RESEARCH ARTICLE

Preventability of 7-Day Versus 30-Day Readmissions at an Academic Children's Hospital

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ABSTRACT

BACKGROUND AND OBJECTIVES: The 30-day readmission rate is a common quality metric used by Medicare for adult patients. However, studies in pediatrics have shown lower readmission rates and potentially less preventability. Therefore, some question the utility of the 30-day readmission time frame in pediatrics. Our objective was to describe the characteristics of patients readmitted within 30 days of discharge over a 1-year period and determine the preventability of readmissions occurring 0 to 7 vs 8 to 30 days after discharge from a pediatric hospitalist service at an academic children's hospital.

METHODS: Retrospective chart review and hospital administrative data were used to gather medical characteristics, demographics, and process-level metrics for readmitted patients between July 1, 2015, and June 30, 2016. All readmissions were reviewed by 2 senior authors and assigned a preventability category. Subgroup analysis comparing preventability in 0-to-7– and 8-to-30–day readmissions groups was performed. Qualitative thematic analysis was performed on readmissions deemed preventable.

RESULTS: Of 1523 discharges that occurred during the study period, 49 patients, with 65 distinct readmission encounters, were readmitted for an overall 30-day readmission rate of 4.3% (65 of 1523). Twenty-eight percent (9 of 32) of readmissions within 7 days of discharge and 12.1% (4 of 33) occurring 8 to 30 days after discharge were deemed potentially preventable ($P = .13$). Combined, the 30-day preventable readmission rate was 20% (13 of 65).

CONCLUSIONS: We identified a possible association between preventability and time to readmission. If confirmed by larger studies, the 7-day, rather than 30-day, time frame may represent a better quality metric for readmitted pediatric patients.

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The readmission rate is a common metric used to assess the quality of health care delivered during hospital admissions.[1,2] In the adult population, the Centers for Medicare and Medicaid Services (CMS) has reduced reimbursement to hospitals for select conditions if their readmission rates reach certain thresholds, providing direct financial incentive to reduce readmission rates.[3,4] Although the CMS does not currently reduce reimbursement for pediatric readmissions, readmission rates within pediatrics are still used to assess quality of care but not in the disease-specific manner seen with adults.[5–8] Beyond the cost to the health care system, readmissions can represent significant financial and psychological burdens to families, often requiring caregivers to take leave from work, pay for child care for other dependents, or pay for housing and transportation to be nearer to the hospital.[9–12]

Traditionally, the CMS and insurers have used the 30-day time frame from discharge to readmission as the main readmission-related quality metric.[13] In adults, this time frame is used because adults have high rates of readmission within this time period, and many of these readmissions may be preventable.[14] Studies in pediatrics, however, have shown lower overall admission and 30-day readmission rates and potentially less preventability.[15–17] Hence, the 30-day readmission rate may have limited utility as a quality metric in the pediatric population.

Shorter readmission time frames have been examined in both pediatric and adult populations.[16,18–22] An analysis by Hain et al[16] of 15-day readmissions in pediatrics found that 20% of cases were deemed preventable, but this was not compared with 30- or 7-day rates. In another study of pediatric patients, using a different readmission preventability tool, Toomey et al[19] found that 30% of 30-day readmissions were preventable and that readmissions that occurred closer to the index admission were more likely to be deemed preventable. Studying adult patients, Graham et al[18] found that readmissions within 7 days of discharge were preventable 20% of the time compared with 10% for those that occurred 8 to 30 days after discharge. Hence, they proposed that the 7-day readmission rate may be a better quality metric for adult patients. We postulated that similar findings

