Importance: It is uncertain whether children with bleeding disorders are at higher risk of posttonsillectomy hemorrhage compared with the general pediatric population.

Objectives: To estimate the national rate of posttonsillectomy hemorrhage in children previously diagnosed with von Willebrand disease (VWD) or hemophilia, and to analyze potential risk factors for postoperative bleeding in these children.


Setting: Academic and community-based nonrehabilitation hospitals from 44 states participating in the KID project.

Participants: An estimated 508 children with either VWD or hemophilia.

Interventions: Tonsillectomy with and without adenotonsillectomy, and subsequent hospitalization.

Main Outcome Measure: Treatment for posttonsillectomy hemorrhage.

Methods: We extracted all cases of tonsillectomy, adenotonsillectomy, and posttonsillectomy hemorrhage in patients with VWD or hemophilia using International Classification of Diseases, Ninth Revision diagnostic and procedure codes and applied national weights to estimate rates of posttonsillectomy hemorrhage. Using data regarding patient demographic characteristics, surgical indication, blood transfusion, hospital length of stay, and mortality, we conducted bivariate analyses to identify associations between possible risk factors and posttonsillectomy hemorrhage.

Results: Mean age was 7 years, and most patients were male, white, urbanites who had private insurance and underwent tonsillectomy for airway obstruction. The hemorrhage rate within 1 day of tonsillectomy (immediate) was 1.6% while the hemorrhage rate at least 2 days after tonsillectomy (delayed) was estimated at 15%. Delayed hemorrhage was associated with older age (P < .001) and was as high as 35% in children at least 16 years old. The rate of blood transfusion was 2.4%. There were no fatalities.

Conclusions and Relevance: The frequency of immediate posttonsillectomy hemorrhage in children with VWD or hemophilia is similar to rates in the general healthy population. However, among children with VWD or hemophilia, the rate of delayed hemorrhage is substantially higher, especially in older children.


Tonsillectomy is among the most common surgical procedures in the United States and is performed in children approximately 530,000 times each year. Posttonsillectomy hemorrhage is a well-documented complication, with an overall frequency of up to 5%. Reported risk factors for hemorrhage include the following: older patient age, male sex, history of recurrent acute tonsillitis or peritonsillar abscess, hot surgical techniques, such as monopolar electrocautery, and perioperative use of aspirin and ketorolac.

Coagulopathies are plausible, but uncertain, risk factors for posttonsillectomy hemorrhage. According to recent case series, bleeding rates for children with known coagulopathies are between 2% and 17%. This wide range may be attributed to the highly unpredictable presentation of certain coagulopathies, especially von Willebrand disease (VWD), as well as variation in perioperative management of these disorders due to a lack of standard guidelines. Because VWD is the most common hereditary bleeding disorder with a prevalence of about 1% and the hemophilia disorders are the second...
most common with an incidence of 1:50,000 males in the United States, the burden of posttonsillectomy hemorrhage attributable to known coagulopathies is potentially quite substantial. Yet, no national estimates for this burden are available.

The primary objective of the current study was to estimate the national rate of posttonsillectomy hemorrhage in children previously diagnosed with VWD or hemophilia, 2 of the most common and well-recognized hereditary bleeding disorders. We also analyzed potential risk factors for postoperative bleeding in this select pediatric population.

**METHODS**

We conducted a cross-sectional analysis of the Healthcare Cost and Utilization Project Kids’ Inpatient Database (KID) from the Agency for Healthcare Research and Quality for 2000, 2003, 2006, and 2009. KID is a national all-payer inpatient care database for children and adolescents up to age 20 years in the United States. The database sampled from 2500 to 4000 US academic and community hospitals in 44 states and contained between 2 to 3 million discharges in 2009. The KID sampling scheme permits nationally representative estimates of patient outcomes. Detailed sampling and data collection methods for these databases have been previously described elsewhere. The KID previously has been used in published analyses of resources utilization and outcomes following laparoscopic appendectomy and congenital heart surgery.

We evaluated inpatients based on the following assumptions: (1) children with clinically significant postoperative hemorrhage would be admitted for evaluation and subsequent management; and (2) children with known VWD or hemophilia would be admitted perioperatively for medical management. We supported these assumptions by examining the 2006 National Survey of Ambulatory Surgery database, the most recent release, in which we found no cases of ambulatory tonsillectomies performed in patients with VWD or hemophilia. This study used publicly available, de-identified data sets and was judged exempt by the University of Michigan Medical School institutional review board.

