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Acute care revisits after adenotonsillectomy in a pediatric Medicaid population in Ohio



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ABSTRACT

Introduction: Guidelines for inpatient admission after pediatric tonsillectomy have been proposed to improve the safety of this procedure. This study examined the association between performing adenotonsillectomy in an inpatient setting and acute care revisits within 30 days among children enrolled in a Medicaid Accountable Care Organization in Ohio.

Methods: The Accountable Care Organization's claims database was queried for adenotonsillectomies performed in children ages 0–18 years in 2008–2014. Procedures associated with an inpatient facility stay were classified as inpatient adenotonsillectomies. The primary outcome was emergency department visit or inpatient re-admission within 30 days. Secondary outcomes were revisits within 7 days and >7 days post-discharge. Logistic regression was used to test for association between inpatient procedure and need for revisits.

Results: Adenotonsillectomies in 8835 girls and 7773 boys (age 6.8 ± 3.8 years) were analyzed, of which 842 (5%) were inpatient procedures. Revisits were required in 2511 (15%) cases and were primarily visits to the emergency department. In multivariable analysis, inpatient and outpatient procedures had comparable need for 30-day revisits (OR = 0.85; 95% CI: 0.69, 1.05; $p = 0.124$). In sub-analyses, inpatient adenotonsillectomy was associated with lower odds of early (≤ 7 days post-discharge; OR = 0.76; 95% CI: 0.58, 0.99; $p = 0.045$) but not later (≥ 8 days) revisits.

Conclusions: In a pediatric Medicaid population, inpatient adenotonsillectomy was not associated with greater odds of acute care revisits, compared to outpatient procedures. Appropriate risk stratification of children undergoing adenotonsillectomy can reduce the need for early acute care revisits by scheduling high-risk patients for prolonged observation.

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1. Introduction

Tonsillectomy is a common surgical procedure in children. Indications for this procedure include not only recurrent tonsillitis, but increasingly, obstructive sleep apnea (OSA) or sleep-disordered breathing (SDB) [1]. Although most tonsillectomies are performed in an outpatient setting, the risk of complications in the

postoperative period has spurred the development of guidelines to identify patients who should be admitted for an overnight stay after this procedure [1–3]. As obstructive sleep apnea (OSA) and obesity are recognized as risk factors for complications after tonsillectomy, particularly in children <3 years of age, many of these patients are now admitted for postoperative observation [4]. At our institution, risk stratification of tonsillectomy patients according to these and other factors has reduced the rate of unanticipated admissions from 2.2% to 1.4%, as previously described [2]. Criteria for inpatient admission after tonsillectomy, including the presence of comorbidities and age <3 years, were included in the guidelines published by the American Academy of Otolaryngology-Head and Neck Surgery (AAO-HNS) [4]. Yet, significant variation exists across institutions in the rate and predictors of overnight stay after this procedure [5]. For example, the admission rate following tonsillectomy in 3–5 year old children ranged from 5% to 90% across

Abbreviations and acronyms: AAO-HNS, American Academy of Otolaryngology-Head and Neck Surgery; ACO, accountable care organization; CI, confidence interval; ED, emergency department; IQR, interquartile range; LOS, length of stay; OR, odds ratio; OSA, obstructive sleep apnea; PFK, Partners for Kids; SD, standard deviation; SDB, sleep-disordered breathing.

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pediatric hospitals [5]. This wide range is consistent with studies demonstrating considerable variability between institutions and physicians in the criteria for planned overnight admission after tonsillectomy [6,7]. Part of this variation exists because there are no uniformly accepted criteria for postoperative disposition after tonsillectomy apart from findings of polysomnography (PSG). Nationally, PSG is obtained in less than 10% of children prior to adenotonsillectomy [8]. In most institutions, the otolaryngologist dictates the location and postoperative course of the tonsillectomy patient.

