Variation in Hospitalization Rates Following Emergency Department Visits in Children with Medical Complexity

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Objectives To evaluate factors associated with admission from emergency department (ED) encounters for children with medical complexity (CMC) and to quantify the hospital admission rate as well as variation in adjusted hospital admission rates across EDs.

Study design Retrospective study of 271 806 visits to 37 EDs in freestanding children's hospitals from January 1, 2014, to June 30, 2017, for patients of all ages with a complex chronic condition. Associations between patient demographic, clinical, and health services characteristics and the likelihood of hospital admission were identified using generalized linear models, which were then used to calculate adjusted hospital admission rates.

Results Hospital admission occurred with 25.7% of ED visits. Characteristics with the greatest aOR of hospitalization were ≥3 compared with 0 prior hospitalizations in 365 days (4.7; 95% CI, 4.5-4.9), ED arrival overnight compared with during workday 3.2 (95% CI, 3.1-3.3)], and ≥6 vs 0-1 chronic conditions (1.6; 95% CI, 1.5-1.6). Adjusted hospital admission rates varied significantly ($P < .001$) across EDs (21.1% [10th percentile]) and 30.0% [90th percentile]). Significant variation remained when excluding low-intensity ED visits, excluding hospitalizations requiring surgery and/or intensive care, or restricting the cohort to overnight ED arrival and to children with ≥3 prior hospitalizations.

Conclusions CMC are frequently admitted from the ED. Substantial variation in CMC hospital admission rates across EDs exists after case-mix adjustment. *(J Pediatr 2019;214:113-20)*.

Children with medical complexity (CMC) have lifelong, complex chronic conditions (CCCs) associated with multimorbidity, severe functional limitations, myriad health care needs, and high resource use.[1,2] Owing to their fragile underlying conditions, CMC are vulnerable to fluctuations in health that often necessitate emergency department (ED) care.[3] Deciding when and where to seek emergency care, however, has multiple poorly understood motivators, including chronic disease instability, access to and quality of ambulatory and preventive care, caregiver self-efficacy, and community and family assets, among others.[4-6] The relative presence or absence of these factors may lead to important differences in how CMC and their families use the ED.

Once a child is in the ED, the decision to admit or discharge is driven by multiple factors. For example, illness acuity, ED provider risk tolerance and expertise with CMC, outpatient access, caregiver comfort with contingency plans, distance to care, presentation timing, hospital census, and other characteristics can influence family and provider disposition decision making.[7,8] Although the relative contribution of any of these factors to admission decisions is poorly understood, the way in which these factors vary across institutions and populations might plausibly create important differences in CMC ED admission rates. Because prior studies of interventions designed to reduce hospitalizations focus on avoiding ED visits altogether, the opportunity to lower hospital use by focusing on potentially modifiable variation in admissions for CMC already in the ED remains largely unexplored.[9-11]

Although hospitalizations have been a long-standing measure of a potentially avoidable CMC health service, little is known about the opportunity to influence

CCC	Complex chronic condition
CMC	Children with medical complexity
ED	Emergency department
ICD	*International Classification of Diseases*
PHIS	Pediatric Health Information System

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the hospitalization risk from an ED visit.[12-14] Therefore, our objectives were to identify factors associated with admission within ED encounters and to quantify both the overall ED admission rate for CMC and admission rate variation across children's hospitals. Confirming variation in risk-adjusted ED admission rates suggests that either opportunities may exist for reduction or that risk remains poorly understood. This study is a necessary first step to identify explanatory variables and eventually design interventions to decrease excessive variation.

Methods

This is a retrospective study of patients with encounters for any reason from 37 EDs in freestanding children's hospitals in 23 states between July 1, 2014, and June 30, 2017, that submitted data to the Pediatric Health Information System (PHIS). Patients were included if they had ≥1 CCC, identified using the *International Classification of Diseases* (ICD) diagnosis classification scheme used by Feudtner et al.[15] CCCs represent defined diagnosis groupings expected to last >12 months, and involve either a single organ system severely enough to require specialty pediatric care and hospitalization, or multiple organ systems.[15] Patients who died in the ED as well as patients transferred in from, or out to, another health care facility were excluded. For patients with multiple ED visits during the time period, a single, randomly selected ED visit was selected for analysis as an index ED visit. This method removed the significant limitations in analysis of variation in hospitalization rates across EDs that would exist if clustering of data were necessary from including all the patients' ED visits. PHIS quality and integrity are assured by the Children's Hospital Association (Lenexa, Kansas). All data were de-identified before database inclusion. An encrypted unique patient linking variable allowed tracking individual patients across ED and inpatient visits. This study was exempted from human subjects' research by the Boston Children's Hospital Institutional Review Board.

