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Risk Factors for Hospital Readmission within 30-Days: A New Quality Measure for Children with Sickle Cell Disease

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Abstract

Background—The National Association of Children's Hospitals (NACHRI) established hospital readmission within 30-days as a benchmark for quality care in children with Sickle Cell Disease (SCD). Among children with SCD, limited data exists to identify risk factors for readmission and whether they are modifiable.

Procedure—We performed a retrospective cohort study to identify risk factors for readmission. All admissions for children with SCD in a one-year period were reviewed; cases were defined as children with SCD readmitted within 30-days after their first admission during the study period and controls, children with SCD who were not readmitted.

Results—We identified 30 cases and 70 controls. No difference in demographic data was found between groups. The most common admission and readmission diagnosis was pain, 78% and 70%, respectively. The greatest risk factor for readmission was no outpatient hematology follow-up in within 30-days of discharge (OR 7.7, 95% CI 2.4–24.4). A diagnosis of asthma was also a risk factor for readmission (OR 2.9, 95% CI 1.2–7.3). Patients who required supplemental oxygen to maintain saturations in the normal range and were on room air for ≤ 24 hours at discharge were also more likely to be readmitted (OR 3.3, 95% CI 1.1–9.7). Multivariate analysis identified lack of outpatient follow-up and disease severity, defined as ≥ 3 admissions in the previous 12 months as predictors for readmission ($R^2=0.41$).

Conclusions—Potentially modifiable risk factors exist to decrease the rate of readmission of children with SCD admitted to the hospital for pain.

Keywords

Readmission Rate; Sickle Cell Disease; Children

Introduction

Insurance companies, accrediting organizations and hospital administrators have become increasingly interested in using quality measures as a tool to compare healthcare

organizations and ultimately, improve patient care. Existing quality measures primarily target adult-focused healthcare issues and were designed in adult-oriented institutions. The utility of quality measures developed for adults and subsequently applied to children is unclear. The National Association of Children's Hospitals and Related Institutions (NACHRI) Readmission has established a new benchmark for quality care in children re-hospitalized with Sickle Cell Disease (SCD) within 30-days of discharge[1].

Published readmission rates for pediatric patients with SCD range from 5–10%, but represent readmission within seven days[2], much shorter than the current measure of 30-days employed by NACHRI. The Child Health Corporation of America (CHCA) reported a 30-day readmission rate of 14% or less in the top 50% of children's hospitals[3]. Ballas, et al. prospectively followed 182 adults with SCD reporting a 47% readmission rate within 30 days of discharge. The primary risk factor for readmission identified by Ballas and Lusardi was discharge on an oral opioid dose much lower than the parental dose received in the hospital resulting in rebound pain or withdrawal symptoms[4]. No complimentary study has been published in children with SCD.

Despite the edict by NACHRI that readmission within 30-days of discharge was a quality measure; no evidence to support the validity of this measure had been previously described. Limited information exist identifying risk factors for readmission in children with SCD and whether these risk factors are modifiable. The primary objective of this study was to identify the risk factors for 30-day readmission in children with SCD.

Methods

The protocol was reviewed by the Washington University School of Medicine Human Research Protection Office and approved. To identify risk factors for readmission, we designed a retrospective cohort study comparing children with SCD who were readmitted within 30-days of discharge with those who were not readmitted. We retrospectively reviewed all hospital admissions for children with SCD at St. Louis Children's Hospital from October 1, 2005 to October 1, 2006. We used ICD-9 codes 282.60, 282.62, 282.64 and 282.42 to identify eligible patients. Inclusion criteria were any patient admitted to the hospital during the study period with a diagnosis of SCD confirmed by hemoglobin analysis. Exclusion criteria included patients admitted more than 12 times in a one-year period because of the high likelihood non-medical and non-modifiable risk factors contributed to the high hospitalization rate and out-of-state patients who were primarily followed at another institution. Each individual patient participated in the study only once.