The development of risk stratification guidelines for tonsillectomy cases has been primarily intended to reduce unplanned admissions and improve safety [2]. It is unclear if scheduling high-risk tonsillectomy patients for overnight observation would increase or decrease the need for acute care revisits. Revisits and readmissions after pediatric surgery have increasingly been considered as a measure of procedural quality, notwithstanding the complex reasons why patients may require unanticipated post-surgical care [9–13]. Acute care revisit rates within 30 days of pediatric tonsillectomy have been reported to range from 6 to 11%, including visits to the emergency department (ED) and visits resulting in overnight hospitalization (readmission) [11–14]. Common reasons for revisits were pain, nausea or vomiting, dehydration, and bleeding [11,14]. Recent studies have noted that inpatients had more acute care revisits than outpatients after tonsillectomy [11], or pediatric otolaryngologic surgery in general [15]. Furthermore, the publication of the AAO-HNS practice guidelines was followed by a nationwide increase in the rate of hospital revisits (from 8.2% to 9.0%) after pediatric tonsillectomy [16]. In an era of cost containment, associations between inpatient admission after tonsillectomy and increased risk of revisits are concerning because they suggest inpatient tonsillectomy may increase resource use both during the index admission and after discharge. To investigate whether inpatient as compared to outpatient tonsillectomy was associated with acute care revisit risk, we analyzed a Medicaid population of children enrolled in Partners for Kids (PFK), an Accountable Care Organization (ACO) in Ohio [17]. Our primary hypothesis was that inpatient tonsillectomies were less likely to result in ED visits or overnight re-admission. Our secondary aims were to evaluate the decrease in revisits associated with inpatient admission in the immediate post-discharge period; and to compare inpatient cases admitted overnight to inpatient cases where patients were discharged on the day of service after extended postoperative monitoring.

2. Materials and methods

Following Institutional Review Board approval (IRB15-00264), the PFK claims database was queried for tonsillectomy with adenoidectomy (adenotonsillectomy) procedures performed in children ages 0–18 years between January 1, 2008 and December 31, 2014. Tonsillectomies without adenoidectomy were excluded from the data query to reduce the possibility of confounding by focusing on a single type of procedure. Procedures were performed at our institution (a tertiary-care academic pediatric hospital) or by community otorhinolaryngologists affiliated with the PFK ACO [17]. Patients with missing data on demographic characteristics or date of discharge after adenotonsillectomy were excluded. Inpatient designation of encounters was determined according to whether the encounter was associated with an inpatient facility stay, but not according to whether a patient remained in the hospital overnight. In some cases, patients were discharged from an inpatient unit on the day of service according to the discretion of the attending physician.

The primary outcome was defined as any ED visit or inpatient

re-admission occurring within 30 days of the adenotonsillectomy procedure. Secondary outcomes were ED revisits or readmissions within 7 days of discharge, as compared to ED revisits or readmissions more than 7 days after discharge. Total amounts paid by the ACO for each ED visit and readmission were adjusted to 2014 U.S. dollars using the U.S. city average Consumer Price Index for medical care [18], and described as medians with interquartile ranges (IQR) for revisits occurring within 30 days of adenotonsillectomy.

Patient gender, age in years (0–2, 3–5, 6–11, or 12–18), year of service, indication for adenotonsillectomy (tonsil or adenoid hypertrophy; chronic tonsillitis or adenoiditis; or other), number and type of revisits, and days from discharge until the earliest revisit (if applicable) were described for inpatient and outpatient adenotonsillectomy encounters. To test the primary hypothesis, revisits (including ED visits and inpatient readmissions) were compared between inpatient and outpatient groups using Chi-square tests and logistic regression. To test the secondary hypothesis, revisits were further subdivided into encounters ≤ 7 days as compared to ≥ 8 days after discharge. Lastly, to distinguish between patients admitted to an inpatient unit but discharged on the day of service, and patients admitted overnight, this analysis was repeated while dividing the inpatient category according to hospital length of stay (LOS). Multivariable models adjusted for patient age, gender, indication for adenotonsillectomy, and year of service. Analyses were performed in Stata 13.1/IC (College Station, TX: StataCorp, LP), and $p < 0.05$ was considered statistically significant.

