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Association Between Age and Weight as Risk Factors for Complication After Tonsillectomy in Healthy Children

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IMPORTANCE The 1996 Tonsillectomy and Adenoidectomy Inpatient Guidelines of the American Academy of Otolaryngology–Head and Neck Surgery (AAO-HNS) Pediatric Otolaryngology Committee recommended that children younger than 3 years be admitted following tonsillectomy. Recommendations for hospital observation were not included as a key action statement in the 2011 AAO-HNS Clinical Practice Guidelines for Tonsillectomy in Children.

OBJECTIVE To examine the association between posttonsillectomy complication rate and the age and weight of the child at the time of surgery.

DESIGN, SETTING, AND PARTICIPANTS This was a multicenter case series study with medical record review of 2139 consecutive children ages 3 to 6 years who underwent tonsillectomy at 1 tertiary care academic center and 5 acute care centers in New Orleans, Louisiana, between 2005 and 2015. Children with moderate to severe developmental delay, bleeding disorders, and other major medical comorbidities were excluded.

MAIN OUTCOMES AND MEASURES Complications examined included respiratory distress, dehydration requiring intravenous fluids, and bleeding.

RESULTS Of the 2139 patients, 1817 met inclusion criteria. A total of 1011 (55.6%) were male. The mean (SD) age at the time of the procedure was 46 (14) months (range, 12-72 months). The mean weight at the time of the procedure was 17 (5) kg (range, 9-43 kg). A total of 95 patients (5.2%) had a postoperative complication. Of the 455 children younger than 3 years in the study, 32 (7.0%) had complications compared with 63 (4.6%) of the 1362 patients 3 years or older. The odds of having a complication in children younger than 3 years was 1.5 times greater than it was in children 3 years or older (odds ratio [OR], 1.56; 95% CI, 1.00-2.42). When examining total complications, children younger than 3 years were more likely to experience a complication within the first 24 hours after surgery than children 3 years or older (25% vs 9.5%; OR, 3.17; 95% CI, 1.00-10.11). The children admitted to the hospital had a greater risk of complication than those treated as an outpatient, independent of age (6.9% vs 93.0%; OR, 3.49; 95% CI, 2.0.18-6.05). No association between weight and complications was found on logistic regression (area under the curve = 0.5268; P = .66).

CONCLUSIONS AND RELEVANCE Healthy children younger than 3 years may be at an increased risk for complication following tonsillectomy. Those children may also be at increased risk for complications within the first 24 hours after surgery compared with children 3 years or older. Our data suggest that complications are independent of weight in these patients. In our cohort, those patients selected for overnight observation were associated with an increased number of adverse events following tonsillectomy, suggesting that clinician judgment is crucial in determining which patients are safe for outpatient tonsillectomy.

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Tonsillectomy is the second most common pediatric surgery performed in the United States, with more than 530 000 procedures performed on children younger than 15 years each year.[1] As such, tonsillectomy has a significant effect on the health care system. Meier et al[2] demonstrated that the mean (SD) cost for same-day tonsillectomy and adenoidectomy procedures was $1355 ($505). Inpatient tonsillectomy results in predictably higher costs, averaging $6000 to $9000 for a 2- to 3-day admission depending on the hospital setting.[3] Financial burden on patients' families is similarly varied but important to consider, including costs of transportation, missed work, and child care; it is reasonable to assume these costs also increase with length of stay, although this has not been independently studied.

Although tonsillectomy is a routine procedure performed by general and pediatric otolaryngologists, there is significant variation in preoperative, intraoperative, and postoperative patient treatment among clinicians.[2-4] In 1996, the Pediatric Otolaryngology Committee of the American Academy of Otolaryngology–Head and Neck Surgery (AAO-HNS)[5] released pediatric inpatient tonsillectomy guidelines recommending admission following tonsillectomy for all children younger than 3 years. This recommendation was based on studies from the 1980s and 1990s that suggested children younger than 3 years are at greater risk for posttonsillectomy complications. The AAO-HNS published the Clinical Practice Guideline: Tonsillectomy in Children in 2011.[1] The guideline does not include a key action statement regarding which pediatric patients should be admitted after pediatric tonsillectomy, although 1 sentence in statement 5 does note that it is generally recommended that children younger than 3 years with sleep disordered breathing (SDB) be hospitalized after tonsillectomy. Not surprisingly, posttonsillectomy admission rates vary greatly across practice settings and based on patient age and comorbidities, ranging from 5% to 90%.[6]

