greatest proportion of explained variation included pediatric hospitalization volume, ED volume, the number of pediatricians per capita working in the community, and the racial/ethnic composition of the patient population. Our findings suggest that additional unmeasured factors, perhaps related to physician and hospital preferences and health system infrastructure, are associated with hospitals' direct admission rates. Identification of such modifiable factors would enable structurally diverse hospitals to develop the infrastructure necessary to support pediatric direct admission processes.

We found that hospitals with the lowest ED volumes had the highest RADAR while the highest volume EDs had the lowest RADAR. Recognizing that high volume EDs experience greater rates of overcrowding, longer wait times and higher rates of left without being seen – all associated with patient dissatisfaction and adverse outcomes – development of direct admission systems for pediatric patients may be particularly beneficial at these hospitals.^{19–21} However, communication between referring and accepting healthcare professionals, a prerequisite for direct admissions, may be particularly challenging in high volume hospitals where referring providers may not have personal relationships with inpatient healthcare professionals. Linking communication systems for direct admissions to existing ED referral systems is one potential mechanism to facilitate direct admission referrals while enabling the identification of pediatric patients appropriate for this admission approach.

Our finding that hospitals with the highest pediatric volumes had the highest risk-adjusted direct admission rates was contrary to our hypothesis that direct admission rates would be higher at hospitals with small pediatric volumes. The relatively large number of children admitted to specialty services at higher volume pediatric centers may explain this result. It is plausible that hospital admissions facilitated by specialists who provide patient care across both ambulatory and inpatient settings may lead to higher direct admission rates at high-volume pediatric centers. We also observed that communities with smaller pediatrician workforces per capita had higher direct admission rates than those with larger pediatrician workforces. Direct admissions in these settings may be enabled by closer relationships between referring and accepting pediatricians, which may facilitate handoffs at the time of hospital admission.

Risk-adjusted direct admission rates were considerably lower in hospitals that provided care to larger black and Hispanic populations. Past studies have shown that direct admission rates are associated with access to primary care, and caregivers of both black and Hispanic children are less likely to report having a usual source of care or a medical home.^{22–25} We postulate that hospitals caring for a larger proportion of non-white patients are more likely to represent safety-net hospitals, where lower operating margins and disparities in access to outpatient care may limit investment in direct admission systems.^{26,27} A previous qualitative study identified lack of financial incentives for collaboration, competing priorities, and mismatched expectations between hospitals and primary care providers as barriers to effective transitions in a safety-net system; addressing these barriers may support the development of effective direct admission systems.^{28,29}

We had hypothesized that joint ventures between physicians and hospitals and high levels of physician-hospital integration would be positively associated with RADAR and have implications for contemporary accountable care organizations, which align physicians and hospitals to promote care coordination across sites of care.³⁰ However, we did not find significant associations between these characteristics and RADAR; the majority of variation in RADAR was unexplained by our models. Additional factors that may account for variation in hospitals' RADAR that we could not evaluate using these datasets include: hospital-based resources to support direct admission processes, including nurse-patient ratios, physician staffing patterns, and patient referral communication systems; the availability of shared electronic medical records across ambulatory care clinics and hospitals; and hospitals' culture regarding care coordination between outpatient- and inpatient-based clinicians.⁷

These results should be interpreted in light of several limitations. First, although the KID includes data from 44 states, several states did not provide hospital-level identifiers allowing the KID to be linked to the AHA and AHRF, which limited this analysis to 26 states. Second, race/ethnicity data was missing for almost 14% of patients included in our sample. This data represented three states included in our analysis that did not provide race/ethnicity data to the KID and was therefore not missing at random; in our sensitivity analysis excluding these states our results were essentially unchanged. Third, our analysis was limited to variables available in these three datasets; we have limited knowledge about several aspects of clinical care such as the admitting service/provider location, and hospital-

system variables that were specific to pediatric care. Fourth, our workforce variables were limited to the pediatric and ED workforce, and do not include family doctors who provide a substantial proportion of pediatric care in some communities. Finally, the KID 2012, the most recent national pediatric data available from HCUP, does not provide hospital-level identifiers allowing the KID to be linked to the AHA and AHRF.

