Published in final edited form as:

Pediatr Blood Cancer. 2012 January ; 58(1): 61–65. doi:10.1002/pbc.23221.

Thirty-Day Readmission Rates Following Hospitalization for Pediatric Sickle Cell Crisis at Freestanding Children's Hospitals: Risk Factors and Hospital Variation

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Abstract

Background—Readmission within 30 days after hospitalization for sickle cell crisis was developed by The National Association of Children's Hospitals (NACHRI) to improve hospital quality, however, there have been few studies validating this.

Procedure—We performed a retrospective examination of 12,104 hospitalizations for sickle crisis from July 1, 2006 and December 31, 2008 at 33 freestanding children's hospitals in the Pediatric Health Information System (PHIS) database. Hospitalizations met NACHRI criteria; inpatient admission, APR DRG code 662, age < 18, discharge home, and length of stay within 2 SD of the mean. We describe 30-day readmission rates, identify factors associated with readmission accounting for patient-level clustering and compare unadjusted versus adjusted variation in readmission rates.

Results—We identified 4,762 patients with 12,104 qualifying hospitalizations (1–30 per patient). Two thousand seventy-four (17%) hospitalizations resulted in a readmission within 30 days. Significant factors associated with readmission were age (OR 1.06/year, $P < 0.0001$), inpatient use of steroids (OR 1.48, $P = 0.01$) admission for pain without other sickle complications (OR 1.52, $P < 0.0001$) and simple transfusion (OR 0.58, $P = 0.0002$). There was significant variation in readmission rates between hospitals, even after accounting for clustering by patient and hospital case mix.

Conclusions—In a sample of free-standing children's hospitals, 17% of hospitalizations for sickle cell crisis result in readmission within 30 days. Older patients, those treated with steroids and those admitted for pain are more likely to be readmitted; simple transfusion is protective.

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Conflict of interest: Nothing to declare.

Even after adjusting for case mix substantial hospital variation remains, but specific hospital to hospital comparisons differ depending on the exact methods used.

Keywords

health services research; pediatrics; readmission rates; sickle cell disease

INTRODUCTION

Thirty-day readmission rates are gaining use in medicine as a marker of healthcare quality [1]. The Centers for Medicare and Medicaid Services (CMS) now publicize 30-day readmission rates for acute MI, heart failure and pneumonia, and hospitals with high rates of preventable readmissions may face reduced reimbursement [2]. The recent Patient Protection and Affordable Care Act includes a provision for a hospital readmissions reduction program [3]. The rationale for targeting readmissions is the premise that having a high readmission rate not only reflects on the quality of the index hospitalizations, but may also highlight areas for improvement in discharge practices and the transition to outpatient care [4,5].

Readmission within 30 days after admission for sickle cell crisis was developed as a non-core ORYX measure by The National Association of Children's Hospitals (NACHRI) as a way to drive internal hospital quality improvement [6,7]. However, to date there have been few studies to validate this marker and debate remains as to its value. One single-institution study identified co-morbid asthma, oxygen within 24 hr of discharge, disease severity and lack of clinic follow-up within 30 days as factors associated with higher risk of readmission, however, their study design did not allow for an actual estimate of readmission rates [6,8]. A NACHRI, multi-state study of sickle cell disease care utilization found an overall readmission rate of 33.4%, with lower rates in children (12.8% in children age 1–9 and 23.4% for patients ages 10–17); however, it did not examine factors other than age associated with readmission [9]. Corticosteroids have also been implicated in higher sickle cell readmission rates, specifically after a diagnosis of acute chest syndrome [10,11], although this has not been shown in all studies [12]. Use of a standardized sickle cell pain plan has been shown to reduce readmission rates [8,13]. Finally, work in other diseases has identified African-American race, public insurance, neighborhood conditions, including high measures of poverty, patient complexity, disease severity, and weekend discharge as factors leading to greater risk of readmission with comprehensive discharge planning being shown to reduce readmissions rates [13–16].

Because of the need for quality markers in SCD, and the fact that the 30-day readmission rate has recently come under scrutiny, we aimed to assess this measurement in a large database. Our study aimed to (1) describe the overall rate of readmission within 30 days following hospitalization for sickle cell crisis among children's hospitals in a national database, (2) identify factors associated with early readmission, and (3) describe hospital variation and the effect of adjusting for individual patients and case mix.

