Original Research—Pediatric Otolaryngology

A Cross-sectional Analysis of Pediatric Ambulatory Tonsillectomy Surgery in the United States

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Abstract
Objectives. To report nationwide estimates of ambulatory tonsillectomies performed in hospitals and ambulatory surgery centers in the United States.

Study Design. Cross-sectional survey.

Setting. National databases.

Subjects and Methods. We analyzed the 2010 National Hospital Ambulatory Medical Care Survey of hospitals and ambulatory surgery centers for pediatric patients undergoing tonsillectomy with or without adenoidectomy. We determined estimations of the number of procedures, demographics, and outcomes. A tonsillectomy cohort from the 2009 National Inpatient Sample served as a comparison group.

Results. In 2010, there were an estimated 339,000 (95% CI, 288,000-391,000) ambulatory tonsillectomies in the United States. The mean age was 7.8 years (SD, 5.1), and 71,000 (21.0%) were <3 years old. The male:female ratio was even (51% vs 49%). The racial makeup mirrored the US census (69% white, 18% Hispanic, and 12% black). Obstructive sleep-disordered breathing was reported in 48%. Perioperative events such as apnea, hypoxia, or bleeding occurred 7.8% of the time. Approximately 9% of patients could not be discharged home. When compared with cases of inpatient tonsillectomies, ambulatory cases comprised older patients (7.8 vs 5.9 years, P < .001) and were less likely to include obstructive sleep-disordered breathing (48% vs 77%, P < .001).

Conclusion. Tonsillectomy was one of the most common ambulatory surgical procedures in 2010 in the United States. The majority of patients were low risk, but some at higher risk were included (age <3 years and obstructive sleep apnea). The National Hospital Ambulatory Medical Care Survey estimates provide useful baseline data for future research on quality measures and outcomes.

Keywords
tonsillectomy, ambulatory

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Tonsillectomy with or without adenoidectomy (T&A) is one of the most common procedures in children, with >500,000 performed in the United States in 2006.1,2 T&A is the first-line treatment for children with obstructive sleep-disordered breathing (oSDB).3 The majority of T&As are performed in the ambulatory setting.2 Despite T&A being a common ambulatory procedure, national data of this population’s demographics, indications, and perioperative outcomes are limited. Previous studies were limited to single-institution or statewide analyses.4-6

The National Hospital Ambulatory Medical Care Survey (NHAMCS) is an annual survey produced by the National Center for Health Statistics, Centers for Disease Control and Prevention, that can provide a general estimation of ambulatory health care visits. In 2010, the NHAMCS collected information to determine ambulatory surgery data from ambulatory surgery centers that can be used to estimate ambulatory procedures for the entire United States. Our primary aim was to determine the demographics and perioperative outcomes of an ambulatory T&A among pediatric patients. A secondary objective was to compare an ambulatory surgical group and an inpatient cohort and determine the proportion of patients at high risk for perioperative complications while undergoing ambulatory procedures. We hypothesized that majority of ambulatory T&As were performed in children without comorbidities, such as obstructive sleep apnea (OSA), asthma, or obesity.

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Materials and Methods

This study was approved by the UT Southwestern Institutional Review Board as exempt status.

Data Sources

We examined the 2010 NHAMCS for T&As. The NHAMCS is a complex survey that estimates ambulatory procedures performed at hospitals as well as ambulatory surgery centers. This does not include patients admitted under 23-hour observation or inpatient status. Sample data are weighted to estimate procedures for the entire United States. In 2010, it estimated that 48.3 million ambulatory procedures were performed. Further information about the sampling strategy and the ambulatory surgery definitions of the survey is described elsewhere.7 We utilized *International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM)* codes 28.2 (tonsillectomy without adenoidectomy) and 28.3 (tonsillectomy with adenoidectomy) to identify our patients. We then searched for patients ≤21 years old per the American Academy of Pediatrics definition of children.8

