RESEARCH ARTICLE

Interfacility Transfers Among Patients With Complex Chronic Conditions

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ABSTRACT

OBJECTIVES: To describe interfacility transfers among children with complex chronic conditions (CCCs) and determine if interfacility transfer was associated with health outcomes. We hypothesized that interfacility transfer would be associated with length of stay (LOS), receipt of critical care services, and in-hospital mortality.

METHODS: In this retrospective cohort study, we used data from the 2012 Kids' Inpatient Database. CCC hospitalizations were identified by *International Classification of Diseases, Ninth Revision* codes. Receipt of critical care services was inferred by using *International Classification of Diseases, Ninth Revision* diagnosis and procedure codes. We performed a descriptive analysis of CCC hospitalizations then determined if transfer was associated with LOS, mortality, or receipt of critical care services using survey-adapted quasi-Poisson or logistic regression models, controlling for hospital and patient demographics.

RESULTS: There were 551 974 non–birth hospitalizations with at least 1 CCC diagnosis code. Of these, 13% involved an interfacility transfer. Compared with patients with CCCs who were not transferred, patients with CCCs who were transferred in and ultimately discharged from the receiving hospital had an adjusted LOS rate ratio of 1.6 (95% confidence interval [CI]: 1.5–1.7; $P < .001$), were more likely to have received critical care services (adjusted odds ratio 3.0; 95% CI: 2.7–3.2; $P < .001$), and had higher in-hospital mortality (adjusted odds ratio 3.6; 95% CI: 3.2–3.9; $P < .001$) (controlling for patient and hospital characteristics).

CONCLUSIONS: Many hospitalizations for children with CCCs involve interfacility transfer. Compared with in-house admissions, hospitalizations of patients who are transferred in and ultimately discharged from the receiving hospital involve longer LOS, greater odds of receipt of critical care services, and in-hospital mortality. Further evaluation of the role of clinical and transfer logistic factors is needed to improve outcomes.

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Pediatric patients are often transferred from 1 hospital to another to receive definitive inpatient care.[1] Recently, interfacility transfers for pediatric patients have increased significantly because of the regionalization of pediatric care as fewer hospitals are able to provide inpatient care to pediatric patients.[2] Interfacility transfers among children increased by 25% from 2006 to 2013 on the basis of data from multiple states, revealing that pediatric hospital care is increasingly dependent on regional referral centers.[2,3] Transitions in care are a particularly vulnerable period for patients. Episodes of transition are associated with increased risk of adverse events, such as medication errors and delays in treatment, often because of poor communication.[4–6] Transferring a patient between facilities only heightens this risk, particularly if the personnel and infrastructure to support pediatric patients are not present.[6,7]

Children with complex chronic conditions (CCCs) make up a large proportion of inpatient care and resource use.[8] They account for one-half of hospital days in children who are admitted and typically have a significantly longer length of stay (LOS) than children without CCCs.[9,10] Multiple entities on the federal, national, and state levels have identified children with CCCs as a priority population to improve care while reducing costs by optimizing medical homes, access to outpatient care, and reducing rehospitalizations.[9,11–14] Transfer patterns among patients with CCCs have not been thoroughly described despite the possibility that transfer may place these patients at higher risk because of potential delays in care and poor communication. Additionally, these patients may be more likely to be transfered because of their potential to require specialized centers for care that may not be local to their homes. Describing CCC transfer patterns and associated outcomes will inform efforts to improve the infrastructure to support interfacility transfers among children with CCCs.

The purpose for this study was to examine the characteristics and transfer patterns for hospitalizations involving children with CCCs. We described the frequency and demographics of pediatric hospitalizations among patients with at least 1 CCC who experienced interfacility transfer. We also evaluated the LOS, odds of receiving critical care services, and odds of in-hospital mortality associated with interfacility transfer among CCC hospitalizations. We hypothesized that a significant portion of CCC hospitalizations would involve an interfacility transfer and that hospitalized children with CCCs who were transferred would be more likely to have a longer LOS, receive critical care services, and experience in-hospital mortality.