METHODS

Data Source

Data were obtained from the Pediatric Health Information System (PHIS) database, which contains administrative and billing data from over 40 freestanding, non-competing pediatric hospitals in the United States that are affiliated with the Child Health Corporation of America (Shawnee Mission, KS). The majority are teaching hospitals in large metropolitan areas. We limited our analysis to the 33 hospitals that provided both discharge data (patient demographics, diagnosis, and procedure codes) and resource utilization data (pharmacy and clinical charges) to PHIS during the study period, and had at least 50 qualifying admissions. Data are de-identified; however, a unique patient identifier is included so patients may be tracked across encounters. Reliability and validity checks are applied to the data by the participating hospitals and by the Child Health Corporation of America. The study protocol was approved by the Institutional Review Board at Children's Hospital Boston.

Population/Sample

We included all hospitalizations for sickle cell crisis between July 1, 2006 and December 31, 2008 which met NACHRI's Pediatric Quality Measurement System definition [17]. Hospitalizations were limited to inpatient admissions with an APR DRG version 20 code of 662 (sickle cell anemia crisis, which includes HbSS, HbSC, or HbS Beta/thal), including all severity levels (1–4) for patients age less than 18 discharged to home with a length of stay within 2 SD of the mean. We eliminated any index admission between December 1, 2008 and December 31, 2008 since we did not have a full 30 days of follow-up for those patients.

Exposure/Outcome

The unit of analysis was each unique hospitalization. Our main outcome measure was whether each hospitalization was followed by a readmission within 30 days.

Additional Variables

We chose multiple variables to analyze that we felt might reasonably be associated with readmission rates. These included patient demographics (age, gender, race, and sickle genotype), payer (government, private, or other), hospitalization factors (length of stay, discharge day of the week and season), co-morbidities (asthma, acute chest syndrome), additional therapies (corticosteroids, hydroxyurea, oxygen, oxygen on the day of discharge, narcotic pain medication, simple and exchange transfusions, ICU care and ventilatory support), APR-DRG severity score, and hospital factors (number of beds or number of sickle admissions during study period). Many of these factors (age, asthma, public insurance, weekend discharge, oxygen on the day of discharge, use of corticosteroids, hospital size) were factors identified from a literature review as being associated with readmission rates [6,11,15,16,18,19]. Since there is no universally agreed upon measure of sickle cell disease severity, we chose multiple markers such as the need for higher level care, APR-DRG score and comorbidities as proxies for disease severity based on clinical experience.

Winter was defined as December–March according to peak influenza season. Acute chest was defined as either the ICD-9 code for acute chest syndrome, or any ICD-9 code for

pneumonia. The APR-DRG severity scale is a 4-point scale calculated on a disease-specific basis using an algorithm which combines primary and secondary ICD-9 diagnosis and procedure codes [20] and has been shown to be a sensitive measure of hospital case mix [21]. Because uncomplicated pain crisis is not clearly identifiable by ICD-9 code, we created a composite variable for pain, defined as an admission for sickle cell crisis during which narcotic pain medication was given, without any other identifiable sickle complication (acute chest, pneumonia, splenic sequestration, priapism) or fever.

Analysis

Factors associated with readmission rates—We examined the association between each candidate risk factor and the outcome of readmission within 30 days with univariate logistic regression using generalized estimating equations (GEE) to account for potential correlation in outcomes between repeated hospitalizations within an individual patient [22–24]. Variables with P -value < 0.20 were then considered for inclusion in a multiple logistic regression model to identify factors independently associated with readmission rates. Variables with adjusted P -values < 0.01 were retained in the final model.

Crude and adjusted readmission rates—We initially examined crude readmission rates for each hospital. Because some patients were represented multiple times in the dataset, we then examined readmission rates accounting for repeated measures within patients by using GEE. Finally, since we hypothesized that hospital which saw sicker patients would have higher readmission rates, we further adjusted for case mix using the variables found to be significant in the final multivariate model. Data were analyzed using SAS software, Version 9.1 of the SAS System for Windows (SAS Institute, Inc., Cary, NC).

RESULTS

Patient Characteristics

During the study period there were 12,104 qualifying admissions for sickle cell crisis among the 33 hospitals that met our entry criteria. This represented 4,762 individual patients, with a range of 1–30 (median 2.0) sickle cell crisis admissions per patient during the 30 months of the study period. Almost half (49%) of patients had a single admission, 20% had two admissions and 31% had three admissions or more. Fewer than 20% of patients accounted for 50% of total admissions.

