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The cost of emergency care for children across differing levels of emergency department pediatric readiness

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Abstract

High emergency department (ED) pediatric readiness is associated with improved survival in children, but the cost is unknown. We evaluated the costs of emergency care for children across quartiles of ED pediatric readiness. This was a retrospective cohort study of children aged 0–17 years receiving emergency services in 747 EDs in 9 states from January 1, 2012, through December 31, 2017. We measured ED pediatric readiness using the weighted Pediatric Readiness Score (range: 0–100). The primary outcome was the total cost of acute care (ED and inpatient) in 2022 dollars, adjusted for ED case mix and hospital characteristics. A total of 15 138 599 children received emergency services, including 27.6% with injuries and 72.4% with acute medical illness. The average adjusted per-patient cost by quartile of ED pediatric readiness ranged from $991 (quartile 1) to $1064 (quartile 4) for injured children and $1104–$1217 for medical children. The resulting cost differences were $72 (95% CI: −$6 to $151) and $113 (95% CI: $20–$206), respectively. Receiving emergency care in high-readiness EDs was not associated with marked increases in the cost of delivering services.

Key words: emergency services; children; cost; emergency department pediatric readiness.

Introduction

The National Pediatric Readiness Project (NPRP) is a national quality-improvement initiative to improve the quality and consistency of emergency care for children across the United States.[1] The concept of emergency department (ED) pediatric readiness is integral to the NPRP and includes the 6 domains of care coordination, personnel, quality improvement, patient safety, policies, and equipment. Previous studies have shown that high ED pediatric readiness is associated with improved survival among critically ill children,[2] injured children admitted to US trauma centers,[3,4] and children with different clinical conditions requiring hospitalization.[5] The optimized survival associated with high-readiness EDs persists to 1 year in children.[4,5]

However, evidence on the cost of ED pediatric readiness is lacking. This is reflective of the broader deficit of published information related to the health care costs of children and specifically the cost of pediatric emergency care. While there are sources for the average cost of an ED visit for children,[6,7] costs can be calculated in different ways and an ED visit may be defined differently (eg, only discharges). Other sources of health care costs for children are limited to admissions.[8] Beyond these sources for the health care costs of children, there is very little published literature on the adjusted cost of care

† A complete list of study group members appears in the Acknowledgments.

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for children. We found no recent studies detailing the adjusted costs of emergency care for children, the key drivers of costs, costs across different types of hospitals, and other key aspects of understanding health care costs for children. These limitations create a barrier to evaluating the cost impact and cost-effectiveness of specific programs and interventions to improve the emergency care of children, including ED pediatric readiness.

In this study, we estimated the average adjusted per-child cost of delivering emergency services across 747 EDs with differing levels of pediatric readiness in 9 states, including the key drivers of costs. We used a diverse sample of children, hospitals, and states to assess whether receiving emergency services in high-readiness EDs is associated with higher costs than in low-readiness EDs, after accounting for patient and hospital factors.

Methods

Study design

This was a retrospective cohort study. The study protocol was reviewed and approved by the Institutional Review Boards at Oregon Health & Science University and the University of Utah School of Medicine, which waived the requirement for informed consent. We used the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) cohort study guidelines.[9]

Study setting

We included 747 EDs in 9 states that completed the 2013 NPRP assessment of ED pediatric readiness, had patient-level charges for ED and inpatient services, provided the necessary patient and hospital information, and cared for at least 10 children over the 6-year period. We set the minimum ED volume threshold at a low level to include a wide variety of EDs across many geographic regions, while maintaining statistical stability of the cost models. The 9 states included Arizona, Florida, Maryland, Minnesota, New Jersey, New York, North Carolina, Rhode Island, and Wisconsin. We worked directly with agencies in each of these states to obtain state-level administrative data with the necessary patient and hospital identifiers for all ED visits and admissions for children during the study period. We selected the 9 states based on availability of data (including patient and hospital identifiers, plus ED and inpatient charges), geographic representation, and alignment with a recent analysis of 11 states demonstrating the survival benefit associated with high-readiness EDs.[5] Comparing study hospitals from the 9 states with hospitals from the other 41 states, the study hospitals had slightly higher ED pediatric readiness, more pediatric inpatient services, higher ED pediatric volume, and a greater proportion of academic and children's hospitals (Table S1). The data sources included demographic information; International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) and International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10-CM) diagnostic and procedure codes; total facility charges; and disposition from the ED and inpatient settings.

