Length of Stay and Cost of Pediatric Readmissions

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abstract

BACKGROUND AND OBJECTIVES: Readmissions burden the health care system. Despite increasing attention to readmission rates, little is known about the duration and cost of readmissions. The objective of this study was to assess, nationally, the length of stay (LOS) and costs for 30-day readmissions in children.

METHODS: We performed a retrospective analysis of 30-day readmissions by using the 2013 Nationwide Readmissions Database. We used generalized linear mixed effects models adjusted for important clinical and demographic factors to assess LOS and cost for index admissions, readmissions, and the episode of care (index admission plus readmission).

RESULTS: A total of 125 183 (4.5%) children had a 30-day readmission; 87.1% of readmissions were to the same hospital. Readmitted children had an adjusted episode LOS that was 2 times longer (5.8 vs 2.9 days) and total costs that were 2.3 times higher ($12 250 vs $5340) than those who were not readmitted. Associations of readmissions with episode LOS and costs varied significantly by condition ($P < .001$). Children readmitted to a different versus the same hospital had an episode LOS that was the same (5.8 days; $P = .279$) but higher episode of care costs ($15 876 vs $11 661; $P < .001$).

CONCLUSIONS: Readmitted children spend twice as many days in the hospital compared with children who are not readmitted and have higher hospital costs, especially when readmitted to a different hospital. In addition to readmission rate, readmission metrics may benefit from measurement of total LOS and costs for both the index admission and its associated readmission.

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WHAT'S KNOWN ON THIS SUBJECT: Despite the low rate of readmissions in children, readmission metrics are being adopted to adjust reimbursement payments. Although attention has been given to readmission rates in children, little is known about the length of stay (LOS) and cost of readmissions.

WHAT THIS STUDY ADDS: Readmissions are associated with episode LOS and costs that are approximately double those of index admissions without readmission. Readmission metrics that incorporate episode LOS may provide a better estimate of resource use than readmission rate alone.

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Readmissions burden the health care system with increased resource use and health care costs.[1,2] Although readmission rates are as high as 20% for adult Medicare beneficiaries,[1] among children, readmission rates are low, with ~6.5% of hospitalized children experiencing an unplanned readmission at an acute care children's hospital within 30 days.[3] Despite the relatively low rate of pediatric readmissions, efforts are underway to adopt readmission metrics that penalize hospitals financially for excess pediatric readmissions, with the aim of advancing hospital quality and controlling costs.[4–7] Beyond their financial impact, readmissions may extend a patient's total inpatient days for a given episode of care (ie, the number of days a patient spends in the hospital for their combined index admission and readmission). Consequently, readmissions may further increase the psychosocial burdens, financial distress, and overall life disruption for pediatric patients and their families.[8–11]

Current readmission metrics do not account for the impact of the total number of days spent in the hospital but rather focus on measuring readmissions rates.[4–7] Although the authors of many studies have examined the relationship between index admission length of stay (LOS) and readmission rates,[12] few authors have examined the LOS and costs of readmissions.[13–15] In a study of adults hospitalized with heart failure, no correlation was found between index LOS or readmission rate and 30-day survival; however, total hospital days during a 30-day episode of care was associated with improved survival.[14] Despite a possible benefit for use of this metric in adults, little is known about the total number of hospital days and hospital costs for children with a readmission.

Among children, ~14% of readmissions occur at a hospital different from that of the index admission.[16] For adult patients, when readmissions are fragmented across multiple hospitals, the readmission LOS increases, whereas efficient, cost-effective care decreases.[15,17] Likewise, data from health systems reveal that fragmentation of care for adults with chronic conditions results in increased health care costs, worsened outcomes (eg, increases in mortality), and longer intervals between health maintenance visits.[17,18] Although readmissions to different hospitals are associated with longer total LOS among adults, relatively little is known about the effect of fragmentation of care on overall LOS for hospitalized children.[15,16] Therefore, our objectives in this study were (1) to assess, nationally, the LOS and cost for 30-day readmissions in children; (2) to compare the LOS and cost between index admissions, readmissions, and for the episode of care (ie, combined index admission and readmission); and (3) to describe the impact on LOS and cost when a readmission occurs to the same versus a different hospital from that of the index admission.

