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Repeated critical illness and unplanned readmissions within one year to pediatric ICUs

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Abstract

Objectives—To determine the incidence of unplanned readmissions to pediatric intensive care units (PICUs) within one year and examine risk factors associated with repeated readmission.

Design, Settings, & Patients—Retrospective cohort study of 93,379 patients discharged between 2009 and 2010 from 76 North American PICUs.

Measurements—Outcomes of index admissions and unplanned readmissions were compared. Timing of readmissions and variation of proportion of readmissions across sites were examined. Cumulative incidence curves for readmission were constructed. Time-to-event analyses were performed to examine factors associated with readmission within one year and to estimate their hazard ratios (HR).

Main Results—Eleven percent (10,233) of patients had 15,625 unplanned readmissions within one year to the same PICU; 3.4% had two or more readmissions. Readmissions had significantly higher PICU mortality and longer PICU length of stay, compared to index admissions (4.0% versus 2.5%, and 2.5 versus 1.6 days, all P<0.001). Median time to readmission was 30 days for all readmissions; 3.5 days for readmissions during the same hospitalization; and 66 days for different hospitalizations. Time-to-event analyses showed that having more complex chronic conditions (CCCs) was associated with earlier readmission—adjusted HR 2.9 for one CCC; HR 4.8 for two CCC; HR 9.6 for three or more CCC, all P<0.001 compared no CCC). Most specific CCC conferred a greater risk of readmission, and some had considerably higher risk than others.

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Conclusions—Unplanned readmissions occurred in a sizable minority of PICU patients. Patients with CCCs and particular conditions were at much higher risk for readmission.

Keywords

Hospital Readmission; Intensive Care Units; Pediatric; Child

Introduction

Anecdotally and from studies that record more admissions than patients (1–2), it is known that some children, for example those with complex chronic conditions (CCC), are repeatedly admitted to pediatric intensive care units (PICUs) for both planned and unplanned reasons. Unplanned readmissions are a focus of healthcare quality measurement, as they may be preventable (3) and are associated with worse outcomes (4–5) and higher costs (6–7). Furthermore, repeated critical illness and hospitalization negatively impact patients and families (8–10). Except for a few studies focused on early readmissions (4) and readmissions during the same hospitalization (11–13), it is not known how often unplanned PICU readmissions occur and who are at most risk.

Using a multi-institutional cohort, we sought to determine the incidence and outcomes of unplanned PICU readmissions within one year and examine the patient characteristics and conditions that are associated with repeated readmission. This information will permit clinicians and administrators to better plan resources and interventions to address such readmissions, as well as provide anticipatory guidance to patients and families.

Methods

We performed a retrospective cohort study of patients discharged between 2009 and 2010 and followed for one year at 92 North American PICUs that participated in the Virtual Pediatric Systems (VPS, LLC, Los Angeles, CA). VPS contains encounter-level information entered by VPS-trained persons at the individual sites. Annual certification of data definitions, routine interrater reliability testing, and automated and manual data cleaning queries ensure data validity and quality (14). Our outcome was unplanned PICU readmissions within one year of index PICU discharge, during the same or different hospitalization and to the same PICU. Sites varied in the duration of data contributed (submitted as 3-month quarters). To ensure one year of follow-up, we included only sites that contributed ≥5 consecutive quarters of data, and no study patients were drawn from the last year of data contributed by a site. For example, if a site had 10 consecutive quarters of data (eg, July 2009 through December 2011), study patients were those discharged during the first 6 quarters (July 2009 through December 2010), but all 10 quarters could be used to identify these patients' unplanned readmissions within one year from index discharge. Unique patient identifiers permitted detection of readmissions to the same PICU, but not to another PICU (VPS or otherwise). We excluded patients who died during their first admission.