Overall 2,074 hospitalizations (17%) resulted in a readmission within 30 days. Time to readmission ranged from 0 to 30 days, with a median of 13 days. Nine hundred fifty-one patients (20%) had at least one hospitalization leading to a readmission within 30 days (range 1–25). Characteristics of the study population, including baseline differences between the group that was readmitted within 30 days and the group that was not, after accounting for clustering by patient, are in Table I.

Hospitalizations that were a readmission (i.e., fell within 30 days of a prior admission) were more likely to be for pain (univariate OR 2.26, $P < 0.0001$), and less likely to be associated with transfusion (OR 0.71, $P < 0.0001$) oxygen (OR 0.67, $P < 0.0001$), or acute chest (OR 0.55, $P < 0.0001$).

Factors Associated With 30-Day Readmission

In the final multivariate model accounting for clustering by patient, older age, use of corticosteroids, and hospitalization for pain were associated with higher odds of readmission within 30 days. Simple red cell transfusion was associated with a lower odds of readmission. See Table II for detailed results.

Readmission Rates by Hospital

Crude readmission rates by hospital ranged from 5.4% to 26.1% (mean 13.9%). After accounting for clustering by patient the rate ranged from 3.3% to 14% (mean 8.3%). After additionally accounting for case mix by adjusting for significant factors from our final multivariate model the readmission rate ranged from 2.3% to 13.3% (mean 5%). However, individual hospital rankings differed depending on the method used (Fig. 1).

DISCUSSION

This is the first multi-site study to compare readmission rates for children with sickle cell disease across hospitals, to account for clustering by patient, and to examine factors associated with readmission. We found striking differences in readmission rates across hospitals, even after accounting for patient mix. Our finding that patients admitted for pain are more likely to be readmitted gives a focus for quality improvement in reducing readmission rates.

There are no national benchmarks for readmission in sickle cell disease. However, our findings of an overall 17% readmission rate is similar to published readmission rates of 15% for pediatric patients with asthma, and 12.8–23.4% for patients with SCD under age 18 [9,15,25]. However, it is a lower rate than prior studies in adult sickle cell disease which identified a 50% readmission rate following admission for painful crisis and an overall readmission rate of 33.4% [9,26]. Our data again support the fact that admissions, and readmissions, increase with age [19].

We found that older patients, patients treated with corticosteroids, and those hospitalized for pain were more likely to be readmitted within 30 days, while patients who received a red cell transfusion were less likely to be readmitted. This may indicate that early readmission is, at least in part, a sign of disease severity. Age and reason for admission are not modifiable risk factors; however, by identifying patients at higher risk of readmission, clinicians can better focus interventions designed to reduce preventable readmission rates. The fact that patients admitted with pain but without other identifiable sickle cell complications have a higher rate of early readmission is particularly striking, especially since the readmissions were also more likely to be for pain rather than other sickle complications. This may indicate that we are still under treating pain, especially in the outpatient setting, and that a focus on more aggressive home symptom management may prevent some bounce-back admissions.

Our data on hospital variation in readmissions rates showed that almost all hospitals had a significant drop in readmission rate after we accounted for patient clustering. This agrees with what we see clinically and has recently been shown to be true; that a small number of

patients account for a disproportionate number of admissions [9]. If crude readmission rates are used as a measure of hospital quality, we will not be accounting for these challenging patients whose needs for both inpatient and outpatient services are significant.

Further adjusting for case mix resulted in an additional decrease in readmission rates, although less striking than the change seen when accounting for clustering by patient. This indicates that there are still hospital factors that contribute to the variation in readmission rates that are not accounted for in our model. These may represent unknown patient factors, or systems factors such as access to follow-up care. This finding raises an important point; rather than simply comparing crude readmission rates, it might be a better marker to examine adjusted rates per hospital taking into account case mix and repeated patients, as well as track changes over time.

Our data were limited to the inpatient setting, so information on discharge planning or outpatient follow-up, both of which may be important means of reducing preventable readmissions, is lacking. However, one advantage of our study is that it used all hospitalizations and accounted for clustering by patient. Other studies of readmission have used the initial hospitalization only, which does not account for the fact that a small number of patients disproportionately account for high rates of inpatient use.

There has been much discussion about the usefulness of 30-day readmission rates as a quality marker. A recent study showed that states with higher ranking health systems also had higher readmission rates [27]. Therefore, higher readmission rates may reflect worse disease, or conversely, may indicate better access to care leading to higher hospital utilization. CMS, in their published data on 30-day readmission rates for adult conditions, calculates a risk-adjusted standardized rate that attempts to account for the difference in case mix between hospitals [4].