METHODS

Study Design and Data Source

We performed a retrospective cohort analysis by using the 2013 Agency for Healthcare Research and Quality (AHRQ) Nationwide Readmissions Database (NRD). The NRD is an administrative database that contains information on inpatient stays from January 1, 2013, to December 31, 2013, for all payers and allows for weighted national estimates of readmissions for all US individuals. Data within the NRD are aggregated from 21 geographically diverse states representing 49% of the US population. The NRD contains deidentified patient-level data with unique verified patient identifiers to track individuals within and across hospitals in a state.

Study Population

Children 0 to 18 years of age with an index admission between January 1, 2013, and November 30, 2013, were included. We chose an end date of November 30, 2013, to allow for a full 30-day readmission window for all index admissions. We excluded index admissions for normal newborns on the basis of the Medicare Severity Diagnosis Related Group, transfers to another acute care hospital, mortalities, and patients who left the hospital against medical advice.

Index Admissions

All-condition (ie, admission for any reason) and condition-specific (ie, admission for a specific disease) index admissions were assessed across patient age groups (infant from birth to <1, 1–4, 5–9, 10–14, and 15–18 years). Condition-specific index admissions were identified on the basis of All Patient–Refined Diagnosis Related Groups (3M Health Information System, Wallingford, CT). The most prevalent condition-specific index admissions were assessed for each age group.

Hospital Readmissions

A readmission was defined as an admission within 30 days after a preceding discharge. Only readmissions within the same major diagnostic category (MDC) as the index admission were included; 20 584 readmissions for a different MDC were excluded. MDCs represent 25 diagnostic categories (mostly organized by organ system) assigned from the *International Classification of Diseases, Ninth Revision, Clinical Modification* diagnosis and procedure codes. Any-hospital readmission was defined as a readmission to any hospital during the study period. Same-hospital readmission was defined as a readmission to the same hospital from which the patient was discharged during the index hospitalization. Different-hospital readmission was defined

as a readmission to a hospital different from the 1 from which the patient was discharged during the index hospitalization. Readmission prevalence (eg, number) and rates were measured on the discharge level.

Main Outcome Measure

The main outcome measures were LOS and cost for index admissions, for readmissions, and for the episode of care (ie, combined index admission and readmission). Costs in the NRD are estimated from hospital-level charges by using hospital-specific and year-specific cost-to-charge ratios that are available through AHRQ.

Patient and Hospital Characteristics

Patient Demographic Characteristics

Patient demographic characteristics included age, sex, and payer (government, private, or other); the location of the patient's home residence defined by using the Urban-Rural Classification Scheme for Counties (National Center for Health Statistics, 2013)[19] and categorized into large metropolitan, small metropolitan, micropolitan, or other (not metropolitan or micropolitan); and the discharge disposition (home, post–acute care, home with home nursing services, or unknown).

Patient Clinical Characteristics

Patient clinical characteristics included the type and number of chronic conditions as well as the severity of the illness. Chronic conditions were identified in the NRD by using the AHRQ's Chronic Condition Indicator (CCI),[20] and the number of chronic conditions per patient were counted (0, 1, 2–3, or ≥4). CCIs define a chronic condition as any condition expected to last 12 months or longer and meeting 1 or both of the following criteria: (1) the condition places limitations on self-care, independent living, and social interactions, and (2) it results in the need for ongoing intervention with medical products, services, and special equipment.[20] The number and type of chronic conditions (ie, complex versus not) were distinguished in the NRD by using Feudtner's et al[21] complex chronic conditions (CCCs). CCCs are defined as medical conditions expected to last for at least 12 months that are severe enough to warrant involvement of multiple subspecialists and/or have a high probability of hospitalization. Severity of illness was defined by using the 3M Health System's All Patient–Refined Diagnosis Related Group weights.[22] In addition to CCIs and CCCs, we chose to examine severity of illness because of its association with LOS and cost.[23]

Hospital Characteristics

Hospital characteristics were defined by using NRD data elements and included hospital ownership (government, private not-for-profit, and private-investor owned); hospital location and teaching status (nonmetropolitan nonteaching, small metropolitan teaching, small-metropolitan nonteaching, large metropolitan teaching, or large metropolitan nonteaching), and bed size (small, medium, and large).