Complications following tonsillectomy have been widely studied. The most common complications include bleeding and respiratory compromise.[6] Complications have been divided into "early" complications (primary hemorrhage and respiratory compromise) and "late" complications (dehydration and secondary hemorrhage).[7] Posttonsillectomy hemorrhage occurs in approximately 2% to 3% of pediatric patients undergoing tonsillectomy, whereas respiratory compromise after pediatric tonsillectomy to treat obstructive sleep apnea (OSA) is experienced in as many as 6.4% of patients.[1,8,9] Despite efforts to identify patients at greatest risk for complications and implement preventative measures, unplanned encounters following pediatric tonsillectomy range from 6.3% to 7.6%.[10,11] Findings reported in recent literature on the safety of outpatient pediatric tonsillectomy in children younger than 3 years are conflicting.[7,9,12-17]

The gold standard for assessing dehydration in children is based on percentage of body weight loss.[18,19] Because low body weight is a risk factor for more severe dehydration in children with diarrheal illnesses, we hypothesized that children with low body weight were at greater risk for complication following tonsillectomy when compared with children of greater body weight.[20]

Key Points

Question Is outpatient tonsillectomy safe in children younger than 3 years, and is weight in kilograms a predictor of posttonsillectomy complications?

Findings In this cohort study of 1817 patients, healthy children younger than 3 years were at an increased risk for complications following tonsillectomy; those children may also be at increased risk for complications within the first 24 hours after surgery when compared with children 3 years or older. Our data suggest that complications are independent of weight.

Meaning Children younger than 3 years may benefit from 23-hour observation after tonsillectomy; clinician judgment is crucial in determining which patients are safe for outpatient tonsillectomy.

The primary objective of this study was to investigate if otherwise healthy children younger than 3 years were at an increased risk for posttonsillectomy complication when compared with a similar group, children ages 3 to 6 years. A secondary objective was to determine if lower weight was associated with an increased risk for posttonsillectomy complications. Although obesity and increased body mass index are risk factors for posttonsillectomy respiratory compromise, to our knowledge, this is the first study examining the relationship between posttonsillectomy complication and weight.[21,22]

Methods

A cohort study with medical record review was performed in 2362 consecutive patients 6 years or younger who underwent tonsillectomy at Ochsner Clinic Foundation, Main Campus, and 5 satellite hospitals from January 1, 2005, to July 1, 2015. Patients were identified using *International Classification of Diseases, Ninth Revision (ICD-9)*, procedures codes 28.2, 28.3, and 28.7, as well as Current Procedural Terminology codes 42820 and 42825. Institutional review board approval was obtained at Tulane University School of Medicine and the Ochsner Clinic Foundation. Patient consent was not required by the institutional review board for inclusion in the study.

Patient age at the time of the procedure was recorded in months and weight was recorded in kilograms. In our practice, children who weighed less than 10 kg were routinely admitted after tonsillectomy, regardless of age. Patient postoperative status was recorded, including inpatient, 23-hour observation, and outpatient (discharged from the postanesthesia care unit [PACU]).

In an attempt to capture patients eligible for outpatient tonsillectomy, patients were excluded if they had any of the following diagnoses: metabolic disorders, chromosomal anomalies, coagulopathies, tracheotomy and/or gastrostomy dependence, craniofacial anomalies, severe developmental delay, or severe cardiac or pulmonary disease. Patients were excluded if previously diagnosed as having moderate to severe OSA as documented by a sleep study, if the patient was

lost to follow-up, or if the medical record was incomplete. Patients with a clinical diagnosis of SDB, OSA without a sleep study, or a normal sleep study result were included.