METHODS

Data Source and Study Population

We performed a cross-sectional analysis of pediatric hospitalizations using the 2012 Healthcare Cost and Utilization Project Kids' Inpatient Database (KID), a nationally representative survey of pediatric discharge records (Fig 1). Hospitalizations were included if they had at least 1 *International Classification of Diseases, Ninth Revision* (ICD-9) code consistent with a CCC.[15] Children who were born during the hospitalization were not included in analyses because outcomes associated with the regionalization of neonatal care have been studied elsewhere, and conclusions from neonatal transfer data may not be applicable to all patients with CCCs.[16,17] Discharges with missing transfer information were excluded from the analysis. On the basis of KID definitions, CCC hospitalizations were classified as follows: (1) transferred in and out of the facility; (2) transferred in, with the hospitalization concluding with discharge or death (TAD); (3) not transferred in or out, with hospitalization concluding with discharge or death; and (4) not transferred in and transferred out.

Study Outcomes

The primary outcomes were LOS in days; receipt of critical care services, defined by the presence of at least 1 ICD-9 diagnosis or procedure code consistent with critical care services (on the basis of previous publications)[18,19] (Table 1); and in-hospital mortality.

Covariates

Patient and admission facility characteristics were procured from the KID. Patient characteristics included age, sex, race and/or ethnicity, household income, median household income national quartile for patient zip code of residence, expected primary payer, and number of CCCs. The hospitalization resource intensity scores for kids (H-RISKs), a measure of relative severity of illness for patients who are hospitalized that was developed using the KID, were calculated to estimate severity of disease for each hospitalization.[20] Admission facility characteristics included hospital bed size, rural or urban location, teaching status, and whether the hospital was a children's hospital. The KID defines children's hospitals on the basis of information provided by the Children's Hospital Association.[21]

Statistical Analysis

For the analysis, we followed Healthcare Cost and Utilization Project analytic recommendations to account for the complex sampling design and used design-based survey statistical methods for descriptive and inferential procedures.[21,22] These include weighted estimation of population totals, means, and proportions (with corresponding confidence intervals [CIs]). Design-based weighted regression models were used to study associations (adjusted and unadjusted) between the primary outcomes and transfer status (CCC hospitalizations without transfer and CCC TAD hospitalizations only).[23] The unadjusted association of transfer status with LOS corresponded to the exponential of the quasi-Poisson regression parameter (with 95% Wald CI).[24] Adjusted associations included age, sex, race, H-RISK,[20] household income, expected primary payer, number of CCCs, and hospital characteristics as covariates. Similarly, the associations of transfer status with receipt of critical care services and death were estimated by using logistic regression (unadjusted and adjusted by the same covariates).

Variance components were computed by using linearization methods that took into account design elements such as strata,