Statistical Analysis

Using weights to achieve national estimates of index admissions and readmissions, we summarized continuous variables with medians and interquartile ranges (IQRs) and categorical variables with frequencies and percentages. We used generalized linear mixed effects models with exponential distributions to assess the relationship between the outcomes and patients' demographic, clinical, and hospital characteristics. Each model was adjusted for the following fixed effects: age, sex, payer, number of CCCs, patient complexity (ie, presence of a CCC), index hospital, and severity of illness. All statistical analyses were performed by using SAS version 9.4 (SAS Institute, Inc, Cary, NC), and P values <.001 were considered statistically significant because of the large sample size. The Office of Research Integrity at Children's Mercy Hospital deemed this study exempt from institutional board review.

RESULTS

Study Population

The study included 2 752 407 index admissions and 125 183 thirty-day, all-condition readmissions, for an overall readmission rate of 4.5% (Table 1). Eighty-seven percent (n = 108 997) of readmissions were to the same hospital (Supplemental Table 2). The median age at index admission was 1 year (IQR: 0–12 years); 50.7% of index admissions were for male patients; 53.7% were associated with public insurance; and 83.0% were for patients residing in a metropolitan area. Nearly 53% of children overall had a chronic condition (of any complexity); 22.7% of children had at least 1 CCC. Approximately 76% of index admissions were at private, not-for-profit hospitals, with 67.7% of index admissions occurring at teaching hospitals located in metropolitan areas. Index admissions associated with a hospital readmission had a longer unadjusted LOS (median: 3 [IQR: 2–5] vs 2 [IQR: 2–4] days; P < .001) and higher cost (median: $5248 [IQR: $2558–$10 996] vs $3426 [IQR: $1637–$7743]; P < .001) than those without a readmission.

Patient and Hospital Characteristics Associated With 30-Day Hospital Readmission

Infants <1 year of age accounted for the largest percentage (47.9%) of index admissions across all age categories, and these infants accounted for the second highest percentage (24.0%) of total readmissions (Table 1). However, the readmission rate was higher for