Patient population

Patients included consecutive children under 18 years with an ED visit (including admissions through the ED) in the study states from January 1, 2012, through December 31, 2017. We created a chronologic patient-level dataset and used the first ED visit for each child during the study interval for the analysis, regardless of ED disposition (discharge, transfer, or admission) or survival (overall mortality: 0.05%). We included children transferred to another hospital, provided there was a matched record from the second facility. We selected the study period to coincide with the 2013 national ED pediatric readiness assessment and assumed that ED pediatric readiness remained constant over the 6-year period. We excluded children who were missing data on sex or payer status and EDs without a matched 2013 NPRP assessment or seeing fewer than 10 children over 6 years (Figure S1). We divided the cohort into children with injury versus medical illness using ICD-9-CM and ICD-10-CM diagnosis codes to evaluate potential cost differences in children with different clinical conditions.

ED pediatric readiness

The primary exposure variable was ED pediatric readiness for the initial ED visit, measured using the weighted Pediatric Readiness Score (wPRS) from the 2013 NPRP assessment.[10] We matched the NPRP assessment to the index ED visit using hospital name, address, and zip code. The NPRP assessment was a national 55-question evaluation of US EDs taken by 4149 EDs (response rate: 82.7%) in all 50 states[10] based on national ED guidelines for children.[11] The assessment was completed by ED managers from January 1 through August 31, 2013.[10] The wPRS is a weighted score from 0 to 100 (with 100 representing EDs completely "ready" to care for children), created from specific questions in the NPRP assessment that has been used as a global measure of ED pediatric readiness.[10] The distribution of wPRS in the 9 states (median wPRS: 73; IQR: 59–87) was the same as the quartiles used to assess the survival benefit of ED pediatric readiness among hospitalized children.[5] The quartiles of ED pediatric readiness were as follows: quartile 1 (wPRS: 0–58), quartile 2 (wPRS: 59–72), quartile 3 (wPRS: 73–87), and quartile 4 (wPRS: 88–100).

Variables

We collected the following patient-level variables: demographics (age, sex, race, and ethnicity), health insurance status (private, public, self-pay, or other), complex chronic conditions,[12] severity of illness (the Severity Classification System[13]), mechanism and severity of injury (injured patients only), surgical procedures, interhospital transfer, and in-hospital mortality. To identify and define surgical procedures, we used ICD-9-CM and ICD-10-CM procedure codes and the Agency for Healthcare Research and Quality Clinical Classification System.[14] To generate a measure of injury severity for injured children, we used ICD ISS Map v2.0 (Association for the Advancement of Automotive Medicine, Chicago, IL) to convert ICD-9-CM and ICD-10-CM diagnosis codes into the Injury Severity Score (ISS).[15,16] We have validated the ISS generated from ICD diagnosis codes against hand-abstracted ISS values.[17] For analyses focused on admitted children, we included children admitted from the ED, transferred from the ED for admission at another hospital, or who died in the ED (ie, children who would have been admitted had they survived), as defined in a study of hospitalized children.[5]

We also included ED and hospital characteristics associated with ED pediatric readiness and cost (ie, hospital-level confounders), as generated from the patient sample, NPRP

Table 1. Characteristics of children presenting to 747 emergency departments in 9 states.

