Received: 24 January 2022 | Revised: 19 May 2022 | Accepted: 5 July 2022

DOI: 10.1002/lio2.867

ORIGINAL RESEARCH

Laryngoscope Investigative Otolaryngology

Characteristics of acute otitis media in primary care are associated with tympanostomy tube outcomes

Lydia Zhong BA[1] | Rana F. Hamdy MD, MPH, MSCE[2,3] | Jeannie Chang Pitter MD[3,4] | Ellen K. Hamburger MD[3,4] | Hengameh Behzadpour MSHS[1] | Diego Preciado MD, PhD[1,3]

[1]Division of Pediatric Otolaryngology, Children's National Hospital, Washington, District of Columbia, USA

[2]Division of Pediatric Infectious Diseases, Children's National Hospital, Washington, District of Columbia, USA

[3]Department of Pediatrics, George Washington School of Medicine and Health Sciences, Washington, District of Columbia, USA

[4]Children's National Pediatricians & Associates, Washington, District of Columbia, USA

Correspondence
Diego Preciado, Division of Pediatric Otolaryngology, Children's National Health System, 111 Michigan Avenue NW, Washington, DC 20010, USA.
Email: dpreciad@childrensnational.org

Abstract

Objective: To identify characteristics of acute otitis media (AOM) at primary care presentation associated with TT placement and outcomes.

Methods: A retrospective cohort study of pediatric patients (birth—12 years old) with AOM at an academic primary care pediatric practice and affiliated tertiary referral free-standing Children's hospital from August 1, 2017 to December 31, 2019 was performed. The outcomes measured were TT placement, postoperative otorrhea, need for additional tube placement, and other complications (i.e., perforation and/or granulation).

Results: The 3189 patients were included, 484 of whom were referred to otolaryngology. Multivariate logistic regression analysis revealed that a greater number of AOM episodes diagnosed at primary care was associated with tube placement (OR = 1.21; 95% CI, 1.04–1.41, $p = .02$). Of the 336 patients who received tubes, older age at first AOM diagnosis was associated with postoperative otorrhea (OR = 1.02; 95% CI, 1.01–1.03; $p = .001$) and additional tube placement (OR = 1.03; 95% CI, 1.02–1.04; $p < .001$). Older age was also associated with other complications (OR = 1.02; 95% CI, 1.01–1.03; $p = .001$) by univariate analysis. Additionally, postoperative otorrhea was more common among patients who first received an AOM diagnosis at primary care in the spring (OR = 2.69; 95% CI, 1.37–5.29; $p = .004$), summer (OR = 2.88; 95% CI, 1.46–5.69; $p = .002$), and fall (OR = 2.18; 95% CI, 1.20–3.96; $p = .01$) seasons.

Conclusions: Clinical data from pediatric primary care visits found older age at first AOM diagnosis and having a first AOM diagnosis outside of winter to be associated with a more complicated eventual disease course.

Level of evidence: 3—cohort study.

KEYWORDS
acute otitis media, otorrhea, outcomes, tympanostomy tube

1 | INTRODUCTION

Acute otitis media (AOM) is one of the most common reasons for acute care visits in children and results in approximately $2.88 billion of additional health care expenses annually.[1] AOM also remains the foremost reason children in the United States are prescribed antibiotics.[2] Guidelines developed by the American Academy of Pediatrics endorse treating AOM with antibiotics in children of any age presenting with severe signs or symptoms (moderate or severe otalgia or otalgia ≥48 h or temperature ≥ 39°C) and in children younger than 24 months presenting with non-severe, bilateral AOM.[3] If AOM episodes occur recurrently or middle ear effusions do not resolve over time, patients may be referred to an otolaryngologist and recommended surgical placement of tympanostomy tubes (TT).[4]

TT placement is the most commonly performed surgery on children in the United States; one in 15 children has tubes placed by age three, and 667,000 children have TT placed under the age of 15 every year.[4–6] TT are placed in the tympanic membranes to relieve negative pressure and prevent fluid buildup in the middle ear, and will typically stay in place for 6–18 months before falling out naturally.[4]