The NHAMCS has well-defined categories and variables within each category; for an example, see Appendix 1 (available in the online version of the article).9 We extracted the following information from the NHAMCS: age, sex (male or female), race (white, black, Asian, Pacific Islander, or American Indian), payer (private insurance, Medicaid or Children’s Health Insurance Program, self-pay), operative time (minutes), total time from operating room to discharge (minutes), final diagnosis, procedures performed, oxygen given (yes or no), type of anesthesia used (general, intravenous sedation, monitored anesthesia care, local, regional), anesthesia provider (anesthesiologist, certified registered nurse anesthetist, surgeon, unknown), perioperative events (apnea, bleeding/hemorrhage, difficulty waking up, dysrhythmia/arrhythmia, high blood pressure, low blood pressure, hypoxia, incontinence, nausea, and vomiting), and disposition (home, observation, admission, or emergency room).

In the NHAMCS, the categories for final diagnosis and procedures performed are blank and do not have set options. The procedures and diagnoses are written in, and the *ICD-9-CM* and *Current Procedural Terminology* codes are optional. The category for perioperative symptoms has all of the aforementioned options listed, and the user is able to check any and all applicable ones. Again, this does not use *ICD-9-CM* codes for tracking.

To test our secondary objective, we compared the 2010 NHAMCS with the 2009 National Inpatient Sample (NIS). The NIS is a nationally representative sample of inpatient admissions. It excludes those admissions discharged under observation status. Inpatient admission generally refers to the “2-midnight” rule of expected care (see Centers for Medicare and Medicaid Services website for detailed discussion of inpatient admission status).9 This includes patients who are admitted with an anticipated 48-hour stay, even if they are discharged early. In addition, patients are included if they are admitted under observation status, have prolonged stays, and are subsequently changed to inpatient status. We determined T&A using *ICD-9-CM* codes 28.2 and 28.3. We included patients ≤21 years old where T&A was considered the principal procedure regardless of length of stay. We collected the following information from the NIS: age in years, sex (male or female), race (white, black, and Hispanic), discharge diagnoses (adenotonsillar hypertrophy, OSA, sore throat), procedures performed (tonsillectomy with or without adenoidectomy), comorbidities (obesity, asthma, gastroesophageal reflux disorder [GERD]), and primary payer (Medicaid or private payer).

We determined the following discharge diagnoses from the NHAMCS and the NIS with *ICD-9-CM* codes: tonsillar hypertrophy (474.11), strep throat (034.0), tonsillitis (463.0, 474.00), Down syndrome (758.0), OSA (327.23), obesity (278.00, 278.01, 278.03) asthma (493.00 to 493.92), and GERD (530.81). For the NIS, we excluded patients with hospital stays longer than the 75th percentile for length of stay (~2 days), as we assumed that these represented outliers.

The following variables were created for the analysis: sore throat (combined *ICD-9-CM* codes 47400–chronic tonsillitis, 47402–chronic tonsillitis and adenoiditis, 463–acute tonsillitis, and 0340–strep sore throat), oSDB (combined *ICD-9-CM* codes 471.11, 474.10, and 327.23), perioperative events (we combined the NHAMCS’s perioperative events: apnea, bleeding/hemorrhage, difficulty waking up, dysrhythmia/arrhythmia, high blood pressure, low blood pressure, hypoxia, incontinence, nausea, and vomiting), and age <3 years old.

Statistical Analysis

The NHAMCS and NIS both require statistical weighting to produce estimated counts of observations. We used Taylor series linearization to weigh the surveys, and we performed the following statistics on the estimated counts of observations: means, medians, standard deviation, and interquartile ranges for continuous data and percentages with 95% CIs for categorical data. Variables with <30 unweighted observations were excluded from the analysis but noted in the results. Also, if the statistical variance for the 95% CI exceeded 30%, the results were considered unreliable. For the NIS, cell counts <10 were excluded, as these can potentially be used to identify patients or institutions, which is prohibited according the Healthcare Cost and Utilization Project’s user agreement.