RADAR were associated with several hospital and community characteristics, with pediatric hospitalization volume, ED volume, and the number of pediatricians per capita working in the community accounting for greatest proportion of explained variation. These findings suggest opportunities for structurally diverse hospitals to develop direct admission systems to improve continuity of care and decrease health care costs among hospitalized children, and for future qualitative work to identify health system factors associated with high pediatric direct admission rates.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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What's new

One-in-four pediatric hospitalizations begin as direct admissions, with considerable variation in direct admission rates across hospitals. This study linked three national datasets to understand how hospital and community characteristics are associated with pediatric direct admission rates in the United States.

Figure 1.
Study sample following application of eligibility criteria

Figure 2.
Distribution of unadjusted and risk-adjusted direct admission rates across hospitals.

Figure 3.

A: Proportion of variation in risk-adjusted direct admission rates attributed to hospital and community characteristics; B: Proportion of explained variation in risk-adjusted direct admission rates attributed to hospital and community characteristics.

Table 1

Sociodemographic and clinical characteristics of children and adolescents.

Characteristic	Direct admission 42645 (20.2%) n (%)	Emergency department admission 168813 (79.8) n (%)	p-value
Age ¹ (median [IQR])	2 [0–6]	2 [0–6]	<0.01
Gender: ²			
Female	18795 (45.5)	74070 (44.4)	<0.01
Race/ethnicity: ³			
White	19032 (44.6)	61573 (36.5)	<0.0001
Black	3358 (7.9)	31427 (18.6)	
Hispanic	8493 (19.9)	40926 (24.2)	
Other	2950 (6.9)	14763 (8.8)	
Primary payor:			
Public	19619 (46.0)	90962 (53.9)	<0.0001
Private	20547 (48.2)	66023 (39.1)	
Uninsured	991 (2.3)	6953 (4.1)	
No charge or other	1488 (3.5)	4875 (2.9)	
Medical complexity:			
Non-chronic disease	26305 (61.7)	90099 (53.4)	<0.0001
Non-complex chronic disease	12100 (28.4)	62352 (36.9)	
Complex chronic disease	4240 (9.9)	16362 (9.7)	
Disease severity:			
1	27022 (63.4)	100419 (59.5)	<0.0001
2	13105 (30.7)	57537 (34.1)	
3	2239 (5.3)	9595 (5.7)	
4	279 (0.7)	1262 (0.8)	
Reason for hospitalization:			
Pneumonia	10203 (23.9)	41404 (24.5)	<0.0001
Asthma	6274 (14.7)	38811 (23)	
Bronchiolitis	8121 (19)	27957 (16.6)	
Dehydration	6142 (14.4)	16044 (9.5)	
Cellulitis	4189 (9.8)	14384 (8.5)	
Urinary tract infection	2753 (6.5)	11931 (7.1)	
Fever	1978 (4.6)	6582 (3.9)	
Influenza	1673 (3.9)	6084 (3.6)	
Gastroenteritis	1312 (3.1)	5616 (3.3)	

¹Missing for 576 children;²Missing for 3370 children;

³Missing for 28,936 children (8812 in direct admission group and 20,124 in ED admission group)

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Table 2

Hospital and community characteristics and associated unadjusted direct admission rates.