Clinical guidelines recommend TT placement for patients with recurrent AOM with effusion and for chronic effusion.[4] Studies exploring the outcomes of patients who receive TT have produced varied results on the effectiveness of TT in preventing recurrent AOM. These studies are also difficult to pool due to heterogeneity in reported outcomes.[7] Although TTs may not decrease the number of AOM episodes compared to medical management over the ensuing 2 years after placement, they do appear to reduce symptom severity and the need for oral antibiotics while increasing the time to a first occurrence of AOM.[8] Another study found that TT did not decrease the rate of new AOM episodes but did decrease the percentage of time with AOM compared to placebo.[7] Research on the occurrence of adverse events that may occur after TT placement surgery has also been challenging to synthesize because highly variable definitions are often used and follow-up outcomes and duration are different between different studies, though there is literature exploring some of the most commonly reported adverse events after TT placement.

Otorrhea is a common occurrence after TT placement.[8] Van Dongen et al. found that two-thirds of children with TT experienced at least one episode of otorrhea in the year following placement.[9] They also determined that otorrhea in children with TT could be predicted by age, a recent history of upper respiratory tract infections, and the presence of older siblings.[9] However, these are characteristics that are determined after TT placement, and there remains a dearth of research that explores primary care history preoperative predictors.

The aim of this study was to utilize data collected from a large primary care pediatric practice to identify factors that are associated with TT placement, as well as to identify factors that are associated with postoperative disease course. We hypothesized that those with more involved cases of AOM, such as concurrent infectious diagnoses, would be more likely to receive TT and experience a more complex postoperative disease course.

2 | MATERIALS AND METHODS

After receiving approval from the institutional review board at Children's National Hospital, we reviewed all cases of AOM diagnosed at the two sites of our affiliated primary care practice, Children's National Pediatricians & Associates (CNPA)–Foggy Bottom and Capitol Hill, from August 2017 to July 2019. Patients aged birth to 12 were included if they presented with a diagnosis of AOM and were seen by an otolaryngologist at Children's National Hospital for an ear-related concern. Patients with incomplete preoperative and operative data or immunosuppressive states who are particularly susceptible to AOM were excluded.

Patients were identified using International Classification of Diseases 10th Revision (ICD-10) codes for AOM. Patient charts were reviewed for biological sex, age at first CNPA visit with AOM diagnosis, season of first CNPA visit with AOM diagnosis, number of AOM diagnoses at CNPA, number of intramuscular ceftriaxone treatments at CNPA, number of concurrent conjunctivitis diagnoses at CNPA, number of concurrent respiratory diagnoses at CNPA, provider type at CNPA (nurse practitioner, resident physician, attending physician), and insurance status (public vs private). The seasons were defined as winter (December 31–March 20), spring (March 21–June 20), summer (June 21–September 20), and fall (September 21–December 20). Patient charts for those seen by a pediatric otolaryngologist at Children's National Hospital were all reviewed, and those seen for an ear-related concern were additionally reviewed for possible TT placement, adenoidectomy at the time of TT placement, age at TT placement, surgeon, number of postoperative otorrhea episodes, number of additional TT placement, and occurrence of other complications (i.e., perforation and/or granulation). The number of postoperative otorrhea episodes was determined from narrative reports by patients recorded by otolaryngologists during follow-up visits following TT placement, and the number of other complications was determined from diagnoses made by an otolaryngologist. Importantly, beyond referral notes, surgeons did not have access to the full electronic record from the primary care office, as the electronic records between the specialty and primary clinics are completely independent.

TABLE 1 Summary of participants

	Number of patients (%)
Total	3189
Had an ear-related visit at Children's National Hospital ENT Clinic	484 (15.2%)
Had TT placement	336 (336/484, 69.4%)
Had adenoidectomy at time of TT placement	44 (44/336, 13.1%)
Had postoperative otorrhea	179 (179/336, 53.3%)
Had other complications (i.e., perforation, granulation)	26 (26/336, 7.7%)
Had additional TT placement	51 (51/336, 15.2%)

TABLE 2 Factors associated with TT placement after ear-related otolaryngology visit in univariate and multivariate analyses