Differences between NHAMCS and NIS patient demographics were compared with Student’s *t* tests with unequal variances for continuous data and the equality of proportions with large-sample statistics for categorical data. Stata 15 (StataCorp, College Station, Texas) was used for statistical analysis. Significance was set at *P* ≤ .01 to account for large sample sizes. To improve the reporting of these large numbers, data were rounded to 2 digits.

Results

In 2010, there were an estimated 340,000 (95% CI, 290,000–390,000) ambulatory T&As performed in the...
United States. The mean patient age was 7.8 years (SD = 5.1), and 71,000 (21%) patients were <3 years old. The population was 51% male. The racial makeup was 69% white, 18% Hispanic, and 12% black. The most common diagnoses were oSDB (48%) and sore throat (45%). Payer status was private for 61% and Medicaid for 30%. We were unable to make statistical estimations for obesity, asthma, or GERD due to small sample size (unable to make statistical estimations for obesity, asthma, or GERD due to small sample size).

Between ambulatory and inpatient tonsillectomy cases, the ambulatory group was older (7.8 vs 5.9 years; 95% CI difference, 1.8-2.0; $P < .001$) and less likely to be <3 years old (21% vs 48%, $P < .001$). There were fewer males (51% vs 83%, $P < .001$). A larger proportion of the ambulatory group was white (69% vs 57%, $P < .001$), and a lower proportion was black (12% vs 16%, $P = .001$) or Hispanic (18% vs 27%, $P < .001$). A larger proportion of the ambulatory group was white (69% vs 57%, $P < .001$), and a lower proportion was black (12% vs 16%, $P = .001$) or Hispanic (18% vs 27%, $P < .001$; Table 1). A lower proportion of the ambulatory group had oSDB (48% vs 77%, $P < .001$) or Medicaid insurance (30% vs 51%, $P < .001$), and a higher proportion had private insurance (61% vs 43%, $P < .001$). There were too few observations in the ambulatory T&A group in the NHAMCS with asthma, obesity, or GERD to make comparisons.

A brief overview of the children excluded from the NIS (children who stayed <2 days) showed that they were similar to children who stayed <2 days with respect to sex and prevalence of asthma, GERD, obesity, and OSA. These patients, however, were more likely to be diagnosed with a complication of care, such as respiratory failure (12% vs 4.5%, Pearson $\chi^2 = 33$; $P < .001$).

### Table 1. Demographics of Pediatric Adenotonsillar Surgical Procedures in the United States, 2009-2010.

<table>
<thead>
<tr>
<th>Variable</th>
<th>NHAMCS (n = 339,364)</th>
<th>NIS (n = 10,004)</th>
<th>Difference (95% CI)</th>
<th>$P$ Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>7.8 ± 5.1</td>
<td>5.9 ± 5.4</td>
<td>1.8 to 2.0</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Age &lt;3 y</td>
<td>70,975 (21)</td>
<td>4024 (48)</td>
<td>−15 to −13</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Male</td>
<td>171,494 (51)</td>
<td>8287 (83)</td>
<td>−12 to −9.7</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>White</td>
<td>234,145 (69)</td>
<td>5710 (57)</td>
<td>17 to 1</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Black</td>
<td>40,976 (12)</td>
<td>1643 (16)</td>
<td>−4.8 to −1.2</td>
<td>.001</td>
</tr>
<tr>
<td>Hispanic</td>
<td>62,257 (18)</td>
<td>2668 (27)</td>
<td>−7.6 to −4.6</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>oSDB</td>
<td>163,676 (48)</td>
<td>7723 (77)</td>
<td>−30 to −27</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Sore throat</td>
<td>151,291 (45)</td>
<td>3471 (35)</td>
<td>19 to 21</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Obesity</td>
<td>40,596 (12)</td>
<td>1147 (11)</td>
<td>−0.83 to 2.8</td>
<td>.30</td>
</tr>
<tr>
<td>Asthma</td>
<td>—e</td>
<td>1632 (16)</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>GERD</td>
<td>—e</td>
<td>1118 (11)</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Medicaid</td>
<td>101,423 (30)</td>
<td>5107 (51)</td>
<td>−22 to −20</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Private pay</td>
<td>207,328 (61)</td>
<td>4333 (43)</td>
<td>17 to 19</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

Abbreviations: GERD, gastroesophageal reflux disease; NHAMCS, National Hospital Ambulatory Medical Care Survey; NIS, National Inpatient Sample; oSDB, obstructive sleep-disordered breathing.