Main Outcome Measure

Hospital admission from the ED visit was the main outcome of interest. Hospital admission was distinguished using ED disposition information available in PHIS, and included all hospital stays whether designated as inpatient or observation status. Only hospital admissions to the same hospital affiliated with the ED visit were measured. For each ED, the hospital admission rate was calculated from the number of admissions for patients with a CCC divided by the total number of ED visits for patients with a CCC. This outcome represents all-condition hospital admissions, that is, hospital admissions and ED visits for any reason.

Patient Demographics and Clinical Characteristics

To adjust for differences in case-mix across EDs, we assessed patients' demographic characteristics, including age (0 years, 1-4 years, 5-10 years, 11-15 years, 16-18 years, and ≥19 years), sex, race/ethnicity (non-Hispanic white, non-Hispanic black, Hispanic, Asian, or other), insurance (public, private, or other [ie, self-pay, other payor, charity, or hospital did not bill]), and location of home residence (by US zip code) from hospital (<5 miles, 5-10 miles, 11-20 miles, and >20 miles).

We assessed the type of CCC experienced by the children (eg, cardiovascular, neuromuscular, renal) and the use of medical technology (eg, gastrostomy, tracheostomy). To allow us to further account for less complex comorbid conditions, we also assessed the number of chronic conditions (of any complexity), using the Agency for Healthcare Research and Quality Chronic Condition Indicator (CCI) classification system, which categorizes ≥14 000 ICD diagnosis codes into chronic vs nonchronic conditions. To improve the sensitivity of these categorizations, CCCs and CCIs were assigned using diagnostic codes from all ED encounters (as well as hospitalizations) for patients in 365 days before their index visit.

To account for encounter-specific severity of illness, we also characterized visits by All Patient Refined Diagnosis Related Group (3M, Maplewood, Minnesota), and assessed the visit's illness severity using the 5-category classification system based on principal ICD codes from the encounter used by Alessandrini et al.[16] These latter categorizations were included to represent the wide spectrum of acute illness severity that children with even highly complex conditions can experience within our models. For example, a child with a complex neuromuscular condition can have ED visits for low, medium, and high acuity acute illnesses.

Patient ED and Hospital Use Characteristics

We assessed the number of ED visits not resulting in hospital admission (ie, discharged home from the ED) as well as hospitalizations (0, 1, 2, ≥3) in the 365 days before each patient's index ED visit. We measured the number of days between the index ED visit and the most recent prior use (within 7 days, 8-30 days, or 31-365 days). Arrival hour for the index ED visit was also assessed (8:00 a.m.-3:59 p.m., 4:00 p.m.-11:59 p.m., 12:00 a.m.-7:59 a.m.).

Statistical Analyses

The χ^2 test was used to assess bivariable associations of hospital readmission rate with patients' demographic, clinical, and health services characteristics. Each of these characteristics had significant bivariable associations with the outcome, and were entered simultaneously into a multivariable, generalized linear model with hospital admission rate as the outcome, accounting for clustering within ED using a random effect. Using this model, we calculated the adjusted hospital admission rates across EDs. The covariance structure of the random effects for these models as well as one including only the random effect for hospital were tested against a zero matrix to ensure statistically significant variation in unadjusted and adjusted admission rates. Data were analyzed using SAS version 9.4. (SAS Institute, Cary, North Carolina).

Planned Sensitivity Analyses

We hypothesized a priori that several clinical scenarios should minimize variation in ED admission rates across children's hospitals. To test this hypothesis, adjusted hospital admission rates were recalculated among four separate subgroups, created by excluding (1) ED visits without high-severity primary diagnoses, (2) children with <3 hospitalizations in the prior year, (3) children arriving before midnight, or (4) hospital admissions associated with any of the following: surgery, intensive care, or low-resource ED visits where no medications or treatments were administered, no laboratory or diagnostic testing was performed as determined from PHIS data.[17] Observing persistent variation despite these sensitivity analyses could support speculation that some variation may be potentially modifiable.

Results

Of the 271 806 ED visits included for CMC during the study (**Figure 1**; available at www.jpeds.com), 25.7% resulted in hospital admission. Of all the included ED visits, the median age (IQR) was 6 years (IQR, 1-13 years); 53.9% were male, 45.0% were non-Hispanic white, and 62.6% used public insurance (**Table I**). CMC lived a median of 13 miles (IQR, 6-27 miles) from their visited ED. Most patients (81.9%) visited the ED between 8:00 a.m. and 11:59 p.m. CMCs' most common CCC were neuromuscular (24.2%), cardiovascular (22.0%), and gastroenterologic (21.6%) (**Table II**). Most (67.7%) had multiple coexisting chronic conditions. In the 365 days before their index ED visit, 43.3% of CMC had ≥1 ED visit resulting in discharge home and 57.8% had ≥1 hospitalization (**Table III**; available at www.jpeds.com).