	Entire cohort ($N = 484$)	TT Placed ($N = 336$)	No TT placed ($N = 148$)	Odds ratio (95% CI)	*p* value	Adjusted odds ratio (95% CI)	*p* values
Sex, *n* (%)							
Male	283 (58.5%)	199 (59.2%)	84 (56.8%)	(Reference)		(Reference)	
Female	201 (41.5%)	137 (40.8%)	64 (43.2%)	0.90 (0.61–1.34)	.61	0.95 (0.64–1.43)	.82
Age at First CNPA AOM Diagnosis, mean in months (SD)	25.30 (25.10)	24.95 (24.35)	26.09 (26.80)	1.00 (0.99–1.01)	.65	1.00 (1.00–1.01)	.35
Season							
Winter	133 (27.4%)	90 (26.8%)	43 (29.1%)	(Reference)		(Reference)	
Spring	100 (20.7%)	68 (20.2%)	32 (21.6%)	1.02 (0.58–1.77)	.96	1.02 (0.58–1.81)	.94
Summer	88 (18.2%)	66 (19.6%)	22 (14.9%)	1.43 (0.78–2.62)	.24	1.51 (0.81–2.80)	.19
Fall	163 (33.7%)	112 (33.3%)	51 (34.5%)	1.05 (0.64–1.72)	.85	1.04 (0.63–1.73)	.88
Number of AOM Episodes, mean (SD)	2.93 (1.88)	3.08 (1.94)	2.59 (1.73)	1.16 (1.04–1.30)	.01	1.21 (1.04–1.41)	.02
Ceftriaxone treatment, mean (SD)	0.34 (0.68)	0.37 (0.71)	0.27 (0.60)	1.26 (0.92–1.73)	.14	1.02 (0.72–1.46)	.89
Concurrent conjunctivitis, mean (SD)	0.28 (0.56)	0.29 (0.57)	0.24 (0.53)	1.19 (0.83–1.71)	.35	1.01 (0.68–1.50)	.97
Concurrent respiratory diagnoses, mean (SD)	0.85 (0.96)	0.86 (1.02)	0.84 (0.84)	1.01 (0.83–1.24)	.90	0.91 (0.71–1.16)	.44
Insurance							
Public	65 (13.4%)	39 (11.6%)	26 (17.6%)	(Reference)		(Reference)	
Private	419 (86.6%)	297 (88.4%)	122 (82.4%)	1.62 (0.95–2.78)	.08	1.48 (0.85–2.59)	.17
CNPA provider Type							
Nurse practitioner	86 (17.8%)	49 (14.6%)	37 (25.0%)	(Reference)		(Reference)	
Resident physician	118 (24.4%)	86 (25.6%)	32 (21.6%)	2.03 (1.13–3.66)	.02	1.88 (1.02–3.48)	.04
Attending physician	280 (57.9%)	201 (59.8%)	79 (53.4%)	1.92 (1.17–3.17)	.01	1.84 (1.10–3.08)	.02

TABLE 3 Factors associated with postoperative otorrhea in univariate and multivariate analyses