	Values
Diagnosis category	
Injury	4 183 292 (27.6%)
Medical illness	10 955 307 (72.4%)
Age, median (IQR), y	6.0 (2.0–12.0)
Female	7 230 324 (47.8%)
Race	
White	7 139 918 (47.2%)
Black	3 026 476 (20.0%)
Other	2 716 324 (17.9%)
Unknown	2 255 881 (14.9%)
Hispanic	3 246 872 (21.4%)
Complex chronic conditions	
0	14 867 791 (98.2%)
1+	270 808 (1.8%)
Insurance type	
Private	5 725 252 (37.8%)
Public	7 939 795 (52.4%)
Self-pay	1 174 047 (7.8%)
Other	299 505 (2.0%)
Injury Severity Score (injured children only)	
0–8	4 145 862 (99.1%)
9+	37 430 (0.9%)
Clinical Severity Index	
1–2 (minor)	5 728 543 (37.8%)
3 (moderate)	7 171 664 (47.4%)
4–5 (severe)	1 222 862 (8.1%)
Unknown	1 015 530 (6.7%)
wPRS	
Quartile 1: 0–58	1 970 795 (13.0%)
Quartile 2: 59–72	2 491 253 (16.5%)
Quartile 3: 73–87	3 445 602 (22.8%)
Quartile 4: 88–100	7 230 949 (47.8%)
Type of hospital	
Children's hospital	1 810 246 (12.0%)
Academic teaching hospitals	6 634 464 (43.8%)
Nonacademic, level II trauma centers	380 659 (2.5%)
Non-university, but academic-affiliated	754 493 (5.0%)
Nonacademic community and private hospitals	5 558 737 (36.7%)
Admission	555 823 (3.7%)
Any operative procedure	278 348 (1.8%)
Mortality	7125 (0.047%)
ED deaths	5353 (0.035%)
Inpatient deaths	1772 (0.012%)
Unadjusted costs	
Total cost: Median (IQR)	$608 ($354–$914)
Total cost: Mean (SD)	$1155 ($5638)
Mean cost for injured children by wPRS	
Mean cost wPRS quartile 1 (SD)	$931 (2760)
Mean cost wPRS quartile 2 (SD)	$943 (2835)
Mean cost wPRS quartile 3 (SD)	$859 (2993)
Mean cost wPRS quartile 4 (SD)	$1272 (7787)
Mean cost for injured children admitted through the ED by wPRS (n = 60 840)[a]	
Mean cost wPRS quartile 1 (SD)	$15 128 (30 150)
Mean cost wPRS quartile 2 (SD)	$12 334 (18 538)
Mean cost wPRS quartile 3 (SD)	$10 760 (32 528)
Mean cost wPRS quartile 4 (SD)	$18 063 (45 842)
Mean cost for medical children by wPRS	
Mean cost wPRS quartile 1 (SD)	$976 (2570)
Mean cost wPRS quartile 2 (SD)	$920 (2363)
Mean cost wPRS quartile 3 (SD)	$965 (3240)
Mean cost wPRS quartile 4 (SD)	$1431 (7522)
Mean cost for medical children admitted through the ED by wPRS (n = 500 336)[a]	
Mean cost wPRS quartile 1	$8380 (12 958)
Mean cost wPRS quartile 2	$7098 (8868)
Mean cost wPRS quartile 3	$7483 (16 403)
Mean cost wPRS quartile 4	$10 987 (27 402)

Data are presented as n (%) unless otherwise indicated; n = 15 138 599.
Abbreviations: ED, emergency department; wPRS, weighted Pediatric Readiness Score.
[a]Admissions included children admitted from the ED, transferred to another ED for admission, and those who died in the ED (ie, children who would have been admitted had they survived), as previously defined.[5]

assessment, and American Hospital Association hospital survey.[18] We classified hospitals into 5 types: (1) children's hospitals; (2) academic teaching hospitals, including level I trauma centers; (3) non-university hospitals affiliated with an academic hospital; (4) level II trauma centers without an academic affiliation; and (5) nonacademic community and private hospitals. These categories reflect differences in pediatric inpatient resources, specialty services, and expertise at each hospital. Additional hospital variables included annual ED pediatric volume and pediatric admission volume through the ED.

Outcomes

The primary outcome was the cost of delivering acute health care, including facility and professional costs for emergency and inpatient services. We considered ED pediatric readiness as an exposure that affects the entire episode of acute care by reducing the likelihood of early death,[2,3,5] with the inclusion of ED and inpatient costs. This strategy allowed for a comprehensive evaluation of the patient costs associated with ED pediatric readiness. We converted facility charges (as available in ED and inpatient records) to costs using hospital- and year-specific cost-to-charge ratios.[19,20] For admitted patients, ED charges were bundled into the facility charges. Because the data sources did not include professional fees,[21] we used adjusted professional fee ratios from the Truven Health MarketScan database for ED visits and admissions, matched by admission status and payer source.[22] We focused on the costs of acute care at the initial hospital to align with measurement of ED pediatric readiness and because transfers were uncommon (0.22%). We did not evaluate costs beyond the acute care period (eg, postdischarge, outpatient visits, rehabilitation) or out-of-pocket expenses. Per recommendations,[23] we adjusted costs to the most recent year (2022 US dollars) using national data from the Bureau of Economic Analysis for personal consumption expenditures.[24]

For children missing cost information, we imputed per-unit costs based on the mean cost of acute care from observed values, matched on state, admission status (discharge vs admission from the ED), and clinical condition (injury vs acute medical illness). Costs were missing for 19.0% of the sample, ranging from 0% to 35.5% by state. Based on the variation and amount of missing cost data, we compared characteristics of children and hospitals with versus without cost data (Table S2) and conducted sensitivity analyses restricted to children with observed values for cost. Children with and without cost values were similar, except that children missing costs had higher proportions of missingness for race and ethnicity and

Table 2. Multivariable cost models for injured and medically ill children presenting to 747 emergency departments.