3. Results

There were 16,608 patients meeting inclusion criteria (8835 girls and 7773 boys; mean age 6.8 ± 3.8 years). Over the study period, 842 (5%) adenotonsillectomies were associated with an inpatient facility stay, of which 492 involved overnight stay after the procedure. In the inpatient group, 120 (14%) patients required ≥ 2 days of hospitalization. Among all patients in the study cohort, 2305 (14%) visited the ED within 30 days of discharge, 135 (1%) required readmission within 30 days of discharge, and 71 (0.4%) had both an ED revisit and an inpatient admission during this period. The most common reasons for ED visits or readmission were bleeding, dehydration, and pain. Median paid amounts (in 2014 dollars) were \$154 (IQR: \$78, \$302) for each ED visit and \$5152 (IQR: \$2,569, \$8541) for each readmission. Inpatient procedures were less likely to require ED visits after discharge (12% requiring ED visits, compared to 15% in the outpatient group; $p = 0.041$; Table 1), but no more likely to require inpatient readmission (2% readmitted, compared to 1% in the outpatient group; $p = 0.306$). The composite primary outcome of ED visits or readmissions within 30 days was comparable between the inpatient group ($n = 114$, 14%) and the outpatient group ($n = 2,419$, 15%). Inpatient cases were more likely to involve male patients, patients age ≤ 5 years, and patients undergoing adenotonsillectomy for hypertrophy of the tonsils or adenoids.

Multivariable logistic regression found comparable odds of ED visit or readmission (OR = 0.85, 95% CI: 0.69, 1.05; $p = 0.124$; Table 2) associated with inpatient as compared to outpatient surgery. In the multivariable model, age < 3 years (compared to ages 3–11 years), chronic tonsillitis, and later year of service were associated with higher odds of acute care revisits. Further multivariable analysis distinguished between ED visits or readmissions within 7 days of discharge as compared to ≥ 8 days since discharge (Table 3). Adjusted odds ratios indicated that inpatient admission was associated with lower odds of ED visits or readmissions in the first week after discharge (OR = 0.76; 95% CI: 0.58, 0.99; $p = 0.045$) but not thereafter (OR = 1.03; 95% CI: 0.76, 1.40; $p = 0.855$). To

Table 1
Patient characteristics by setting of adenotonsillectomy (N = 16,608).

Variable	Outpatient (N = 15,766)		Inpatient (N = 842)		P ^a
	N (%)	Mean (SD)	N (%)	Mean (SD)	
Male	7318 (46%)		455 (54%)		<0.001
Age					<0.001
<3 years	1210 (8%)		196 (23%)		
3–5 years	5510 (35%)		379 (45%)		
6–11 years	7040 (45%)		214 (25%)		
12–18 years	2006 (13%)		53 (6%)		
Year of service					<0.001
2008	2056 (13%)		49 (6%)		
2009	2238 (14%)		57 (7%)		
2010	2143 (14%)		245 (29%)		
2011	2362 (15%)		381 (45%)		
2012	2638 (17%)		60 (7%)		
2013	2357 (15%)		25 (3%)		
2014	1972 (13%)		25 (3%)		
Indication for procedure					<0.001
Hypertrophy of tonsils or adenoids	8265 (52%)		717 (85%)		
Chronic tonsillitis or adenoiditis	5476 (35%)		46 (5%)		
Other	2025 (13%)		79 (9%)		
Any acute care revisit	2419 (15%)		114 (14%)		0.156
ED visits	2292 (15%)		101 (12%)		0.041
Days to first revisit ^b		7.7 (18.8)		8.0 (6.5)	0.843
Revisits ≤7 days post-discharge	1490 (9%)		64 (8%)		0.073
Revisits ≥8 days post-discharge	929 (6%)		50 (6%)		0.956

SD = standard deviation, ED = emergency department.

^a Chi-square test for categorical variables and independent *t*-test for continuous variables.^b Among patients with 1 or more ED visit or readmission.**Table 2**
Multivariable logistic regression of any emergency department visit or inpatient readmission after adenotonsillectomy (N = 16,608).