	Entire cohort ($N = 336$)	Postop otorrhea ($N = 179$)	No postop otorrhea ($N = 157$)	Odds ratio (95% CI)	*p* value	Adjusted odds ratio (95% CI)	*p* value
Sex, *n* (%)							
Male	199 (59.2%)	106 (59.2%)	93 (59.2%)	(Reference)		(Reference)	
Female	137 (40.8%)	73 (40.8%)	64 (40.8%)	1.00 (0.65–1.55)	>.99	0.96 (0.60–1.53)	.86
Age at first CNPA AOM diagnosis, mean in months (SD)	24.95 (24.35)	28.85 (27.16)	20.51 (19.86)	1.02 (1.01–1.03)	.002	1.02 (1.01–1.03)	.001
Season							
Winter	90 (26.8%)	35 (19.6%)	55 (35.0%)	(Reference)		(Reference)	
Spring	68 (20.2%)	41 (22.9%)	27 (17.2%)	2.39 (1.25–4.55)	.01	2.69 (1.37–5.29)	.004
Summer	66 (19.6%)	41 (22.9%)	25 (15.9%)	2.58 (1.34–4.95)	.01	2.88 (1.46–5.69)	.002
Fall	112 (33.3%)	62 (34.1%)	50 (31.8%)	1.95 (1.11–3.43)	.02	2.18 (1.20–3.96)	.01
Number of AOM episodes, mean (SD)	3.08 (1.94)	2.99 (1.95)	3.19 (1.92)	0.95 (0.85–1.06)	.34	1.09 (0.93–1.29)	.29
Ceftriaxone treatment, mean (SD)	0.37 (0.71)	0.38 (0.76)	0.36 (0.64)	1.05 (0.77–1.42)	.76	1.31 (0.91–1.88)	.14
Concurrent conjunctivitis, mean (SD)	0.29 (0.57)	0.28 (0.58)	0.31 (0.56)	0.94 (0.65–1.36)	.74	1.05 (0.69–1.62)	.81
Concurrent Respiratory Diagnoses, mean (SD)	0.86 (1.02)	0.74 (0.98)	0.99 (1.04)	0.79 (0.63–0.98)	.03	0.78 (0.59–1.03)	.09
Insurance							
Public	39 (11.6%)	22 (12.3%)	17 (10.8%)	(Reference)		(Reference)	
Private	297 (88.4%)	157 (87.7%)	140 (89.2%)	0.87 (0.44–1.70)	.68	0.79 (0.38–1.62)	.51
CNPA provider type							
Nurse practitioner	49 (14.6%)	29 (16.2%)	20 (12.7%)	(Reference)		(Reference)	
Resident physician	86 (25.6%)	48 (26.8%)	38 (24.2%)	0.87 (0.43–1.77)	.70	0.75 (0.35–1.62)	.47
Attending physician	201 (59.8%)	102 (57.0%)	99 (63.1%)	0.71 (0.38–1.34)	.29	0.63 (0.32–1.24)	.18

TABLE 4 Factors associated with additional TT placement in univariate and multivariate analyses

	Entire cohort (N = 336)	Additional TT placed (N = 51)	No additional TT placed (N = 285)	Odds ratio (95% CI)	p values	Adjusted odds ratio (95% CI)	p values
Sex, *n* (%)						—[a]	
Male	199 (59.2%)	27 (52.9%)	172 (60.4%)	(Reference)			
Female	137 (40.8%)	24 (47.1%)	113 (39.6%)	1.35 (0.74–2.46)	.32		
Age at first CNPA AOM diagnosis, mean in months (SD)	24.95 (24.35)	44.16 (32.63)	21.52 (20.83)	1.03 (1.02–1.04)	<.001	1.03 (1.02–1.04)	<.001
Season						—[a]	
Winter	90 (26.8%)	14 (27.5%)	76 (26.7%)	(Reference)			
Spring	68 (20.2%)	12 (23.5%)	56 (19.6%)	1.16 (0.50–2.71)	.73		
Summer	66 (19.6%)	9 (17.6%)	57 (20.0%)	0.86 (0.35–2.12)	.74		
Fall	112 (33.3%)	16 (31.4%)	96 (33.7%)	0.90 (0.42–1.97)	.80		
Number of AOM Episodes, mean (SD)	3.08 (1.94)	2.51 (1.67)	3.19 (1.97)	0.81 (0.68–0.97)	.02	1.24 (0.98–1.57)	.07
Ceftriaxone treatment, mean (SD)	0.37 (0.71)	0.14 (0.45)	0.41 (0.74)	0.41 (0.20–0.85)	.02	0.62 (0.30–1.30)	.21
Concurrent conjunctivitis, mean (SD)	0.29 (0.57)	0.24 (0.65)	0.31 (0.56)	0.79 (0.44–1.41)	.42	—[a]	
Concurrent respiratory diagnoses, mean (SD)	0.86 (1.02)	0.45 (0.70)	0.93 (1.05)	0.52 (0.34–0.79)	.002	0.57 (0.35–0.92)	.02
Insurance						—[a]	
Public	39 (11.6%)	5 (9.8%)	34 (11.9%)	(Reference)			
Private	297 (88.4%)	46 (90.2%)	251 (88.1%)	1.25 (0.46–3.35)	.66		
CNPA provider type						—[a]	
Nurse practitioner	49 (14.6%)	6 (11.8%)	43 (15.1%)	(Reference)			
Resident physician	86 (25.6%)	15 (29.4%)	71 (24.9%)	1.51 (0.55–4.20)	.43		
Attending physician	201 (59.8%)	30 (58.8%)	171 (60.0%)	1.26 (0.49–3.21)	.63		

[a]Not included in multivariate analysis because too few outcomes were reported, and the univariate analysis was p > .2.

