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Blood transfusion in children with sickle cell disease undergoing tonsillectomy☆

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ABSTRACT

Introduction: Tonsillectomy is the second most common surgery in children with sickle cell disease. These children are at an increased risk of perioperative complications due to vaso-occlusive events. Although controversial, preoperative blood transfusions are sometimes given in an effort to prevent such complications. The purpose of this study is to analyze trends in the use of blood transfusion for management of children with sickle cell disease (SCD) undergoing tonsillectomy in a national database.

Methods: Patients in the 1997–2012 KID with a primary procedure matching the ICD-9 procedure code for tonsillectomy (28.2–28.3) and diagnosis code for SCD (282.60–282.69) were examined. Patients were split into groups by blood transfusion status and compared across variables including complication rate, length of stay (LOS), and hospital charges. Statistical analysis included chi-square test for trend, Mann-Whitney *U* test, and independent *t*-test.

Results: 1133 patients with SCD underwent tonsillectomy. There was a strong positive correlation between increasing chronologic year and the proportion of patients receiving blood transfusions, 47 (30.1%) in 1997 to 78 (42.5%) in 2012 ($r = 0.94$, $p = 0.005$). During this period, there was no significant change in the rate of complications ($r = -0.1$, $p = 0.87$). Overall, patients receiving blood transfusion had a longer mean LOS (3.1 ± 2.4 days vs. 2.5 ± 2.2 days, $p < 0.005$) and higher mean charge ($17,318 ± 13,191 vs. $13,532 ± 12,124, $p < 0.005$) compared to patients who did not receive blood transfusion. The rate of complications in the transfusion group, 18 of 352(5.1%), was not significantly different ($p = 0.48$) from the group without transfusion, 40 of 626 (6.4%).

Conclusions: From 1997 to 2012, there was a significant increase in the proportion of patients with SCD receiving perioperative blood transfusions for tonsillectomy. While the frequency of transfusion rose, those who received a transfusion had similar complication rates with increased charges and length of hospital stays compared to those who did not receive a transfusion.

1. Introduction

There are an estimated 100,000 people with sickle cell disease (SCD) in the US. Children account for nearly one third of this population and are more likely to undergo surgery than their peers without SCD [1,2]. Children with SCD often have tonsillar hypertrophy and/or recurrent tonsillitis necessitating the need for surgery and making adenotonsillectomy one of the most commonly performed procedures in children with SCD, second only to cholecystectomy [3]. Due to the defective hemoglobin in SCD (HbS), patients with SCD are at risk of developing vaso-occlusive events. The most common of these are acute pain crises, which can be precipitated by factors such as cold temperature, infection, dehydration, physical exertion, anxiety, and hormonal changes associated with menses [4–6]. The added physiologic stressors of surgical trauma and general anesthesia complicate the situation. In addition to standard surgical complications such as hemorrhage and post-operative infection, patients with SCD are at an increased risk of vaso-occlusive complications during surgery. Insufficient oxygenation and circulatory stasis lead to HbS polymerization, which can cause vaso-occlusive crises, ischemic infarcts and acute chest syndrome. Patients with SCD who undergo tonsillectomy have been reported to have surgical complication rates of 21–32% [7,8].

Preoperative blood transfusions are commonly given to patients with SCD in an effort to decrease intraoperative and postoperative

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complications by decreasing the percentage of HbS RBCs, improving anemia, and suppressing hematopoiesis [7]. A conservative approach consists of RBC transfusion to reach a hemoglobin concentration ≥10 g/dL, while a more aggressive approach incorporates exchange transfusion to lower the HbS to less than 30% [9]. The risks associated with any non-autogenic blood transfusion include acute and delayed transfusion reactions and potential transmission of blood-borne disease, thus the benefits to patients must outweigh the risks. Due to the potential harm to patients, clinical trials evaluating the safety and efficacy of perioperative management of children with SCD pose ethical issues and are very difficult to perform. The purpose of this study is to look at trends in the perioperative management of children with SCD who undergo tonsillectomy by using a large, national, de-identified, pediatric inpatient database from the years of 1997–2012.

2. Methods

2.1. Data source

The Kids' Inpatient Database (KID), part of the Healthcare Cost and Utilization Project (HCUP), is the largest national pediatric inpatient database in the US. The KID is released every 3 years with the most recent edition containing data from the year 2012. The database samples 80% of all pediatric discharges and 10% of all in-hospital births from all community, non-rehabilitation hospitals in participating states. Since its start in 1997, it has grown from 22 states to 44 states reporting data in 2012. The database includes information on the hospital course in the form International Classification of Disease, Ninth Revision, Clinical Modification (ICD-9 CM) Diagnosis (DC) and Procedure (PC) and clinical classification software codes (CCS). Additionally, the database contains demographic information including patient age at time of admission, sex, race, and primary expected payer. Patient age at the time of admission is reported in whole number years, ranging from 0 to 18 in the 1997 KID and 0 to 20 in all editions thereafter. All data in the KID is de-identified, therefore this study did not require approval from the Office of Research Integrity at the Medical University of South Carolina. In compliance with the HCUP data use agreement, no values less than or equal to ten were reported in this study in order to protect patient anonymity.