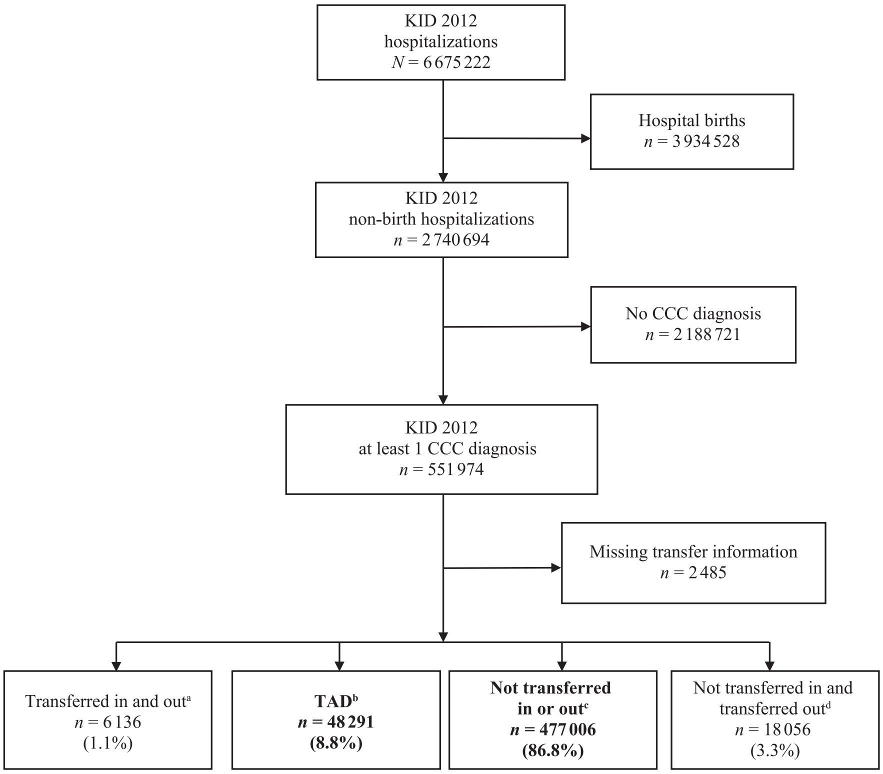

FIGURE 1 Extraction of CCC hospitalizations and transfer categories from the 2012 KID. [a] Transferred in from an acute care or other health facility and then transferred out to a different acute care or other health facility. [b] Transferred in from an acute care or other health facility, with the hospitalization concluding with discharge from the hospital or death. [c] Not transferred in or out, with hospitalization concluding with discharge from the hospital or death. [d] Not transferred in and subsequently transferred to an acute care or other health facility.

cluster, and sampling weights.[21] All analyses were completed by using SAS version 9.4 (SAS Institute, Inc, Cary, NC) and R version 3.5.2 for Windows.[25] All tests were 2-sided, and $P \leq .05$ was considered statistically significant. This study was deemed exempt by our institutional review board.

RESULTS

2012 KID Data and Interfacility Transfer Patterns

There were 6 675 222 hospitalizations in the 2012 KID. There were 551 974 (8.3%) hospitalizations that involved patients with at least 1 CCC ICD-9 diagnosis code, excluding in-hospital births (Fig 1). Of these hospitalizations, 2485 (0.5%) were missing transfer information. Among patients with CCCs with transfer data, transfer status was characterized as transferred in and out (1.1%), TAD (8.8%), not transferred in or out (86.8%), and not transferred in and transferred out (3.3%). Approximately 14% of CCC hospitalizations involved some form of interfacility transfer, compared with ~12% of non-CCC pediatric hospitalizations ($P < .001$).

Characteristics of CCC TAD Hospitalizations

Just over one-third (95% CI: 33.1–35.5) of CCC TAD hospitalizations involved a child with ≥2 CCCs, whereas 29.6% (95% CI: 28.5–30.7) of nontransfer CCC hospitalizations involved children with ≥2 CCCs ($P < .001$) (Table 2). Nearly one-quarter (95% CI: 22.5–24.8) of CCC TAD hospitalizations involved patients <12 months of age, compared with 13.2% (95% CI: 12.8–13.7) of nontransfer CCC hospitalizations ($P < .001$). The H-RISK was slightly higher for CCC TAD hospitalizations, with a score of 4.5 (95% CI: 4.3–4.8) vs 3.3 (95% CI: 3.2–3.4) for nontransfer CCC hospitalizations ($P < .001$). Approximately 91% (95% CI: 88.4–93.1) of CCC TAD hospitalizations occurred in urban teaching hospitals, compared with 87% of nontransfer CCC hospitalizations (95% CI: 84.6–88.8) ($P = .001$). Overall, 64% (95% CI: 58.5–69.7) of hospitalizations for children with at least 1 CCC occurred at children's hospitals. The proportion of CCC TAD and nontransfer CCC hospitalizations occurring at children's hospitals was similar ($P = .169$). There was a slightly higher proportion of Medicaid hospitalizations among CCC TAD hospitalizations (54.6% [95% CI: 52.2–56.9]) compared with nontransfer CCC hospitalizations (47.9% [95% CI: 45.8–50.1]) ($P < .001$).

LOS

CCC TAD hospitalizations were twice as likely to involve 1 additional day of hospitalization compared with CCC hospitalizations without a transfer (LOS rate ratio 2.0 [95% CI: 1.8–2.1]; $P < .001$) (Table 3). After adjustment for patient and hospital characteristics, the LOS rate ratio was 1.6 (95% CI: 1.5–1.7) between CCC TAD and CCC nontransfer hospitalizations ($P < .001$). Multiple hospitalization characteristics were associated with LOS, including age, hospital location, and having >1 CCC. LOS was longer for children aged <12 months compared with hospitalizations for children in all other age groups ($P < .001$). Hospitalization in an urban teaching hospital was also associated with longer LOS compared with rural and urban nonteaching hospitals ($P < .001$). Similarly, hospitalization in a children's hospital was associated with a longer LOS compared with non–children's hospitals ($P < .001$).