TABLE 5 Factors associated with other complications in univariate analysis

	Entire cohort ($N = 336$)	Other complications ($N = 26$)	No other complications ($N = 310$)	Odds ratio (95% CI)	*p* values
Sex, *n* (%)					
Male	199 (59.2%)	12 (46.2%)	187 (60.3%)	(Reference)	
Female	137 (40.8%)	14 (53.8%)	123 (39.7%)	1.77 (0.79–3.96)	.16
Age at first CNPA AOM diagnosis, mean in months (SD)	24.95 (24.35)	40.69 (33.61)	23.63 (22.99)	1.02 (1.01–1.03)	.001
Season					
Winter	90 (26.8%)	5 (19.2%)	85 (27.4%)	(Reference)	
Spring	68 (20.2%)	9 (34.6%)	59 (19.0%)	2.59 (0.83–8.13)	.10
Summer	66 (19.6%)	6 (23.1%)	60 (19.4%)	1.70 (0.50–5.83)	.40
Fall	112 (33.3%)	6 (23.1%)	106 (34.2%)	0.96 (0.28–3.26)	.95
Number of AOM episodes, mean (SD)	3.08 (1.94)	3.00 (1.96)	3.09 (1.94)	0.98 (0.79–1.20)	.82
Ceftriaxone treatment, mean (SD)	0.37 (0.71)	0.35 (0.75)	0.37 (0.71)	0.95 (0.53–1.71)	.86
Concurrent conjunctivitis, mean (SD)	0.30 (0.57)	0.50 (0.99)	0.28 (0.52)	1.67 (0.97–2.87)	.07
Concurrent respiratory diagnoses, mean (SD)	0.86 (1.02)	0.77 (1.03)	0.86 (1.01)	0.91 (0.60–1.38)	.65
Insurance					
Public	39 (11.6%)	6 (23.1%)	33 (10.6%)	(Reference)	
Private	297 (88.4%)	20 (76.9%)	277 (89.4%)	0.40 (0.15–1.06)	.07
CNPA provider type					
Nurse practitioner	49	6	43	(Reference)	
Resident physician	86	4	82	0.35 (0.09–1.31)	.12
Attending physician	201	16	185	0.62 (0.23–1.68)	.35

Unique AOM episodes were defined as new onset of symptoms more than 17 days after a previous AOM encounter.[10] This cut-off derived from previous studies demonstrating that if AOM recurred ≥17 days after start of treatment for a preceding episode, then it was likely a new episode since episodes would have been treated with an antimicrobial for 10 days, and most AOM episodes occurring ≥7 days after completion of therapy were found to be new infections with different pathogens rather than bacteriologic relapses.[10]

Patients diagnosed with AOM and conjunctivitis or respiratory infections at the same visit were considered to have concurrent diagnoses. A concurrent respiratory diagnosis included any diagnosis with an ICD-19 code J00-J99 in the "Diseases of the Respiratory System" chapter. For example, this includes cough and bronchitis/bronchiolitis/wheezing but does not include nasal allergies or primary nasal symptoms only. Concurrent conjunctivitis was also included in the analysis as a separate diagnosis to determine whether patients with concurrent conjunctivitis (conjunctivitis-otitis syndrome, typically associated with *Haemophilus influenzae*) were more likely to require ceftriaxone treatment compared to patients with only AOM. Unique postoperative otorrhea episodes were defined as separated by at least 17 days. Perforations of the tympanic membrane, granulations, or both were considered other complications and grouped together for analysis due to the limited number of occurrences.

For multivariate analyses, logistic regression was performed with effect sizes reported as odds ratios with corresponding 95% confidence intervals. Univariate numerical variables were evaluated with Mann–Whitney tests. Chi-squared tests were used for categorical variables. Analyses were conducted using Stata17 from StataCorp. A *p*-value of less than .05 was considered to be statistically significant.