For all admissions, multiple patient and clinical variables were available, as well as dates/times of admission and discharge, diagnoses, and procedures. Demographics included

gender, age, race, insurance, and number of CCCs. Patients of all ages were included as adults are cared for in PICUs (15). CCCs were defined using Feudtner's definition (16) and identified among diagnoses using a list of VPS codes developed by Edwards et al. (17). Sites that did not report secondary diagnoses were excluded, because we considered CCC particularly relevant to readmission risk. Admission variables included planned, peri-operative, trauma, patient origin, risk of PICU mortality, and whether invasive ventilation via endotracheal tube or tracheostomy was used. Risk of mortality was estimated using Paediatric Index of Mortality 2 (PIM2) (18) and was used as a proxy for admission severity-of-illness. Discharge variables included disposition location, discharge season, and PICU length of stay (LOS). Discharge season was included to control for seasonal illness variation (19–20) and was categorized as four 3-month blocks.

Analysis

Characteristics were reported as proportions/rates and 95% confidence intervals (CI), means and standard deviations (SD), and medians and interquartile ranges (IQR). Characteristics of included and excluded sites were compared using Pearson's chi^2 test. Characteristics of admissions (index and planned readmissions) and unplanned readmissions were compared using Pearson's chi^2 test, unpaired two-tailed t-test, or Mann-Whitney U test. To compare outcomes of index admissions and unplanned readmissions, we performed bivariate analyses of their PICU LOS and mortality (index admissions resulting in death were included in mortality comparison only). We reported the primary reasons for admissions and unplanned readmissions, which are the first diagnosis in VPS.

To describe variation across PICUs, we calculated the median proportion of unplanned readmissions within one year and the ranges of these readmissions among the sites.

Using descriptive statistics and histograms, we described the time from index PICU discharge to unplanned readmission for readmissions during the same and different hospitalizations. We constructed curves for cumulative incidences of unplanned PICU readmission within one year by number of CCC and for specific chronic conditions, using only time to first unplanned readmission.

We examined factors associated with unplanned PICU readmission within one year and estimated their hazard ratios (HR), using Cox proportional hazard conditional risk set models (time from the previous event) for multiple failure-time data (21). This modeling allows for multiple unplanned readmissions for the same patient where time to each readmission was measured from the previous (unplanned or planned) PICU discharge. Patients were censored at one year from index discharge. PICU mortality was treated as non-informative censoring, rather than a competing risk, because it is relatively rare. Estimation of risk was stratified for each sequential unplanned readmission within one year, with index admission being the first stratum. Stratified risk did not change with planned readmissions. Unplanned readmissions beyond the fourth were consider within the fourth stratum because few patients had >4 within one year. To accommodate multiple levels of clustering, patients were treated as random effects, and PICU sites were adjusted for as a fixed effect.

Two models were fitted: 1) a model in which the number of CCCs was a primary predictor; and 2) a model with covariates for specific chronic conditions. Factors adjusted for in these models included the characteristics listed above. Because of non-linear relationships with readmission, age was parsimoniously divided into an ordinal variable, and PIM2 and LOS were transformed into cubic splines. Institutional variables included number of licensed PICU beds (≤ 17, 18–24, ≥25 beds), presence of a separate intermediate-level care unit, and presence of a pediatric critical care fellowship program. The PICU's average daily census by quarter of discharge was used as a metric of ICU strain, which has been shown to affect ICU triage decisions (22). Sepsis diagnosis was included because many survivors of pediatric severe sepsis have unplanned hospital readmissions (23). Independent variables for the final models were included if their *P*-value was <0.2 in multivariate analysis. Race and insurance were excluded because they were unavailable for a sizable proportion of observations.

When information was available for only a subgroup of the patients, we noted this in the text or tables. Statistical significance was determined using a *P*-value of <0.05. *Stata 14* (StataCorp LP, College Station, TX) was used for analyses and figures. Because all data were deidentified, this study qualified for exemption from review by the University of California, San Francisco Committee on Human Research.