Receipt of Critical Care Services

CCC TAD hospitalizations were more likely to involve critical care services compared with CCC hospitalizations without a transfer in our unadjusted analysis (odds ratio [OR] 3.7; 95% CI: 3.4–3.9) ($P < .001$) (Table 3). After adjustment for patient and hospital characteristics, odds of receipt of critical care services remained higher for CCC TAD hospitalizations compared with CCC

TABLE 1 ICD-9 Diagnoses and Procedure Codes Used To Indicate Receipt of Critical Care Services

Type	Condition	Code
PCS	Insertion of nasopharyngeal airway	96.01
	Insertion of oropharyngeal airway	96.02
	Insertion of endotracheal tube	96.04
	Other intubation of respiratory tract	96.05
	Continuous invasive mechanical ventilation of unspecified duration	96.7
	Continuous invasive mechanical ventilation for <96 consecutive h	96.71
	Continuous invasive mechanical ventilation for ≥96 consecutive h	96.72
CM	Cardiac arrest	427.5
	Respiratory failure	518.81
	Acute or chronic respiratory failure	518.84
	Apnea	786.03
	Respiratory arrest	799.1

CM, Clinical Modification; PCS, Procedural Coding System.

hospitalizations without a transfer (adjusted odds ratio [aOR] 3.0; 95% CI: 2.7–3.2) ($P < .001$). Multiple patient and hospital characteristics were associated with receipt of critical care services. Age <12 months was associated with higher odds of receipt of critical care services compared with each of the older age groups ($P < .001$). H-RISK and the presence of ≥2 CCCs were also associated with higher odds of receipt of critical care services (aOR 1.1 [95% CI: 1.1–1.2] and aOR 1.7 [95% CI: 1.7–1.8], respectively) ($P < .001$). Having self-pay or Medicaid as the primary payer, compared with private insurance, was also associated with higher odds of receipt of critical care services (aOR 1.4 [95% CI: 1.3–1.7] for self-pay and aOR 1.4 [95% CI: 1.3–1.4] for Medicaid) ($P < .001$).

In-Hospital Mortality

CCC TAD hospitalizations had ~5 times the odds of in-hospital mortality as nontransfer CCC hospitalizations (OR 4.5; 95% CI: 4.1–4.9) ($P < .001$) (Table 3). The association was attenuated, but persisted, after adjustment for hospital and patient characteristics (aOR 3.6; 95% CI: 3.2–3.9) ($P < .001$). Patient and hospital factors associated with higher mortality among patients with CCC included having ≥2 CCCs, age <1 year, self-pay status, Hispanic ethnicity, Asian or Pacific Islander ethnicity, and other race (all $P \leq .003$). Notable factors associated with lower mortality for CCC TAD hospitalizations included hospitalization at a children's hospital versus a non–children's hospital (aOR 0.8; 95% CI: 0.7–0.9) ($P < .001$) and hospitalizations involving patients whose median household income for their zip code of residence was at or >$48 000 compared with those from zip codes with median household income <$38 999 (aOR 0.8 [95% CI: 0.7–0.9] for $48 000–62 999 stratum) ($P = .001$).

DISCUSSION

Approximately 1 in 8 CCC hospitalizations in the 2012 KID involved an interfacility transfer. Not surprisingly, the majority of interfacility transfers for patients with CCCs involved transfer to a facility from which they were ultimately discharged or died. Compared with CCC hospitalizations not involving a transfer, CCC TAD hospitalizations involved a longer LOS, higher odds of receiving critical care services, and higher odds of in-hospital mortality. These characteristics identify patients with CCCs undergoing interfacility transfer as a particularly vulnerable subpopulation among pediatric patients who are hospitalized.

The increased risk associated with interfacility transfer is likely multifactorial. There is often a complex network of care team members participating in an interfacility transfer, including parents, nurses, coordinators, and emergency medical transport specialists in addition to physicians.[26] Authors of previous studies have described factors associated with interfacility transfers among pediatric hospitalizations, noting that patients with higher disease severity and those with ≥1 CCC diagnosis are more likely to undergo transfer.[1] Studies exploring the association between transfer and health outcomes have been largely condition specific.[17,27,28] Transferred patients with trauma experienced longer time to receiving specialized evaluation; however, mortality and complication rates were not different between patients who were transferred and those not transfered after adjustment for illness severity.[27] Among children with critical illness and injury who underwent interfacility transfer, children transferred from an acute care floor had a higher risk of mortality, and both floor and ICU transfers involved a longer LOS.[29] Although these patient populations are not directly comparable with ours, cumulatively, these studies provide evidence that interfacility transfer may be an independent risk factor for poorer clinical outcomes, including mortality, and longer LOS.