Twenty-six percent of index ED visits resulted in hospital admission. The most common reasons for these ED visits included bronchiolitis and pneumonia (7.4%), gastroenteritis and hypovolemia (6.7%), and seizure (5.9%).

Table I. Demographic characteristics and hospital admission rates from ED visits for children with medical complexity

Characteristics	n (%)	Rate of hospital admission,* n (%)
Overall cohort	271 806	69 931 (25.7)
Age at ED visit, y		
0	45 528 (16.8)	12 534 (27.5)
1-4	70 782 (26.0)	17 314 (24.5)
5-10	61 871 (22.8)	14 318 (23.1)
11-15	50 872 (18.7)	13 100 (25.8)
16-18	30 096 (11.1)	8532 (28.3)
19+	12 657 (4.7)	4133 (32.7)
Sex		
Male	146 423 (53.9)	37 529 (25.6)
Female	125 360 (46.1)	32 391 (25.8)
Race/ethnicity		
Non-Hispanic white	122 214 (45.0)	36 017 (29.5)
Non-Hispanic black	67 454 (24.8)	14 837 (22.0)
Hispanic	62 765 (23.1)	14 062 (22.4)
Other	19 373 (7.1)	5015 (25.9)
Payor		
Public	168 203 (62.6)	41 061 (24.4)
Private	90 819 (33.8)	26 266 (28.9)
Self-pay	4920 (1.8)	632 (12.8)
Other	4826 (1.8)	1406 (29.1)
Distance from ED to hospital, miles		
<5	47 852 (17.7)	8312 (17.4)
5-10	61 235 (22.7)	12174 (19.9)
11-20	67 896 (25.1)	16 333 (24.1)
>20	93 003 (34.4)	32 613 (35.1)
ED arrival hour		
8:00 a.m. to 3:59 p.m.	107 606 (39.6)	19 474 (18.1)
4:00 p.m. to 11:59 p.m.	115 007 (42.3)	31 180 (27.1)
12:00 a.m. to 7:59 a.m.	49 053 (18.1)	19 277 (39.3)

*Shown are the percentage of ED visits with each patient characteristic that resulted in hospital admission. For example, 27.5% of visits for children age zero years resulted in admission. All bivariable hospital admission rate comparisons within groups were statistically significant ($P < .05$).

Bivariable Associations of Patient Characteristics and Hospital Admission

Patient Demographic Characteristics. Hospital admission rates varied by race/ethnicity, with the lowest and highest rates observed for non-Hispanic black (22.0%) and non-Hispanic white (29.5%) children, respectively (**Table I**). The hospital admission rates were higher for CMC with private insurance compared with public (28.9% vs 24.4%). Hospital admission rates increased as the distance between the ED and CMC home residence widened (from 17.4% [<5 miles] to 35.1% [>20 miles]). CMC had higher hospital admission rates when arriving to the ED overnight (ie, 12:00 a.m.-7:59 a.m.) compared with workday (ie, 8:00 a.m.-3:59 p.m.; 39.3% vs 18.1%).

Patient Clinical Characteristics. Hospital admission rates varied by CCC (**Table II**). The highest rates were observed with transplant (48.0%), malignancy (38.6%), and renal (36.2%) CCCs. Hospital admission rates increased as the number of coexisting conditions increased (from 14.6% [1 condition] to 43.6% [≥6 conditions]) and with increasing severity of the health problem responsible for the ED visit (from 4.1% [least severe] to 78.6% [most severe]) (**Table II**).

Patient Health Service Characteristics. Hospital admission rates decreased as the number of ED visits that did not result in admission within 365 days increased (from 28.3% for no prior ED visits to 18.5% with ≥3 prior visits) (**Table III**). Conversely, hospital admission rates increased as the number of prior hospitalizations within 365 days grew (from 11.2% with no prior hospitalizations to 50.1% with ≥3 prior hospitalizations) (**Table III**).

Multivariable Associations of Patient Characteristics and Hospital. The demographic and clinical characteristics with the largest effect sizes for hospital admission were severity of health associated with the ED visit, distance from the ED, arrival hour, and the number of organ systems affected by coexisting conditions (**Figure 2**). For example, CMC had a 0.3 (95% CI, 0.3-0.4) to 7.1 (95% CI, 6.5-7.6) adjusted odds of admission for visits with the lowest and highest severity, respectively (with mid-range severity

Table II. Clinical characteristics and hospital admission rates from ED visits for children with medical complexity