TABLE 1 Characteristics of the Study Population

	Index Admissions,[a] *N* (%)	Index Admissions Without a Readmission,[a] *N* (%)	Index Admissions With a Readmission,[a] *N* (%)
Index admissions	2 752 407 (100.0)	2 627 223 (95.5)	125 183 (4.5)
Patient demographics and clinical characteristics			
Age at admission, y			
0	1 319 645 (47.9)	1 289 662 (49.1)	29 982 (24.0)
1–4	333 977 (12.1)	315 265 (12.0)	18 712 (14.9)
5–9	259 197 (9.4)	242 898 (9.2)	16 299 (13.0)
10–14	307 195 (11.2)	281 781 (10.7)	25 414 (20.3)
15–18	532 393 (19.3)	497 617 (18.9)	34 776 (27.8)
Sex			
Male	1 396 462 (50.7)	1 332 332 (50.7)	64 129 (51.2)
Payer			
Government	1 478 849 (53.7)	1 411 725 (53.7)	67 124 (53.6)
Private	1 102 728 (40.1)	1 051 723 (40.0)	51 004 (40.7)
Other	170 830 (6.2)	163 776 (6.2)	7054 (5.6)
Location of patient's home residence			
Large metropolitan counties	1 348 945 (49.1)	1 287 172 (49.1)	61 773 (49.5)
Small metropolitan counties	930 008 (33.9)	887 990 (33.9)	42 018 (33.7)
Micropolitan counties	284 241 (10.4)	271 854 (10.4)	12 386 (9.9)
Other	182 763 (6.7)	174 080 (6.6)	8683 (7.0)
Discharge disposition			
Routine	2 621 547 (95.3)	2 505 719 (95.4)	115 827 (92.5)
Postacute care	24 931 (0.9)	23 511 (0.9)	1420 (1.1)
Home health	103 688 (3.8)	95 762 (3.6)	7926 (6.3)
Unknown	1375 (0)	1375 (0.1)	—
Chronic conditions of any complexity (CCIs)[b]			
0	1 315 368 (47.8)	1 289 286 (49.1)	26 082 (20.8)
1	706 166 (25.7)	683 510 (26.0)	22 656 (18.1)
2–3	485 501 (17.6)	438 512 (16.7)	46 989 (37.5)
≥4	245 371 (8.9)	215 914 (8.2)	29 457 (23.5)
CCCs[c]			
0	2 126 608 (77.3)	2 070 171 (78.8)	56 438 (45.1)
1	426 389 (15.5)	381 745 (14.5)	44 644 (35.7)
≥2	199 410 (7.2)	175 308 (6.7)	24 102 (19.3)
Severity of illness[d]	0.5 (0.4–0.9)	0.5 (0.4–0.9)	0.8 (0.5–1.1)
Hospital characteristics			
Hospital type			
Government, nonfederal	394 231 (14.3)	374 841 (14.3)	19 390 (15.5)
Private, not for profit	2 084 036 (75.7)	1 986 965 (75.6)	97 071 (77.5)
Private, investor owned	274 139 (10.0)	265 417 (10.1)	8723 (7.0)
Hospital location and teaching status			
Large metropolitan, teaching	1 111 343 (40.4)	1 049 571 (39.9)	61 773 (49.3)
Large metropolitan, nonteaching	370 171 (13.4)	358 047 (13.6)	12 123 (9.7)
Small metropolitan, teaching	752 434 (27.3)	714 768 (27.2)	37 666 (30.1)
Small metropolitan, nonteaching	301 881 (11.0)	293 623 (11.2)	8258 (6.6)
Nonmetropolitan	216 577 (7.9)	211 214 (8.0)	5363 (4.3)
Bed size			
Small	258 486 (9.4)	245 621 (9.3)	12 865 (10.3)
Medium	643 682 (23.4)	615 331 (23.4)	28 351 (22.6)
Large	1 850 239 (67.2)	1 766 272 (67.2)	83 967 (67.1)

$P < .001$ is for all comparisons of index admissions with and without a readmission. —, not applicable.

[a] Individual categories of data may not add to the total number of index admissions because of the presence of missing or incomplete data.

[b] Chronic conditions were identified by using the AHRQ's CCI. CCIs define a chronic condition as any condition expected to last 12 mo or longer and meeting 1 or both of the following criteria: (1) the condition places limitations on self-care, independent living, and social interactions; and/or (2) it results in the need for ongoing intervention with medical products, services, and special equipment.

[c] CCCs were identified by using the classification scheme described by Feudtner et al[21] and are defined as medical conditions expected to last for at least 12 mo that are severe enough to warrant the involvement of multiple subspecialists and/or have a high probability of hospitalization.

[d] Severity of illness data are presented as median (interquartile range).

adolescents versus infants (eg, 6.5% for children age 15–18 years versus 2.3% of infants <1 year; $P < .001$).

Most readmissions were for children with 1 or more chronic conditions (of any complexity) (79.2%) or children with 1 or more CCCs (54.9%). We observed statistically significant, but modest, differences in readmission

rates by subcategories of sex, payer, location of patient's home residence, discharge disposition, and severity of illness. Patient characteristics that were significantly associated (all $P < .001$) with increased readmission rates to a different hospital included age (ie, infants <1 year old), government insurance, absence of CCIs or CCCs, and a lower severity of illness (Supplemental Table 2).

Nearly 80% of index admissions with readmissions occurred at private, not-for-profit hospitals and metropolitan teaching hospitals (Table 1). Hospital characteristics that were associated with increased rates of return to a different hospital included the index admission occurring at a private, investor-owned hospital, a nonmetropolitan and/or nonteaching hospital, or a hospital with a small bed size (Supplemental Table 2).