First, we identified the study cohort of patients whose inpatient discharges involved tonsillectomy using *International Classification of Diseases, Ninth Revision (ICD-9-CM)* diagnostic and procedure codes. This cohort included all discharges for children whose administrative data indicated that they underwent tonsillectomy or adenotonsillectomy during the hospitalization (*ICD-9-CM* procedure codes 28.2, 28.3, and 28.99). We used diagnostic codes for VWD (286.4) or hemophilia A, B, and C (286.0, 286.1, 286.2, 286.3, 286.01, and 286.02) to refine the cohort further. Second, we extracted additional data about patient age, sex, insurance provider, income quartile, and area of residence. We stratified race into white and non-white (including black, Hispanic, Asian, and other groups); insurance provider into public/government (Medicaid or Medicare), private, and other (including self-pay and no charge); and area of residence into urban and rural. Third, we determined the clinical indication for tonsillectomy by using relevant *ICD-9-CM* diagnostic codes for infection (034.0, 457.2, 463, 472.1, 472.2, 474.0, 474.00, 474.01, 474.02, 474.8, and 474.9) or airway obstruction (327.23, 474.1, 474.10, 474.11, 474.12, 519.8, 780.57, and 799.01). These indications were not mutually exclusive.

Patients with posttonsillectomy hemorrhage were identified using *ICD-9-CM* procedure code 28.7 (control of hemorrhage after tonsillectomy and adenoidectomy). There are no *ICD-9-CM* diagnostic codes specific to posttonsillectomy hemorrhage. Next, we determined whether the hemorrhage was immediate (within postoperative day [POD] 1) or delayed (POD ≥2) by using a variable available within KID that reports the number of days from admission until completion of a given procedure. We defined immediate hemorrhage as records reporting *ICD-9-CM* code 28.7 occurring on POD 0 or 1 after documented tonsillectomy. Delayed hemorrhage was defined as records with *ICD-9-CM* code 28.7 occurring on POD 2 or later after tonsillectomy or adenotonsillectomy, or with *ICD-9-CM* procedure code 28.7 but without any procedure codes for tonsillectomy or adenotonsillectomy (ie, likely a hospitalization separate from the initial hospitalization for tonsillectomy). We also gathered data about whole blood and red blood cell (RBC) transfusion (*ICD-9-CM* procedure codes 99.00, 99.02, 99.03, and 99.04), hospital length of stay (LOS), and inpatient mortality.

Statistical analysis was conducted using STATA, version 12.1 (StataCorp LP). Owing to low case volumes for this target population in individual years, we pooled data from 2000, 2003, 2006, and 2009 to obtain annualized rates for the outcomes of interest across all years. All categorical data are given as percentages while continuous variables are presented as means (95% CIs). We performed χ² tests using weighted observations to determine whether immediate or delayed hemorrhages were associated with demographic characteristics or other potential risk factors. Because almost all delayed hemorrhages were interpreted as readmissions, indications for the original tonsillectomy were unknown in these cases, precluding a complete evaluation of surgical indication as a risk factor for hemorrhage. All statistical tests of significance were 2-sided (P < .05).

During the 4-year pooled study time frame, there were an estimated 508 weighted discharges related to tonsillectomies among children with VWD or hemophilia. The mean age of all patients was 7.0 years (95% CI, 6.4-7.5). Other key characteristics of the study cohort are reported in the Table. The mean LOS for all patients was 2.1 days (95% CI, 1.8-2.4). From an overall standpoint, 51% of patients were hospitalized after tonsillectomy for 1 day or less, 25% for 2 days, and 23% for 3 or more days. The distribution is shown in the Figure. Older children tended to have shorter LOSs compared with their younger counterparts (P = .05).