	Injured children (n = 4 183 292; 746 hospitals), coefficient (95% CI)	Medical children (n = 10 955 307; 747 hospitals), coefficient (95% CI)
ED Pediatric Readiness Score		
Quartile 1: 0–58	Reference	Reference
Quartile 2: 59–72	1.05 (0.97,1.13)	1.01 (0.94,1.09)
Quartile 3: 73–87	1.03 (0.96,1.10)	1.05 (0.98,1.13)
Quartile 4: 88–100	1.07 (0.99,1.16)	1.10 (1.02,1.19)
Age group		
0–4 y	Reference	Reference
5–12 y	1.19 (1.17,1.20)	0.99 (0.98,1.01)
13–15 y	1.40 (1.37,1.44)	1.23 (1.19,1.27)
16–17 y	1.52 (1.48,1.56)	1.30 (1.26,1.35)
Sex		
Male	Reference	Reference
Female	0.98 (0.98,0.99)	0.97 (0.97,0.98)
Race		
White	Reference	Reference
Black	0.95 (0.92,0.97)	0.88 (0.86,0.91)
Other	1.04 (1.00,1.07)	0.99 (0.95,1.04)
Unknown	0.99 (0.95,1.03)	0.99 (0.95,1.03)
Hispanic		
Non-Hispanic	Reference	Reference
Hispanic	0.97 (0.94,1.00)	0.93 (0.90,0.96)
Unknown	1.04 (1.00,1.08)	1.02 (0.98,1.06)
Insurance type		
Private	Reference	Reference
Public	1.04 (1.02,1.06)	0.94 (0.93,0.96)
Self-pay	0.99 (0.97,1.01)	0.83 (0.81,0.85)
Other	1.11 (1.06,1.17)	0.92 (0.87,0.98)
Complex chronic conditions		
0	Reference	Reference
1+	2.09 (1.84,2.37)	2.79 (2.49,3.13)
Injury Severity Score		
0–8	Reference	—
9+	5.60 (5.14,6.09)	—
Severity Classification System		
1–2 (lowest severity)	Reference	Reference
3	1.35 (1.33,1.38)	1.74 (1.69,1.79)
4–5 (highest severity)	2.91 (2.68,3.15)	5.45 (5.00,5.95)
Unknown	1.13 (1.10,1.15)	1.29 (1.26,1.32)
Mechanism of injury		
Fall	Reference	—
Gunshot, stab, penetrating injury	0.82 (0.80,0.84)	—
Bicycle/pedestrian	1.39 (1.34,1.43)	—
Motor vehicle	1.28 (1.22,1.35)	—
Other	0.90 (0.88,0.91)	—
Unknown	0.99 (0.96,1.01)	—
Type of hospital		
Community and private	Reference	Reference
Non-university, academic-affiliated	1.06 (0.93,1.21)	0.97 (0.84,1.12)
Nonacademic level II trauma centers	1.01 (0.87,1.19)	1.09 (0.82,1.44)
Academic teaching hospitals + level I	1.05 (0.98,1.12)	1.01 (0.94,1.09)
Children's hospitals	1.48 (1.29,1.70)	1.14 (0.99,1.32)
Annual pediatric ED volume, quartile		
1–1767 patients/y	Reference	Reference
1768–4220 patients/y	0.76 (0.68,0.86)	0.77 (0.70,0.85)
4221–8552 patients/y	0.66 (0.58,0.74)	0.68 (0.61,0.76)
≥8553 patients/y	0.64 (0.55,0.75)	0.66 (0.58,0.76)
Annual pediatric admissions through the ED, quartile		
0–9 patients/y	Reference	Reference
10–46 patients/y	0.96 (0.87,1.05)	0.97 (0.88,1.06)
47–317 patients/y	0.96 (0.87,1.05)	1.01 (0.92,1.11)
≥318 patients/y	1.09 (0.97,1.22)	1.26 (1.12,1.41)

The models also included state and year as fixed effects (not shown above). There were 747 EDs that provided care to medical children and 746 EDs for injured children. Abbreviation: ED, emergency department.

were overrepresented in private and community hospitals (Table S2).