Results

There were 76 included and 16 excluded PICUs; included sites had more pediatric beds then excluded sites (Table 1). Supplemental Figure 1 is a flowchart of included and excluded patients, admissions, and units. The 76 units contributed 442 quarters of data between 2009 and 2010. After excluding 2,437 patients who died during their first admission, 93,379 patients and 115,157 total admissions remained for analysis. Of these patients, 10,233 (11%) had 15,625 unplanned readmissions within one year—7.6% had one readmission, 2.0% had two, 1.4% had ≥3. Unplanned readmissions within one year accounted for 20% of all ICU patient-care days. Twenty-one percent of patients with a CCC had an unplanned readmission, compared to 4% of patients without a CCC. Twenty-six percent of unplanned readmissions were during the same hospitalization.

The proportion of admissions that were unplanned readmissions within one year varied among PICUs, ranging 4.6–26.9% (median 13.5%, IQR 10.6–15.1%).

Characteristics of admissions and unplanned readmission are presented in Table 2. Readmitted admissions more often patients who were younger, on public insurance, had CCCs, and invasively ventilated during their index PICU admission. Trauma patients were less frequently readmitted. The PICU mortality for index admissions was 2.5% versus 4.0% for unplanned readmissions (P<0.001). The median PICU LOS for index admissions was 1.6 days (IQR 0.9–3.4) versus 2.5 days (IQR 1.1–6.0, P<0.001) for unplanned readmissions. Unplanned readmissions were primarily due to respiratory, infectious, and neurological conditions; index admissions and planned readmissions were commonly due to respiratory, cardiac, and neurological conditions (Supplemental Table 1).

The timing of unplanned readmissions is shown in Supplemental Figure 2. The median time to readmission was 30 days (IQR 5–106) for all readmissions; 3.5 days (IQR 1.2–9.0) for readmissions during the same hospitalization and 66 days (IQR 24–151) for different hospitalizations. Figure 1 and Supplemental Figure 3 depict the cumulative incidence curves grouped by number of CCCs and specific conditions, respectively, using only time to first unplanned readmission.

Time-to-event analyses showed that having a CCC was significantly associated with earlier unplanned PICU readmission, after controlling for age, PIM2 score, whether the admission was unplanned, perioperative, trauma-related, or from another institution, use of invasive ventilation, discharge disposition, PICU site, number of PICU and pediatric beds, and each unit's average daily census by quarter. Having more CCCs was associated with greater hazard of readmission (HR 2.9 for one CCC; HR 4.8 for two CCCs; HR 9.6 for ≥ three CCCs, all P<0.001 and compared to not having a CCC) (Table 3). Other variables were also significantly associated with greater or lower hazard for readmission. Being over 18 months of age was associated with lower hazards of readmission, compared to being 0–1 months. PICU admissions for perioperative or trauma reasons were associated with lower hazards of readmission. Compared to being discharged to the general ward, most disposition locations were associated with lower hazards for readmission. Unplanned admission and using invasive ventilation were associated with higher hazards for readmission.

In the model with specific chronic conditions, most conditions were associated with greater risk of earlier readmission, after adjusting for the other conditions and the same covariates controlled for in the CCC model (Table 4). Chronic heart failure, bronchopulmonary dysplasia, cystic fibrosis, miscellaneous chronic respiratory conditions, cerebral palsy, static encephalopathy, muscular dystrophy, spinal muscular atrophy type 1, miscellaneous neurologic/neuromuscular conditions, central nervous system tumors, solid tumors, hemopoietic cancers, miscellaneous gastrointestinal conditions, renal conditions, diabetes, metabolic conditions, immunologic conditions, and congenital infections all had >50% higher hazards for readmission. Hemopoietic cancers had the highest hazard for readmission (HR 2.1 [95% CI 1.9–2.3]). Asthma was associated with a statistically lower hazard of readmission.

Gender, patient origin, sepsis diagnosis, PICU LOS, discharge season, and presence of a pediatric critical care fellowship program were not included in the models as they were not associated with earlier readmission (P>0.2).

Discussion

Repeated illness and unplanned PICU admissions can lead to physical and psychological morbidity for patients and considerable stress for families (8–10). For institutions, lengthy unplanned PICU readmissions may be obstacles to hospital efficiency, potentially delaying admissions of other critically ill patients or patients needing major elective surgeries. Thus, readmissions are relevant to patients, families, clinicians, and administrators. This is the first study to examine the frequency, timing, and outcomes of unplanned PICU readmissions within one year and to explore their reasons and risk factors.