Characteristics	n (%)	Rate of hospital admission,* n (%)
No. of chronic conditions		
0†	7603 (2.8)	1080 (14.2)
1	80 216 (29.5)	11 733 (14.6)
2-3	90 859 (33.4)	21 354 (23.5)
4-5	42 961 (15.8)	13 881 (32.3)
6+	50 167 (18.5)	21 883 (43.6)
CCC		
Congenital/genetic	48 067 (17.7)	12 775 (26.6)
Hematologic/immunologic	45 130 (16.6)	12 863 (28.5)
Cardiovascular	59 721 (22.0)	17 056 (28.6)
Neuromuscular	65 820 (24.2)	20 107 (30.5)
Neonatal	17 005 (6.3)	5384 (31.7)
Respiratory	25 747 (9.5)	8378 (32.5)
Metabolic	39 065 (14.4)	13 440 (34.4)
Technology assistance	72 810 (26.8)	26 099 (35.8)
Gastrointestinal	58 687 (21.6)	20 985 (35.8)
Renal	29 473 (10.8)	10 672 (36.2)
Malignancy	24 740 (9.1)	9550 (38.6)
Transplant	5941 (2.2)	2853 (48.0)
Severity of ED visit‡		
1 (lowest)	4662 (1.7)	189 (4.1)
2	69 241 (25.5)	6580 (9.5)
3	136 669 (50.3)	302 50 (22.1)
4	44 410 (16.3)	23 213 (52.3)
5 (highest)	5792 (2.1)	4551 (78.6)
Resources used in ED visit§		
Low	44 111 (16.2)	125 (0.3)
Not low	227 695 (83.8)	69 806 (30.7)

AHRQ, AHRQ Chronic Condition Indicator System.
*Shown are the percentage of ED visits with each patient characteristic that resulted in hospital admission. For example, 43.6% of visits for children with 6 or more chronic conditions resulted in admission. All bivariable hospital admission rate comparisons within groups were statistically significant ($P < .05$).
†Some children with a CCC (required for cohort inclusion) did not have a chronic condition designated by the AHRQ Chronic Condition Indicator System because the AHRQ system does not classify some of the CCCs (eg, cancer) as a chronic condition.
‡Severity of the primary diagnosis for the ED visit was assessed with Alessandrini and et al's 5-category classification system based on ICD codes.
§Low-resource use ED visits were those that had no medications, laboratory/radiographic testing, or treatments performed.

as the reference group). CMC had adjusted odds of 1.8 (95% CI, 1.7-1.8) of admission when residing >20 compared with <5 miles from the ED. CMC had a 3.2 (95% CI, 3.1-3.3) adjusted odds of admission when arriving to the ED overnight compared with workday hours. CMC had a 1.6 (95% CI, 1.5-1.6) adjusted odds of admission when having ≥6 chronic conditions compared with 0 or 1 (Figure 2).

Health services with large effects for hospital admission included number of prior ED visits not resulting in admission and number of prior hospitalizations in 365 days. CMC had a 0.7 (95% CI, 0.7-0.7) adjusted odds of admission with ≥3 compared with zero prior ED visits (Figure 1). In contrast, CMC had a 4.7 (95% CI, 4.5-4.9) adjusted odds of hospital admission with ≥3 compared with zero prior hospitalizations (Figure 2).

Other notable characteristics with smaller yet significant multivariable associations with hospitalization were race/ethnicity, payor, and age (Table IV; available at www.jpeds.com).

Hospital Admission Rates Across EDs. Hospital admission occurred with 25.7% of ED visits. Unadjusted hospital admission rates for CMC varied significantly ($P < .001$) across EDs (Figure 3), from 18.5% (10th percentile) to 34.0% (90th percentile). Significant variation ($P < .001$) in hospital admission rates for CMC remained after adjusting for patient demographic, clinical, and health services characteristics associated with hospital admissions. Adjusting for these characteristics, hospital admission rates for EDs in the 10th percentile or below vs the 90th percentile or above were 21.1% and 30.0%, respectively. Significant variation in hospital admission rates across EDs for CMC remained in each of the preplanned sensitivity analyses (Figure 3).

Discussion

The main findings from this study suggest that >1 in 4 children with a CCC who visited a children's hospital ED experienced hospital admission. Substantial variation exists in hospitalization rates for children with CCCs across EDs; EDs with the highest rates admitted >1 in 3 children. This variation remained after case-mix adjustment for demographic, clinical, and prior health services characteristics that correlated strongly with the likelihood of hospitalization. By confirming the sizable variation in CMC risk-adjusted ED admission rates across US children's hospitals and identifying several potential explanatory variables, these findings constitute an essential first step in a line of research to develop interventions which may ultimately reduce ED admissions.