Hospital characteristics	Number of hospitals (%) (total 933 hospitals)	Median direct admission rate (%) [IQR] (median across hospitals 21.3% [5.1–41.0])	p-values
Region:			
Northeast	234 (25.1)	12.5 (3.0–33.4)	<0.0001
South	267 (28.6)	25.6 (4.6–45.5)	
Midwest	181 (19.4)	27.4 (10.6–44.1)	
West	251 (26.9)	24.1 (9.8–40.3)	
Teaching hospital:			
Yes	137 (14.7)	8.3 (2.7–23.8)	<0.0001
No	796 (85.3)	24.7 (7.1–43.4)	
Hospital ownership/control:			
Government, non federal	124 (13.3)	24.5 (4.9–48.2)	0.71
Nongovernment not-for-profit	733 (78.6)	21.0 (5.4–40.3)	
Investor-owned (for-profit)	76 (8.2)	24.0 (4.0–40.8)	
Hospital setting:			
Rural	247 (26.5)	33.5 (14.8–50.9)	<0.0001
Urban	686 (73.5)	17.5 (4.4–36.7)	
Hospital structure:			
Children's hospital	103 (11.0)	9.7 (2.6–20.6)	<0.0001
General hospital	830 (89.0)	24.5 (6.3–43.3)	
Hospitalists provide care: [†]			
Yes	690 (74.0)	18.6 (4.7–37)	<0.0001
No	164 (17.6)	29.5 (5.8–45.8)	
Pediatric intensive care unit:			
Yes	187 (20.0)	11 (2.7–30.4)	<0.0001
No	746 (80.0)	25.1 (7.4–43.5)	
Pediatric hospitalization volume:			
Low (<185 hospitalizations/year)	269 (28.8)	21.4 (3.7–41.2)	<0.0001
Intermediate (186–986 hospitalizations/year)	444 (47.6)	26.2 (9.5–43.5)	
High (>986 hospitalizations/year)	220 (23.6)	14.1 (3.1–34.6)	
ED volume (quartiles):			
Q1: <24585/year	233 (25.0)	36.5 (15.9–51.9)	<0.0001
Q2: 24678–41246/year	233 (25.0)	26.5 (8.2–42.3)	
Q3: 41301–62121/year	234 (25.1)	18.3 (6.2–34.9)	
Q4: >62137/year	233 (25.0)	10.2 (2.8–26.4)	

Hospital characteristics	Number of hospitals (%) (total 933 hospitals)	Median direct admission rate (%) [IQR] (median across hospitals 21.3% [5.1–41.0])	p-values
Physician-hospital integration:			
Low	471 (50.5)	24.6 (6.0–44.1)	0.03
High	462 (49.5)	19.8 (4.7–38.5)	
Joint venture: ²			
Yes	370 (39.7)	19.9 (4.7–40.3)	0.24
No	506 (54.2)	22.5 (5.4–41.2)	
Community characteristics			
Children living in poverty (%; quartiles):			
Q1: 3.7–14.1	233 (24.5)	16.1 (4.1–34.4)	<0.001
Q2: 14.2–20.4	235 (25.2)	28.3 (9.8–44.2)	
Q3: 20.5–23.8	230 (24.7)	24.9 (10.2–42.3)	
Q4: 24.0–51.6	235 (25.2)	17.4 (3.3–38.5)	
Adults with 4 yrs college education (%; quartiles):			
Q1: 7.6%–18.6%	232 (24.8)	33 (9.8–50)	<0.0001
Q2: 18.7%–26.3%	236 (25.2)	25.1 (12.2–43.2)	
Q3: 26.4%–34.2%	230 (24.6)	26 (9.3–44.4)	
Q4: 34.3%–59.5%	237 (25.4)	17.4 (4.5–33.5)	
Hospital bed supply/100,000 population (n; quartiles):			
Q1: 38.6–178.9	233 (25.0)	19.6 (5–38.2)	0.01
Q2: 180.8–250.3	231 (24.8)	24.8 (10.2–42.3)	
Q3: 250.4–351.2	235 (25.2)	17.2 (3.6–37.3)	
Q4: 352.6–2737.8	234 (25.1)	25.7 (5.2–44.1)	
Designated Health professional shortage area:			
Yes (full county)	406 (43.5)	20.6 (6–38)	0.69
No/other	527 (56.5)	22.1 (4.4–42.6)	
Pediatricians/100,000 population (n; quartiles):			
Q1: 0–8.79	232 (24.9)	28.9 (12.1–45.5)	<0.0001
Q2: 8.83–12.94	234 (25.1)	29 (13.2–44.3)	
Q3: 12.96–18.49	233 (25.0)	19 (4.5–41)	
Q4: 18.64–82.9	234 (25.1)	9.7 (2.7–26.9)	
Emergency medicine physicians /100,000 population (n; quartiles):			
Q1: 0–4.67	232 (24.9)	30 (9.7–47.9)	<0.001
Q2: 4.68–8.67	235 (25.2)	20 (5–38.5)	
Q3: 8.71–12.19	232 (24.9)	16.6 (4.4–36.8)	
Q4: 12.21–73.38	234 (25.1)	20.1 (4.4–38.9)	