Variable	OR	95% CI	P
Inpatient procedure	0.85	(0.69, 1.05)	0.124
Male	1.00	(0.92, 1.09)	0.973
Age			
<3 years	ref.		
3–5 years	0.73	(0.63, 0.85)	<0.001
6–11 years	0.63	(0.54, 0.74)	<0.001
12–18 years	0.90	(0.75, 1.08)	0.252
Year of service			
2008	ref.		
2009	1.09	(0.91, 1.30)	0.349
2010	1.24	(1.04, 1.47)	0.017
2011	1.40	(1.18, 1.65)	<0.001
2012	1.42	(1.21, 1.68)	<0.001
2013	1.41	(1.19, 1.67)	<0.001
2014	1.53	(1.28, 1.82)	<0.001
Indication for procedure			
Hypertrophy of tonsils or adenoids	ref.		
Chronic tonsillitis or adenoiditis	1.18	(1.07, 1.30)	0.001
Other	1.15	(1.01, 1.31)	0.039

OR = odds ratio, CI = confidence interval.

examine the influence of hospital LOS in patients admitted to an inpatient unit, this analysis was repeated with sub-categorization of the inpatient group according to whether they were discharged on the day of surgery (Table 4). In the analysis of 7-day revisits, encounters with admission to an inpatient unit but a same-day discharge were associated with reduced odds of revisits, compared to outpatient adenotonsillectomy (OR = 0.58; 95% CI: 0.37, 0.91; *p* = 0.017), whereas encounters associated with overnight stay in an inpatient unit had similar odds of revisits to outpatient procedures (OR = 0.89; 95% CI: 0.64, 1.24; *p* = 0.492). Because of limitations of the PFK data use agreement on minimum reportable cell sizes, no sub-analysis of readmissions as distinct from ED visits was performed while differentiating between admissions ≤7 days and ≥8 days after discharge.

4. Discussion

Inpatient admission after adenotonsillectomy is advocated to reduce the risk associated with performing this procedure in patients with known and suspected comorbidities, such as obesity and OSA, as well as patients with other risk factors for postoperative complications, such as age <3 years [2,4]. However, limitations on hospital resources and the pressure for cost containment have meant that the majority of tonsillectomies are performed in outpatient settings [1], with considerable variability in risk stratification and determination of which cases require inpatient admission [5–7]. Admission for extended postoperative monitoring incurs additional cost, but may reduce early postoperative acute care revisits due to complications such as nausea, vomiting, or bleeding, which can be managed while the patient remains in the hospital. However, recent studies have reported increased need for ED visits and inpatient readmission following inpatient as compared to outpatient tonsillectomy [11,15]. Our study of a pediatric Medicaid population challenges this conclusion by demonstrating a comparable incidence of acute care revisits within 30 days (and a lower incidence of acute care revisits within 7 days) after inpatient as compared to outpatient adenotonsillectomy.

Acute care revisits after pediatric tonsillectomy are primarily visits to an ambulatory facility or ED, rather than inpatient readmission [12]. Whereas postoperative bleeding is a major clinical concern after pediatric tonsillectomy, previous studies have reported that the leading reasons for acute care revisits after this procedure are due to pain, nausea and vomiting [11]. In our data, bleeding, pain, and dehydration were the primary reasons for ED visits or inpatient readmission. Among patients undergoing adenotonsillectomy for OSA or SDB, a further concern in the long term is that OSA or SDB symptoms do not completely resolve after the procedure in a majority of cases [19]. Prior studies have described older age, OSA or SDB symptoms, the number of comorbidities, Medicaid insurance, and inpatient procedures as risk factors predicting higher odds of an acute care revisit [11,13]. In one study, the increased risk of revisits for patients undergoing inpatient

Table 3
Multivariable logistic regression of post-adenotonsillectomy emergency department visit or inpatient readmission ≤ 7 days and ≥ 8 days after initial discharge (N = 16,608).