TABLE 1 Demographics and Process Measures

	Readmitted Patients ($N = 49$)	Nonreadmitted Patients ($N = 1341$)	P[a]
Age,[b] y, mean (SD)	5.3 (5.9)	4.2 (5.7)	.18
Sex, *n* (%)			.42
Female	26 (53.1)	633 (47.2)	
Male	23 (46.9)	708 (52.8)	
Race, *n* (%)			.71
White	39 (71.4)	1007 (75.1)	
African American	0 (0.0)	39 (2.9)	
Asian American	2 (4.1)	44 (3.3)	
Other or multiracial	7 (20.4)	189 (14.1)	
Declined or unavailable	1 (4.1)	62 (4.6)	
Ethnicity, *n* (%)			.41
Hispanic	14 (28.6)	260 (19.4)	
Non-Hispanic	33 (67.3)	970 (72.3)	
Declined or unavailable	2 (4.1)	111 (8.3)	
Insurance type, *n* (%)			.008
Private	6 (10.2)	502 (37.4)	
Public	43 (87.8)	804 (60.0)	
Military	0 (0.0)	28 (2.1)	
Uninsured	0 (0.0)	5 (0.4)	
Other or unknown	0 (0.0)	2 (0.1)	
Index LOS, d, median (IQR)[b]	4.0 (1.5–6.5)	2.0 (1–4)	<.001
Readmission LOS, d, median (IQR)[c]	3.0 (2–7)	—	—
Originating in ED[b]	18 (36.7)	395 (29.5)	.27
Day of discharge[b]	—	—	.08

ED, emergency department; IQR, interquartile range; —, not applicable.
[a] χ^2, *t*, or Mann-Whitney rank-sum test used to calculate *P* values.
[b] Calculated by using index admission.
[c] Calculated by using readmission encounters ($n = 65$).

may occur within the pediatric population. We therefore conducted a study to describe the characteristics of readmitted patients over a 12-month period and compare the preventability of readmissions occurring within 7 days of discharge to those occurring 8 to 30 days after discharge.

METHODS

Study Design and Participants

We conducted a retrospective cohort study of unplanned hospital readmissions within 30 days of discharge at our 151-bed academic children's hospital located in the Pacific Northwest. A convenience sample consisting of all patients <18 years of age who had at least 1 discharge from the pediatric hospitalist service between July 1, 2015, and June 30, 2016, were included in the study. Patients with an additional admission occurring ≤30 days after discharge that resulted in another discharge from the pediatric hospitalist service were considered readmitted patients. To account for readmissions of patients discharged during the final month of the study period (June 2016), all patients discharged during this time period were monitored for 30 days, and any readmissions occurring during this time frame were included in analysis. We excluded discharges due to planned readmissions, discharges whose primary admission was to the newborn nursery or NICU, and discharges from services other than the pediatric hospitalist service.

Data Collection

Hospital administrative data for all patients discharged from the pediatric hospitalist service were obtained, deidentified, and secured by using Health Insurance Portability and Accountability Act–compliant cloud storage software and used for statistical comparison with readmitted patients. Retrospective chart review and hospital administrative data were used to gather demographic information, medical characteristics, and process-level metrics for readmitted patients. Deidentified study data were entered and managed in a secure, Web-based database called Research Electronic Data Capture.[23]

Outcomes

We had 2 main aims in the study. The first aim was to describe the characteristics of patients readmitted to the pediatric hospitalist service within 30 days of discharge, and determine the 30-day readmission rate, over a 1-year period. The first discharge from the pediatric hospitalist service during the study period was defined as the index admission regardless of the admitting service (eg, PICU). Any subsequent admissions within 30 days of discharge that resulted in discharge from the pediatric hospitalist service during the study period were defined as readmissions. Patients with multiple admissions during the study period had each admission or readmission encounter included in readmission rate and preventability analyses, but only the index admission was used in demographic analyses. The readmission rate was calculated by using the total number of readmission encounters as the numerator and the total number of discharge encounters as the denominator.

The second aim was to compare the preventability of readmissions occurring in the first 7 days after discharge to those readmitted 8 to 30 days after discharge. Using previously described methods,[16] each readmission within 30 days of discharge was reviewed by 2 senior authors, and a preventability category was assigned after consensus was reached. Subgroup analysis was performed to compare the preventability of 0-to-7–day versus 8-to-30–day readmissions. Additionally, directed qualitative content analysis[24] was undertaken by 2 senior authors to determine themes for those readmissions deemed preventable.