Definitions

Patients with SCD may be hospitalized multiple times in a one-year period; we, therefore, chose to use the first admission only for each individual patient. We defined the index or primary admission as the first hospital admission during the one-year study period preceding the readmission by ≤ 30 -days. A readmission was defined as a hospital admission, occurring ≤ 30 -days after the index admission. Cases were defined as children with SCD who were readmitted within 30-days of their previous discharge for their first admission during the 12-month study period. Controls were defined as children with SCD who were not readmitted within 30-days of their previous discharge for their first admission during the 12-month study period. Disease severity was defined as patients with ≥ 3 hospitalizations for SCD-related morbidity in a oneyear period[5]. Frequent pain episodes of 3 or more is the most commonly used definition for SCD-related disease severity and has been associated with poorer quality of life in both children with SCD and their caregivers [6]. Asthma symptoms during admission were defined as the presence of chest pain, cough, hypoxia, wheezing, respiratory distress such as tachypnea or increased work of breathing, or decreased breath

sounds in a patient with a history of asthma. Acute chest syndrome was defined as a new radiologic density on chest x-ray accompanied by two of the following: temperature $> 38.5^{\circ}\text{C}$, tachypnea, dyspnea, intercostal or supraclavicular retractions, nasal flaring, chest wall pain, or oxygen saturation of $<90\%$ room air by pulse oximetry. SCD-pain episode was defined as moderate to severe pain due to vaso-occlusion, and not a non-SCD cause, in the usual location for the individual patient.

Medical Record Extraction

A data collection tool was prepared and piloted prior to the initiation of the study. A single reviewer extracted data from both archival medical records and an electronic medical record. Baseline characteristics including type of SCD, co-morbid diagnoses, hemoglobin level, oxygen saturations, and frequency of hospitalization were collected for each patient. For each index admission and readmission, the following were collected: admission and discharge diagnoses, length of stay, primary admitting service, location of treatment, admission and discharge hemoglobin, presence of asthma symptoms, use of steroids, presence of fever, antibiotic administration, presence of pain, type and method of opioid administration, timing of opioid weaning, duration of oral analgesics, use of oxygen, discharge oxygen saturations, whether or not a follow-up appointment was given at discharge and adherence to the hospital follow-up appointment that was given.

Statistical Methods

The statistical software package, SPSS 15.0.0, was used to perform statistical analysis. Continuous variables were analyzed using Student's T-test. Dichotomous variables were analyzed using Chi Square and Fisher's Exact test. Baseline characteristics of the cohort study are presented in descriptive tables. Odds ratios were calculated where appropriate including 95% confidence intervals (CI). Univariate analysis was done such that the dependent variable was subsequent hospitalization within 30-days of index admission, and the independent variables include, length of stay, duration of oral medications prior to discharge, timing of first opioid wean ($<$ or $>$ 24 hours), asthma diagnosis, use of steroids, disease severity, follow-up, <24 hours on room air after use of supplemental oxygen and return to baseline oxygen saturations at discharge. Disease severity was defined as ≥ 3 hospitalizations which is a dichotomous variable rather than a continuous variable because hospitalization frequency is not normally distributed. Based on the results of univariate analysis, a multivariate model was developed. We selected covariates for use in the multivariate model that were significant at the 0.01 level in the univariate analysis to control for multiple hypothesis testing.

Results

Study Population

During the 12-month study period, we reviewed 255 admissions among 105 individual children with SCD. We excluded from analysis five patients as shown in Figure 1. We identified 30 children with SCD who were readmitted within 30 days after their first admission and 70 children with SCD who were not readmitted after their first admission. Baseline demographics for cases and controls are described in Table 1.

Readmission Visits

For the patients who were readmitted, 50% (15/30) were readmitted within 8-days of discharge and 77% (23/30) within 21-days. The median time between admissions was 8-days (range 1 to 28 days). For patients discharged after 24-hours, 24% (5/21) were

readmitted. Table 2 describes the differences and similarities between cases and controls during the index admission.

Risk Factors for Readmission

The greatest risk factor for readmission was not being seen in the SCD clinic within 30-days of discharge (OR 7.7, 95% CI 2.4–24.4). At least two reason for a lack of an appointment existed. We did not differentiate between there was no appointment made or there was a failure to keep a given appointment. Patients requiring supplemental oxygen to maintain their saturations in the normal range and were subsequently on room air for less than 24 hours prior to discharge were more likely to be readmitted (OR 3.3, 95% CI 1.1–9.7).