Several important factors may explain admission rate variation observed across EDs in this study. First, contextual differences in ED provider or CMC caregiver decision making may lead to ED admission rate variation. For example, the opposing associations of prior ED discharge visits and prior hospitalizations on the likelihood of hospital admission from a current ED visit might reflect reinforcing decision-making patterns for families or providers. A history of multiple ED visits not resulting in admission could lead ED clinicians to feel comfortable sending a child home another time without admission. In contrast, a history of multiple hospitalizations may lead clinicians to strongly assume hospital readmission is required. Such patterns may reinforce outpatient provider expectations as well. For example, a CMC's primary care provider could influence patient, family, or ED provider expectations for admission at the time of acute illnesses. Future research should clarify how information on prior use affects future decision making on disposition. The significant variation in admission rates for children with a history of multiple hospitalizations may suggest subjectivity in admission decisions. Testing this hypothesis could begin by closely examining EDs with low vs high admission rates. Comparing health care provider decision making in EDs, access to high-quality urgent care in community settings, and pre-arrival care planning in settings with low vs high admission

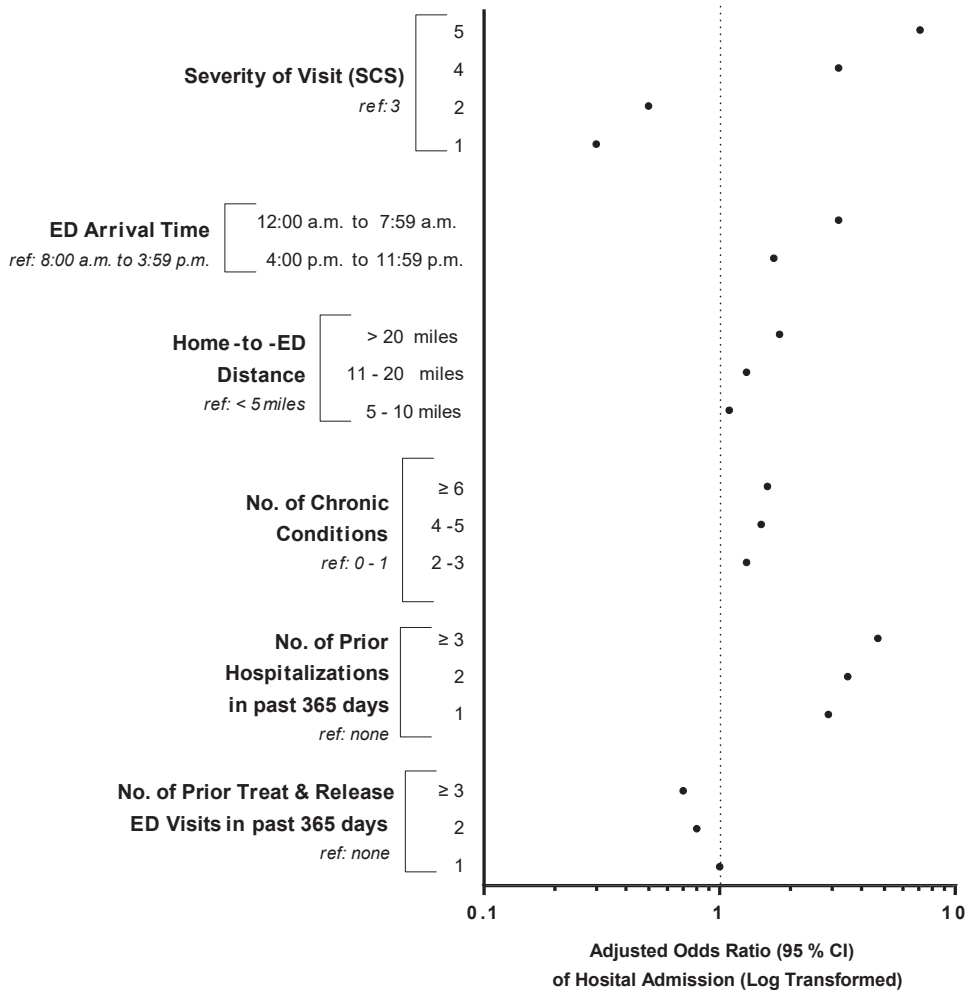

Figure 2. Multivariable analysis of patient characteristics and the odds of hospital admission with ED visits for CMC. Presented are the adjusted odds of hospital admission with 95% confidence intervals (CI). The ranges of the 95% CIs are too small to visualize. For severity of illness, categories 1 and 5 are the lowest and highest severity, respectively. Additional covariates (not shown) in the multivariable model included age, sex, race/ethnicity, and payor.

rates might help to articulate distinctive admission thresholds.

We also observed that the greatest magnitude of admission variation across EDs was for nocturnal vs daytime ED visits. This association has been inconsistently reported in prior pediatric and adult studies.[18] In our clinical experience, disposition decision making for CMC arriving overnight can be particularly challenging and subjective. Familial, social, and system factors, including caregiver transport difficulties and opportunities for prompt follow-up in the morning with an outpatient provider, can strongly influence hospital admission decisions. Lack of overnight availability for imaging modalities and specialized technical personnel (eg, sedation) can drive hospitalization decisions. Moreover, ED staffing models and limited subspecialty/surgical consultant availability at many centers overnight may contribute to increased admission rates. At times, children presenting to the ED overnight may be admitted more for these reasons than for severity of illness or need for hospital care.