2.2. Data analysis

The 1997, 2000, 2003, 2006, 2009, and 2012 KID were queried for admissions with tonsillectomy with or without adenoidectomy (ICD-9 CM PC 28.2–28.3) as the primary procedure, and containing a diagnosis of sickle cell disease (ICD-9 CM DC 292.60–292.69). Admissions which included blood transfusion (ICD-9 PC 99.00–99.04) were identified and tracked across all editions of the KID and compared to the admission that did not include blood transfusion. The ICD-9 CCS code for complication of surgical procedure or medical care (238) and the ICD-9 CM diagnosis code for acute chest syndrome (517.3) were used as markers for complications. CCS data is not available in the 1997 edition of the KID, therefore complication data is from the 2000–2012 KID only. The principal diagnosis was used as the indication for surgery (tonsillar hypertrophy, tonsillitis, or other).

2.3. Statistics

Statistical analysis was performed using Statistical Package for the Social Sciences (SPSS, Version 23; IBM SPSS Inc., Chicago IL). Ordinal data is reported as median and interquartile range. The Mann-Whitney *U* test was performed to determine differences in age of admission, length of stay, and total charges between groups. Chi-square test for homogeneity was used to compare proportions across populations. Chi-square for trend was used to determine if the proportion of patients undergoing blood transfusion changed significantly over time. All values and proportions were calculated using methods that take into account the complex sampling methods used in the KID. Unless otherwise specified, all data is weighted using HCUP supplied weight for generating national estimates. Values were considered significant at the level of $p < 0.05$.

3. Results

3.1. Overall population

There were a total of 69,687 weighted admissions with the primary procedure of tonsillectomy with or without adenoidectomy (T ± A) in the 1997–2012 KID. Of these, 1133 were children with a diagnosis of SCD. Due to the non-normal distribution of the data, a Mann-Whitney *U* test was performed to assess if there were differences between the age at time of surgery between those with and without SCD. The age distributions of the two populations were not similar on visual inspection. Children with SCD were significantly older (7 years, IQR:5, 11) compared to the group without SCD (4 years, IQR:2, 8; $p < 0.001$). The median length of stay (LOS) was longer in the group with SCD (2 days, IQR:2,3) compared to the group without SCD (1 day, IQR:1,2) when analyzed using the Mann-Whitney *U* test ($p < 0.001$). Demographic information is listed in Table 1.

3.2. Sickle cell disease

In total, 399 (35.2%) of the children with SCD admitted for T ± A received a blood transfusion during the hospital course. In each KID year, exchange transfusion occurred in fewer than eleven admissions. Due to the small sample size of the exchange transfusion cohort, all RBC transfusions, including exchange transfusion, were grouped together for analysis. In 1997, 47 of the 155 admissions with SCD (30.1%) received blood transfusion during their hospital stay. In 2012, that number increased to 78 out of 184 admissions (42.5%). Chi-square analysis for trend shows a significant positive linear trend for the proportion of patients with SCD receiving blood transfusion over time from 1997 to 2012 ($p = 0.004$). The change in proportion of patients with SCD receiving a blood transfusion during their hospital stay for tonsillectomy is displayed in Fig. 1.

The median age was equal in both the transfusion and no transfusion groups (7 years, IQR:5, 11) with no significant difference in the age distribution between the two groups ($p = 0.86$, Mann-Whitney *U* test).

Tonsillar hypertrophy (ICD-9 CM 474.10–474.12) was the most common principal diagnosis ($N = 825$), accounting for 72.8% of all admissions. Chronic tonsillitis (ICD-9 CM 474.00–474.02) was the principal diagnosis for 14.8% of admissions ($N = 168$). There was no significant difference in principal diagnosis between the group that received blood transfusion and those who did not (Chi-square, $p = 0.18$).

The mean hospital charges per year were consistently higher in the group that received blood transfusion compared to cohort that did not receive transfusion, although this difference did not reach significance until the year 2006 (Table 2).

The overall median LOS (1997–2012) was the same in both groups, but the distribution of blood transfusion group was longer (2 days;

Table 1
Sickle cell status.

	SCD	No SCD	p
N	1133	68,363	
Median age (years)	7 (IQR:5, 11)	4 (IQR:2, 8)	< 0.001
Median LOS	2 (IQR:2, 3)	1 (IQR:1, 2)	< 0.001

LOS: Length of Stay (days).
IQR: Interquartile Range.