Adjusted Hospital Resource Use of All-Condition Index Admissions With Versus Without Readmissions

In adjusted analyses, index admissions with versus without hospital readmission had similar LOS but lower mean costs ($5170 [95% confidence interval (CI): $4578–$5837] vs $5340 [95% CI: $4729–$6029]; $P < .001$; Fig 1). The adjusted mean LOS and cost for a readmission were 3.6 (95% CI: 3.5–3.6) days and $6328 (95% CI: $6184–$6475), respectively. The adjusted mean LOS and cost for the combined episode of care (including the index admission and readmission) were 5.8 (95% CI: 5.7–5.9) days and $12 250 (95% CI: $12 096–$12 407). When a readmission occurred, the adjusted mean LOS and cost for the combined episode of care were, respectively, 2.0 times longer and 2.3 times higher than the LOS and cost of index admissions without a readmission.

When children were readmitted to a different versus the same hospital, the adjusted mean LOS and costs for the index admission were similar. However, they were significantly greater for a different hospital versus the same hospital during the readmission (LOS 4.1 [95% CI: 4.0–4.3] vs 3.4 [95% CI: 3.3–3.4] days; $P < .001$; and cost ($8172 [95% CI: $7950–$8401] vs $5622 [95% CI: $5490–$5758]; $P < .001$). The adjusted mean LOS for the combined episode of care were the same, but costs were 36.1% higher (cost: $15 876 [95% CI: $14 048–$17 942] vs $11 661 [95% CI: $10 318–$13 178]; $P < .001$) when a readmission occurred to a different versus the same hospital.

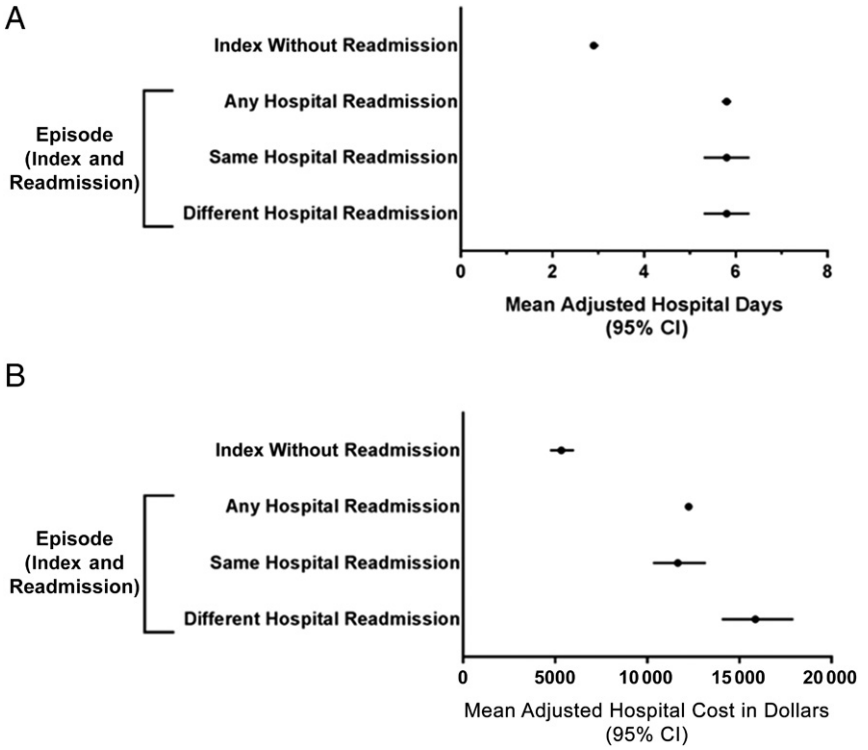

FIGURE 1

Adjusted hospital resource use of all-condition index admissions. A, Hospital use for hospital days (ie, LOS) are presented as the mean with 95% CIs for index admissions without readmissions and for the episode of care. B, Hospital use for cost are presented as the mean with 95% CIs for index admissions without readmissions and for the episode of care. Data are adjusted for age, sex, payer, number of CCCs, patient complexity (ie, presence of a CCC), index hospital, and severity of illness.