Previous studies of PICU readmissions focused on early unplanned readmissions, included only readmissions within the same hospitalization, conflated planned and unplanned readmissions, and/or reflected a single institution (4, 11–12, 24–26). These studies showed that chronic conditions were associated with PICU readmissions. Similarly, studies of hospitalized children showed that CCCs and number of CCCs were associated with rehospitalization (27–29). In a study of 72 U.S children's hospitals, Berry et al. found that 22% of patients in 2003 were rehospitalized within a year; 3% experienced ≥4 rehospitalizations (29). Feudtner et al. found a 17% 1-year incidence of rehospitalization among children admitted to 38 U.S. children's hospitals in 2004 (30). Patients with any CCC (excluding hematologic/immunologic) were more likely to be rehospitalized than those without CCCs. Feudtner also found that patients who had hospitalizations prior to their index admission were more likely to be rehospitalized.

Our study expands on previous ones by concentrating on unplanned PICU readmissions, both "early" or "late" and during the same or different hospitalizations, in a multi-institutional cohort. We observed that 11% of PICU patients had an unplanned readmission within one year; over 3% had two or more. Readmissions had higher mortality rates and longer PICU LOS compared to index admissions, and they accounted for almost a fifth of patient-care days, making their impact disproportionate to their numbers. Eighty-six percent of readmitted children had a CCC. Children with a CCC had a greater than a two-fold risk of unplanned PICU readmission, compared to children without CCCs. This risk increased the more CCCs a patient had. When specific chronic conditions were examined, most conditions conferred a greater risk of readmission, and some had considerably higher risk than others. Notably, most patients, even those with CCC, do not experience a readmission within one year.

Unplanned PICU readmissions are likely an indication of medical fragility (11) and high acute and outpatient/community care needs. Such readmissions may increase as the number of children with CCC grows. Appreciating which patients are more likely to experience readmission could be helpful in providing tailored anticipatory guidance about repeated illness and readmission risks to families (31), as well as concentrate resource planning and efforts to mitigate preventable readmissions (32). For instance, high-risk patients might be kept in the PICU longer to ensure clinical stability, transferred to intermediate care, or provided more intense disposition planning and outpatient follow-up. Additionally, for children with CCC who are in and out of the PICU, pediatric critical care medicine could adopt a patient-centered specialty practice model (33), where intensivists more actively participate in these children's "medical neighborhood", as opposed to providing mostly discrete and transitory care. Some PICUs have moved towards this model by instituting "primary PICU attendings"—one intensivist remains a consistent physician-presence for the patient/family and care team throughout the child's PICU stay and despite changes in the intensivist(s) who orchestrates day-to-day management. Conceivably, the primary PICU attending's involvement could extend beyond the child's PICU or hospital stay (eg, involvement in outpatient communication between the primary/complex care provider and specialty providers). The potential patient-centered and institutional benefits of a primary PICU attending or other manifestations of a PICU patient-centered specialty practice model should be explored and studied quantitatively and qualitatively.

This study has several limitations. First, like other readmission studies (34), we assumed patients received all their critical care at their index institution and we did not have data about patients who were readmitted to a different PICU, died outside their index PICU, or transferred care to other institutions. Thus, we likely underestimated the frequency of PICU readmission (35). However, many patients with CCC tend to receive their on-going care in their respective regional, tertiary center (36). Second, some of the study patients' index admission were likely readmissions of previous admissions that we did not have data on. Third, causes of readmission are undoubtedly multifactorial and interconnected. This is especially true for patients with CCCs, who often depend on multiple people/systems of care to avoid hospitalization (30, 37–40). VPS contains only PICU data; thus, many potential clinical and nonclinical factors could not be controlled for. The potential confounding from differences among institutions in their tendencies to admit patients to their PICU was somewhat mitigated by adjusting for PICU site. Fourth, several variables likely became less relevant to the risk of readmission the further in time from discharge (eg, PIM2, discharge season and location). We did not include interaction terms between these variables and time between admissions because doing so would have violated the assumption of proportional hazards. Finally, we may have introduced bias by excluding sites that reported <5 consecutive quarters of data. However, we do not believe this potential bias to be systematic.