A second potential explanation for our findings is that variation may reflect important local health system differences in quality of outpatient care received by CMC. For example, EDs with higher admission rates may be situated in areas where many families are insufficiently supported with proactive health crisis planning or access to primary care clinicians who are equipped to urgently care for CMC. Not only has this relationship been observed in adult patients,[7,19-22] but CMC receiving accessible, high-quality, comprehensive care have fewer ED visits and hospitalizations, and their family caregivers have more confidence caring for their children at home.[9,11,23-28] Communities with such systems could have more opportunities for ED clinicians to safely discharge CMC from the ED, resulting in lower admission rates.[29]

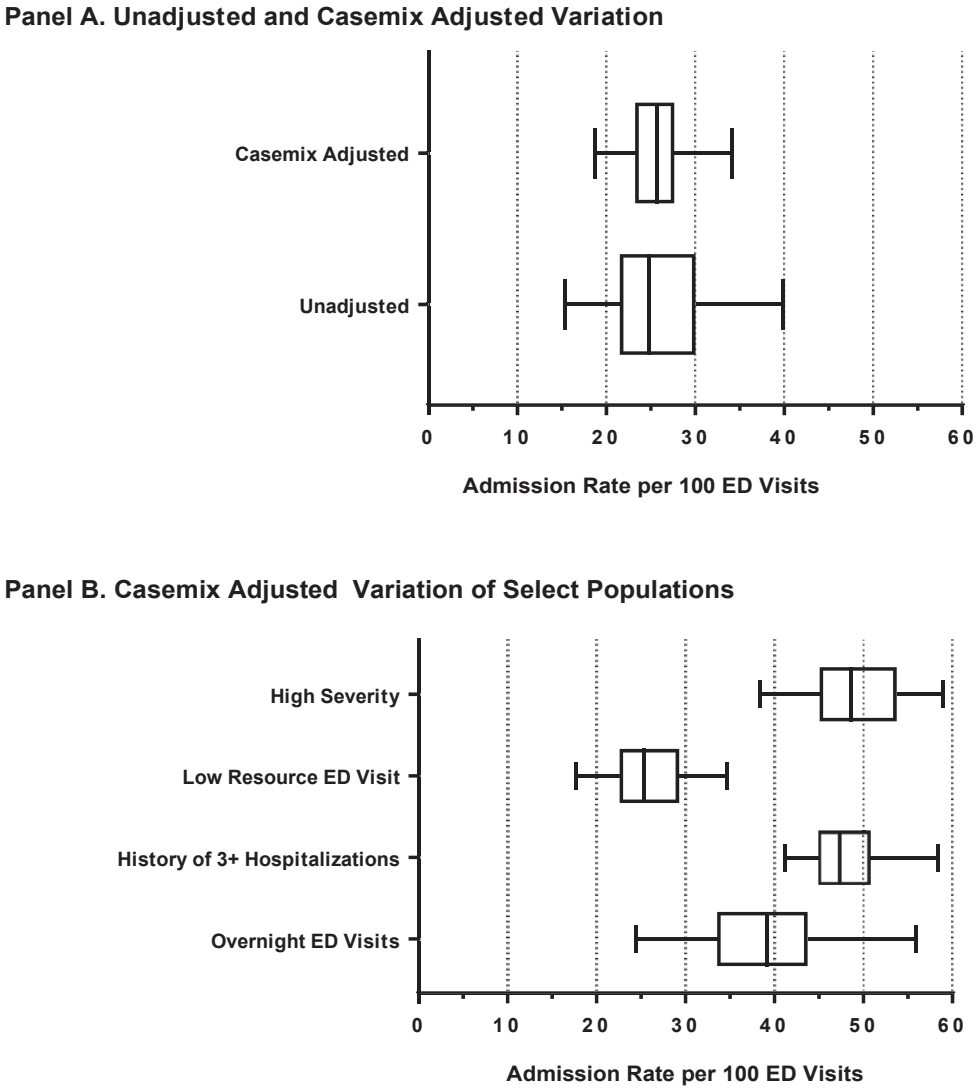

Figure 3. **A,** Variation in case-mix adjusted hospital admission rates across EDs for CMC. Box lines indicate the 25th, 50th, and 75th percentile of admission rates across EDs. Whiskers indicate the minimum and maximum ED admission rates. Case-mix adjusters included age, gender, race/ethnicity, payor, chronic conditions (number and type), severity of illness, distance of home residence from ED, number of prior hospitalizations as well as number of prior ED visits within 365 days that did not result in hospitalization. **B,** High severity indicates a population of children with ED visits for high-severity primary diagnoses; low resource ED visit indicates a population of children with ED visits having no medications administered as well as no laboratory/radiographic testing or other treatments performed; history of ≥3 hospitalizations indicates a population of children with ≥3 hospitalizations within 365 days of the ED encounter; overnight ED visits indicates a population of children arriving to the ED between 12:00 a.m. and 7:59 a.m.