Adjusted Hospital Resource Use of Condition-Specific Index Admissions With Versus Without Readmissions

The degree to which readmissions impacted episode LOS and cost varied significantly ($P < .001$) on the basis of the condition (Fig 2; Supplemental Tables 3 and 4). The largest differences in episode LOS for index admissions with versus without a readmission were observed for fever (rate ratio: 2.7 [95% CI: 2.3–3.2] for infants <1 year old), nonbacterial gastroenteritis (3.0 [95% CI: 2.7–3.3] for 1- to 9-year-old children), seizures (2.8 [95% CI: 2.7–3.0] for 1- to 9-year-old children), and appendectomy (2.9 [95% CI: 2.7–3.2] for 10- to 18-year-old children). Similar findings were observed for hospital cost.

DISCUSSION

Within this large, national cohort of pediatric hospitalizations, we found that readmissions nearly doubled the hospital cost as well as the number of days that children spent in the hospital for a given episode of care. Readmissions to a different versus the same hospital as the index admission were

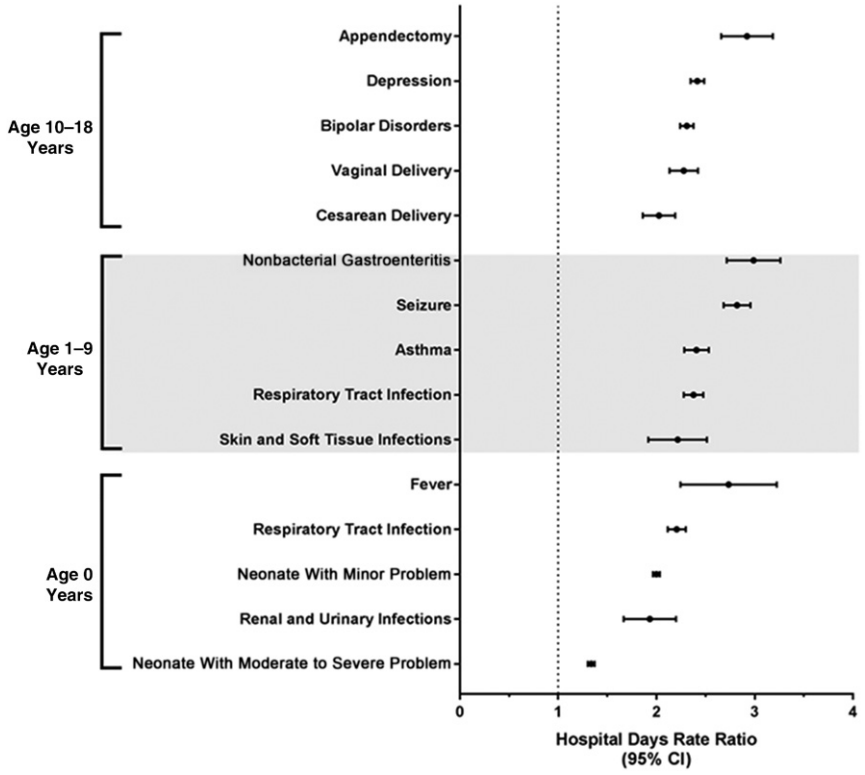

FIGURE 2

Adjusted hospital resource use of condition-specific index admissions with versus without a readmission. Conditions with the greatest differences in episode LOS are presented. Data are presented as rate ratios with 95% CIs of LOS for index admissions with readmissions relative to LOS of index admissions without a readmission. Data are adjusted for age, sex, payer, number of CCCs, patient complexity (ie, presence of a CCC), index hospital, and severity of illness.

associated with higher episode costs but similar episode LOS. The total episode LOS and cost also varied substantially according to the reason for admission. For instance, among infants admitted for fever, those who experienced a readmission had a particularly long episode LOS. These findings may help contextualize pediatric hospital resource use associated with readmissions, beyond reporting the readmission rate alone.