Conclusions

In this multi-institutional study, we found that unplanned PICU readmissions occurred in a sizable minority of PICU patients, that the PICU mortality and LOS was greater in these readmissions than index admissions, and that patients with CCCs and particular conditions were at higher risk for earlier readmission. Further critical care and non-critical care research is needed to further identify patients most at risk for unplanned readmissions and to improve care systems so as to reduce their number and impact. Such efforts could include PICU providers becoming more actively involved in some patients' medical neighborhood and on-going care.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Abbreviations

CCC	complex chronic condition
CI	confidence interval
HR	hazard ratio

IQR	interquartile range
LOS	length of stay
PIM	Paediatric Index of Mortality
PICU	pediatric intensive care unit
SD	standard deviations
VPS	Virtual Pediatric Intensive Care Unit Systems

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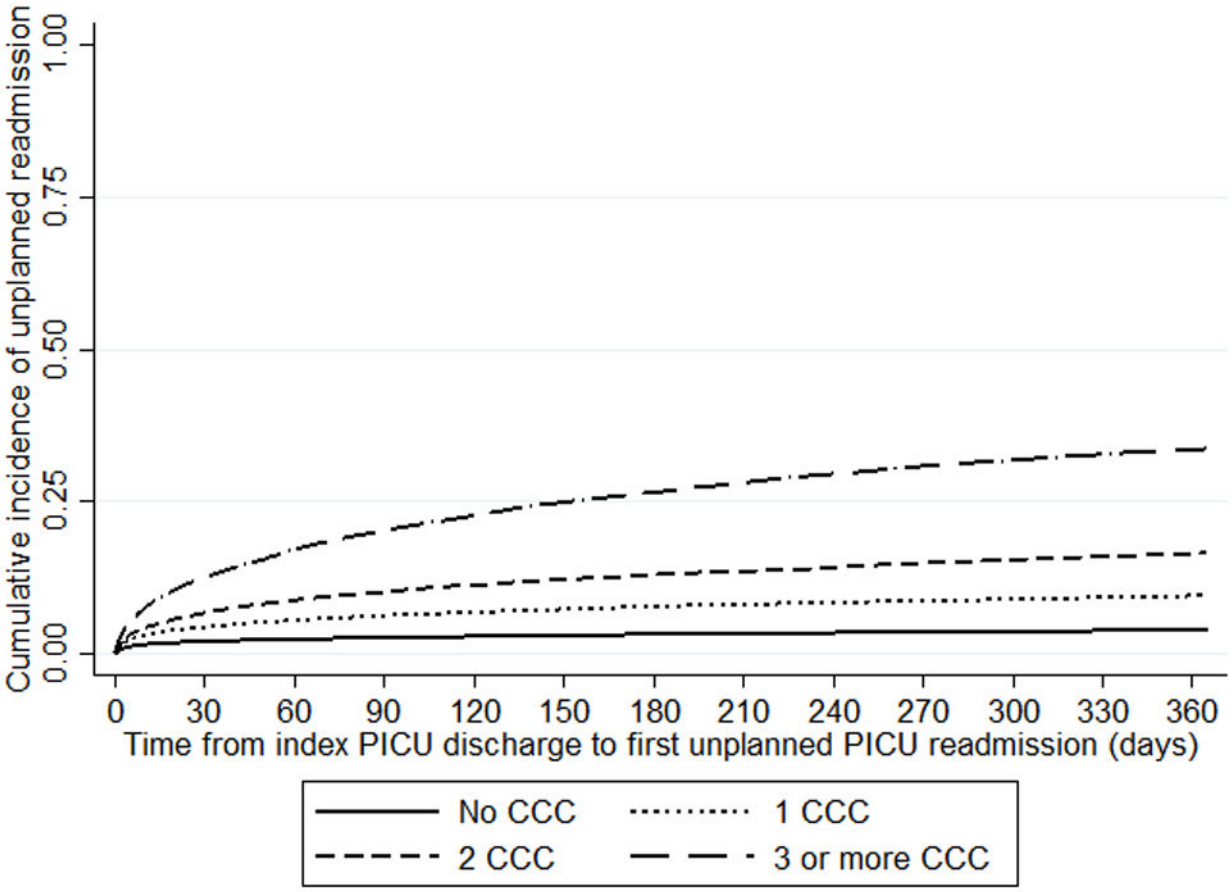