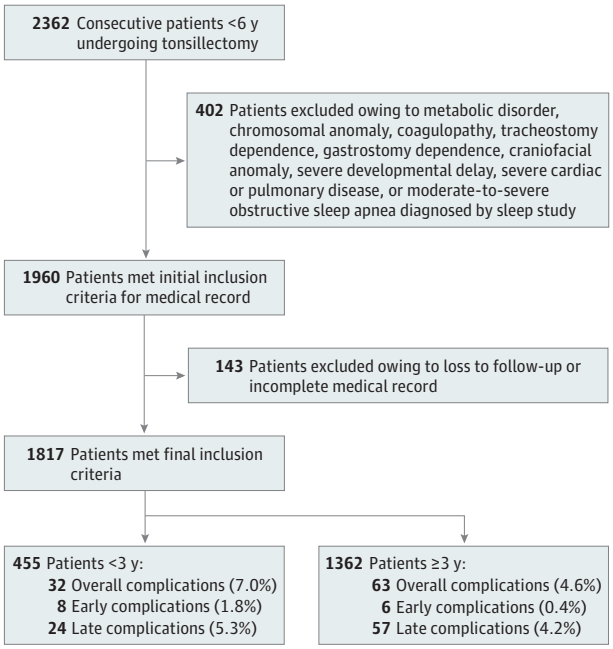
Patients were assessed for complication by review of PACU, emergency department, and clinic visits. Anesthesia reported respiratory events were used as a surrogate for respiratory complications in the PACU. Postoperative complaints, including respiratory distress, bleeding, poor urine output, and poor pain control that required intervention, were considered a complication. This included admission to the hospital, return to the operating room, supplemental oxygen or any other respiratory interventions, and intravenous (IV) fluid repletion. Patients who presented to the emergency department with complaints, including poor pain control, and who were not deemed to be clinically dehydrated and were discharged without IV hydration were not considered to have had a complication.

Categorical variables were summarized using proportions. The unadjusted odds ratios (ORs) and 95% CIs were determined using the χ^2 test. Adjusted ORs were found using logistic regression. Basic descriptive analysis was performed using PROC FREQ SAS/STAT software (version 9.4; SAS Institute Inc). Logistic regression was performed using PROC LOGISTIC to determine significance of potential predictors. $P < .05$ was considered statistically significant. Variables that were statistically significant in a univariate case were considered for a multivariate analysis. There were no significant multivariate models found, and there was no effect modification of variables in the presence of other variables.

Results

Of the 2362 patients whose medical records were reviewed, 1960 met inclusion criteria. Of those, 143 were lost to follow-up or the medical record was incomplete. A total of 1817 patients were included for final analysis (**Figure 1**). A total of 1011 (55.6%) were male. The mean (SD) age at the time of the procedure was 46 (14) months (range, 12-72 months). The procedures were performed by 2 pediatric otolaryngologists and 21 general otolaryngologists (one of whom was K.H.R.). Indications for tonsillectomy included chronic tonsillitis, recurrent tonsillitis, history of peritonsillar abscess, SDB, OSA, and tonsillar hypertrophy. Diagnoses relating to SDB were present in 805 total patients (44.3%), 236 (51.9%) younger than 3 years and 569 (41.8%) 3 years or older. Diagnoses relating to infectious causes, such as chronic tonsillitis, recurrent tonsillitis, or peritonsillar abscess, were the indication for surgery in 814 total patients (44.8%), with 187 patients (41.1%) younger than 3 years and 627 (46.0%) patients 3 years or older receiving the diagnosis. A smaller subset of patients had both obstructive and infectious indications (260 patients [14.3%]; 76 patients <3 years [16.7%]; and 184 patients ≥3 years [13.5%]). A group of patients had neither a sleep disorder or infectious disorder diagnosis. In this population, the most common diagnostic code was for "tonsillar hypertrophy" (460 patients [25.3%]; 111 patients <3 years, 24.4%; 349 patients ≥3 years [25.6%]).

