Postoperative Respiratory Complications and Racial Disparities Following Inpatient Pediatric Tonsillectomy: A Cross-Sectional Study

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Objectives/Hypothesis: To study rates of respiratory complications/interventions among inpatient tonsillectomy patients in the United States and identify risk factors for these events.

Study Design: Retrospective database review.

Methods: Children (age < 18 years) undergoing tonsillectomy with or without adenoidectomy in 2006, 2009, and 2012 were studied using the Kids Inpatient Database, Healthcare Cost and Utilization Project, Agency for Healthcare Research and Quality. Outcomes were analyzed for respiratory events (complications/interventions) and racial disparities. Pearson χ² test was used to analyze categorical data and regression analysis was used for continuous variables. Respiratory events were analyzed by racial identity using logistic regression analysis. A P < .05 was considered significant.

Results: The study included 30,617 patients (41% female, 51% white, 24% African American, 23% Hispanic, 3.0% Asian). The mean age was 5.2 years, and mean length of stay 2.3 days. The overall complication rate was 6.0%, and overall intervention rate was 3.6%. Respiratory events were more common among African American children (odds ratio [OR]: 1.5, 95% confidence interval [CI]: 1.3-1.6) and less common among white children (OR: 0.8, 95% CI: 0.8-0.9). These differences were significant after controlling for age, gender, obesity, obstructive sleep apnea, and asthma. The mortality rate was 0.05% with no ethnic predilection.

Conclusions: Respiratory events after inpatient tonsillectomy included laryngo/bronchospasm, pneumonia, pulmonary edema, intubation, prolonged intubation, and ventilation. Although uncommon, these were more common among African American children. Further research is needed to understand the etiology of this disparity.

Key Words: Tonsillectomy, respiratory complications, healthcare disparities.

Level of Evidence: NA

INTRODUCTION

Tonsillectomy with or without adenoidectomy (T&A) is a relatively safe procedure, with the principal complication being postoperative hemorrhage that occurs in 1% to 4% of cases.1 Postoperative respiratory complications are the most common reason for intensive care monitoring and prolonged hospitalization after T&A.2 Additionally, respiratory complications leading to brain injury are the primary causes of death following T&A in the majority of malpractice suits.2

The Childhood Adenotonsillectomy (CHAT) study reported an overall complication rate after T&A of 7%, with the majority of complications being nonrespiratory related (5.9%).3,4 This was in a mostly outpatient cohort that excluded children with significant comorbidities or very severe obstructive sleep apnea (OSA). The respiratory complication rate was 1.4%. Gender, race, obesity, and polysomnographic parameters showed no association to any post T&A complications. Other nonrandomized studies, however, have reported an increased risk of respiratory complications in certain demographics, such as age less than 3 years and severe OSA. Severe OSA has been shown to disproportionately affect African American children.5–12 Hispanic and African American children may also have different tolerance to narcotic medications that are commonly used after T&A.10,11 These differences may increase the risk of respiratory depression and influence respiratory complications due to dosing problems following T&A. Given these underlying factors, different respiratory complication rates following T&A between racial groups are possible.

The Kids Inpatient Database (KID) is the largest all-payer database of pediatric hospital admissions in the United States.15 When extrapolated to the full population, it can estimate up to 7 million discharges, and in its 2012 release accounted for 50% of all in-hospital live births and 80% of inpatient pediatric discharges. Due to
its large sample size, it is well suited to study conditions like respiratory complications after T&A, which are rare but may disproportionately affect certain populations.

The primary objective of this study was to look at the prevalence of postoperative respiratory complications in children hospitalized after T&A using the KID database. The secondary objective was to see if factors such as race increase the rate of respiratory complications. We hypothesized that African American children are at a higher risk of respiratory complications after inpatient T&A.