Figure 1.
Cumulative incidences of unplanned PICU readmission within one year by number of complex chronic conditions.

Table 1

Institutional characteristics of study sites

Characteristic, n (%)	Included sites n=76 (100%)	Excluded sites[a] n=16 (100%)	P value
Number of licensed pediatric beds			0.03
≤ 110	18 (24)	5 (31)	
111–249	27 (35)	10 (63)	
≥ 250	31 (41)	1 (6)	
Number of licensed pediatric ICU beds			0.77
≤ 17	28 (37)	7 (44)	
18–24	31 (41)	5 (31)	
≥ 25	17 (22)	4 (25)	
Affiliated PCCM fellowship program	37 (49)	6 (38)	0.42
Number of consecutive quarters of data[b]			
5–8	21 (28)		
9–10	21 (28)		
11–12	34 (45)		

ICU, intensive care unit; PCCM, pediatric critical care medicine

[a] 14 excluded sites because they contributed <5 consecutive quarters of data; 2 excluded sites contributed ≥5 quarters of consecutive data but did not report secondary diagnoses

[b] Study patients were not drawn from the last 4 quarters of a site's data, though unplanned readmissions could be identified during those quarters

Table 2

Characteristics of PICU admissions by readmission status

Characteristic, % (95% CI)	Not readmitted n=99,532 (85%)	Readmitted n=15,625 (15%)
Male sex †	55.9 (55.6–56.2)	54.6 (53.8–55.4)
Age, months, median (IQR) *	55 (12–150)	46 (13–152)
Race[a]		
Caucasian †	51.9 (51.5–52.2)	49.7 (48.8–50.6)
African American *	18.6 (18.3–18.9)	21.1 (20.4–21.9)
Hispanic *	18.2 (17.9–18.5)	19.8 (19.1–20.6)
Asian/Indian/Pacific Islander †	2.7 (2.6–2.8)	2.3 (2.1–2.6)
Other/mixed	5.6 (5.4–5.7)	5.2 (4.8–5.6)
Unspecified *	3.1 (3–3.3)	1.9 (1.7–2.2)
Insurance[b]		
Medicaid/Medicare/Government *	51.1 (50.6–51.5)	62.6 (61.4–63.7)
Commercial *	43.7 (43.3–44.2)	34.8 (33.6–35.9)
Self-Pay *	3.2 (3.1–3.4)	1.2 (0.9–1.5)
Other †	2 (1.8–2.1)	1.5 (1.2–1.8)
Complex chronic condition		
No CCC *	48 (47.7–48.3)	13.8 (13.2–14.3)
1 CCC *	23.5 (23.2–23.7)	18.3 (17.7–18.9)
2 CCC *	13.5 (13.3–13.8)	18.6 (18–19.2)
≥3 CCC *	15 (14.8–15.2)	49.4 (48.6–50.1)
Unplanned *	68.1 (67.8–68.4)	100
Pre-/post-operative *	37.7 (37.4–38)	12.7 (12.2–13.2)
Origin		
Emergency Department	46.2 (45.9–46.5)	45.5 (44.7–46.2)
OR/PACU/procedure suite *	34.7 (34.4–35)	9.5 (9.1–10)
General ward *	11 (10.8–11.1)	29.9 (29.1–30.6)
Another ICU *	3.3 (3.2–3.4)	1.7 (1.5–1.9)
Intermediate/telemetry unit *	1.5 (1.4–1.6)	7.1 (6.7–7.5)
Chronic/rehabilitation facility *	0.1 (0.1–0.2)	0.8 (0.7–1)
Outpatient/home *	2.7 (2.6–2.8)	5.2 (4.8–5.5)
Other	0.5 (0.4–0.5)	0.4 (0.3–0.5)
Trauma *	9.5 (9.3–9.7)	1.5 (1.4–1.7)
PIM2 risk of mortality, %, mean (SD) *	2.2 (5.4)	3.6 (8.1)
Invasive ventilation used during admission *	29.6 (29.3–29.9)	33.3 (32.6–34)
Disposition		