The second highest risk factor was severity of disease defined as children with 3 or more admissions in the previous 12 months (OR 7.3, 95% CI 2.8–18.9). Patients with a co-morbid history of asthma were more likely to be readmitted (OR 2.9, 95% CI 1.2–7.3). Steroid administration was not a risk factor for readmission (OR 1.2, 95% CI 0.5–3.2).

A number of suspected risk factors were not associated with a re-admission within 30 days. A fever for 24 hours prior to discharge, hemoglobin $\leq$ 2gm below baseline, early weaning of pain medications and trial of oral analgesics immediately prior to discharge were not significant predictors of readmission. Lack of change in pain score between admission and discharge was not predictive of readmission. Blood transfusion during the first admission was not protective.

Approximately 7% (2/30) of readmitted patients were discharged in less than 24 hours from their first admission due to family request. Additionally, 17% (5/30) of readmitted patients reported running out of or not having their pain medications at the time of their readmission. Request for early release in <24 hours and lack of home medications were not identified among nonreadmitted patient.

Multivariate Analysis-Model Predictive of Readmission

Only disease severity and discharge follow-up reached statistical significance with a $p < 0.01$. The final model included a lack of outpatient follow-up and disease severity as predictors for 30-day readmission. This model explained 41% of variance.

DISCUSSION

The most important finding of this study is the impact of outpatient follow-up on readmission rate in children with SCD. The care of children with SCD is best provided by physicians experienced in the treatment of SCD. Children with SCD seen at least once in a pediatric SCD or hematology clinic have fewer ED visits, decreased hospital length of stay and cost[7]. More recently, children with SCD and pneumococcal sepsis who were not followed by a hematologist demonstrated increased mortality [8]. The importance of regular follow-up with a hematologist was reinforced in this study.

Post-discharge hospital follow-up has been shown to be important in other chronic conditions such as asthma. Schmalings, et al. found that patients who did not keep post-discharge follow-up appointments demonstrated poor adherence to asthma therapy[9]. Lack of outpatient follow-up after hospitalization has also been found to be an independent risk factor for death in Angolan children with SCD[10]. Strategies aimed at arranging timely follow-up shortly after discharge is necessary to decrease the 30-day readmission rate. Additional effort will need to be focused on ensuring patients are able to keep their appointments such as providing transportation and/or alternative clinic hours.

The contribution of disease severity to 30-day readmission rate is not surprising. Previous research has reported an increase in mortality in adults with frequent SCD pain episodes[5]. Although no uniform consensus exists regarding the definition of disease severity in SCD, ≥ 3 hospitalizations for SCD-related morbidity in a one-year period remains one of the most commonly used definitions in both observational studies[5] and treatment studies[6]. Children with severe disease have more disease-related complications which increases the number of possible admissions eligible for a readmission within 30-days. The modification of disease severity is not as easily accomplished as a hospital follow-up appointment. Interventions to improve 30-day readmission rate should include methods to recognize patients eligible for disease-modifying agents.

Previous research has established asthma as a risk factor for pain, acute chest syndrome and early mortality [11,12]. The fact that children with asthma and SCD were more likely to be readmitted is consistent with these findings. The quality measure, 30-day readmission rate, has also been applied to asthma suggesting that it is a disease process at risk for hospital readmission. A higher readmission rate was seen in patients receiving dexamethasone than in patients who did not for acute chest syndrome[13] and was confirmed by a second study reporting 23 episodes of readmission within 14 days for children who received dexamethasone for acute chest syndrome[14]. Although steroid administration was not predictive of readmission in our cohort, these results may be biased by the low rate of glucocorticoid administration for an asthma exacerbation in this cohort.

The application of quality measures in pediatrics is unclear, particularly when used in complex chronic disease states where multiple factors, independent of the disease process or medical care, may influence the designated measure. The specific measure, readmission within 30-days for patients with Sickle Cell Anemia (SCA) was originally developed as an Oryx non-core measure by JCAHO and NACHRI[15]. It was recently published in a compendium of quality measures by the Centers for Medicaid and Medicare and has been endorsed by an increasing number of hospital administrations and insurance agencies[1] prior to the publication of any studies assessing the validity of the measure in SCD. In this study, we have published the first study identifying potentially modifiable risk factors that were associated with 30-day hospital readmission for children with SCD.