Variable	ED visit or readmission ≤ 7 days after discharge			ED visit or readmission ≥ 8 days after discharge		
	OR	95% CI	P	OR	95% CI	P
Inpatient procedure	0.76	(0.58, 0.99)	0.045	1.03	(0.76, 1.40)	0.855
Male	0.96	(0.86, 1.07)	0.440	1.07	(0.94, 1.22)	0.313
Age						
<3 years	ref.			ref.		
3–5 years	0.87	(0.72, 1.05)	0.156	0.62	(0.50, 0.77)	<0.001
6–11 years	0.73	(0.60, 0.88)	0.001	0.58	(0.47, 0.72)	<0.001
12–18 years	0.98	(0.78, 1.23)	0.881	0.83	(0.64, 1.07)	0.146
Year of service						
2008	ref.			ref.		
2009	1.09	(0.86, 1.38)	0.472	1.07	(0.83, 1.38)	0.579
2010	1.37	(1.09, 1.71)	0.006	1.04	(0.81, 1.35)	0.739
2011	1.77	(1.43, 2.19)	<0.001	0.91	(0.71, 1.18)	0.488
2012	1.60	(1.29, 1.98)	<0.001	1.14	(0.90, 1.46)	0.280
2013	1.63	(1.31, 2.03)	<0.001	1.09	(0.84, 1.40)	0.517
2014	1.76	(1.41, 2.19)	<0.001	1.16	(0.90, 1.51)	0.249
Indication for procedure						
Hypertrophy of tonsils or adenoids	ref.			ref.		
Chronic tonsillitis or adenoiditis	1.18	(1.05, 1.33)	0.006	1.14	(0.99, 1.32)	0.077
Other	1.22	(1.05, 1.43)	0.012	1.00	(0.82, 1.23)	0.967

OR = odds ratio, CI = confidence interval.

Table 4
Multivariable logistic regression of post-adenotonsillectomy emergency department visit or inpatient readmission ≤ 7 days and ≥ 8 days after initial discharge, disaggregating inpatient procedures by length of stay (N = 16,608).

Variable	ED visit or readmission ≤ 7 days after discharge			ED visit or readmission ≥ 8 days after discharge		
	OR	95% CI	P	OR	95% CI	P
Admission status						
Outpatient procedure	ref.			ref.		
Inpatient admission, discharged on day of service	0.58	(0.37, 0.91)	0.017	1.16	(0.75, 1.80)	0.510
Inpatient admission, overnight stay	0.89	(0.64, 1.24)	0.492	0.94	(0.63, 1.41)	0.765
Male	0.96	(0.86, 1.07)	0.436	1.07	(0.94, 1.22)	0.311
Age						
<3 years	ref.			ref.		
3–5 years	0.88	(0.72, 1.07)	0.190	0.63	(0.50, 0.78)	<0.001
6–11 years	0.74	(0.61, 0.90)	0.002	0.58	(0.47, 0.73)	<0.001
12–18 years	0.99	(0.79, 1.25)	0.960	0.83	(0.64, 1.07)	0.150
Year of service						
2008	ref.			ref.		
2009	1.09	(0.86, 1.38)	0.470	1.07	(0.83, 1.38)	0.580
2010	1.37	(1.09, 1.71)	0.006	1.04	(0.81, 1.34)	0.748
2011	1.78	(1.44, 2.20)	<0.001	0.91	(0.71, 1.18)	0.479
2012	1.60	(1.30, 1.98)	<0.001	1.14	(0.90, 1.46)	0.284
2013	1.63	(1.31, 2.03)	<0.001	1.09	(0.84, 1.40)	0.520
2014	1.76	(1.41, 2.20)	<0.001	1.16	(0.90, 1.51)	0.251
Indication for procedure						
Hypertrophy of tonsils or adenoids	ref.			ref.		
Chronic tonsillitis or adenoiditis	1.18	(1.05, 1.33)	0.006	1.14	(0.99, 1.32)	0.078
Other	1.22	(1.05, 1.43)	0.012	1.00	(0.82, 1.23)	0.967

OR = odds ratio, CI = confidence interval.

tonsillectomy was described as confounded by patient characteristics (e.g., patients with more comorbidities are more likely to be admitted after the procedure, and more likely to seek post-discharge acute care), but persisted in multivariable analysis adjusting for observed risk factors [11]. The trend of increasing revisit rates after tonsillectomy, described in another study [16], may also be due to unforeseen consequences of changes in post-operative management, such as reduced use of opioids and introduction of new discharge teaching plans.