Figure 1. Patient Inclusion Criteria Flowchart



The mean (SD) age at the time of the procedure was 46 (14) months (range, 12-72 months) (**Table 1**). The mean weight at the time of the procedure was 17 (5) kg (range, 9-43 kg). There were 33 children who weighed 10 kg or less and 1784 children who weighed more than 10 kg. Most patients (1693 [93,0%]) were treated as outpatients (discharged from the PACU). For the purposes of data analysis, 23-hour observation (106 patients [5.8%]) and inpatient (18 patients [1.0%]) were combined to represent posttonsillectomy hospitalization. A total of 95 patients (5.2%) had a postoperative complication. Of the 455 children younger than 3 years in the study, 32 (7.0%) had a complication. Of the 33 children who weighed 10 kg or less, 2 had a complication (6%). Early complications accounted for 8 of the 32 total complications (25%). Of the 1362 patients 3 years or older, 63 patients (4.6%) had a complication. Early complications accounted for 6 of the 63 total complications in children older than 3 years (9.5%). In total, 81 of the 95 complications occurred more than 24 hours postoperatively (85%). Complications included hemorrhage (primary, secondary, and requiring operative intervention), dehydration, respiratory distress, and other (**Table 2**). One patient experienced Grisel syndrome, or torticollis, and nontraumatic atlantoaxial subluxation caused by inflammation on postoperative day 4. Early complications were those that presented within the first 24 hours after surgery and included primary hemorrhage and respiratory distress. Late complications were primarily dehydration and secondary hemorrhage. All complications that occurred after 24 hours were considered late complications.

Nine patients had postoperative respiratory complications, ranging from desaturations requiring supplemental oxygen to stertor and stridor to postobstructive pulmonary edema. Each of these patients experienced respiratory distress or

Table 1. Baseline Characteristics of 1817 Study Patients 6 Years or Younger

Characteristic	No. (%)		
	<3 y	≥3 y	Total
Total	455	1362	1817
Sex			
Male	277 (60.9)	734 (53.9)	1011 (55.6)
Female	178 (39.1)	628 (46.1)	806 (44.4)
Weight, mean (SD), kg	13.25 (2.3)	18.47 (5.53)	17 (5.0)
Preoperative diagnosis			
Sleep disordered breathing/mild OSA	236 (51.9)	569 (41.8)	805 (44.3)
Chronic/recurrent tonsillitis	187 (41.1)	627 (46.0)	814 (44.8)
Tonsillitis and SDB	76 (16.7)	184 (13.5)	260 (14.3)
Other (tonsillar hypertrophy)	111 (24.4)	349 (25.6)	460 (25.3)
Method			
Bovie	279 (61.3)	674 (49.5)	953 (52.5)
Coablation	155 (34.1)	543 (39.9)	698 (38.4)
Plasma blade	17 (3.7)	79 (5.8)	96 (5.3)
Snare	0	37 (2.7)	37 (2.7)
Intracapsular microdebrider (tonsillotomy)	3 (0.7)	13 (1.0)	16 (0.9)
Harmonic	1 (0.2)	11 (0.8)	12 (0.7)
Gold laser	0	5 (0.4)	5 (0.3)
Procedure			
T & A	188 (41.3)	797 (58.5)	985 (54.2)
T & A, PET	154 (33.8)	299 (22.0)	453 (24.9)
T	51 (11.2)	117 (8.6)	168 (9.2)
T & A, DLB	6 (1.3)	6 (0.4)	12 (0.6)
T + other	56 (12.3	143 (10.5)	200 (11.0)
Procedure duration, mean (SD), min	66 (21)	62 (17)	63 (18)
Postoperative disposition			
Outpatient	344 (75.6)	1347 (98.9)	1693 (93.1)
23-h Observation	98 (21.5)	12 (8.8)	106 (5.8)
Inpatient	13 (2.9)	3 (0.2)	18 (0.1)

Abbreviations: DLB, direct laryngoscopy and bronchoscopy; OSA, obstructive sleep apnea; PET, pressure equalization tube; SDB, sleep disordered breathing; T & A, tonsillectomy and adenoidectomy; T, tonsillectomy.