3 | RESULTS

The 3189 children <12 years old who presented to the practice between August 1, 2017 and December 31, 2019 with a diagnosis of AOM were included in this study. The 484 (15.2%) of these children were seen by an otolaryngologist at Children's National Hospital for an ear-related concern. Of these patients, 336 (69.4%) had surgical TT placed. The 44 of the 336 patients (13.1%) underwent an adenoidectomy at the time of TT placement. After TT placement, 179 patients (53.3%) reported at least one episode of otorrhea, and 26 patients (7.7%) experienced at least one other complication of perforation and/or granulation. The 51 patients (15.2%) had at least one additional set of TT placed (Table 1).

Multivariate logistic regression analysis of independent variables potentially impacting TT placement among children seen by Children's

National Hospital's pediatric otolaryngology service with a history of recurrent AOM was performed and is summarized in Table 2. Overall, there was a significant association between the number of AOM episodes that were diagnosed at CNPA and TT placement with an odds ratio (OR) of 1.21 (95% CI, 1.04–1.41, $p = .02$). Patients with AOM diagnosed and referred by resident and attending physicians at CNPA had higher rates of eventual TT placement: 57.0% of the patients diagnosed and referred by nurse practitioners at CNPA eventually had TT placement compared to 72.3% and 71.8% of patients diagnosed and referred by resident physicians and attending physicians respectively at CNPA. In other words, in our study, the odds of having TT placement are 88% (OR = 1.88; 95% CI, 1.02–3.48; $p = .04$) and 84% (OR = 1.84; 95% CI, 1.10–3.08; $p = .02$) higher if the patient were diagnosed and referred by resident physicians and attending physicians.

Univariate logistic regression analyses of independent variables potentially impacting postoperative course among patients who received TT were also performed and are summarized in Tables 3–5. The postoperative outcomes explored in this study were otorrhea, additional TT placement, and other complications (i.e., perforation and/or granulation). Multivariate logistic regression analyses were also performed for otorrhea and additional TT placement in Tables 3 and 4; due to the limited number of patients who experienced other complications (such as granulation and tympanic perforation), a multivariate logistic regression analysis could not be performed for other complications. Adenoidectomy at the time of TT placement was not included as a variable in the analyses to avoid overfitting. The multivariate analyses demonstrated that older age at the first CNPA AOM diagnosis correlated with the occurrence of both otorrhea (OR = 1.02; 95% CI, 1.01–1.03; $p = .001$) and additional TT placement (OR = 1.03; 95% CI, 1.02–1.04; $p < .001$). Older age at the first CNPA AOM diagnosis also correlated with the occurrence of other complications in the univariate analysis (OR = 1.02; 95% CI, 1.01–1.03; $p = .001$).

Postoperative otorrhea was associated with patients who first presented at CNPA with an AOM diagnosis in the spring (OR = 2.69; 95% CI, 1.37–5.29; $p = .004$), summer (OR = 2.88; 95% CI, 1.46–5.69; $p = .002$), and fall (OR = 2.18; 95% CI, 1.20–3.96; $p = .01$) seasons according to the multivariate logistic regression analysis. Postoperative otorrhea was also associated with fewer primary care concurrent respiratory diagnoses in a univariate analysis (OR = 0.79; 95% CI, 0.63–0.98; $p = .03$), although this finding was not supported by the multivariate analysis. However, fewer respiratory diagnoses were associated with additional TT placement according to both univariate (OR = 0.52; 95% CI, 0.34–0.79; $P = 0.002$) and multivariate analyses (OR = 0.57; 95% CI, 0.35–0.92; $p = .02$).

4 | DISCUSSION

As the most common reason for antibiotic prescription at an office visit among children,[2] AOM is a prevalent medical condition with implications for not only the health of individuals, but also of the larger healthcare system. For patients who have recurrent infections unresponsive to antibiotics, TT placement is typically the next treatment option in order to avoid any long-term consequences of reduced hearing from effusions and/or to improve quality of life.[4] TT placement is the most commonly performed surgery on children in the United States.[4] As such, it is critical for healthcare providers to be able to make informed decisions about recommending TT placement and anticipating possible postoperative complications before the surgical procedure. We hypothesized that patients who presented to their primary care provider with more complex cases of AOM would be more likely to receive TT and experience postoperative otorrhea and other complications.