The association of inpatient procedure with increased rate of acute care revisits is controversial, because risk stratification of patients is meant to admit those who otherwise would experience complications after discharge and would require unplanned acute care. At our institution, new guidelines for risk stratification of patients scheduled for adenotonsillectomy were implemented in

2011, determining which procedures were performed in the main operating room (OR) as opposed to a free-standing ambulatory care facility [2]. The guidelines indicated performing adenotonsillectomy in the main OR according to patient age <3 years, sleep study findings (apnea-hypopnea index >10, pulse oximetry reading <80% O₂ saturation, end-tidal CO₂ > 50 mmHg), obesity, craniofacial syndromes, and presence of co-morbid conditions (e.g., asthma, diabetes mellitus). Implementation of these guidelines was shown to reduce unanticipated admissions, while only slightly increasing planned admissions [2]. In the present study, we were unable to link claims data to patient medical records to confirm whether case scheduling or inpatient admission were consistent with these guidelines. Furthermore, our analysis of a population-based sample implies that procedures represented in these claims data may have been performed at other institutions where criteria for procedure

location or inpatient admission may vary.

Inpatient admission allows extending the monitoring after the procedure, as well as providing more extensive caregiver education via standardized teaching tools. Consistent with these advantages of inpatient admission, the present study demonstrated that children undergoing inpatient adenotonsillectomy were less likely to have a postoperative acute care visit in the first 7 days after discharge. Disaggregating acute care revisits into ED visits and inpatient readmissions, we found a lower need for ED visits in the inpatient group in the descriptive analysis. Disaggregating inpatient cases according to time of discharge, we found a lower risk of 7-day acute care revisits among patients admitted for inpatient stay but discharged on the day of surgery, compared to outpatient cases. Patients admitted to an inpatient unit and discharged on postoperative day 1 or later had similar odds of acute care revisits to the outpatient group. Notwithstanding limited data on clinical characteristics in the present analysis, inpatient tonsillectomies tend to be performed in higher-risk patients [13,20]. Therefore, the lower rate of ED visits after inpatient adenotonsillectomy is unlikely to be confounded by a lack of comorbidities in the inpatient group. Our secondary analysis demonstrates that even when patients are admitted for overnight stay, there is no concomitant increase in the risk of acute care revisits, relative to performing adenotonsillectomy as an outpatient procedure.

Other risk factors for acute care revisits in our analysis included age <3 years, as compared to ages 3–11 years at surgery. A previous study has shown that all-cause revisits after tonsillectomy were slightly elevated in patients 0–4 years old, but especially elevated among patients ages 15–24 years [11]. Although our data did not include patients age >18 years, our findings of the lowest revisit risk in the 3–11 year age range are consistent with this prior report. Among indications for adenotonsillectomy, we found that chronic tonsillitis or adenoiditis was rarely present in the inpatient group, but was associated with greater risk of revisits. By contrast, earlier work linked OSA or sleep disorder symptoms to increased need for post-tonsillectomy revisits [11]. Our implementation of guidelines for risk stratification of patients undergoing adenotonsillectomy for OSA may have appropriately directed these patients to overnight observation, potentially explaining why they were less likely to require unplanned revisits after discharge. While the risk of acute care revisits was higher in patients with chronic tonsillitis, most of the patients in this group (4609/5506) did not require acute care revisits. Therefore, we recommend that chronic tonsillitis be considered in conjunction with other risk factors for determining which patients should be admitted overnight after adenotonsillectomy. In multivariable analysis, we also noted a trend towards increased revisit rates in more recent years, consistent with a previous study documenting a national trend towards more all-cause revisits after pediatric tonsillectomy [16].