Table 2. Summary of Complications by Age and Type Among 1817 Children 6 Years or Younger

Complication	Children, No. (%)		
	<3 y	≥3 y	Total
Overall complication rate	32 (7.0)	63 (4.6)	95 (5.2)
Total hemorrhage	16 (3.5)	37 (2.7)	53 (2.9)
Hemorrhage requiring return to OR	7 (1.5)	18 (1.3)	25 (1.4)
Total early complications	8 (1.8)	6 (0.4)	14 (0.8)
Primary hemorrhage	2 (0.4)	3 (0.2)	5 (0.3)
Respiratory distress	6 (1.3)	3 (0.2)	9 (0.5)
Total late complications	24 (5.3)	57 (4.2)	81 (4.5)
Secondary hemorrhage	14 (3.1)	34 (2.5)	48 (2.6)
Dehydration	10 (2.2)	22 (1.6)	32 (1.3)
Other	0	1 (0)	1 (0)

Abbreviation: OR, operating room.

airway obstruction in the PACU and was admitted to the hospital for at least 23-hour observation.

Of the 95 patients who experienced complications, 13 developed complications in the PACU and remained in the hospital, either for 23-hour observation or inpatient admission. Those 13 patients included each of the 9 patients who developed respiratory complications, 3 patients who developed primary hemorrhage, and 1 patient who refused oral intake for 6 days. Twelve of the patients with complications were treated in the emergency department and discharged home without admission; each was diagnosed as having clinically significant dehydration. Seventy patients required readmission for IV fluids and/or return to the operating room to control hemorrhage, with an overall unplanned readmission rate for the cohort of 3.9%. Complications related to bleeding and dehydration occurred as early as postoperative day zero and as late as postoperative day 14. The average day of presentation to the ER with complications relating to dehydration or bleeding was postoperative day 6 (3) days.

Children younger than 3 years were significantly more likely to experience a posttonsillectomy complication than those 3 years or older. The odds of having a complication in children younger than 3 years was 1.5 times greater than it was in those 3 years or older (OR, 1.56; 95% CI, 1.00-2.42). However, when controlled for patients admitted overnight, statistical significance was not achieved between the 2 groups (OR, 0.61; 95% CI, 0.37-0.99). The children admitted to the hospital had a much greater risk of experiencing a complication than those who were treated as outpatients, independent of age. The odds of having a complication in children who were admitted were 3.5 times greater than in children treated as outpatients (OR, 3.49; 95% CI, 2.02-6.05). When examining total complications, children younger than 3 years were more likely to experience an early complication than children 3 years or older (25.0% vs 9.5%; OR, 3.17; 95% CI, 1.00-10.11).

A logistic regression analysis was used to determine if complication rate was related to the weight of the patient independent of age. No association was found, suggesting that complications are independent of weight (area under the curve = 0.5268; $P = .66$). A receiver operating curve for weight is shown in **Figure 2**, yielding a plot approximating the diagonal line of no discrimination, confirming no association between weight and complications in our cohort. The incidence of posttonsillectomy complications was compared in children who weighed 10 kg or less vs those who weighed more than 10 kg; there was no statistical significance between the 2 groups (OR, 1.17; 95% CI, 0.28-5.00).

Discussion

To our knowledge, this study represents the largest review of tonsillectomy complications in healthy children 6 years or younger. Children younger than 3 years (0-35) months were