For all children with VWD or hemophilia, the immediate posttonsillectomy hemorrhage rate was 1.6% while the delayed hemorrhage rate was substantially higher at 15%. On bivariate analysis, no significant associations were noted between immediate hemorrhage and age, sex, insurance status, annual income, or surgical indication. Delayed hemorrhage was related only with older age categories (P < .001). The rate of delayed hemorrhage was 10% in children 5 years or younger, 15% in children 6 to 15 years old, and 35% in children at least 16 years old. The whole blood and red blood cell transfusion rate was 2.4% during hospitalizations or readmissions, assuming that each transfusion was administered to a unique patient and not given repeatedly to patients who were later readmitted. No deaths were reported during either the original hospitalization or the readmission in the entire cohort.
von Willebrand disease and hemophilia are families of coagulopathies with different pathophysiologic mechanisms, inheritance patterns, and severity of presentations. The clinical significance of these diseases relates to their potential to cause major bleeding, either spontaneously or precipitated by surgical trauma, resulting in substantial morbidity and even death. Because VWD and hemophilia are the 2 most common hereditary bleeding disorders, the likelihood of performing tonsillectomy on patients previously diagnosed with either of these disorders is significant.

To our knowledge, the present study analyzes the largest nationally representative cohort of tonsillectomy patients with either VWD or hemophilia in the medical literature to date. The 1.6% immediate hemorrhage rate in our analysis is consistent with the rates in major prospective cohort studies of healthy tonsillectomy patients, but despite institutional perioperative protocols for VWD or hemophilia (not described by our available data), the 15% delayed hemorrhage rate was substantially higher than the 1% to 3% prevalence reported in cohorts of healthy patients.14-18 Instead, the delayed hemorrhage rate in our study mirrors most prior case series of patients with VWD or mixed groups of VWD and hemophilia, which report rates of 10% and higher.7,19-22 Our research also confirms prior findings demonstrating a significantly higher risk of bleeding in older children with or without VWD.7,16,23 We speculate that children with either VWD or hemophilia and accepted clinical indications for tonsillectomy might benefit from surgery at an earlier rather than a later age to reduce the risk of delayed hemorrhage. Further research is necessary to determine whether other covariates not captured in this study explain the relationship between older age and elevated risk of delayed hemorrhage.

Our study additionally demonstrates that older children, despite being at higher risk of bleeding, are hospitalized for shorter periods following their initial surgery. The KID data set does not provide clinical information, so it is unknown whether younger children are kept in the hospital longer for other reasons, whether due to dehydration or another complication, or simply as a precaution. While it is unlikely that longer hospitalization alone would mitigate the risk of postoperative hemorrhage, further speculation is premature without knowing more detailed information about what posttonsillectomy day the bleeding occurred and the clinical circumstances surrounding the event. Future studies should not only determine the precise timing and severity of bleeding in tonsillectomy patients with VWD or hemophilia but also identify other potentially modifiable risk factors, such as surgical technique, and investigate appropriate educational initiatives to alert patients and their families to the elevated risk of bleeding.

Developing nationally standardized guidelines for perioperative management of tonsillectomy patients is challenging given the heterogeneous presentation of VWD. Since the late 1970s, many authors have published protocols based primarily on single-institution case reports or small series of patients undergoing tonsillectomy. These protocols vary widely in drug selection, dosing, and patient monitoring.4-7,24 There is even older literature about hemophilia management in tonsillectomy patients. However, there does seem to be greater consensus on general perioperative hemophilia evaluation and treatment, reinforced by the recent publication of US-based best-practice guidelines.25 As a result, it is unclear whether different institutional proto-

### Table. Demographic and Clinical Characteristics of the Study Cohorta

<table>
<thead>
<tr>
<th>Patient Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total No. of tonsillectomies, weighted</td>
<td>508</td>
</tr>
<tr>
<td>Age category, y</td>
<td></td>
</tr>
<tr>
<td>≤5</td>
<td>46.5</td>
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<tr>
<td>6-15</td>
<td>44.9</td>
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<tr>
<td>≥16</td>
<td>8.7</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>57.1</td>
</tr>
<tr>
<td>Female</td>
<td>42.9</td>
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<tr>
<td>Raceb</td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>68.3</td>
</tr>
<tr>
<td>Nonwhite</td>
<td>31.7</td>
</tr>
<tr>
<td>Insurance status</td>
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<td>Public</td>
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<tr>
<td>Private</td>
<td>65.4</td>
</tr>
<tr>
<td>Other</td>
<td>4.7</td>
</tr>
<tr>
<td>Patient area of residencec</td>
<td></td>
</tr>
<tr>
<td>Urban</td>
<td>90.8</td>
</tr>
<tr>
<td>Rural</td>
<td>9.2</td>
</tr>
<tr>
<td>Median household income, based on zip code of residence, percentile</td>
<td></td>
</tr>
<tr>
<td>0-25th</td>
<td>18.3</td>
</tr>
<tr>
<td>26th-50th</td>
<td>20.6</td>
</tr>
<tr>
<td>51st-75th</td>
<td>27.8</td>
</tr>
<tr>
<td>76th-100th</td>
<td>33.3</td>
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<tr>
<td>Surgical indication</td>
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<tr>
<td>Infection</td>
<td>37.0</td>
</tr>
<tr>
<td>Airway obstruction</td>
<td>70.9</td>
</tr>
</tbody>
</table>