Statistical analysis

We used descriptive statistics to characterize the sample by quartile of ED pediatric readiness. To estimate the average adjusted per-patient cost of acute care across levels of ED pediatric readiness, we used a multivariable generalized linear model with a gamma distribution and log link function to account for the right-skewed distribution of costs[25–27] (Stata 17.0; StataCorp, College Station, TX). The unit of analysis was the patient, with separate models for children with injury versus medical conditions. All variables used in the risk-adjustment models were present on presentation to the ED. The injury model was based on a standardized risk-adjustment model for trauma,[3,28] including age, sex, race and ethnicity (as captured in the electronic medical record), health insurance payor (a proxy for socioeconomic status), comorbidities,[12] Severity Classification System (ranging from 1 to 5, with 5 being the most severe),[13] mechanism of injury, severity of injury (ISS), ED and hospital characteristics, state, and year of ED visit. The medical model included the same variables, except for injury mechanism and injury severity. We evaluated ED pediatric readiness by quartile of wPRS using the lowest quartile as the reference group.

We used the marginal effect at the mean for the full sample of children to calculate the mean adjusted per-patient acute care cost for each quartile of ED pediatric readiness, with clustering of standard errors at the hospital level.[29] When estimating costs by hospital type and examples of high-acuity pediatric patients, we predicted costs within each of the subpopulations. We created examples of patients with high clinical acuity using the available predictors to evaluate costs for children requiring more resources and with a higher probability of admission. We calculated differences in costs and 95% CIs using transformed standard error estimates for the mean adjusted costs. Due to the size of the dataset, we used the missing indicator method (creating a category for missing values) to handle categorical variables with missing values in the multivariable models. We calculated the variance inflation factor (VIF) for all variables across quartiles of ED pediatric readiness, with a threshold VIF of 10.[30] To compare models, we used the Akaike information criterion (AIC) and Bayesian information criterion (BIC).

Results

There were 15 138 599 children in the cohort, including 4 183 292 (27.6%) with injury and 10 955 307 (72.4%) with acute medical illness. A total of 7125 (0.05%) children died, including ED and inpatient deaths. The median age was 6 years (IQR: 2–12 years) and 7 230 324 (47.8%) were female. There were 1 222 862 (8.1%) children with high clinical severity (Severity Classification System score 4–5) and 555 823 (3.7%) were admitted. A total of 7 230 949 (47.8%) children received emergency services in high-readiness EDs (quartile 4). Most children (88.0%) were cared for in non–children's hospitals. Patient characteristics and costs are detailed in Table 1. Hospital characteristics by quartile of ED pediatric readiness are listed in Table S3.

The median and mean per-patient costs (unadjusted) of acute care for all children in the sample were $608 (IQR: $354–$914) and $1155 (SD: $5638), respectively (Table 1). We also provide these values across quartiles of ED pediatric readiness for children with injury versus medical illness (Table 1). Among injured children, mean costs ranged from $931 to $1272. For medically ill children, mean costs ranged from $976 to $1431. The unadjusted mean cost for admitted children was $10 695. Mean costs for injured versus medical children admitted through the ED are also included in Table 1.

Results from the multivariable cost models are shown in Table 2. Older age, presence of comorbidities, higher acuity, and greater injury severity were patient factors associated with higher costs. Among hospital factors, children's hospitals (for injured children), low ED volume, and a high level of ED admissions (for medical patients) were associated with higher costs. After accounting for patient and hospital factors, the average adjusted per-patient cost of acute care across quartiles