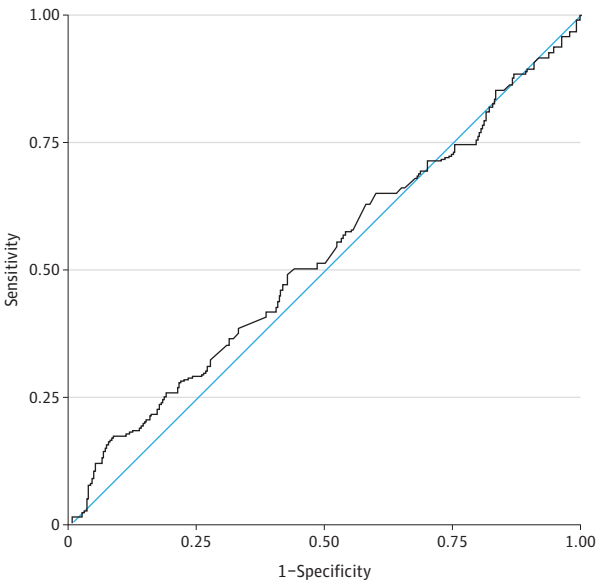
compared with those 3 years or older (36-72 months) to match similar groups. When examining preoperative diagnoses, our cohort demonstrated a nearly even split between obstructive and infectious indications (44.3% vs 44.8% of total patients). Tonsillectomy is increasingly performed for obstructive rather than infectious etiologies. The trends in indications for tonsillectomy have been changing since the 1980s, with some studies now reporting obstructive indications for 90% to 100% of tonsillectomies performed.[23-25] Our results reflect the coding and billing practices of a diverse group of clinicians. Because our data collection spans 2005 to 2015, we may have captured part of the trend shift in tonsillectomy indication in our cohort.

Our rates of overall complications (5.2%) and hemorrhage (2.9%) are consistent with complication rates documented in the literature, suggesting that our results are externally valid.[8,14,16,26] Unplanned readmission occurred in 3.9% of our patients, which is slightly lower than documented revisit rates of 6% to 8%, although we did not include ambulatory or ER visits where the patient did not require intervention.[10,11,27] Our cohort experienced a very low rate of respiratory complications (0.5%) compared with those in the literature, which reports respiratory complications in 6.4% to 18% of children following tonsillectomy.[9,14,28,29] There may have been underreporting of respiratory events in those patients with planned posttonsillectomy admissions because minor events in these patients may have been anticipated by the PACU staff. Postoperative respiratory distress has been linked to documented OSA, obesity, craniofacial anomalies, trisomy 21 and other genetic syndromes, and coexistent cardiac and pulmonary disease.[29] An abundance of literature suggests that it is not safe to perform outpatient tonsillectomy in these patients, and so they were excluded from our study.[9,29-32] We acknowledge that many patients with undiagnosed moderate to severe OSA may have been included in our study because they had not received a preoperative polysomnogram.

There was a statistically significant increase in the rate of posttonsillectomy complications in children younger than 3 years compared with those ages 3 to 6 years. We also found that children younger than 3 years are significantly more likely to experience complications within the first 24 hours after surgery than children older than 3 years, although the sample size for this calculation was small and further investigation in this area is warranted. Our data support the original recommendations of the AAO-HNS Pediatric Otolaryngology Committee that children younger than 3 years should be observed in the hospital following tonsillectomy.

However, when controlling for overnight admissions, the association between age and complications is lost. There was a strong association between complications of any type and overnight admission. Although this does include complications that occurred in PACU, there was a far greater rate of late complications, such as dehydration and/or bleeding. This suggests that clinicians may be accurately assessing patients at greater risk for complications and observing those children overnight in the hospital. Not surprisingly, this also suggests that a single overnight admission does not decrease late complications, such as dehydration and bleeding. In this data set, dehydration and bleeding occurred as late as 14 days postoperatively. Benefits of overnight admission include airway observation and intervention, IV hydration, and IV pain control, but when considering delayed dehydration and hemorrhage following tonsillectomy, the advantage of a single overnight admission has not been demonstrated by prior studies and is not evident in our series.[8] A single overnight admission has not been shown to improve posttonsillectomy pain control over a 7-day postoperative period compared with outpatient tonsillectomy.[33] Poor pain control is thought to contribute to poor oral intake and thus dehydration and bleeding following tonsillectomy.[17]

Figure 2. Receiver Operating Characteristic Curve for Tonsillectomy Complications as a Function of Weight (kg)



Area under the curve = 0.5268; P = .66.