From this study, we observed an expected statistically significant association between the number of AOM diagnoses at primary care and the placement of TT, which is consistent with our hypothesis. This is also consistent with current guidelines for TT placement, which state TT placement may be warranted in the case of recurrent AOM with three or more distinct and well-documented episodes within 6 months or four or more episodes within 12 months.[4]

Patients referred from CNPA by residents or attending physicians for AOM-related concern had eventual TT placement more often than referrals where nurse practitioners made the AOM diagnosis. Whether this had to do with severity of disease or diagnostic accuracy is unclear. Of note, the otolaryngologist at Children's National Hospital who decides treatment plan and TT placement is generally unaware of whom in the primary care practice made the diagnosis and referral.

We did not observe any association between the number of ceftriaxone treatments, concurrent conjunctivitis diagnoses, or concurrent respiratory diagnoses with TT placement. These variables had been included in this analysis because our group has collected unpublished data demonstrating a strong correlation between the presence of conjunctivitis and receipt of IM ceftriaxone, which highlighted these variables as possible risk factors.

Among patients who had TT placement, there was a statistically significant association between older age at the first primary care AOM diagnosis and postoperative otorrhea. Younger children are known to have a propensity for AOM due to immature eustachian tube function; as children grow, their eustachian tube function improves, decreasing the likelihood of AOM.[11] Given this, the association between older age at first primary care AOM diagnosis and the occurrence of postoperative otorrhea was an unexpected finding. It is possible that older patients presenting with AOM needing TT experience ongoing, unresolved eustachian tube dysfunction or other inciting factors for recurrent AOM, which may influence postoperative course.

Similarly, AOM is typically more common in the winter months because of the seasonal incidence of viral upper respiratory infections, which increase a child's propensity for AOM.[12] Although seasonal variations may not be consistently generalizable to all parts of the country, these trends do hold true to our study site. The data collected here, however, indicate that patients presenting to CNPA with AOM in the spring, summer, and fall months were more likely to have postoperative otorrhea. This points to an individual patient's predisposition for AOM beyond the expected correlation with winter months, which may predict a more complicated postoperative course. The association between season at first CNPA AOM diagnosis and postoperative course may also be related to our finding that additional TT placement was associated with fewer concurrent respiratory diagnoses; for each additional concurrent respiratory diagnosis at the time of AOM diagnosis, the odds of having additional TT placed was 57% lower (OR = 0.57; 95% CI, 0.35–0.92; $p = .02$). The presence of a concurrent respiratory diagnosis may be suggestive of a respiratory virus, which circulate predominantly in the winter. Thus, a less complicated postoperative course (i.e., no postoperative otorrhea or additional TT placement) appears to be associated with AOM that may be attributable to viral respiratory infections. Ultimately, the observed association between older age and spring, summer, and fall AOM with postoperative otorrhea may serve to help providers and patients understand potential predictors for disease course after TT placement.

Limitations of these findings include the retrospective collection of data, the small sample size of patients who experienced certain postoperative outcomes, lack of data regarding daycare attendance and presence of middle ear fluid at the time of TT placement, and a general loss to follow-up after TT placement; the average length of time between TT placement and last recorded communication with otolaryngology was 14.31 months, which included office visits and/or recorded telephone encounters with questions about or descriptions of otorrhea or complications. The 45 of the 336 patients had no ENT communication after TT placement and were effectively considered as patients with no postoperative complications in the analysis. Additionally, our analysis does not include children diagnosed by CNPA who may have sought otolaryngology care outside of Children's National Hospital. The children included in our analysis of postoperative course were also only those seen by Children's National pediatric otolaryngology service with a history of recurrent AOM. Future studies with a larger sample size of patients reporting postoperative course would provide more reliable results.