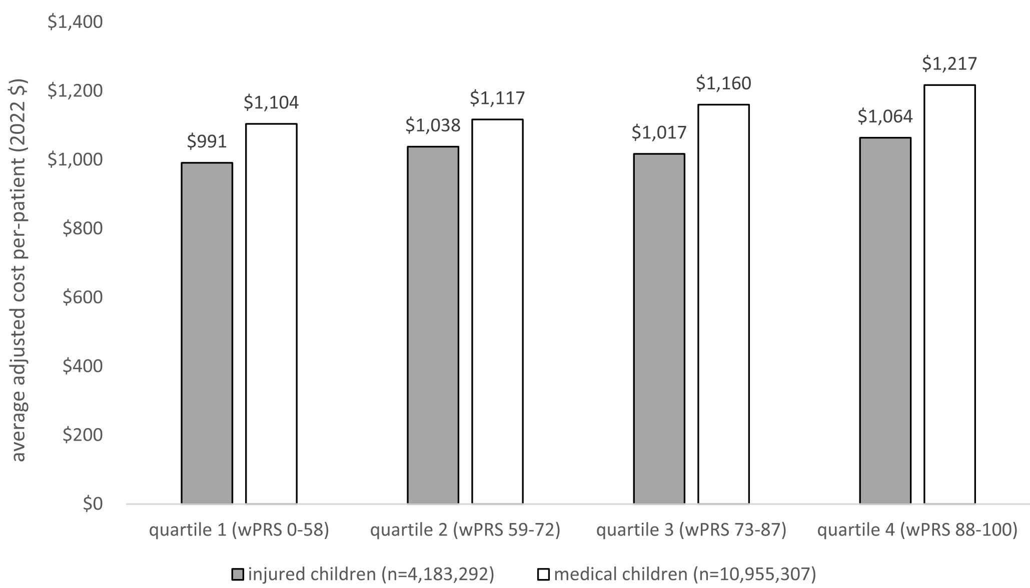

Figure 1. Average adjusted per-patient costs by quartile of emergency department pediatric readiness for injured (n = 4 183 292) and medically ill children (n = 10 955 307).