Characteristic, % (95% CI)	Not readmitted n=99,532 (85%)	Readmitted n=15,625 (15%)
General ward *	65.5 (65.2–66.8)	56 (55.2–56.8)
Another ICU	2.3 (2.3–2.4)	2 (1.8–2.2)
Intermediate/telemetry unit †	12.1 (11.9–12.3)	14.2 (13.7–14.8)
OR	0.5 (0.4–0.5)	0.5 (0.4–0.7)
Chronic/rehabilitation facility *	0.8 (0.7–0.8)	2 (1.8–2.2)
Home *	17.8 (17.6–18)	20.8 (20.2–21.5)
Hospice †	0 (0–0.1)	0.2 (0.1–0.2)
Other †	0.9 (0.9–1)	0.3 (0.2–0.4)
LOS, days, median (IQR) *	1.6 (0.9–3.5)	2.5 (1.1–6)

CCC, complex chronic condition; CI, confidence interval; PACU, post-anesthesia care unit; ICU, intensive care unit; IQR, interquartile range; LOS, length of stay; OR, operating room; PIM, Paediatric Index of Mortality; PICU, pediatric intensive care unit; SD, standard deviation

† P < 0.05;

* P ≤ 0.001 by chi2 test, t-test, or Mann-Whitney *U* test

[a] Based on 72,558 (74%) index admissions from 55 sites that supplied race

[b] Based on 41,847 (43%) index admissions from 30 sites that supplied insurance

Table 3

Hazard ratios of predictor variables in base model of unplanned PICU readmission within one year[a]

Patient or admission variable	HR (95% CI)	P value
Complex chronic condition		
No CCC (reference)		
1 CCC	2.86 (2.68–3.05)	<0.001
2 CCC	4.78 (4.48–5.1)	<0.001
≥3 CCC	9.56 (8.98–10.2)	<0.001
Age		
0–1 months (reference)		
2–3 months	1.13 (1.03–1.24)	0.008
4-–5 months	1.08 (0.98–1.19)	0.11
6–17 months	0.96 (0.89–1.03)	0.26
18 mon – 4 yr	0.77 (0.71–0.83)	<0.001
5–9 years	0.66 (0.61–0.72)	<0.001
10–17 years	0.76 (0.71–0.82)	<0.001
18–29 years	0.76 (0.69–0.84)	0.001
≥30 years	0.71 (0.5–0.995)	0.047
Unplanned index admission	1.46 (1.37–1.55)	<0.001
Perioperative	0.7 (0.66–0.74)	<0.001
Trauma	0.57 (0.51–0.64)	<0.001
Admitted from another institution	0.85 (0.81–0.89)	<0.001
Invasive ventilation used during admission	1.09 (1.04–1.14)	<0.001
Disposition		
General ward (reference)		
Intermediate/telemetry unit	1.05 (0.99–1.11)	0.1
Another ICU	0.43 (0.36–0.52)	<0.001
Operating room	0.79 (0.63–0.99)	0.04
Chronic/rehabilitation facility	0.9 (0.8–1.02)	0.1
Hospice	0.24 (0.1–0.57)	0.002
Home	0.88 (0.84–0.92)	<0.001
Other	0.51 (0.38–0.69)	<0.001
Admitted to PICU with		
Pediatric beds		
≤110 (reference)		
111–249	1.72 (1–2.98)	0.05
≥250	2.18 (1.22–3.88)	0.008
ICU beds		
≤17 (reference)		
18–24	0.84 (0.63–1.13)	0.25
≥25	0.66 (0.51–0.84	0.001

CCC, complex chronic condition; CI, confidence interval; PACU, post-anesthesia care unit; ICU, intensive care unit; IQR, interquartile range; OR, odds ratio; PICU, pediatric intensive care unit

[a]Model adjusted for PICU site and the unit's average daily census by quarter at patients' discharge, as well as PIM2 score as cubic splines.