Covariates of Interest

We characterized the demographic makeup of the readmitted population and assessed for differences when compared with nonreadmitted patients. Demographic variables included age, sex, race, ethnicity, primary language, and insurance type. Similarly, process metrics, including length of stay (LOS), day of the week of discharge (calculated as a categorical variable), and percentage originating from an emergency department were compared between the readmitted and nonreadmitted groups. Problem list diagnosis categories, the presence of durable medical devices, and the number of specialties consulted during hospitalization were obtained during chart review of readmitted patients and used as proxies for medical complexity.

Statistical Analysis

Data were analyzed by using SPSS statistical analysis software (version 24; IBM SPSS Statistics, IBM Corporation). We used descriptive statistics to characterize the overall population and χ^2, *t*, or Mann-Whitney rank-sum tests to compare groups. We compared 0-to-7–day readmissions to 8-to-30–day readmissions on demographic variables and preventability using χ^2, *t*, or Fisher's exact tests.

Ethical Considerations

This study was approved by the Oregon Health and Science University institutional review board (00016971).

RESULTS

Demographics

Of 1390 individual patients discharged from the pediatric hospitalist service during the study period, 49 were readmitted with 65 distinct readmission encounters (Table 1). The total number of discharge encounters during the study period was 1523 (each patient could have multiple admissions and/or discharge encounters) for an overall readmission rate of 4.3% (65 of 1523). Bivariate analysis did not demonstrate significant differences between those who were readmitted versus those who were not in regard to age, sex, race, or ethnicity (Table 1). However, more readmitted patients had public insurance compared with nonreadmitted patients (87.8% vs 60%; $P = .008$; Table 1).

Process Measures

Readmitted patients had longer median LOS for their index admissions than nonreadmitted patients (4 vs 2 days, respectively; $P < .001$; Table 1). There was

no difference in likelihood of the index admission originating in the emergency department between the readmitted and nonreadmitted groups (36.7% vs 29.5%; $P = .27$). The day of the week of discharge from the hospital did not differ between the 2 groups (Table 1).

Description of Readmitted Patients

Thirty-two readmissions (49.2%), involving 27 individual patients, occurred within 7 days of discharge, and 33 readmissions (50.7%), involving 29 individual patients, occurred from 8 to 30 days after discharge (Table 2). Neurologic conditions accounted for the most common diagnostic category among readmitted patients at 59.2%, followed by pulmonary conditions at 49.0% and gastrointestinal and genetic and/or metabolic conditions, each present in 42.9% of patients (Table 2). Sixty-one percent of patients had diagnoses in at least 4 categories. Nearly two-thirds (65.3%) of readmitted patients used a durable medical device, the most common being a feeding tube (87.5%), followed by tracheostomy (15.6%). Readmitted patients received a median of 2 specialty consults (range 0–7; Table 2).

Subgroup Analysis: 0-to-7–Day Versus 8-to-30–Day Readmissions

Twenty patients had readmissions in the 0-to-7–day time frame, 22 patients had readmissions in the 8-to-30–day time frame, and 7 patients had readmission encounters in both time frames. The 7 patients with readmission encounters in both time frames were assigned to the 0-to-7–day group for demographic analysis (Table 3). Bivariate analysis comparing 0-to-7– to 8-to-30–day readmissions did not demonstrate any significant differences in demographics (Table 3). In analyzing preventability, 28.1% (9 of 32) of 0-to-7–day readmissions and 12.1% (4 of 33) of 8-to-30–day readmissions were deemed potentially preventable ($P = .13$; Table 4). The combined 0-to-30–day preventability rate was 20.0% (13 of 65). Qualitative analysis of preventable cases revealed several themes: discharge too early, inadequate outpatient equipment services, inadequate in-hospital care, inadequate follow-up, inadequate communication between care teams, and inadequate outpatient management (Table 5).