MATERIALS AND METHODS

Data Source

This study was approved by the University of Texas Southwestern Medical Center Institutional Review Board. The study pooled the 2006, 2009, and 2012 KID to calculate pediatric T&A discharges. The KID database was developed for the Healthcare Cost and Utilization Project (HCUP) and is sponsored by the Agency for Healthcare Research and Quality. It contains samples from all community, nonrehabilitative hospitals in the United States participating in HCUP. The KID uses the discharge abstracts of hospitalized children and does not take into account rehospitalizations. It includes any child admitted to the hospital for an inpatient stay and excludes children admitted under observation status. Children whose status is changed from observation to inpatient during their hospitalization are included (e-mail communication from HCUP support staff in May 2017). Discharges of the International Classification of Diseases, Ninth Revision, Clinical Modifications (ICD-9 CM) procedural codes for T&A (28.2 and 28.3) were included. Data were pooled from multiple years to help reduce statistical noise inherent in a survey analysis that relies on a single year of data. We excluded discharges when the age was ≥18 years, and when race was Native American or other due to small sample size and to minimize noise and variability.

Measured Outcomes

Incidences of complications in children undergoing T&A were determined using ICD-9-CM codes and HCUP’s Clinical Classification Software (CCS). We included overall complications of medical or surgical care, postoperative bleeding, and cardiac complications. The respiratory complications included were postoperative pulmonary edema, laryngospasm, bronchospasm, pneumonia, and respiratory complications not classified elsewhere. The respiratory interventions included were endotracheal intubation/mechanical ventilation, noninvasive mechanical ventilation, oral or nasal airway, and other respiratory intervention. Laryngospasm and bronchospasm were combined into one category for analyses. To further aid analysis, all respiratory complications were grouped as a single variable called respiratory complication, all respiratory interventions were grouped as respiratory intervention, and both respiratory complications and respiratory interventions were grouped as respiratory event.

The following variables were also recorded: race (white, African American [black or African American], Hispanic, and Asian), gender, age, type of insurance (Medicaid or private), length of stay, total charges, comorbidities (Down syndrome, sickle cell anemia, bleeding disorder, obesity, asthma), OSA, strep throat, and control of tonsil hemorrhage. The severity and diagnostic criteria for these variables is not included in the database. See Supporting Table 1 in the online version of this article for the full list of ICD-9-CM and CCS codes used in study.

Statistical Analysis

The KID uses a complex survey design that requires the use of survey weights to estimate counts. Statistical analysis was performed on these estimations. Taylor series linearization for complex survey designs was used to estimate counts. Baseline characteristics are described as means and 95% confidence intervals (CI) for continuous variable and percentages and 95% CI for categorical data. Differences in outcomes between racial groups were determined with Pearson $\chi^2$ test for categorical data and linear regression for continuous variables. To determine if respiratory complications were associated with race, we performed unadjusted and adjusted logistic regression analysis. Unadjusted analysis was performed using the population mean as the reference group. Adjusted analysis controlled for age (modeled as a cubic function—age$^3$), gender, OSA, obesity, and asthma. We chose a cubic model for age to reflect the usual age distribution of hospitalized pediatric patients—early peak for children under 3 years followed by a second smaller peak among adolescents. Missing values were handled by list-wise deletion. Significance was set as $P$ value < .05. All statistics were performed with Stata statistical software version 15 (StataCorp, College Station, TX).

RESULTS

Demographics

The study included 30,617 children who underwent inpatient T&A. Demographic data and descriptive statistics are presented in Table I. The average age was 5.2 years, with 53% less than 3 years old. There was a predominance of males ($n$ = 17,980, 59%). Estimated counts by ethnicity were: 15,651 white (51%), 7,236 African Americans (24%), 6,946 Hispanics (23%), and 785 (3%) Asians. Strep throat and/or tonsillitis was the indication for inpatient T&A in 10% and OSA in 58% of cases. The other 32% were unspecified. The mean total charges for inpatient T&A were $20,330, with a mean length of stay of 2.3 days. Of all children, 48% had Medicaid insurance, but this was higher for African Americans (67%, $P$ < .001) and Hispanics (64%, $P$ < .001). There was a significantly higher prevalence of OSA and obesity in Hispanic, African American, and Asian children (Table I).