The data and analytic approach of this study introduce some limitations to our conclusions. Patients enrolled in the PFK ACO have Medicaid public insurance, and may be at a higher risk of acute care revisits than the general population of children undergoing tonsillectomy [11,13]. In principle, some acute care revisits may have been missed by the PFK claims database if patients experienced a change in insurance status soon after the procedure, and had a different payor at the time of the acute care revisit. However, this is unlikely to bias any observed differences between inpatient and outpatient groups. Furthermore, we were unable to determine from the claims data if inpatient admission was consistent with institutional guidelines, or was due to specific comorbidities identified in the patients undergoing this procedure. The discharge of patients after admission to an inpatient unit was also not standardized. At our institution, patients undergoing adenotonsillectomy may be admitted to an inpatient unit for

extended observation, but ultimately discharged on the evening of the same day at the attending surgeon's discretion, if the family is comfortable with going home that day. Finally, the claims data lacked information on the number of comorbidities, OSA symptoms, and other clinical factors that have been linked to acute care revisits after tonsillectomy [11,13]. Although this precluded an analysis of clinical confounding factors, we would expect the lower need for ED revisits in the inpatient group to be even more pronounced when comparing inpatient and outpatient procedures in children with evidently similar clinical risk profiles. Nevertheless, our conclusions should be validated with further adjustment for potential confounding mechanisms.

The need for inpatient admission after tonsillectomy is controversial, with many institutions preferring to perform this procedure in an outpatient setting [3,5]. While outpatient surgery is valuable for controlling the costs associated with surgery, there is a risk that lack of postoperative monitoring leads to adverse outcomes, including mortality [21,22], and greater need for acute care after discharge. Our study is the first to present data suggesting inpatient admission in adenotonsillectomy cases is not associated with an increase in the risk of acute care revisits, as compared to outpatient adenotonsillectomy. Furthermore, our findings suggest that some of the costs of inpatient admission may be offset by a lower need for acute care revisits within 1 week of the procedure, although the exact extent of this offset in cost remains to be demonstrated. Although interventions such as post-discharge telephone calls have been evaluated for reducing acute care revisits after pediatric surgery [23], we argue that risk stratification for inpatient admission is an important strategy for improving postoperative outcomes and reducing unplanned revisits. In our recent work [24], we have pursued further development of cost-efficient risk-stratification tools that may improve our ability to identify patients at risk of complications after adenotonsillectomy, and proactively schedule them for inpatient stay. Generalizing from the present study of a pediatric Medicaid population in Ohio, we expect this strategy to have the most success in reducing acute care revisits among vulnerable patient populations who are most likely to seek ED care or inpatient readmission after tonsillectomy.

Conflict of interest

The authors report no potential conflicts of interest.

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References

- [1] R. Subramanyam, A. Varughese, J.P. Willging, S. Sadhasivam, Future of pediatric tonsillectomy and perioperative outcomes, *Int. J. Pediatr. Otorhinolaryngol.* 77 (2) (2013 Feb) 194–199.
- [2] V.T. Raman, K.R. Jatana, C.A. Elmaraghy, J.D. Tobias, Guidelines to decrease unanticipated hospital admission following adenotonsillectomy in the pediatric population, *Int. J. Pediatr. Otorhinolaryngol.* 78 (1) (2014 Jan) 19–22.
- [3] M. Mahadevan, G. van der Meer, M. Gruber, et al., The starship children's hospital tonsillectomy: a further 10 years of experience, *Laryngoscope* 126 (12) (2016 Apr 27) E416–E420.
- [4] R.F. Baugh, S.M. Archer, R.B. Mitchell, et al., Clinical practice guideline: tonsillectomy in children, *Otolaryngol. Head. Neck Surg.* 144 (1 Suppl) (2011 Jan) S1–S30.
- [5] S.S. Goyal, R. Shah, D.W. Roberson, M.L. Schwartz, Variation in post-adenotonsillectomy admission practices in 24 pediatric hospitals, *Laryngoscope* 123 (10) (2013 Oct) 2560–2566.
- [6] H.C. Nardone, K.M. McKee-Cole, N.R. Friedman, Current pediatric tertiary care admission practices following adenotonsillectomy, *JAMA Otolaryngol. Head. Neck Surg.* 142 (5) (2016 Mar 24) 452–456.