DISCUSSION

We found that ~1 in 5 readmissions occurring in the first 30 days after discharge were potentially preventable. Readmissions occurring within 7 days were more than twice as likely to be judged as preventable as those occurring between 8 and 30 days after discharge, although this result was not statistically significant. However, this difference is consistent with other studies of preventability,[16,18,19,22] and this finding

TABLE 2 Description of Readmitted Patients

	Frequency ($N = 49$)[a]
Primary language, *n* (%)	
English	42 (85.7)
Spanish	4 (8.2)
Other	3 (6.1)
Problem list diagnosis by category,[b] *n* (%)	
Neurologic	29 (59.2)
Pulmonary	24 (49.0)
Developmental or intellectual disability	24 (49)
Gastrointestinal	21 (42.9)
Genetic and/or metabolic disorder or congenital anomaly	21 (42.9)
Failure to thrive and/or eating disorder	12 (24.5)
Infectious disease	10 (20.4)
Endocrine	8 (16.3)
Hematologic	8 (16.3)
Genitourinary and/or renal	8 (16.3)
Cardiac	7 (14.3)
Prematurity (<37 wk)	6 (12.2)
Pain	5 (10.2)
Obesity	3 (6.1)
Cancer and/or transplant	2 (4.1)
Other	8 (16.3)
Only 1 diagnosis category	8 (16.3)
Diagnosis in ≥4 diagnosis categories	30 (61.2)
Presence of durable medical device,[b] *n* (%)	32 (65.3)
Feeding tube	28 (87.5)
Tracheostomy	5 (15.6)
Ventilator	2 (6.3)
Ventriculoperitoneal shunt	5 (15.6)
Baclofen pump	1 (3.1)
Central line	3 (9.4)
Other	1 (3.1)
Specialty consults,[b] No., median (range)	2 (0–7)
Time to readmission,[c] d, *n* (%)	
≤7[d]	32 (49.2)
8–30[e]	33 (50.7)

[a] $N = 49$ unique patients.
[b] Calculated cumulatively by using index admission and all subsequent admissions ($n = 65$ encounters).
[c] By encounter, calculated by using time between discharge-readmission encounters ($n = 65$).
[d] $N = 27$ patients and 32 encounters.
[e] $N = 29$ patients and 33 encounters.

TABLE 3 Comparison of Readmitted Patients by Readmission Time Frame

	0–7 d (*N* = 27 Patients)	8–30 d (*N* = 22 Patients)	*P*[a]
Age,[b] y, mean (SD)	5.4 (5.8)	4.9 (6.3)	.77
Sex, *n* (%)			.45
Female	13 (48.1)	13 (59.1)	
Male	14 (51.9)	9 (40.9)	
Race, *n* (%)			.35
White	22 (81.5)	17 (77.3)	
African American	0 (0.0)	0 (0.0)	
Asian American	0 (0.0)	2 (9.1)	
Multiracial or other	4 (14.8)	3 (13.6)	
Declined or unavailable	1 (3.7)	0 (0.0)	
Ethnicity, *n* (%)			.41
Hispanic	7 (25.9)	7 (31.8)	
Non-Hispanic	18 (66.7)	15 (68.1)	
Declined or unavailable	2 (7.4)	0 (0.0)	
Language, *n* (%)			.54
English	23 (85.1)	19 (86.4)	
Spanish	3 (11.1)	1 (4.5)	
Other	1 (3.7)	2 (9.1)	
Insurance, *n* (%)			.64
Private	3 (11.1)	3 (13.6)	
Public	24 (88.9)	19 (86.4)	

Patients with encounters in both time frames ($n = 7$) were assigned to the 0-to-7–d group.
[a] χ^2 or *t* tests used to calculate *P* value.
[b] Mean age calculated by using age at time of index admission.

supports the notion that using a shorter readmission time frame could represent a more meaningful quality metric. Our study also confirmed findings from other studies concerning the readmitted patient population: that they have high medical complexity, have longer LOS, and are more likely to have public insurance.[7,25–27]

Using qualitative methods, we found that the reasons for preventability were varied and specific to the patient care delivered during admission. Use of discharge checklists and readiness tools,[28–30] which stress process metrics (such as medications available at discharge and primary care provider notification), would have mitigated perhaps 3 readmissions (1 with a medication error [coded as inadequate outpatient management], 1 without appropriate home supplies [coded as inadequate outpatient equipment services], and 1 without timely follow-up with a primary care provider [coded as inadequate follow-up]). Each of these readmissions occurred within the 7-day time frame, showing the potential importance of such tools for this group of patients. Such checklists would not have addressed the majority of the preventable readmissions, especially those occurring in the 8-to-30–day time frame.