We suggest that more input and analysis is needed before using the 30-day readmission rate as a marker of hospital quality for sickle cell crisis. If readmission rates for patients with SCD are going to be used for this purpose then we propose that rates be adjusted for case mix and for clustering by patient, given that this is a chronic disease where the burden on the healthcare system is often based on a subset of patients. Finally, as healthcare providers we should consider ways to develop clinically relevant process or outcomes measures to track across institutions, rather than using measures developed by outside institutions.

ACKNOWLEDGMENT

Dr. Sobota was supported during this work by the Harvard Pediatric Health Services Research Fellowship, funded by AHRQ T32 NRSA: HS000063. Dr. Neufeld is supported by NIH K24 grant HL004184.

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Fig. 1. Readmission rates by hospital showing crude (unadjusted) rate, rate after accounting for clustering by patient, and rate after further adjusting for case mix; in ascending order by crude readmission rate.

TABLE I
 Characteristics of Hospitalizations: Comparison Between Hospitalizations That Did and Did Not Result in Readmission

Variable	Cohort (n = 12,104)	Not readmitted (10,030)	Readmitted (2074)	OR ^a	P-value ^d
Pain ^b	7,147 (59%)	5,610 (56%)	1,537 (74%)	1.06	<0.0001
Simple transfusion	2,402 (20%)	2,155 (21%)	247 (12%)	0.93	<0.0001
Acute chest syndrome	2,623 (22%)	2,377 (24%)	246 (12%)	0.94	<0.0001
Length of stay (days)	3.6 ± 2.3	3.6	3.8	n/a	<0.0001
Age	10.8 ± 5.2	10.4	12.6	n/a	<0.0001
DRG severity	1.6 ± 0.74	1.6	1.5	n/a	<0.0001
Exchange	192 (1.6%)	177 (1.8%)	15 (0.72%)	0.93	0.001
Fever	1,832 (15%)	1,614 (16%)	218 (10%)	0.97	0.0017
Oxygen	2,205 (18%)	1,922 (19%)	283 (14%)	0.97	0.0035
Narcotics	10,597 (88%)	8,638 (86%)	1,959 (94%)	1.03	0.01
Winter (Dec–March)	3,454 (28%)	2,819 (28%)	635 (31%)	1.02	0.023
ICU	415 (3.4%)	376 (3.8%)	39 (1.9%)	0.95	0.025
Hydroxyurea	2,683 (22%)	2,044 (20%)	639 (31%)	0.97	0.039
Splenic sequestration	701 (5.8%)	627 (6.2%)	74 (3.6%)	0.97	0.064
HbSS	9,812 (81%)	8,092 (81%)	1,720 (83%)	1.02	0.065
Number of hospital beds	298 ± 100	299	292	n/a	0.15
Priapism	94 (0.78%)	65 (0.65%)	29 (1.4%)	1.08	0.16
Steroids	717 (5.9%)	584 (5.8%)	133 (6.4%)	1.02	0.19
Ventilator	269 (2.2%)	236 (2.4%)	33 (1.6%)	0.97	0.21
Oxygen on day of d/c	114 (0.94%)	93 (0.93%)	21 (1.0%)	1.04	0.41
Male	6150 (51%)	5,115 (51%)	1,035 (50%)	1.00	0.43
Hosp sickle admits	632 ± 438	631	636	n/a	0.54
Black	11,516 (95%)	9,512 (95%)	2,004 (97%)	1.01	0.55
Asthma	2,274 (19%)	1,803 (18%)	471 (23%)	1.00	0.72
Gov (payer)	7,342 (61%)	6,032 (60%)	1,310 (63%)	1.00	0.77

^a Odds ratios and P-values account for clustering by patient;

^b Pain is a composite variable combining sickle crisis, use of narcotics, and lack of acute chest syndrome, fever, splenic sequestration, or priapism.

TABLE II

Factors Associated With 30-Day Readmission

Variable	OR (CI)	P-value
Steroids	1.48 (1.09–2.02)	0.01
Pain	1.53 (1.24–1.86)	<0.0001
Age (by year)	1.06 (1.04–1.07)	<0.0001
PRBC	0.58 (0.43–0.77)	0.0002

Final multivariate model containing only significant variables from the initial model.