Alternatively, it is also important to consider that patients with CCCs may be more likely to present to the facility closest to them at times of acute illness, regardless of the level of specialized care available, leading to subsequent transfer. Whereas for a scheduled or routine admission, the patient may be directly admitted to a more specialized facility. This decision pattern could make CCC hospitalizations involving transfer inherently higher risk because they are more likely to involve acute or unexpected illness. Further exploration of the role of hospital proximity, parent decision-making, and disease severity on presentation will likely improve our understanding of the risks associated with interfacility transfer.

Collectively, our work supports previous findings that care for children with CCCs is concentrated in children's and teaching hospitals.[8] A large majority of nontransfer CCC hospitalizations occurred at urban teaching hospitals, implying that families with children with CCCs may elect to present at urban teaching hospitals or live

TABLE 2 Characteristics of CCC Hospitalizations for Patients Who Were TAD and CCC Hospitalizations Without a Transfer In or Out

Label and Level	All CCC Cases, N = 549 489[a]	TAD, n = 48 291 (8.8%)	Not Transferred In or Out, n = 477 006 (86.8%)	P
	% (95% CI)	% (95% CI)	% (95% CI)	
No. CCC diagnoses[b]				
Single CCC	69.2 (68.2–70.2)	65.7 (64.5–66.9)	70.4 (69.3–71.5)	<.001
≥2 CCCs	30.8 (29.8–31.8)	34.3 (33.1–35.5)	29.6 (28.5–30.7)	—
Age category[b]				
<12 mo	17.2 (16.8–17.7)	23.6 (22.5–24.8)	13.2 (12.8–13.7)	<.001
1–5 y	20.8 (20.2–21.4)	21.1 (20.3–21.8)	21.9 (21.4–22.5)	—
5–10 y	14.7 (14.3–15.1)	13.8 (13.2–14.4)	15.6 (15.2–16.0)	—
10–15 y	16.2 (15.8–16.6)	14.7 (14.1–15.2)	17.1 (16.7–17.5)	—
>15 y	31.1 (29.9–32.2)	26.8 (25.4–28.2)	32.1 (30.8–33.4)	—
H-RISK[c]	3.6 (3.5–3.8)	4.5 (4.3–4.8)	3.3 (3.2–3.4)	<.001
Sex[b]				
Male	52.2 (51.9–52.5)	54.6 (53.9–55.3)	51.7 (51.3–52.0)	<.001
Female	47.8 (47.5–48.1)	45.4 (44.7–46.1)	48.3 (48.0–48.7)	—
Hospital bed size[d]				
Small	9.6 (6.4–12.9)	7.9 (4.5–11.3)	9.7 (6.2–13.1)	.290
Medium	22.8 (16.8–28.7)	22.4 (14.9–30.0)	22.7 (16.5–29.0)	—
Large	67.6 (61.6–73.6)	69.7 (62.3–77.0)	67.6 (61.3–73.9)	—
Location and teaching status of hospital[b]				
Rural	3.1 (2.5–3.7)	1.7 (0.5–3.0)	2.9 (2.3–3.4)	.001
Urban nonteaching	11.2 (9.4–13.0)	7.5 (5.6–9.4)	10.5 (8.6–12.3)	—
Urban teaching	85.7 (83.7–87.8)	90.8 (88.4–93.1)	86.7 (84.6–88.8)	—
Hospital designation				
Not a children's hospital	35.9 (30.3–41.5)	34.7 (27.4–42.0)	37.9 (32.1–43.7)	.169
Children hospital	64.1 (58.5–69.7)	65.3 (58.0–72.6)	62.1 (56.3–67.9)	—
Primary expected payer[b]				
Medicare	1.1 (0.9–1.2)	0.9 (0.7–1.1)	1.1 (0.9–1.3)	<.001
Medicaid	48.8 (46.8–50.9)	54.6 (52.2–56.9)	47.9 (45.8–50.1)	—
Private insurance	41.5 (39.7–43.3)	36.0 (33.5–38.4)	42.3 (40.4–44.2)	—
Self-pay	2.6 (2.1–3.0)	2.6 (2.1–3.0)	2.5 (2.1–3.0)	—
No charge	0.2 (0.1–0.3)	0.1 (0.0–0.2)	0.2 (0.1–0.3)	—
Other	5.8 (4.3–7.4)	5.9 (4.4–7.4)	5.9 (4.2–7.6)	—
Race or ethnicity[b]				
White	50.6 (47.7–53.4)	52.2 (49.0–55.5)	50.4 (47.4–53.4)	<.001
Black	21.0 (19.3–22.7)	19.4 (17.4–21.5)	21.3 (19.5–23.0)	—
Hispanic	19.5 (16.8–22.2)	17.5 (15.2–19.8)	19.8 (16.9–22.7)	—
Asian or Pacific Islander	2.9 (2.4–3.4)	2.6 (2.1–3.0)	2.9 (2.4–3.4)	—
Native American	0.7 (0.5–1.0)	1.4 (0.8–2.0)	0.6 (0.4–0.8)	—
Other	5.3 (4.3–6.3)	6.8 (5.6–8.1)	5.0 (4.0–5.9)	—
Median household income national quartile for patient zip code, $[b]				
1–38 999	30.0 (28.0–31.9)	32.0 (29.4–34.5)	29.7 (27.7–31.7)	<.001
39 000–47 999	24.4 (23.3–25.4)	26.8 (25.2–28.3)	24.0 (22.9–25.1)	—
48 000–62 999	24.2 (23.2–25.2)	22.4 (21.3–23.6)	24.4 (23.4–25.5)	—
63 000+	21.5 (19.6–23.4)	18.8 (16.2–21.4)	21.9 (19.9–23.9)	—