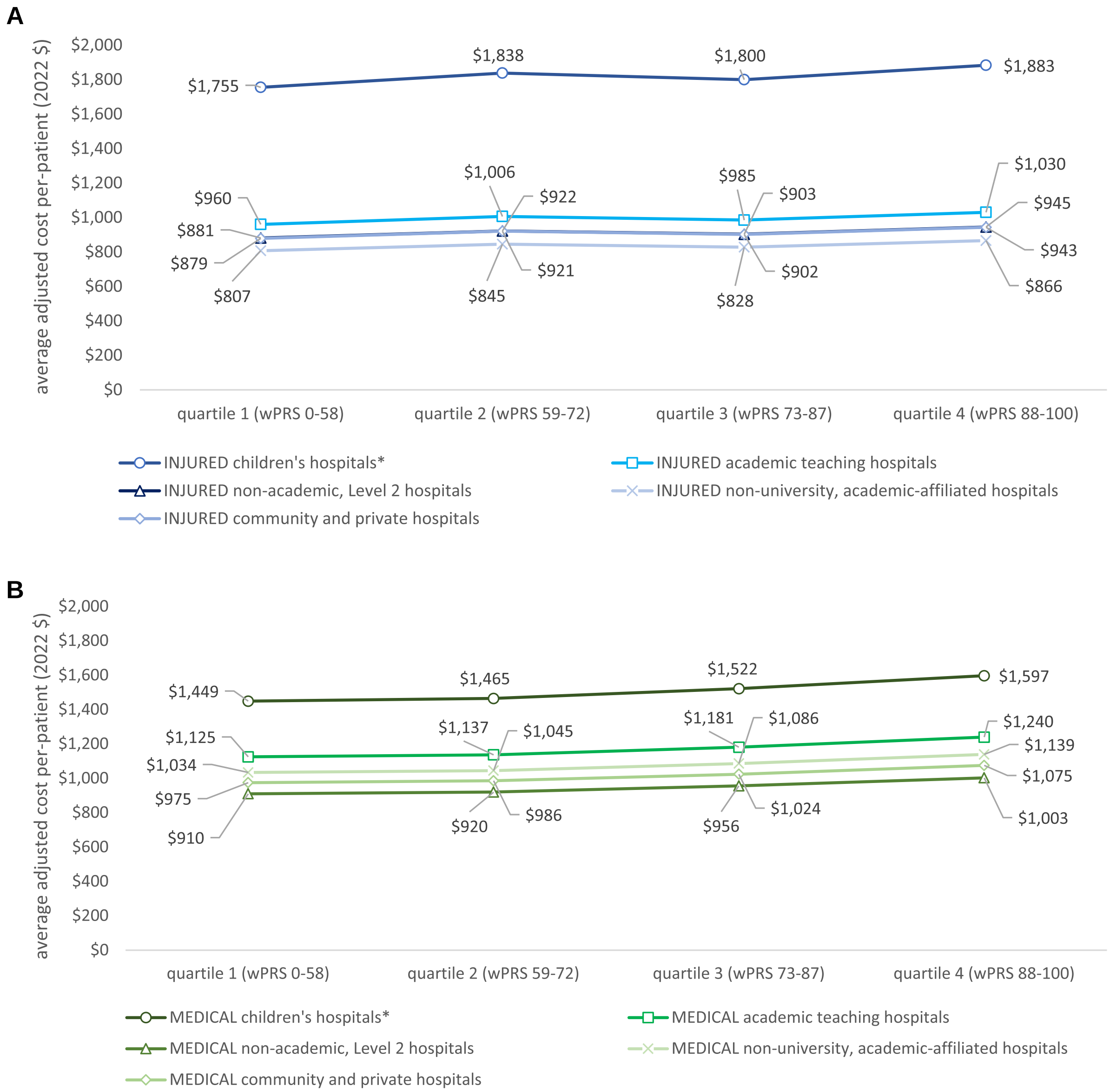

Figure 2. Average adjusted per-patient costs by quartile of emergency department pediatric readiness stratified by hospital type. A. Injured children (n = 4 183 292). B. Medically ill children (n = 10 955 307). *Children's hospitals provide inpatient pediatric services, pediatric critical care, specialty services, and resources unavailable at many other hospitals, all of which can increase hospital service costs. Abbreviation: wPRS, weighted Pediatric Readiness Score.

of ED pediatric readiness ranged from $991 to $1064 for injured children and from $1104 to $1217 for medical children (Figure 1). Differences in the adjusted cost of care (quartile 4 vs quartile 1 of ED pediatric readiness) were $72 (95% CI: −$6 to $151) for injured children and $113 (95% CI: $20–$206) for children with medical illness.

In Figure 2, we show the average adjusted costs for each quartile of ED pediatric readiness by hospital type. Children's hospitals had the highest adjusted cost of care. When compared within similar types of hospitals, differences in the average adjusted cost across levels of ED pediatric readiness (quartile 4 vs quartile 1) ranged from $59 to $128 for injured children and $93 to $148 for medically ill children.

We also estimated cost differences for hypothetical examples of high-acuity children receiving emergency services. For a child with moderate–severe injuries, adjusted costs ranged from $21 013 among low-readiness EDs (quartile 1) to $22 548 for high-readiness EDs (quartile 4), resulting in a difference of $1535. For a child with high-acuity medical illness, adjusted costs were $3729 among low-readiness EDs and $4111 among high-readiness EDs, yielding a cost difference of $382.

We conducted several sensitivity analyses. First, we truncated costs at the 99% percentile to test the influence of high outlier values, which showed cost differences (quartile 4 vs quartile 1 of ED pediatric readiness) of $46 for injured children and $86 for medical children. Next, we excluded the 3 states with greater than 20% missing values for cost, which yielded adjusted cost differences (quartile 4 vs quartile 1) of $18 for injured children and −$11 for medical children. Models restricted to children with nonmissing costs demonstrated cost differences (ED readiness quartile 4 vs quartile 1) of $78 for the injury cohort and $134 for the medical cohort. To evaluate the potential impact of interfacility transfers, we imputed total costs for children transferred from the ED with values equal to twice the median admission cost, matched on levels of ED readiness. This model demonstrated cost differences (quartile 4 vs quartile 1) of $72 for injured children and $113 for medically ill children. To test the impact of hospital type on the costs of ED pediatric readiness, we tested an interaction term, which showed effect modification in the injury cohort ($P < .001$) and medical cohort ($P < .001$). Models including the interaction term yielded similar cost estimates to the primary models for ED readiness quartiles 2 to 4 but were unable to estimate costs for quartile 1 and model fit was not improved. For these reasons, we did not include the interaction term in the primary models. Finally, we analyzed costs after excluding all hospital-level variables from the models, which yielded cost differences (quartile 4 vs quartile 1 of ED pediatric readiness) of $155 (95% CI: $73–$236) for injured children and $220 (95% CI: $129–$310) for medical children (Table S4).

Discussion

Among children receiving emergency services in 9 states, there were modestly increased adjusted costs of acute care among EDs in the highest versus lowest quartiles of pediatric readiness. Costs differed by hospital type, but within the same types of hospitals, cost differences were similar to those from the overall sample. These findings suggest that receiving care in high-readiness EDs is not associated with marked increases in the cost of delivering emergency care. However, the 95% CIs around the cost estimates and the steps required to calculate costs in a broad sample of children receiving emergency services create the possibility of larger cost differences across levels of ED readiness. Our results also provide adjusted cost values for the emergency care of children, which add substantially to the pediatric cost literature.