Asthma was present in 17%, obesity in 5.9%, Down syndrome in 4.9%, sickle cell anemia in 1.7% (8.3% of African American children), and bleeding disorders in 1.7% of patients. African American compared to white children had the following differences: Down syndrome (2.9% vs. 5.1%, $P$ < .001) and bleeding disorders (0.5% vs. 2.2%, $P$ < .001). Conversely, sickle cell anemia (8.3% vs. 0.2%, $P$ < .001), obesity (8.2% vs. 3.7%, $P$ < .001), OSA (71% vs. 52%, $P$ < .001), and asthma (24% vs. 13%, $P$ < .001) were more common in African American compared to white children. When compared to white children, Hispanic children (9.2% vs. 3.7%, $P$ < .001) and Asian children (6.6% vs. 3.7%, $P$ < .01) were more likely to be obese. Hispanic patients were more likely to have asthma when compared to white children (17% vs. 13%, $P$ < .001) (Table I).
Complications and Interventions

The overall complication rate was 6.0% (95% CI: 5.7%–6.4%). The bleeding rate was 1.5% (95% CI: 1.4%–1.8%), and 1.1% (95% CI: 1.0%–1.4%) underwent a surgical procedure for control of tonsil hemorrhage. Cardiac complications occurred in 0.2% (95% CI: 0.2%–0.3%). The respiratory complication rate was 2.4% (95% CI: 2.2%–2.6%); the breakdown was as follows: laryngospasm/bronchospasm (0.6%, 95% CI: 0.5%–0.7%), pneumonia (1.3%, 95% CI: 1.2–1.5), postoperative pulmonary edema (0.6%, 95% CI: 0.5%–0.7%), and other respiratory complications (1.3%, 95% CI: 1.2%–1.5%). The respiratory intervention rate was 3.6%; the breakdown was as follows: postoperative intubation (1.9%, 95% CI: 1.7–2.1), noninvasive mechanical ventilation (1.7%, 95% CI: 1.5–1.9), and prolonged mechanical ventilation (1.9%, 95% CI: 1.7%–2.1%). The mortality rate was 0.05% (95% CI: 0.03%–0.1%). Table II summarizes the complications and interventions.

Logistic Analysis

Unadjusted logistic regression was then performed using the inpatient T&A population means as the reference group (Table III). African American children had elevated risks of respiratory complications (odds ratio [OR]: 1.6, 95% CI: 1.4-1.8]), respiratory interventions (OR: 1.7, 95% CI: 1.5-1.9), and any respiratory event (OR: 1.6, 95% CI: 1.3-1.6). White children had a lower risk of respiratory interventions (OR: 0.8, 95% CI: 0.8-0.9) and any respiratory event (OR: 0.8, 95% CI: 0.8-0.9). This analysis did not show significant differences for Hispanic and Asian children when compared to the population mean.

We compared patients with a variable of interest to those without. For example, we compared patients with asthma against those without asthma and calculated ORs of having a respiratory event (Table IV). The overall rate...
of respiratory events was 6.4%. Significant factors included age ≤3 years (OR: 1.27, P < .001), male sex (OR: 1.43, P < .001), obesity (OR: 2.25, P < .001), OSA (OR: 1.71, P < .001), prematurity (OR: 3.93, P < .001), epilepsy (OR: 3.44, P < .001), congenital heart disease (OR: 2.43, P < .001), Down syndrome (OR: 1.30, P = .3), and asthma (OR: 2.04, P < .001).

DISCUSSION

In this large sample of inpatient pediatric T&A patients utilizing the 2006 to 2012 KID, we found the rate of respiratory complications was 2.4%, and the rate of respiratory interventions was 3.6%. African American children were more likely to have respiratory complications and interventions, and white children were at lower risk of respiratory interventions and events when compared to the population mean. When compared to the population mean, neither Asian nor Hispanic children had a significant difference in risk. When controlling for age, gender, obesity, OSA, and asthma the significance of the discrepancies remained. Taken together, these findings imply that respiratory complications are rare events, but African American children are disproportionately affected among inpatient T&A patients.