Data refer to the 95% CI of population counts. The difference is in percentages except for age, which is in years.

$P$ value is based on Student’s $t$ test and equality of proportions with large-sample statistics.

The number of patients with this condition is too small to make statistical estimations. The sample size and percentage of inpatient patients with these conditions are provided for perspective.
procedures occurred. The mean age was 7.8 years (SD = 5.1). Of these, 299,000 (88%) were <15 years old, and 71,000 (21%) were <3 years old.

In a study by Bhattacharya et al, the authors saw an increase from 441,000 to 695,000 T&As between 1996 and 2006. Our analysis identified 350,000 patients. This seems to be a significant decrease from the prior study. Partially, this may be attributed to using different databases. We used the NHAMCS and NIS, whereas they used the National Hospital Discharge Survey and National Survey of Ambulatory Surgery. Another difference is that they included adenoidectomy alone, whereas this was excluded from our analysis. It is unclear whether their cohort included patients admitted under 23-hour observation; ours did not. These factors may all contribute to this apparent decrease in surgical procedures performed. Another contributor to this discrepancy is the change in sampling design for the 2010 survey. Due to limited federal resources at the time, the surveyors could not update the sampling frame. This limitation also meant larger standard errors, which can hinder statistical significance between subgroups.

oSDB and frequent sore throat were the most frequent diagnoses, and oSDB was significantly more common in the inpatient tonsillectomy group. Perioperative events appeared to be uncommon, and the majority of patients were discharged home. It is noteworthy that 9% of patients required treatment to an acute care facility for further treatment. These were unplanned admissions due to perioperative complications that did not allow for discharge home. The majority were children without the comorbidities of asthma, obesity, or OSA.

The rates of obesity in the ambulatory and inpatient groups were 12% and 11%, respectively, and the rates of oSDB were 48% and 77%. The rates of obesity seem low given the known association between obesity and oSDB. Kohler et al found that body mass index was a significant predictor of apnea-hypopnea index. This may be a product of the manual element in filling out the surveys and possible underreporting of risk factors.

Postoperative respiratory complications are the most common reason for intensive care monitoring and prolonged hospitalization after T&A. A large survey regarding posttonsillectomy mortalities showed that the majority of pediatric deaths occurred at home during sleep. This highlights the importance of identifying risk factors and predictors for postoperative respiratory complications. This will allow us to stratify patients who are at low risk of postoperative complications following T&A. We identified a postoperative complication rate of 7.8%, and 9% of patients required further evaluation in the emergency room or admission for observation. Brigger et al performed a systematic review of 16 studies of ambulatory T&A and reported a complication rate of 8.8% and an unplanned admission rate of 8.0%. Children aged <4 years were at elevated risk of complications, with an odds ratio of 1.64. We found a significantly higher percentage of children aged <3 years in our inpatient cohort. This may reflect practice trends due to prior studies such as the review by Brigger et al.

There are several well-established risk factors for postoperative respiratory complications. These include young age (<3 years), OS, obesity, and other medical comorbidities. In fact, the 2011 clinical practice guidelines for tonsillectomy in children recommends admission for these groups. In this study, we found that indications for surgery in the ambulatory cohort favored sore throat over oSDB, whereas the opposite is true for the inpatient cohort. There is also a significantly lower percentage of patients with oSDB in the ambulatory cohort. We were unable to evaluate for obesity and other medical comorbidities due to low numbers in the ambulatory cohort.