¹ Missing for 79 hospitals;

²Missing for 57 hospitals

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Table 3
Generalized linear model of hospital and community factors on risk-adjusted direct admission rates

Parameter *	Estimate	Standard error	t-value	(p-value)	F-value	(p-value)
Intercept	13.65	4.29	3.18	(<0.01)		
Pediatric hospitalization volume:					28.53	<.0001
Low (<185 hospitalizations/year)	-18.35	2.95	-6.21	(<0.0001)		
Intermediate (186-986 hospitalizations/year)	-4.20	2.41	-1.74	(0.08)		
High (>986 hospitalizations/year)	ref					
ED volume (quartiles):					24.09	<.0001
Q1: 24585/year	22.60	2.73	8.27	(<0.0001)		
Q2: 24678-41246/year	9.57	2.31	4.13	(<0.0001)		
Q3: 41301-62121/year	5.13	2.08	2.47	(0.01)		
Q4: >62137/year	ref					
Pediatric case mix: % non-white race	-0.09	0.02	-3.75	(<0.001)	14.09	(<0.001)
Hospital type: general hospital *	11.85	3.26	3.63	(<0.001)	13.17	(<0.001)
Pediatricians/100,000 population (n, quartiles):					6.53	(<0.001)
Q1: 0-8.79	9.09	2.79	3.26	(<0.01)		
Q2: 8.83-12.94	11.27	2.56	4.4	(<0.0001)		
Q3: 12.96-18.49	6.90	2.32	2.97	(<0.01)		
Q4: 18.64-82.9	ref					
Hospital bed supply/100,000					4.07	(<0.001)
Q1: 38.6-178.9	-4.23	2.34	-1.81	(0.07)		
Q2: 180.8-250.3	0.98	2.19	0.45	(0.65)		
Q3: 250.4-351.2	-4.83	2.09	-2.31	(0.02)		
Q4: 352.6-2737.8	ref					
Emergency medicine physicians/100,000 population					2.78	(0.04)
Q1: 0-4.67	2.42	2.42	1	(0.32)		
Q2: 4.68-8.67	-3.34	2.33	-1.43	(0.15)		

Parameter*	Estimate	Standard error	t-value	(p-value)	F-value	(p-value)
Q3: 8.71–12.19	-2.12	2.18	-0.97	(0.33)		
Q4: 12.21–73.38	ref					
Hospital ownership/control:					2.64	(0.07)
Government, non-federal	4.44	2.19	2.03	(0.04)		
Investor-owned (for-profit)	-2.14	2.66	-0.81	(0.42)		
Nongovernment not-for-profit	ref					
Hospitalists provide care: ¹					2.11	(0.12)
Yes	ref					
No	1.23	2.04	0.61	(0.54)		
Missing	5.43	2.66	2.04	(0.04)		
Pediatric case mix: % children with medical complexity	0.20	0.14	1.41	(0.16)	1.99	(0.16)
Children living in poverty (%; quartiles):					1.32	(0.27)
Q1: 3.7–14.1	1.15	2.40	0.48	(0.63)		
Q2: 14.2–20.4	3.60	2.11	1.71	(0.09)		
Q3: 20.5–23.8	3.13	2.14	1.46	(0.14)		
Q4: 24.0–51.6	ref					

* Presented from largest to smallest F-value;

** children's hospitals is referent group