Previous studies have shown postoperative respiratory complications are associated with age <3 years, prematurity, cerebral palsy, seizure, congenital heart disease, obesity, and OSA.5–8,11,17,18 Our analysis is in agreement with these findings (Table IV). Previous studies have shown postoperative respiratory complications are associated with age <3 years, prematurity, cerebral palsy, seizure, congenital heart disease, obesity, and OSA.5–8,11,17,18 Our analysis is in agreement with these findings (Table IV).

### TABLE II.
Inpatient Tonsillectomy Patients Interventions or Procedures by Race Compared to White Children—2006–2012 Kids Inpatient Database

<table>
<thead>
<tr>
<th>Procedure or Intervention*</th>
<th>Population</th>
<th>White</th>
<th>African American†</th>
<th>Hispanic</th>
<th>Asian</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. (%)</td>
<td>30,617 (100%)</td>
<td>15,651 (51%)</td>
<td>7,236 (24%)</td>
<td>6,946 (23%)</td>
<td>785 (3%)</td>
</tr>
<tr>
<td>Any complication of care</td>
<td>6.0%</td>
<td>6.2%</td>
<td>6.7%‡</td>
<td>5.1%‡</td>
<td>5.7%‡</td>
</tr>
<tr>
<td>Control tonsil bleed</td>
<td>1.1%</td>
<td>1.2%</td>
<td>1.0%</td>
<td>0.9%</td>
<td>1.2%</td>
</tr>
<tr>
<td>Blood transfusion</td>
<td>1.7%</td>
<td>1.4%</td>
<td>3.0%‡</td>
<td>1.4%</td>
<td>1.8%</td>
</tr>
<tr>
<td>Total respiratory complications</td>
<td>2.4%</td>
<td>2.1%</td>
<td>3.6%‡</td>
<td>1.9%</td>
<td>1.8%</td>
</tr>
<tr>
<td>Laryngo/bronchospasm</td>
<td>0.60%</td>
<td>0.51%</td>
<td>1.0%‡</td>
<td>0.37%</td>
<td>0.63%</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>1.3%</td>
<td>1.2%</td>
<td>1.7%‡</td>
<td>1.1%</td>
<td>0.39%</td>
</tr>
<tr>
<td>Postoperative pulmonary edema</td>
<td>0.66%</td>
<td>0.46%</td>
<td>1.2%‡</td>
<td>0.52%</td>
<td>0.94%</td>
</tr>
<tr>
<td>Other respiratory complications</td>
<td>1.3%</td>
<td>1.3%</td>
<td>1.7%‡</td>
<td>1.1%</td>
<td>0.39%</td>
</tr>
<tr>
<td>Total respiratory interventions</td>
<td>3.6%</td>
<td>3.3%</td>
<td>5.1%‡</td>
<td>3.3%</td>
<td>3.4%</td>
</tr>
<tr>
<td>Postoperative intubation</td>
<td>1.8%</td>
<td>1.4%</td>
<td>3.4%‡</td>
<td>1.5%</td>
<td>1.6%</td>
</tr>
<tr>
<td>Noninvasive mechanical ventilation</td>
<td>1.4%</td>
<td>1.1%</td>
<td>2.0%‡</td>
<td>1.3%</td>
<td>1.8%‡</td>
</tr>
<tr>
<td>Prolonged mechanical ventilation</td>
<td>1.9%</td>
<td>1.8%</td>
<td>2.8%‡</td>
<td>1.7%</td>
<td>1.6%</td>
</tr>
<tr>
<td>Other respiratory therapy</td>
<td>1.0%</td>
<td>0.68%</td>
<td>1.7%‡</td>
<td>1.3%</td>
<td>0.72%</td>
</tr>
</tbody>
</table>

*P value is based upon logistic regression of categorical values. White children are used as the baseline value. †Black or African American. ‡P < .001. §P < .01. #P < .05.