Relationships between outpatient quality and ED admission rates, however, may prove to be complex. The same ambulatory care characteristics that prevent ED admissions could inflate admission rates in some EDs. For example, high-quality ambulatory care and access may largely eliminate lower severity ED visits, leaving a cohort of CMC presenting to EDs with high-severity illnesses. This higher severity could translate into higher admission rates in communities with high quality care. Additional research confirming associations between ED admissions and ambulatory quality, access, and crisis planning are needed. Health care claims data across the continuum would help contextualize hospital admission rates with local and regional conditional probabilities of ED visits themselves.

A third potential explanation for the observed variation may be due to differences in the severity of illness not accounted for in our models. Consistent with prior studies, children with specific types of CCCs associated with medical fragility did have higher admission rates (eg, malignancy and transplantation).[30,31] Recent research has highlighted the role specific medical device complications play in ED and hospital use for CMC, and a deeper

exploration into the influence of devices in ED admissions would be a helpful future direction.[32,33] We also observed that ED admissions were more common when children had a higher number of chronic conditions and a higher illness severity as a reason for the ED visit. Casting doubt on this theory, however, is that substantial variation remained even after selecting visits that we hypothesized would represent the most appropriate ED use and therefore least variation across EDs, including high severity visits, overnight arrivals, ≥3 hospitalizations in the prior year, and excluding low-resource ED visits.

Finally, we observed several important and unexpected disparities in admission rates, most notably by payer and race. Non-Hispanic white and privately insured CMC had the highest admission rates in our sample. Extant literature indicates racial/ethnic disparities in ED experiences,[34,35] and these findings beg the questions, "Why are ED admission rates so different among these groups?" and "Is one group's rate too high or another's too low?". The root causes of these disparities are likely complex, and follow-up research dedicated to unraveling these racial/ethnic and other sociodemographic disparities in ED admission rates is needed.

This study has several limitations. Admissions to a hospital different than the one affiliated with the ED were not measured, which could lead to undercounting hospitalizations. The definition of a single, randomly selected index visit for patients with multiple visits may have distorted admission rates. Although we did integrate each patient's visits over the year before the index, future research dedicated to longitudinal patterns of ED use for individual children would be valuable. Although CCCs are frequently used to identify CMC, this research may not generalize to CMC defined using different schemes. Information on the clinical severity of the health problem responsible for the ED visit was assessed with resources used in the ED (ie, medications and treatments administered, laboratory and radiographic testing performed) and the primary diagnosis associated with the visit; however, administrative data did not directly measure severity of physiologic distress or functional impairment. Although sensitivity analyses were constructed to focus on clinical situations expected to have less admission variability, the data were not positioned to assess which admissions were truly preventable or excessive.

The data lacked information on provider and family perceptions of the children's health status and necessity of hospital admission. No community health services information was available to assess how preceding or subsequent use of primary or specialty care—or the quality of that care—may have influenced whether hospital admission occurred. Although prior studies report similar hospitalization rates for children seen in pediatric and general EDs, findings from the current study may generalize best to pediatric EDs.[8] Exploring whether differences in ED provider training, for example, having consistently staffed fellowship-trained pediatric ED providers, is associated with ED admission rate variation, would be an additional useful future step.

Despite these limitations, the findings from the current study should stimulate additional investigations into variation in hospital admission rates from ED visits for children with CCCs. ED admission rates are an important use outcome given that the overall CMC admission rate (26%) is much higher than the reported rate of hospitalization from ED visits for all children (~4%-10%)[36]; it is also higher than national ED visit rates reported in adult patients, including Medicare beneficiaries.[20,37] Future research is needed to elucidate underlying causes of rate variations, components of appropriate or inappropriate ED admissions, disparities in ED admissions, and which ED-oriented interventions could reduce CMC hospitalizations. Together, this valuable information will advance knowledge on best practices and models of urgent care for CMC, which are critical to optimize their health and well-being. ■