- [7] D. Setabutr, E.A. Adil, I. Chaikhoutdinov, M.M. Carr, Impact of the pediatric tonsillectomy and polysomnography clinical practice guidelines, *Int. J. Pediatr. Otorhinolaryngol.* 78 (3) (2014 Mar) 517–521.
- [8] D.E. Tunkel, Polysomnography before tonsillectomy in children: who and when? *Otolaryngol. Head. Neck Surg.* 146 (2) (2012 Feb) 191–193.
- [9] N.R. Payne, A. Flood, Preventing pediatric readmissions: which ones and how? *J. Pediatr.* 166 (3) (2015 Mar) 519–520.
- [10] B. Kogon, A. Jain, M. Oster, K. Woodall, K. Kanter, P. Kirshbom, Risk factors associated with readmission after pediatric cardiothoracic surgery, *Ann. Thorac. Surg.* 94 (3) (2012 Sep) 865–873.
- [11] M.B. Edmonson, J.C. Eickhoff, C. Zhang, A population-based study of acute care revisits following tonsillectomy, *J. Pediatr.* 166 (3) (2015 Mar), 607–12.e5.
- [12] S. Shay, N.L. Shapiro, N. Bhattacharyya, Revisit rates and diagnoses following pediatric tonsillectomy in a large multistate population, *Laryngoscope* 125 (2) (2015 Feb) 457–461.
- [13] M. Duval, J. Wilkes, K. Korgenski, R. Srivastava, J. Meier, Causes, costs, and risk factors for unplanned return visits after adenotonsillectomy in children, *Int. J. Pediatr. Otorhinolaryngol.* 79 (10) (2015 Oct) 1640–1646.
- [14] S. Mahant, R. Keren, R. Localio, et al., Variation in quality of tonsillectomy perioperative care and revisit rates in children's hospitals, *Pediatrics* 133 (2) (2014 Feb) 280–288.
- [15] R. Murray, T. Logvinenko, D. Roberson, Frequency and cause of readmissions following pediatric otolaryngologic surgery, *Laryngoscope* 126 (1) (2016 Jan) 199–204.
- [16] S. Mahant, M. Hall, S.L. Ishman, et al., Association of national guidelines with tonsillectomy perioperative care and outcomes, *Pediatrics* 136 (1) (2015 Jul) 53–60.
- [17] K.J. Kelleher, J. Cooper, K. Deans, et al., Cost saving and quality of care in a pediatric accountable care organization, *Pediatrics* 135 (3) (2015 Mar) e582–e589.
- [18] U.S. Bureau of Labor Statistics. Databases, Tables & Calculators by Subject: Inflation & Prices. Available at: <http://www.bls.gov/data/> (Accessed 2 June 2016).
- [19] R. Bhattacharjee, L. Kheirandish-Goza, K. Spruyt, et al., Adenotonsillectomy outcomes in treatment of obstructive sleep apnea in children: a multicenter retrospective study, *Am. J. Respir. Crit. Care Med.* 182 (5) (2010 Sep 1) 676–683.
- [20] M. Amoils, K.W. Chang, O. Saynina, P.H. Wise, A. Honkanen, Postoperative complications in pediatric tonsillectomy and adenoidectomy in ambulatory vs inpatient settings, *JAMA Otolaryngol. Head. Neck Surg.* 142 (4) (2016 Apr 1) 344–350.
- [21] C.J. Coté, K.L. Posner, K.B. Domino, Death or neurologic injury after tonsillectomy in children with a focus on obstructive sleep apnea: houston, we have a problem!, *Anesth. Analg.* 118 (6) (2014 Jun) 1276–1283.
- [22] C.J. Coté, Anesthesiological considerations for children with obstructive sleep apnea, *Curr. Opin. Anaesthesiol.* 28 (3) (2015 Jun) 327–332.
- [23] C. Yang, C.M. Chen, Effects of post-discharge telephone calls on the rate of emergency department visits in paediatric patients, *J. Paediatr. Child. Health* 48 (10) (2012 Oct) 931–935.
- [24] V.T. Raman, M. Splaingard, D. Tumin, J. Rice, K.R. Jatana, J.D. Tobias, Utility of screening questionnaire, obesity, neck circumference, and sleep polysomnography to predict sleep-disordered breathing in children and adolescents, *Paediatr. Anaesth.* 26 (6) (2016 Jun) 655–664.