There is also a growing body of literature that suggests that there may be a racial predilection to postoperative respiratory complications, with black children being at higher risk. We are unable to assign causality due to the
nature of this study, but there were significantly fewer white children and significantly more black and Hispanic children in the inpatient cohort. This again may reflect recognition of higher-risk populations or higher rates of other comorbidities, such as obesity or age <3 years. The racial makeup of the ambulatory cohort from the NHAMCS mirrored that of the United States was 72% white, 16% Hispanic, and 12% black. This is similar to the NHAMCS, which was 69.1% white, 17.3% Hispanic, and 12.7% black. This suggests that there are fewer racial discrepancies in the ambulatory group when compared with the inpatient group.

Another interesting finding is the proportion of males among the inpatient cohort. This finding is consistent with other studies. Kou et al found that male children were at a higher risk of experiencing a postoperative complication following tonsillectomy, with an odds ratio of 1.43. There are limitations to this study that should be considered. We are using databases, which may inherently contain errors and misclassifications. In addition, these numbers are estimations per statistical weighting. The NHAMCS is a written form with some open-ended entries that can lead to inaccuracies. In addition, the sampling strategy for the 2010 survey used fewer survey sites, which led to wider 95% CIs. Future surveys will certainly incorporate changes that improve the accuracy of the results. The surveys also do not quantify the severity of postoperative complications, such as duration of oxygen therapy needed or persistence of other symptoms. Some patients may have had transient symptoms that resolved spontaneously.

Another limitation is that we did not have any quantitative values, such as apnea-hypopnea index or body mass index. This information would have been useful to further stratify per severity of disease, as this has been shown to have an effect. The number of patients in the ambulatory cohort with risk factors such as obesity and asthma was also too low to perform meaningful statistical analysis. We were able to make comparisons between our cohorts’ demographic information, but we had operative and perioperative data from only the NHAMCS database. This was not available in the NIS, so we were unable to assess any differences.

We also excluded the population of patients with inpatient T&A whose lengths of stay exceeded the 75th percentile. We assumed that many of the outliers would include patients from special populations, such as cerebral palsy or craniofacial disorders. We reasoned that excluding outliers for the inpatient cohort would create more statistical noise in an already limited data analysis, and we were unable to account for these cases in the ambulatory database. However, this decision could have made the inpatient cohort appear healthier than typically seen.

There is no nationally representative survey of patients who are admitted under 23-hour observation status, and they likely represent a large population of patients who undergo T&A. The survey is also unable to distinguish between planned and unplanned admissions. This could provide further information to stratify high- and low-risk subgroups. Patients undergoing multiple procedures are a potential confounder, as they may have prolonged hospital stays due to the other procedure. Unfortunately, given the nature of the survey, it is difficult to exclude these patients and would require going through each entry to identify what procedures were done. However, during our analysis, we did note that the majority of patients with multiple procedures were having other otolaryngologic procedures performed, such as nasal endoscopy, tympanostomy tube placement, and examinations under anesthesia.

There are several future quality and outcome studies that can potentially benefit from these data. For example, although 88% of children were discharged home, approximately 12% of the ambulatory group was unable to be sent home directly after surgery. It would be useful to further identify and characterize the 12% at high risk for admission preoperatively to facilitate perioperative planning. Further studies on the threshold of OSA severity that requires overnight observation would be equally useful.

Conclusion
T&A is one of the most common procedures performed in the United States. The majority of cases are performed safely on an ambulatory basis. The majority of patients were low risk, but some at higher risk (age <3 years and OSA) were included. When compared with an inpatient cohort, the ambulatory T&A group was older and less likely to have OSA, and there were more white children and fewer black and Hispanic children. The NHAMCS estimates provide useful baseline data for future research on quality measures and outcomes.

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Author Contributions
Yann-Fuu Kou, data analysis writing, editing, final approval of the published version and agreement to be accountable; Ron B. Mitchell, substantial contributions to design and interpretation of work with final approval of the published version and agreement to be accountable; helped with editing and revising critically for important intellectual content; Romaine F. Johnson, statistics, data analysis, writing, editing, final approval of the published version and agreement to be accountable.

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Supplemental Material
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References