TABLE 4 Readmission Preventability: 0 to 7 vs 8 to 30 Days After Discharge

	0–7 d	8–30 d	*P*
Category[a]			
1: Readmission not preventable in most circumstances	9	13	
2: Readmission more likely not preventable	14	13	
3: Readmission of uncertain preventability	1	2	
4: Readmission more likely preventable	6	2	
5: Readmission preventable in most circumstances	3	2	
Preventable[c]	28.1% (9 of 32)	12.1% (4 of 33)	.13[b]

[a] As described in Hain et al.[16]
[b] *P* value calculated by using Fisher's exact test.
[c] Preventable = sum of categories 4 and 5.

Development of appropriate contingency care plans for parents and ambulatory providers would have addressed those patients whose readmissions were related to the themes of inadequate follow-up and inadequate outpatient management. Better communication among primary care and subspecialist providers, and tools to improve in-hospital care, may have mitigated those readmissions related to the themes of inadequate communication between care teams and inadequate in-hospital care. Challenges around inpatient to outpatient communication, frequent staff turnover, quality metrics related to decreasing LOS, and institutional pressures to optimize bed capacities will need to be considered to address some of these issues. Despite these challenges, the use of qualitative methods to identify themes related to preventable readmissions was useful for identifying potential solutions and could be further refined in future studies.

The readmission preventability rate within our cohort of 20% was similar to that reported by Hain et al[16] but lower than that reported by Toomey et al.[19] The difference in these numbers may reflect the unique characteristics of the preventability scale used. For example, Hain et al[16] proposed a 5-point scale, whereas Toomey et al[19] used a 4-point scale. The main difference between these scales was the presence of a category for uncertain preventability. Among others, reasons for readmission may be related to the medical condition of the patient, caregiver driven, or due to health system limitations in the patient's geographic area. Given the complexity of factors leading to readmission, we believe including

TABLE 5 Description of <30-Day Preventable Readmissions

Patient[a]	Problem List	Day(s) to Readmission	Technology Dependence	Preventability Category[b]	Notes	Theme
1	Pneumonia[c] Spastic quadriplegic[d] Cerebral palsy[d]	1	Yes	5	Discharged with pending blood culture; result positive at 29 h	Discharge too early
2	Viral bronchiolitis[c] Cerebral palsy[d] Developmental delay[d]	1	Yes	4	Family preference, family felt uncomfortable with care	Discharge too early
3	Viral bronchiolitis[c] Dehydration[d] Otherwise healthy[d]	1	No	4	Initial admission to PICU; discharge 1 d after transfer to floor	Discharge too early
4	Acute hypoxic respiratory failure[c] Cerebral palsy[d] Epilepsy[d]	2	Yes	5	Home health supplies (eg, chest percussion vest or hospital bed) delivery delayed	Inadequate outpatient equipment services
5	Increased seizure frequency in setting of acute viral illness[c] Congenital disorder of glycosylation[d] hypercalciuria[d]	2	Yes	4	Did not have primary care provider follow-up in timely manner; on readmission unchanged clinical status	Inadequate follow-up
6	MRSA infection[c] Complement deficiency[d] Chronic hepatitis B[d]	3	No	4	Subspecialist not contacted before readmission; could have changed antibiotics outpatient	Inadequate communication between teams
7	Altered mental status from phenytoin toxicity[c] Epilepsy[d]	5	Yes	5	New medication started; inadequate outpatient drug level monitoring	Inadequate outpatient management
8	Bullous lesion on face[c] Otherwise healthy[d]	5	No	4	Needed better outpatient coordination with subspecialist	Inadequate follow-up
9	MSSA sepsis associated with avascular necrosis left hip[c] Otherwise healthy[d]	6	No	4	Needed additional surgical management before discharge	Inadequate in-hospital care
10	Pneumonia[c] Central line–associated bloodstream infection[d]	11	Yes	5	Nasojejunal tube pulled out at home; gastrostomy tube could have been converted to gastrojejunal tube before discharge	Inadequate in-hospital care