Although prior studies have examined body mass index and obesity as a predictor of complication after tonsillectomy, weight has not been examined to date. To our knowledge, this is the first study to determine if an association exists between weight and complications. We did not find weight to be a useful predictor of complications in our group. Comparing children who weigh 10 kg or less with children who weigh more than 10 kg at the time of surgery was also not a useful predictor of complications. One caveat is that there were only 33 children who weighed 10 kg or less in our cohort, and only 2 experienced complications. A larger sample size would permit more accurate statistical analysis of complications in children who weigh 10 kg or less, although our preliminary data did not detect a relationship. In addition, logistic regression analysis did not find a relationship between weight and complications independent of age in our cohort.

Our data suggest that age rather than weight is useful when preoperatively assessing young, healthy children for the risk of posttonsillectomy complications. This relationship between age and complications cannot be interpreted as "all

healthy children younger than 3 years should be admitted"; understandably, it is much more complicated. Our data suggest that children admitted to the hospital for at least 23-hour observation following tonsillectomy are at 3.5 times greater odds for having a posttonsillectomy complication than children treated as outpatients. The greatest predictor of complications in our series was overnight admission, which is difficult to describe and characterize owing to interclinician variability. This suggests clinicians should continue to rely on their judgment when planning outpatient tonsillectomies and assessing patients for discharge in the PACU.

Limitations

Limitations of this study include those inherent to its retrospective nature. Although we captured data from 6 hospitals in southern Louisiana, we cannot account for patients with complications who did not present to the ambulatory clinics or emergency departments of these facilities. We used PACU anesthesia records as a surrogate for respiratory events in the immediate postoperative period. This is consistent with other retrospective analyses of posttonsillectomy respiratory complications but may contribute to an artificially low rate of respiratory events.[28,29] Although high body mass index has been examined as a predictor of respiratory complications, low body mass index has not been evaluated as a correlate for low weight and risk for dehydration. Body mass index may be a more accurate predictor of risk of dehydration than weight. This is an interesting area for future study. We excluded patients who had moderate to severe OSA as documented by polysomnography; however, patients with mild OSA and symptoms of SDB without a formal sleep study were included. Our series represents significant clinician variation; children who were observed overnight by one clinician may have been discharged by another and reason for overnight admission was not always evident on medical record review.

Although this represents the largest series of young, healthy patients undergoing tonsillectomy, the rates of complications remain low. When statistical analysis based on stratification by type of complication was attempted, often the values were too low to obtain reliable results. Stratification by type of complication would allow investigation into association of patient age and/or weight and early and late complications. Obstructive sleep apnea and respiratory complications following tonsillectomy have been an area of active interest over the past 10 years.[9,28,29] Respiratory distress after tonsillectomy usually presents during PACU observation after tonsillectomy, and children are admitted overnight.[9,28,29] Respiratory distress is an extremely rare cause for presentation to the emergency department following tonsillectomy. Poor pain control, dehydration, and hemorrhage account for revisit rates, and thus increased health care costs, following tonsillectomy.[10,11,27] Continued investigation into predictors of these late complications will help clinicians reduce unplanned patient encounters, readmissions, and patient morbidity following tonsillectomy, improving safety while minimizing health care costs.

Conclusions

Healthy children younger than 3 years may be at an increased risk for complication following tonsillectomy. Those children may also be at increased risk for complications within the first 24 hours after surgery when compared with children 3 years or older. Our data suggest that complications were independent of weight in our patients, although further investigation is needed. In our cohort, those patients selected for overnight observation were associated with an increased number of adverse events following tonsillectomy, suggesting that clinician judgment is crucial in determining which patients are safe for outpatient tonsillectomy.

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Study concept and design: Lawlor, Carter, Rodriguez.
Acquisition, analysis, or interpretation of data: Lawlor, Riley, Carter.
Drafting of the manuscript: Lawlor, Riley, Carter.
Critical revision of the manuscript for important intellectual content: All authors.
Statistical analysis: Lawlor, Carter.
Obtained funding: Lawlor.
Administrative, technical, or material support: Lawlor, Riley, Rodriguez.
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