There are several potential reasons for the modest increase in costs at high-readiness EDs and notably higher costs at children's hospitals. High-readiness EDs and children's hospitals may treat more complex and higher-acuity children, aspects that may not have been fully accounted for in the risk-adjustment models. Such differences in acuity, plus improved survival at high-readiness EDs, would be expected to result in higher admission rates, resulting in higher costs. Children's hospitals are distinct from other types of hospitals because they provide inpatient pediatric services, pediatric critical care, specialty services, and resources unavailable at many other hospitals, all of which are expected to increase baseline costs (whether or not these services are used). Children's hospitals also frequently receive transfers from other hospitals, which can increase costs. Because detailed information on the more granular aspects of hospital services (eg, inpatient pediatric units, pediatric critical care, specialty services, etc) was not available for individual hospitals, this information is represented in the cost models through hospital type and admission volume, which also helps explain the findings in children's hospitals.

To date, there have been few studies quantifying the cost of emergency services for children. Estimates for the average cost of an ED visit for children range from $335 (National Emergency Department Sample)[6] to $1107 (Medical Expenditure Panel Survey [MEPS]),[7] after inflation-adjustment to 2022 dollars. The average unadjusted cost of an ED visit for children in our sample ($1155) was slightly higher than the MEPS estimate. When costs are compared for children admitted through the ED, the national estimate is $13 065 (Kids Inpatient Database,[8] adjusted to 2022 dollars), compared to $10 695 in our sample. Cost estimates may differ across studies and sites due to different data sources, whether professional fees were included, how ED samples were defined (eg, whether inpatient costs for children admitted through the ED were included), inclusion versus exclusion of children who died, use of different cost-to-charge ratios, and how missing costs were handled. Our estimates add to this literature using a large sample of children with a range of clinical conditions across a variety of EDs in the United States.

In the context of studies demonstrating a consistent association between high ED pediatric readiness and improved survival,[2–5] our results suggest that the additional cost of delivering care in high- versus low-readiness EDs is modest. However, a formal cost-effectiveness analysis is needed to assess the "value" (balance of incremental health gains relative to incremental costs) of ED pediatric readiness. If ED pediatric readiness were to be tied to reimbursement through a value-based model (as has been used by the Centers for Medicare and Medicaid Services) to incentivize hospitals to raise their level of ED pediatric readiness, our results suggest that the additional cost of delivering services would be modest. This type of incentive model to encourage EDs to raise their level of ED pediatric readiness could prove effective, as over 60% of children receiving emergency services have public insurance.[31] The additional costs of providing high-readiness emergency services are likely to be shared by hospitals and insurers. However, the increased cost of delivering care may offer indirect financial benefits to hospitals through improved reputation, increases in pediatric volume and complexity, plus reimbursement for inpatient services among children who survive due to effective emergency care. Additional considerations are the hospital costs of reaching and maintaining a high level of ED pediatric readiness, which must be quantified in future research.

Our study has several limitations. While the cohort included a variety of hospitals and ED practice settings in 9 states, it is possible that the inclusion of additional states could have changed our findings. We used administrative data to capture consecutive ED visits, which provided a robust sample of children to generate acute care costs. However, administrative data sources only include facility charges, which require the use of cost-to-charge ratios, professional fee ratios, and deflation adjustment to generate costs. Each of these steps has the potential for error. As an example, cost-to-charge ratios have been shown to vary across different service lines and diagnoses,[32,33] which can change the calculation of costs. Because the provision of emergency services involves many different service lines and diagnoses, we do not expect that the use of hospital-wide cost-to-charge ratios was a source of systematic bias in the study. However, hospital-wide cost-to-charge ratios can contribute to imprecision in estimating true costs, even if more refined approaches may yield the same conclusion.[32] In addition, certain states had notable proportions of missing data for cost, necessitating imputation methods that could have also biased our results. We opted to preserve the sample to minimize selection bias rather than excluding children missing cost data. Sensitivity analyses restricted to patients with observed costs were similar to the primary results.

We created a risk-adjustment cost model based on a similar model for trauma[28] that has been modified for children using emergency services,[3–5] including hospital-level characteristics.

Our adjusted cost estimates reflect attention to many potential confounders and factors impacting costs, but unmeasured confounding could have influenced our findings. Finally, the ED pediatric readiness data were measured in 2013 and may have changed over time. The NPRP assessment of ED pediatric readiness was repeated in 2021[34] and preliminary analyses suggest that there were not major shifts in the readiness of individual EDs.

In summary, high ED pediatric readiness was associated with a modest increase in the cost of delivering emergency services. These findings suggest that health care costs should not be a barrier to hospitals raising their level of ED pediatric readiness and being fully prepared to care for children.

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Supplementary material

Supplementary material is available at *Health Affairs Scholar* online.

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Conflicts of interest

Please see ICMJE form(s) for author conflicts of interest. These have been provided as supplementary materials.

Notes

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