Table 4

Hazard ratios of specific chronic conditions in model of unplanned PICU readmission within one year[a]

Chronic condition/categories	HR (95% CI)	P value
Cardiac		
Arrhythmia, chronic	1.03 (0.87–1.23)	0.73
Congenital heart disease, simple	1.18 (1.1–1.28)	<0.001
Congenital heart disease, complex	1.45 (1.36–1.55)	<0.001
Heart failure, chronic	1.55 (1.4–1.72)	<0.001
Heart transplant	1.23 (0.92–1.6)	0.16
Pulmonary hypertension	1.13 (1.02–1.25)	0.02
Respiratory/airway		
Asthma	0.93 (0.88–0.99)	0.03
Bronchopulmonary dysplasia	1.54 (1.41–1.7)	<0.001
Cystic fibrosis	1.72 (1.39–2.12)	<0.001
Pulmonary hypoplasia	1.19 (0.9–1.59)	0.22
Upper airway anomaly	1.26 (1.18–1.34)	<0.001
Other chronic respiratory condition	1.63 (1.51–1.75)	<0.001
Neurologic		
Cerebral palsy	1.51 (1.42–1.61)	<0.001
Epilepsy	1.21 (1.14–1.28)	<0.001
Static encephalopathy or generalized developmental delay	1.7 (1.61–1.78)	<0.001
Hydrocephalus	1.36 (1.27–1.46)	<0.001
Muscular dystrophy	1.61 (1.38–1.88)	<0.001
Spina bifida	1.36 (1.21–1.53)	<0.001
Spinal cord injury (including paralysis)	1.23 (1.1–1.37)	<0.001
Spinal muscular atrophy, type 1	1.98 (1.69–2.33)	<0.001
Other neurologic/neuromuscular condition	1.65 (1.56–1.75)	<0.001
Oncologic		
Bone marrow transplant	1.40 (1.2–1.65)	<0.001
Central nervous system tumor	1.81 (1.67–1.96)	<0.001
Hemopoietic	2.11 (1.91–2.33)	<0.001
Solid tumor	1.82 (1.65–2)	<0.001
Gastrointestinal		
Liver failure	1.44 (1.26–1.64)	<0.001
Other GI condition	1.55 (1.42–1.69)	<0.001
Hematologic		
Sickle cell	1.41 (1.13–1.75)	0.002
Other hematologic	1.3 (1.17–1.45)	<0.001
Renal condition	1.52 (1.38–1.68)	<0.001
Endocrinologic		
Diabetes	1.54 (1.41–1.68)	<0.001
Other endocrinologic condition	1.38 (1.29–1.48)	<0.001

Chronic condition/categories	HR (95% CI)	P value
Metabolic condition	1.85 (1.72–1.98)	<0.001
Immunologic condition	1.64 (1.49–1.8)	<0.001
Genetic abnormality/syndrome	1.41 (1.34–1.49)	<0.001
Rheumatologic condition	1.29 (1.06–1.58)	0.01
Prematurity	1.21 (1.13–1.3)	<0.001
Congenital infection	1.69 (1.25–2.28)	0.001

CI, confidence interval; GI, gastrointestinal; HR, hazard ratio; PICU, pediatric intensive care unit;

[a]Model adjusted for age, unplanned admission, trauma admission, perioperative admission, sepsis during admission, use of invasive ventilation, disposition location, discharge season, number of pediatric hospital beds, number of PICU beds, PICU site, the unit's average daily census by quarter at patients' discharge, and PIM2 score.