### TABLE III.
Unadjusted and Adjusted Logistic Model of Pediatric Inpatient Tonsillectomy Patients Compared to Population Mean by Race

<table>
<thead>
<tr>
<th>Race</th>
<th>Respiratory Complication*</th>
<th>Respiratory Intervention†</th>
<th>Any Respiratory Event‡</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unadjusted OR (95% CI)‡</td>
<td>Adjusted OR (95% CI)‡</td>
<td>Unadjusted OR (95% CI)‡</td>
</tr>
<tr>
<td>White</td>
<td>0.9 (0.8-1.0)</td>
<td>0.9 (0.8-1.0)</td>
<td>0.8 (0.7-0.8)</td>
</tr>
<tr>
<td>African American</td>
<td>1.6 (1.4-1.8)</td>
<td>1.5 (1.3-1.8)</td>
<td>1.7 (1.5-1.9)</td>
</tr>
<tr>
<td>Hispanic</td>
<td>0.8 (0.7-1.0)</td>
<td>0.8 (0.7-0.9)</td>
<td>1.0 (0.9-1.1)</td>
</tr>
<tr>
<td>Asian</td>
<td>0.8 (0.4-1.5)</td>
<td>0.8 (0.4-1.5)</td>
<td>1.3 (0.9-1.8)</td>
</tr>
</tbody>
</table>

*Adjusted model includes age (modeled as cubic function), gender, obstructive sleep apnea, obesity, sickle cell anemia, and asthma.
†Respiratory complications are any respiratory complication (e.g., pneumonia, laryngospasm, bronchospasm, pulmonary edema, aspiration).
‡Respiratory interventions include any respiratory therapy (e.g., intubation, invasive or noninvasive mechanical ventilation, nasal Trumpet, oral airway, oxygen therapy).
§Any respiratory event includes both respiratory complications or interventions. Patients could have more than one complication or intervention.
$95% CIs that include 1 are not significant.
*Significant value in the adjusted model.
CI = confidence interval; OR = odds ratio.
There are some limitations to this study that should be considered. First, the KID represents an inpatient sample of pediatric T&A patients. Patients hospitalized under observation status are generally excluded from the KID. These patients will tend to be younger, have more comorbidities, and have higher baseline risks for complications. Therefore, these data should not be considered representative of all pediatric T&A patients. Second, the KID uses discharge abstracts that are designed for reimbursements. They may contain errors especially with respect to ICD-9-CM coding schemes. Therefore, some misclassification of records can occur. Third, observations occur at the discharge level and not the patient level, so duplicate records are possible. Finally, comorbidities such as obesity and asthma, and surgical indications such as adenotonsillar hypertrophy and OSA are not differentiated by severity. This is notable, as Kasle et al. reported an association between very severe OSA and respiratory complications following T&A but did not observe this with moderate to severe OSA. The KID does not capture or stratify disease severity. Thus, those groups that have an elevated risk for respiratory events may be skewed by the increased severity of their comorbidities.

The second finding is that racial disparities exist for respiratory complications. African American children are more likely to be affected by adverse respiratory events. African American children were more likely to be obese, have OSA, and be diagnosed with asthma when compared to the population mean. All of these variables have been associated with increased risk of respiratory complications in observational studies; therefore, the increased incidence of respiratory complications after T&A among African American children is understandable. However, even after taking other variables into account, the risk remained elevated.

Disease severity may play a role among African American children because it has been shown they have more severe asthma, obesity, and OSA. Cote et al. demonstrated that African American children under the age of 2 years are 12.5 times more likely to have severe OSA than white children. Setabutr et al. showed that children admitted for respiratory complications had more severe OSA.23