aData are given as percentage unless otherwise indicated. The annualized unweighted number of tonsillectomies was 388. All percentages were calculated using weighted data compiled over the 4 study years, to yield annualized rates. Percentages were based on available data only and may not total 100% due to rounding. Surgical indications were not mutually exclusive.

bMissing more than 20% of all observations.

cMissing more than 30% of all observations.
cols have had any noticeable impact on posttonsillectomy hemorrhage in children with coagulopathies. Evaluating the role of institutional variation in management was beyond the scope of the current study.

This study has several important limitations to consider. KID data sets are retrospective cross-sectional administrative databases, which are subject to sampling strategies that might potentially overlook rare but important adverse events, as well as coding errors of omission and commission. The ICD-9-CM code used to define posttonsillectomy hemorrhage cases may also include postadenoidectomy hemorrhage, potentially increasing the observed rate of bleeding. The KID database also lacks important clinical data, such as perioperative coagulopathy management, duration of surgery, estimated blood volume loss, surgical technique, and whether control of bleeding was done at the bedside or in the operative suite.

Next, the frequency of hemorrhage may be inflated by the inability of the KID database to track patients across multiple admissions, which is important in cases in which patients may have had more than 1 bleeding event. Multiple bleeding episodes may occur in as much as 21.9% of all cases of posttonsillectomy hemorrhage in healthy patients. Furthermore, it is possible that patients had hemorrhagic events that were treated at hospitals not included in the KID database. Finally, the inability to follow up patients over time also precludes us from determining the original indication for tonsillectomy in readmitted patients, as well as the exact posttonsillectomy day on which patients were readmitted. We assumed that any readmissions must have occurred on at least POD 2, because all patients were originally hospitalized for at least 1 day.

In conclusion, the frequency of immediate hemorrhage after tonsillectomy in children with VWD or hemophilia is less than 2%, which is similar to the rates within healthy cohorts of patients. In contrast, the rate of delayed hemorrhage may be as high as 15%, which is consistent with the elevated delayed bleeding rates seen in smaller series of tonsillectomy patients with VWD or hemophilia. Older children are at an even greater risk of delayed hemorrhage. Despite previously published efforts to standardize perioperative coagulopathy management at the institutional level, delayed posttonsillectomy hemorrhage remains a notable risk in children with VWD or hemophilia. Future research should be directed at improving perioperative protocols to reduce bleeding risk further.

Submitted for Publication: September 23, 2012; final revision received October 30, 2012; accepted December 7, 2012.

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Author Contributions: Drs Sun, Auger, Patrick, and Davis had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. Study concept and design: Sun, Auger, and Aliu. Acquisition of data: Sun, Patrick, and DeMonner. Analysis and interpretation of data: Sun, Auger, Patrick, and Davis. Drafting of the manuscript: Sun and DeMonner. Critical revision of the manuscript for important intellectual content: Sun, Auger, Aliu, Patrick, and Davis. Statistical analysis: Sun, Auger, Aliu, Patrick, and DeMonner. Study supervision: Davis.

Conflict of Interest Disclosures: Drs Sun, Auger, and Aliu are Robert Wood Johnson Foundation Clinical Scholars; Drs Sun and Aliu are also supported by the US Department of Veterans Affairs.

Role of the Sponsors: The Robert Wood Johnson Foundation and the US Department of Veterans Affairs were not directly involved in study design, data acquisition and interpretation, or manuscript preparation or review.

Disclaimer: Any opinions expressed herein do not necessarily reflect the opinions of the Robert Wood Johnson Foundation or the US Department of Veterans Affairs.

Additional Contributions: Adam L. Sharp, MD, contributed to the study design and Acham Gebremariam, MS, provided statistical support.

REFERENCES

13. Oyetunj A, Nwomeh BC, Ongutcuk SK, Gonzalez DO, Cornwall EE III, Fullum TM.