—, not applicable.

[a] Cases with transfer information available. Includes all transfer categories.

[b] Proportions with 95% CIs were based on the weighted estimates of total numbers of cases.

[c] The H-RISK was introduced by Richardson et al[20]; values represent means and 95% CIs.

[d] The bed size definition varies according to region on the basis of the American Hospital Association survey of hospitals.

TABLE 3 Unadjusted and Adjusted Estimates of Hospitalization LOS, Receipt of Critical Care Services, and In-Hospital Mortality for CCC TAD Hospitalizations ($n = 48\,291$) and Nontransfer Hospitalizations ($n = 477\,006$)

Type	LOS		Receipt of Critical Care Services[a]		In-Hospital Mortality	
	Risk Ratio (95% CI)	*P*	OR (95% CI)	*P*	OR (95% CI)	*P*
Unadjusted						
Transfer status						
Not transferred	Reference	—	Reference	—	Reference	—
TAD	2.0 (1.8–2.1)	<.001	3.7 (3.4–3.9)	<.001	4.5 (4.1–4.9)	<.001
Adjusted						
Transfer status						—
Not transferred	Reference	—	Reference	—	Reference	—
TAD	1.6 (1.5–1.7)	<.001	3.0 (2.7–3.2)	<.001	3.6 (3.2–3.9)	<.001
No. CCC diagnoses						—
Single CCC	Reference	—	Reference	—	Reference	—
≥2 CCCs	1.3 (1.3–1.4)	<.001	1.7 (1.7–1.8)	<.001	2.2 (2.0–2.4)	<.001
H-RISK[b]	1.0 (1.0–1.0)	<.001	1.1 (1.1–1.1)	<.001	1.1 (1.1–1.1)	<.001
Age, y						—
<1	Reference	—	Reference	—	Reference	—
1–5	0.7 (0.7–0.9)	<.001	0.6 (0.6–0.7)	<.001	0.8 (0.72–0.90)	<.001
5–10	0.7 (0.7–0.7)	<.001	0.4 (0.4–0.5)	<.001	0.7 (0.57–0.74)	<.001
10–15	0.8 (0.7–0.8)	<.001	0.3 (0.3–0.4)	<.001	0.8 (0.66–0.86)	<.001
>15	0.8 (0.8–0.8)	<.001	0.4 (0.4–0.4)	<.001	1.0 (0.9–1.1)	.613
Sex						
Male	Reference	—	Reference	—	Reference	—
Female	1.0 (1.0–1.0)	.859	0.9 (0.8–0.9)	<.001	0.8 (0.7–0.9)	<.001
Median household income based on zip code of patient residence, $						
1–38 999	Reference	—	Reference	—	Reference	—
39 000–47 999	1.0 (1.0–1.0)	.854	1.0 (0.9–1.0)	.133	0.9 (0.8–1.0)	.057
48 000–62 999	1.0 (1.0–1.0)	.203	0.9 (0.9–1.0)	.023	0.8 (0.7–0.9)	.001
63 000+	1.0 (1.0–1.0)	.106	0.9 (0.9–1.0)	.051	0.8 (0.7–0.9)	.001
Primary expected payer						
Private	Reference	—	Reference	—	Reference	—
Medicare	1.0 (1.0–1.1)	.075	1.0 (0.8–1.2)	.621	0.7 (0.5–1.0)	.038
Medicaid	1.1 (1.1–1.1)	<.001	1.4 (1.3–1.4)	<.001	1.0 (0.9–1.1)	.820