Risk factors that were not well characterized in this study included access to transportation, ability to obtain medications, adherence to complicated dosing regimens and other psychosocial stressors such as loss of employment or housing. Some of these factors likely contributed to poor post-discharge follow-up. We identified anecdotal evidence to suggest that lack of medications at home resulted in some of the hospital readmissions. Due to the retrospective nature of this study, we did not accurately report these issues. Even in a prospective study, many of these issues do not lend themselves to easy quantification. Any intervention aimed at reducing the 30-day readmission rate for children with SCD will need to address these psychosocial variables as well. Additionally, the risk factors identified may be institution-specific and may not be generalizable to other medical centers.

We have identified several risk factors for hospital readmission in children with SCD. Some of these factors are potentially modifiable such as developing strategies to improve post-discharge follow-up. Some factors, such as disease activity, may be partially modified.

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Figure 1. Flow diagram describing the total number of admissions to a single hospital for children with SCD in a one year period and description of the retrospective cohort.

Table I

Demographic and Clinical Characteristics of the children with SCD readmitted within 30-days and in children with SCD not readmitted within 30-days in the retrospective cohort.

	Readmitted n=30	Not Readmitted n=70	p-value
Mean Age (Range)	12 (8mo-21 yrs)	10 (10mo-19yrs)	NS
Gender (males)	14 (47%)	33 (47%)	NS
SCD Genotype			
SS	25 (83%)	59 (84%)	NS
SC	2 (7%)	11 (16%)	NS
Sβ ⁺ Thalassemia	1 (3%)	0	
Sβ ^o Thalassemia	2 (7%)	0	
Co-morbidities			
Asthma	21 (70%)	31 (44%)	0.018**
Chronic Transfusion	1 (3%)	3 (4%)	NS
Stroke	6 (20%)	8 (11%)	NS
Baseline Labs			
Hemoglobin (gm/dl)	8.3	8.7	NS
Oxygen Saturations	97	97	NS
Number of Hospitalizations in Previous 12 months (Range)	4 (0–12)	1.4 (0–9)	0.001
Insurance Status			
Medicaid or other State-sponsored Insurance	25 (83%)	53 (76%)	NS

** For the multivariate model, p<0.01 was used to control for multiple hypothesis testing.

Table II

Further Characteristics of the Primary Admission between children with SCD readmitted within 30-days and children with SCD not readmitted within 30-days in a retrospective cohort.

	Readmitted n=30	Not Readmitted n=70	p-value
Length of Stay (LOS)	3.1	3.4	NS
Primary Admission Diagnosis			
Vaso-Occlusive Episode	25 (83%)	53 (76%)	NS
Acute Chest Syndrome	1 (3%)	5 (7%)	NS
Fever	3 (10%)	9 (13%)	NS
Other	1 (3%)	3 (4%)	NS
Primary Discharge Diagnosis			
Vaso-Occlusive Episode	22 (73%)	42 (60%)	NS
Acute Chest Syndrome	5 (17%)	18 (26%)	NS
Fever/Infection	3 (10%)	2 (3%)	NS
Other	0	8 (11%)	NS
Pain			
Patient complained of Pain	29 (97%)	60 (86%)	NS
PCA Use	11 (36%)	9 (13%)	0.01
Intermittent Opioids	13 (43%)	35 (50%)	NS
Duration of IV Pain Meds	2.3 days	1.8 days	NS
Duration of Oral Meds	19 hours	21 hours	NS
Respiratory			
Asthma Symptoms	15 (50%)	26 (37%)	NS
Steroid	9 (53%)	18 (69%)	NS
Oxygen			
Room Air for ≤ 24 hours	15 (50%)	30 (43%)	NS
	9 (60%)	8 (26%)	0.05**
Return to Baseline Saturations at Discharge	22 (73%)	52 (74%)	NS
Saturations not recorded	0	5	
Fever	15 (50%)	38 (54%)	NS
Follow-up			
Appointment Given	13 (43%)	37 (53%)	NS
Seen in SCD-clinic for Follow-up	4 (13%)	38 (54%)	0.001

** For multivariate analysis, we used $p < 0.01$ to control for multiple hypothesis testing.