Our finding that readmissions double the amount of time that children spend in the hospital across all conditions is congruent with those of previous studies of readmissions after condition-specific index admissions. For example, readmissions after index admissions for congestive heart failure and appendectomy doubled the total number of days that patients spent in the hospital.[13,14] With a median of nearly 1 week spent in the hospital, pediatric index admissions and readmissions combined could potentially lead to significant life interruptions and may compound the stressors that patients and families experience with unplanned hospitalizations. Because readmission LOS was, on average, comparable with the index admission LOS, our findings may help providers to estimate the readmission LOS at the time of a return, thus permitting patients and families to make plans (eg, regarding work, school, and child care) to address their life situation.

The readmission duration in the current study may also help interpret the population-based impact of readmission rates on hospital resource use for children. We found that LOS was similar for pediatric index admissions and readmissions. With a 30-day readmission rate of 4.5% and an average index LOS of 3.0 days, the overall impact of combining index admission and readmission bed days (ie, episode LOS) would result in a population-based increase in LOS of 0.14 bed days (ie, a population-based average episode LOS of 3.14 days). The magnitude of this increase in LOS might help inform perceptions of how much or how little pediatric readmissions influence total hospital days at the population level.

Our findings of increased health care costs among children readmitted to a different hospital are similar to those of previous studies of same and different hospital readmissions among adults.[17,24] Within our study, ~12.9% of readmissions occurred at a different hospital. In an effort to reduce fragmentation of hospital care, if readmissions to a different hospital could be discouraged and reduced by 50% (eg, by increasing the number of children who present to the same hospital), this would represent a potential cost savings of nearly $28.4 million annually. Although a proportion of readmissions to a different hospital may be unavoidable, with these findings, we underscore how efforts aimed at incentivizing return to the discharging hospital may improve care coordination and lead to significant cost reductions in health care spending for readmissions over time. Notably, the current practice of penalizing individual hospitals for excess readmissions likely does the opposite.

Hospital location and teaching status were associated with differences in readmission rates in our study. These differences may in part be explained by the regionalization of pediatric subspecialist care (including intensive care services) predominantly within metropolitan areas as well as by a higher complexity and/or severity of illness

among those receiving care at metropolitan teaching hospitals.[25] Although difficult to achieve, improving access to pediatric subspecialist care through changes in the recruitment, training, and distribution of pediatric subspecialist providers across health systems may further incentivize patients to return to the discharging hospital.

We found that readmission duration for certain index admissions (including fever in infants, seizures and nonbacterial gastroenteritis in 1- to 9-year-old children, and appendectomy for acute appendicitis in 10- to 18-year-old children) was much greater than the duration of the index admission itself. Although the authors of previous studies have not observed a statistically significant association between shorter index admission LOS and risk of readmission,[12] perhaps further investigation of these acute illness–related index admissions may help determine if premature discharge related to misdiagnosis, inaccurate assessment of illness severity, or other modifiable factors contributed to the need for the readmission.

These findings should be interpreted in the context of several limitations. The findings are national estimates derived from state-level data within the NRD. The NRD cannot be used to measure readmissions to hospitals in a different state, which may lead to an underestimation of readmissions. The NRD is also not equipped to enable distinguishing patient deaths occurring after discharge, which would inherently eliminate the risk for readmission. Finally, the NRD does not contain information on patients' physiologic and functional status, race and/or ethnicity, family and/or social attributes, or postdischarge follow-up health services, which are known to influence the need for readmission.

CONCLUSIONS

Hospital readmissions in children nearly doubled the index hospitalization cost as well as the number of days that children spent in the hospital. Readmissions to a different versus the same hospital were associated with higher hospital costs. The total episode LOS and cost for the index hospitalization and readmission varied substantially by the reason for admission. These findings may help contextualize pediatric hospital resource use associated with readmissions beyond reporting the readmission rate alone.

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ABBREVIATIONS

AHRQ: Agency for Healthcare Research and Quality
CCC: complex chronic condition
CCI: Chronic Condition Indicator
CI: confidence interval
IQR: interquartile range
LOS: length of stay
MDC: major diagnostic category
NRD: Nationwide Readmissions Database

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