Self-pay	1.0 (0.9–1.0)	.029	1.4 (1.3–1.7)	<.001	1.8 (1.5–2.3)	<.001
No charge	1.0 (0.9–1.1)	.705	1.4 (0.9–2.1)	.109	0.9 (0.4–1.8)	.702
Other	1.1 (1.0–1.1)	.006	1.0 (0.9–1.2)	.687	1.1 (0.9–1.3)	.258
Race or ethnicity						
White	Reference	—	Reference	—	Reference	—
Black	1.0 (1.0–1.1)	.116	0.9 (0.9–1.0)	.034	1.1 (1.0–1.2)	.138
Hispanic	1.0 (1.0–1.2)	.021	0.9 (0.9–1.0)	.100	1.3 (1.1–1.4)	<.001
Asian or Pacific Islander	1.1 (1.1–1.2)	<.001	1.0 (0.9–1.1)	.706	1.6 (1.3–1.8)	<.001
Native American	1.0 (0.9–1.1)	.635	1.0 (0.7–1.3)	.822	1.4 (1.0–2.0)	.077
Other	1.1 (1.0–1.1)	<.001	1.0 (0.9–1.1)	.671	1.3 (1.1–1.5)	.003
Hospital bed size[c]						
Large	Reference	—	Reference	—	Reference	—
Small	0.9 (0.8–1.0)	.010	0.9 (0.7–1.1)	.204	0.9 (0.8–1.2)	.593
Medium	0.9 (0.8–0.9)	<.001	1.0 (0.9–1.1)	.735	1.0 (0.8–1.1)	.593

TABLE 3 Continued

Type	LOS		Receipt of Critical Care Services[a]		In-Hospital Mortality	
	Risk Ratio (95% CI)	*P*	OR (95% CI)	*P*	OR (95% CI)	*P*
Hospital location and teaching status						
Urban teaching	Reference	—	Reference	—	Reference	—
Rural	0.8 (0.7–0.9)	<.001	0.7 (0.6–0.8)	<.001	0.7 (0.5–1.0)	.019
Urban nonteaching	0.9 (0.9–1.0)	.051	1.0 (0.9–1.1)	.665	1.1 (0.9–1.2)	.527
Hospital designation[d]						
Not a children's hospital	Reference	—	Reference	—	Reference	—
Children hospital	1.2 (1.1–1.3)	<.001	1.0 (0.9–1.0)	.239	0.8 (0.7–0.9)	<.001

—, not applicable.
[a] Based on ICD-9 diagnosis and procedure codes consistent with ICU admission.
[b] The H-RISK was introduced by Richardson et al.[20]
[c] The bed size definition varies according to region on the basis of the American Hospital Association survey of hospitals.
[d] Based on information provided by the Children's Hospital Association.

close to such a hospital. The dominance of teaching hospitals is also noted among CCC TAD hospitalizations. Similarly, approximately two-thirds of CCC hospitalizations occur at a children's hospital. The lower odds of in-hospital mortality for CCC TAD hospitalizations in children's hospitals compared with those in non–children's hospitals represents a potentially significant advantage to transfer to children's hospitals for patients with CCCs. This finding may also reflects the need to better equip non–children's hospitals to care for children with CCCs.