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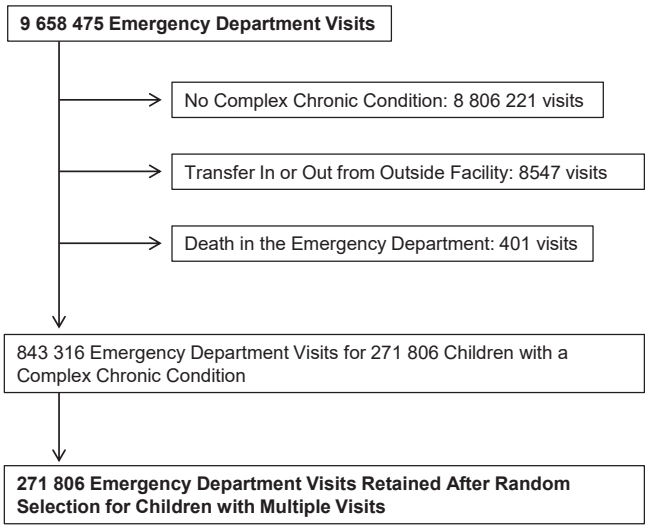

Figure 1. Derivation of the study population.

Table III. Health services characteristics and hospital admission rates from ED visits for CMC

Characteristics	No. (%)	Rate of hospital admission* (n, %)
Prior ED visits that did not result in hospital admission		
Timing of prior visits with the index visit		
No prior within 365 days	154 057 (56.7)	43 668 (28.3)
Within 7 days	11 404 (4.2)	3610 (31.7)
Within 8-30 days	15 355 (5.6)	3733 (24.3)
Within 31-365 days	90 990 (33.5)	18 920 (20.8)
No. of prior ED visits within 365 days		
0	154 057 (56.7)	43 668 (28.3)
1	62 300 (22.9)	15 244 (24.5)
2	27 260 (10.0)	5792 (21.2)
≥3	28 189 (10.4)	5227 (18.5)
Prior hospitalizations		
Timing of prior hospitalizations with the index Visit		
No prior within 365 days	114 702 (42.2)	12 862 (11.2)
Within 7 days	19 005 (7.0)	9928 (52.2)
Within 8-30 days	27 054 (10.0)	12 672 (46.8)
Within 31-365 days	111 045 (40.9)	34 469 (31.0)
No. of prior hospitalizations within 365 days		
0	114 702 (42.2)	12 862 (11.2)
1	94 131 (34.6)	28 990 (30.8)
2	31 705 (11.7)	12 410 (39.1)
≥3	31 268 (11.5)	15 669 (50.1)

*Shown are the percentage of ED visits with each patient characteristic that resulted in hospital admission. For example, 28.3% of visits for children with no prior ED visits in 365 days resulted in admission. All bivariable hospital admission rate comparisons within groups were statistically significant ($P < .05$).

Table IV. Multivariable analysis of patient characteristics and the odds of hospital admission with ED visits for CMC

Characteristics*	Adjusted OR (95% CI) of hospital admission
Demographic characteristics	
Age at ED visit	
0-1 years	Ref
2-4 years	0.9 (0.8-0.9)
5-10 years	0.8 (0.7-0.8)
11-15 years	0.8 (0.7-0.8)
16-18 years	0.8 (0.8-0.9)
≥19 years	0.9 (0.8-0.9)
Sex	
Male	1 (1-1)
Female	Ref
Race/ethnicity	
Non-Hispanic white	Ref
Non-Hispanic black	0.9 (0.9-1)
Hispanic	0.9 (0.9-0.9)
Other	1.0 (0.9-1.0)
Payor	
Public	Ref
Private	1 (1-1)
Other	0.8 (0.7-0.8)
Distance from hospital	
<5 miles	Ref
5-10 miles	1.1 (1.1-1.2)
11-20 miles	1.3 (1.2-1.3)
>20 miles	1.8 (1.7-1.8)
Arrival hour	
8:00 a.m.-3:59 p.m.	Ref
4:00 p.m.-11:59 p.m.	1.7 (1.7-1.8)
12:00 a.m.-7:59 a.m.	3.2 (3.1-3.3)
Clinical characteristics	
Severity of visit (SCS)	
0-1	0.3 (0.3-0.4)
2	0.5 (0.5-0.5)
3	Ref
4	3.2 (3.2-3.3)
5	7.1 (6.5-7.8)
Unknown	2.6 (2.5-2.7)
No. of chronic conditions	
0-1	Ref
2-3	1.3 (1.3-1.4)
4-5	1.5 (1.5-1.6)
≥6	1.6 (1.5-1.6)
Health service characteristics	
No. of treat and release ED visits in past 365 days	
0	Ref
1	1 (1-1)
2	0.8 (0.8-0.9)
≥3	0.7 (0.7-0.7)
No. of hospitalizations in past 365 days	
0	Ref
1	2.9 (2.8-3.0)
2	3.5 (3.4-3.7)
≥3	4.7 (4.5-4.9)

*The characteristics represent all of the variables included in the multivariable analysis. Review the multivariable **Figure 2** for a second presentation of the variables that we have further highlighted.