TABLE 5 Continued

Patient[a]	Problem List	Day(s) to Readmission	Technology Dependence	Preventability Category[b]	Notes	Theme
	Complex genetic syndrome[d]					
	Epilepsy[d]					
11	**Kawasaki disease**[c]	11	No	4	Kawasaki disease not treated during first hospitalization	Inadequate in-hospital care
	Otherwise healthy[d]					
12	**Enteroviral vesicular stomatitis**[c]	21	No	5	Diagnostic error: misdiagnosis of a self-limited viral illness	Inadequate outpatient management
	Developmental delay[d]					
	Sensorineural hearing loss[d]					
13	**Conversion disorder**[c]	28	No	4	Subspecialty consultation (eg, psychology) not done during initial admission for diagnosis of nonepileptic seizures	Inadequate in-hospital care
	Otherwise healthy[d]					

MRSA, methicillin-resistant *Staphylococcus aureus*; MSSA, methicillin-sensitive *S aureus*.

[a] Patients listed in ascending order in time from discharge to readmission.

[b] Categories include the following: 1 = readmission not preventable in most circumstances; 2 = readmission more likely not preventable; 3 = readmission of uncertain preventability; 4 = readmission more likely preventable; and 5 = readmission preventable in most circumstances.

[c] Principal discharge diagnosis listed first (in bold).

[d] Subsequent contributing diagnoses (in italics).

a category of uncertainty is important and more accurately reflects the reality of the readmission process. However, in our study, only 5% of patients fell into the uncertain preventability category.

A recent study by Rodriguez et al[22] further highlights the challenge of determining preventability. The researchers deemed 48% of 3-day readmissions preventable by external chart review, but only 29% to 35% were preventable when determined by discharging and readmitting providers. Furthermore, when taking into account parental opinions, preventability dropped to 25%. This study reinforced the difficulty of determining preventability by chart review, wherein the various nuances of clinical situations may not be fully realized, and hence, preventability rates may be overestimated. Although it is tempting to suggest that the solution to this problem is the development of better prediction models using hospital administrative databases, these analytical models can easily miss unique aspects of clinical management and patient influences. Instead, because the overall numbers of readmissions are low (4.3% in our study), and only a fraction of those are potentially preventable (20% in our study), focusing on individual patient populations, mainly those with complex medical conditions, who consume a larger proportion of health care resources and the bulk of readmissions is more likely to be fruitful.[27,31–36] Intensifying efforts around care coordination,[37,38] particularly involving communication between inpatient and outpatient providers, and primary care and subspecialty providers may be beneficial in reducing overall health care use for this patient population.

Our study had several important limitations. First, it was conducted within a single pediatric hospital medicine service at a medium-sized academic health center over a 1-year period, which limits its overall generalizability and statistical power. Hence, although we did not see a statistical difference in preventability between 0-to-7– and 8-to-30–day readmission time frames, given the sample size, this may reflect a type II error. Assuming a 20%

difference in preventability between the 2 groups (30% vs 10%) powered at 80% with an α of .05, a study would need to include ~124 encounters to detect a significant difference. Thus, conducting larger studies over multiple years, and including additional inpatient services, would address these problems of power and generalizability. Second, we used a tool for determining preventability that is imperfect and subject to interpretation. Additionally, having >2 researchers reach consensus when coding preventability, and using blinded methodology, would reduce the risk of decision bias. Further research into developing more accurate, objective tools to assess and code preventability are needed to address these issues.

CONCLUSIONS

Readmissions occurring within 0 to 7 days of discharge were more likely to be preventable than those occurring 8 to 30 days after discharge. Hence, the 7-day time frame may represent a better quality metric than the 30-day time frame for readmissions of pediatric patients. The overall preventability rate of 20% for all readmissions within 30 days was similar to other studies. Future efforts focused on improving care coordination and discharge planning, especially for patients with complex medical conditions, should be prioritized.

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