We note several patient characteristics associated with clinically significant poorer outcomes. Patients with ≥2 CCCs who were TAD had an increased risk of longer LOS, receipt of critical care services, and increased mortality compared with patients with 1 CCC, likely reflecting a higher severity of disease. Children <1 year of age with at least 1 CCC diagnosis who were TAD were at risk for a longer LOS and receipt of critical care services compared with older children. Odds of in-hospital mortality in this group were higher than those for all age groups, except for those older than 15 years. Infants with CCCs have been noted to have higher in-hospital mortality than patients in other age groups,[30] and hospitalization may be complicated by a number of factors, including feeding concerns, noncommunicative status of the patient, and challenges with home health initiation and follow-up.[31,32] Targeted efforts to coordinate transitions of care, including interfacility transfers, specifically for patients aged <1 year with CCCs may be particularly effective at improving outcomes and health care use among patients with CCCs.

There were significant racial and ethnic and payer-source differences in the odds of in-hospital morality for CCC TAD hospitalizations. Patients of Hispanic ethnicity, Asian or Pacific Islander ethnicity, and other race were associated with higher odds of in-hospital mortality compared with white patients. Similarly, self-pay patients had increased odds of in-hospital mortality compared with privately insured patients. These differences warrant further exploration of factors that are known to lead to adverse outcomes among racial and ethnic minority groups and the uninsured within the inpatient context. Contributing factors may include a lack of linguistic and culturally appropriate services, the presence of implicit racial bias, and difficulty accessing care, particularly for patients without insurance (Medicaid or private).[33–37] Delayed presentation to care due to costs or cultural factors could also contribute. Assessment of the role of these factors during the interfacility transfer process for children with and without CCCs may lead to interventions that improve health equity across all children who are hospitalized. It is also notable that the racial and ethnic differences in in-hospital mortality noted in our study reflect similar racial and ethnic differences in the location of death during end-of-life care.[38] Thus, our findings may also be the result of family choices during end-of-life care.

Describing the transfer patterns and clinical outcomes of patient subpopulations who are more likely to undergo interfacility transfer has yielded targeted efforts to improve clinical outcomes through improved care coordination and transfer infrastructure.[39–44] This work largely reveals a need to standardize aspects of the transfer process, including standardizing scripts for provider and staff handoff and ensuring that all hospitals that care for patients with specific conditions have adequate resources to provide short-term care as well as access to regional specialty centers when needed.[39,41] Given that patients with CCCs are, by definition, more clinically complex and more likely to experience transfer, patients with CCCs may benefit from systematic improvements in the pediatric transfer process more than most pediatric subgroups.

Our study has several limitations similar to those of other analyses of administrative data sets. We were unable to individually identify patients and link data across hospitalizations, thus prohibiting our ability to assess patient characteristics, such as disease severity, before and after transfer. Similarly, we are unable to assess LOS in the transferring hospital;

therefore, LOS in the transferred group does not reflect total LOS (pre- and posttransfer) for patients who were transferred. Although we were able to capture some aspects of disease severity with the H-RISK, our study would have been strengthened if a more clinically relevant, prospectively ascribed measure of severity were available within the KID. The indication for transfer in many cases may be that a patient is clinically worsening or exceeding the level of care at the referring facility, thus making it difficult to separate the risk of the transfer itself from the contribution of patient clinical status by using administrative data. Finally, there are multiple evolving definitions of children with medical complexity. We used 1 definition based on ICD-9 codes[15]; however, this may only represent a subset of patients with complex medical needs.

In the context of these limitations, in our study, we describe the frequency of interfacility transfers among CCC hospitalizations and identify transfer status as an independent risk factor for longer LOS, receipt of critical care services, and in-hospital mortality using a nationally representative data set.

CONCLUSIONS

A significant proportion of hospitalizations of patients with at least 1 CCC involve an interfacility transfer. CCC transfer hospitalizations are more likely to involve a longer LOS, receipt of critical care services, and in-hospital mortality compared with nontransfer CCC hospitalizations, controlling for patient and hospital characteristics. These findings reveal a need for further assessment of transfers involving patients with CCCs by using prospective, multidisciplinary clinical data across a diverse cohort of children to inform interventions to improve outcomes in this vulnerable population.

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