<table>
<thead>
<tr>
<th>Variable</th>
<th>Total, N = 30,617</th>
<th>Respiratory Event, N = 1,981 (6.4%) 1</th>
<th>Odds Ratio</th>
<th>95% CI</th>
<th>P Value 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increasing age, yr, mean (SD)</td>
<td>5.2 (4.6)</td>
<td>4.7 (4.4)</td>
<td>0.97</td>
<td>0.96–0.99</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Age ≤ 3 years, no. (%)</td>
<td>16,198 (52.9)</td>
<td>1,159 (7.2)</td>
<td>1.27</td>
<td>1.14–1.43</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Age &lt; 12 years, no. (%)</td>
<td>26,525 (86.6)</td>
<td>1,744 (6.6)</td>
<td>1.14</td>
<td>0.96–1.35</td>
<td>.14</td>
</tr>
<tr>
<td>Male, no. (%)</td>
<td>17,980 (58.7)</td>
<td>1,319 (7.3)</td>
<td>1.43</td>
<td>1.27–1.61</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Obesity, no. (%)</td>
<td>1,881 (6.1)</td>
<td>238 (12.6)</td>
<td>2.25</td>
<td>1.88–2.69</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>OSA, no. (%)</td>
<td>17,863 (58.3)</td>
<td>1,385 (7.8)</td>
<td>1.71</td>
<td>1.51–1.94</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Prematurity, no. (%)</td>
<td>159 (0.5)</td>
<td>34 (21.2)</td>
<td>3.93</td>
<td>2.44–6.33</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Epilepsy, no. (%)</td>
<td>2,163 (7.1)</td>
<td>370 (17.1)</td>
<td>3.44</td>
<td>2.95–4.01</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Congenital cardiac, no. (%)</td>
<td>804 (2.6)</td>
<td>113 (14.0)</td>
<td>2.43</td>
<td>1.88–3.14</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Sickle cell anemia disease, no. (%)</td>
<td>673 (2.2)</td>
<td>39 (5.8)</td>
<td>0.88</td>
<td>0.59–1.32</td>
<td>.55</td>
</tr>
<tr>
<td>Bleeding disorder, no. (%)</td>
<td>503 (1.6)</td>
<td>38 (7.5)</td>
<td>1.17</td>
<td>0.77–1.76</td>
<td>.47</td>
</tr>
<tr>
<td>Down syndrome, no. (%)</td>
<td>1,430 (4.7)</td>
<td>117 (8.1)</td>
<td>1.30</td>
<td>1.02–1.65</td>
<td>.03</td>
</tr>
<tr>
<td>Asthma, no. (%)</td>
<td>5,078 (16.6)</td>
<td>549 (10.8)</td>
<td>2.04</td>
<td>1.79–2.32</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

1 Any respiratory intervention or complication coded in the discharge record: pneumonia, laryngospasm, bronchospasm, pulmonary edema, mechanical ventilation, non-mechanical ventilation, etc.
2 Compared to patients without variable of interest. Therefore, the P value for asthma compares asthma patients to nonasthma patients.
3 CI = confidence interval; OSA = obstructive sleep apnea; SD = standard deviation.

There is limited literature regarding postoperative complications almost exclusively in African Americans. Rosen et al. also consider sickle cell anemia disease, as this is seen in patients with sickle cell disease. Seizure disorders, these disparities remained.
severe OSA (higher apnea-hypopnea index and lower O₂ nadir) than those admitted for poor oral intake. A study by Fung et al. also demonstrated that obese children are at significantly higher risk of developing postoperative respiratory complications (OR: 7.13). It is therefore reasonable to conclude that African American children are at increased risk of postoperative adverse events due to the positive correlation with the severity of risk factors. Additionally, decreased access to care related to socioeconomic status or racial variation in the use of procedures may contribute to disease severity by delaying care.

There are also previous studies using the KID that reported that African Americans, regardless of the surgery, had worse outcomes. There may also be underlying factors related to airway morphology, decreased lung function, and birth weight that are currently not well understood, that may contribute to postoperative respiratory complications both directly and indirectly.

One final finding of this study was that the percentage of Asian and Hispanic children who experience respiratory events after tonsillectomy is essentially equal to the population averages for all children who undergo tonsillectomy. This finding suggests that these children's comorbidities are the principal driver of respiratory complications. White children also tend to mirror the population, but did show a decreased risk of total respiratory events. One possible cause is that white children had lower rates of many of the identified risk factors for respiratory problems such as obesity, asthma, and OSA. The disease severity of those conditions among white children may also be less when compared to other children. Further study is indicated.

CONCLUSION

Respiratory events are uncommon among inpatient pediatric tonsillectomy patients, but racial disparities appear to be present. Further studies on the cause of these disparities and ways to prevent these events is warranted.

BIBLIOGRAPHY