The decision for TT placement is one that is made for 667,000 children under the age of 15 every year in the United States.[6] Considering the frequency of this procedure and AOM, it is important to fully understand the factors associated with referral for TT placement and postoperative course. By recognizing patients who may benefit the most from TT placement and those who may experience more complex follow-up care, we can implement systems that customize recommendations and care to improve overall outcomes of AOM on individual families and the healthcare system.

5 | CONCLUSION

Despite the frequency of tympanostomy tube placement, there is little synthesis of data from pediatric primary care visits that can inform clinical decision-making and predict postoperative disease course for patients. This research demonstrates that the number of AOM diagnoses at primary care, older age at first AOM diagnosis, and having a first AOM diagnosis in the spring, summer, and fall seasons are some of the factors that may be relevant for consideration.

FUNDING INFORMATION

The authors have no funding or conflicts of interest to disclose.

CONFLICT OF INTEREST

The authors declares there is no potential conflicts of interest.

ORCID

Lydia Zhong https://orcid.org/0000-0002-8275-1048
Hengameh Behzadpour https://orcid.org/0000-0002-0050-8336
Diego Preciado https://orcid.org/0000-0003-0075-8279

REFERENCES

1. Ahmed S, Shapiro NL, Bhattacharyya N. Incremental health care utilization and costs for acute otitis media in children. *Laryngoscope*. 2014;124(1):301-305. doi:10.1002/lary.24190
2. The high cost of acute otitis media. Contemporary Pediatrics, https://www.contemporarypediatrics.com/view/high-cost-acute-otitis-media
3. Lieberthal AS, Carroll AE, Chonmaitree T, et al. The diagnosis and management of acute otitis media. *Pediatrics*. 2013;131(3):e964-e999. doi:10.1542/peds.2012-3488
4. Rosenfeld RM, Schwartz SR, Pynnonen MA, et al. Clinical practice guideline: tympanostomy tubes in children. *Otolaryngol Neck Surg*. 2013;149(1):8-16. doi:10.1177/0194599813487302
5. Rettig E, Tunkel DE. Contemporary concepts in management of acute otitis media in children. *Otolaryngol Clin North Am*. 2014;47(5):651-672. doi:10.1016/j.otc.2014.06.006
6. Cullen KA, Hall MJ, Golosinskiy A. Ambulatory surgery in the United States, 2006. *Natl Health Stat Rep*. 2009;11:1-25.
7. Steele DW, Adam GP, Di M, Halladay CH, Balk EM, Trikalinos TA. Effectiveness of tympanostomy tubes for otitis media: a meta-analysis. *Pediatrics*. 2017;139(6). doi:10.1542/peds.2017-0125
8. Hoberman A, Preciado D, Paradise JL, et al. Tympanostomy tubes or medical management for recurrent acute otitis media. *N Engl J Med*. 2021;384(19):1789-1799. doi:10.1056/NEJMoa2027278
9. van Dongen TMA, van der Heijden GJMG, Freling HG, Venekamp RP, Schilder AGM. Parent-reported Otorrhea in children with Tympanostomy tubes: incidence and predictors. *PLoS ONE*. 2013;8(7):e69062. doi:10.1371/journal.pone.0069062
10. Leibovitz E, Greenberg D, Piglansky L, et al. Recurrent acute otitis media occurring within one month from completion of antibiotic therapy: relationship to the original pathogen. *Pediatr Infect Dis J*. 2003;22(3):209-216. doi:10.1097/01.inf.0000066798.69778.07
11. Kaur R, Morris M, Pichichero ME. Epidemiology of acute otitis media in the postpneumococcal conjugate vaccine era. *Pediatrics*. 2017;140(3). doi:10.1542/peds.2017-0181
12. Stockmann C, Ampofo K, Hersh AL, et al. Seasonality of acute otitis media and the role of respiratory viral activity in children. *Pediatr Infect Dis J*. 2013;32(4):314-319. doi:10.1097/INF.0b013e31827d104e

How to cite this article: Zhong L, Hamdy RF, Pitter JC, Hamburger EK, Behzadpour H, Preciado D. Characteristics of acute otitis media in primary care are associated with tympanostomy tube outcomes. *Laryngoscope Investigative Otolaryngology*. 2022;7(5):1595-1602. doi:10.1002/lio2.867