



## Prevalence of ventilation tubes in children with a tracheostomy tube<sup>☆</sup>

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### ABSTRACT

**Objectives:** To estimate the prevalence of operative ear disease in pediatric patients with tracheostomy tubes, as well as to identify risk factors predictive of operative otologic interventions in this patient cohort.

**Methods:** We hypothesize that the prevalence of operative middle ear disease in patients with a tracheostomy tube is greater than that of the population at large. To validate our anecdotal observations, we queried the CHCA hospital database (PHIS) regarding the association between tympanostomy tube placements in children with tracheostomies. To further investigate, a retrospective chart review was undertaken at our regional tertiary care children's hospital to determine the frequency at which tympanostomy tubes were placed in children who have a tracheostomy. Risk factors were analyzed, applying independent samples *t*-tests and Pearson's Chi-square test. Univariate and multivariate logistic regression models were constructed to estimate odds ratios (OR) and 95% confidence intervals (CI) for predictors of operative ear disease. Institutional review board (IRB) approval was obtained.

**Results:** Of a population of 181 patients with tracheostomies, 37 (or 20%, 95% CI 15–26%) have undergone placement of ventilation tubes in the past 3 years. No statistically significant difference was noted with regards to gender or race. The operative group had an average age of 23.0 months at the time of tracheostomy, compared to 52.5 months in the non-operative group ( $p = 0.0022$ ). In addition, home living situation, term birth, and craniofacial abnormalities were more frequently observed in the operative versus the non-operative group. Multivariate logistic regression models revealed the same factors as predictors of operative ear disease.

**Conclusion:** The presence of a tracheostomy is associated with an increased risk of requiring ventilation tube placement over the population at large. Risk factors for operative middle ear disease among these children include age at time of the tracheostomy, craniofacial abnormalities, term birth, and home living situation.

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## 1. Introduction

Otitis media is a disease of remarkable morbidity and economic impact in the pediatric population. It remains the most common bacterial infection in children as well as the most common condition requiring antimicrobial and/or operative treatment in this age group [1]. In the United States alone, pediatric otitis media is estimated to require an operative intervention on the order of 600,000 cases annually, and the annual economic burden consequent to combined medical and surgical therapy exceeds

\$5 billion [2]. To this regard, the epidemiology, pathophysiology, course of disease and treatment strategies have been well delineated. A review of the literature demonstrates the prevalence of operative otitis media in the pediatric age group to range from 1.1% to 4.5% [3–8]. Alternatively, the prevalence of operative middle ear disease amongst a population of children post tracheostomy tube placement has not been well described. Although the relationship between these entities in the scientific literature is sparse, Palmisano [7] reports in a review on a population of tracheotomized, ventilator-dependent children that 75% progressed to require myringotomy and tympanostomy tube placement for chronic otitis media with effusion. The need for tracheotomy implicates a medically-complex cohort of patients, whom we hypothesize to require ventilation tube placement more commonly as compared to the population at large.

Anecdotal observations of the increased prevalence of operative middle ear disease in this population at a tertiary level pediatric

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hospital prompted a query of the pediatric health information system (PHIS) database. The PHIS database was developed by the Child Health Corporation of America (CHCA), which includes demographic and diagnostic data on 42 of the largest and most advanced children's hospitals in America, with the most demanding standards of pediatric service. Given the inter-institutional corroboration in trends of care, we proceeded to further investigate the features of our patient population, with the intent of estimating the prevalence of operative ear disease, as well as to identify risk factors predictive of operative otologic interventions.

## 2. Methods

Based upon anecdotal observation, we hypothesize that the prevalence of operative middle ear disease in a population of tracheotomized children is greater than that of the population at large. As a prologue to a review of our institution's experience, we first queried the Pediatric Health Information System (PHIS) database from July 1 of 2007 to June 30th of 2010 to determine the total number of tracheostomies performed at each institution as well as the number of tracheostomy dependent patients who went on to require tympanostomy tube placement. These results would serve as a benchmark for comparison to our institutions experience. Consent was obtained from CHCA for publication of PHIS data.

A retrospective chart review of cases from 1999 to 2010 was conducted at our regional tertiary care children's hospital to determine the prevalence of ventilation tube placement amongst children with tracheostomy placement. A search was performed utilizing procedure codes 31600 (planned tracheostomy), 31601 (planned tracheostomy age < 2 y/o), and 31603 (tracheostomy, emergent), and diagnosis code V44.0 (tracheostomy status) yielding a list of 202 patients. Subjects were excluded if they had an incomplete medical record or had died prior to 1 year of age. Demographic data, pertinent co-morbidities, dates and indications for tracheostomy and ear procedures, location of residence, and interval from tracheostomy placement to middle ear procedure were evaluated and compared for the operative vs. non-operative groups. Statistical analysis was performed using SAS version 9.3. Student's *t*-test and Pearson's Chi-square tests were applied, as appropriate. Logistic regression models were constructed to evaluate gender, age, ethnicity, prematurity, residence and comorbidities as predictors of surgical otologic interventions. Unadjusted, minimally adjusted (gender, age, residence), and fully-adjusted odds ratios (OR) were estimated with their 95% confidence intervals (CI). Two-sided statistical significance was determined at  $p < 0.05$ . Results of the aforementioned, 3-year PHIS query were compared to data obtained from our institution specific, retrospective review. Permission was granted from our institutional review board.

## 3. Results

Analysis of the PHIS database demonstrated that on average, 17.1% of tracheostomy dependent patients underwent myringotomy and tympanostomy tube placement. A representative fraction of institutions were chosen at random for display, as demonstrated in Table 1. Institution names were replaced with an assigned number to preserve identity. Results of the query validated our anecdotal observations, justifying a more formal review.

After application of exclusion criteria, 181 cases at our institution between 1999 and 2010 qualified for review. Thirty-seven of 181 patients required an operative otologic intervention, for an estimated prevalence of 20% (95% CI 15–26%). Myringotomy and tympanostomy tube placement accounted for 100% of operative interventions. The average length of time between

**Table 1**

PHIS data demonstrating inter-institutional estimates in the prevalence of operative middle ear disease in children with a tracheostomy tube. Numbers assigned to each institution for anonymity purposes.

Institution	BMTT/trach	Trach total	%
1	45	246	18.3
2	114	472	24.2
3	33	294	11.2
3	43	318	13.5
5	40	217	18.4
6	34	268	12.7
7	20	235	8.5
8	65	320	20.3
9	31	162	19.1
10	23	151	15.2
11	40	246	16.3
12	55	307	17.9
13	23	97	23.7
14	25	176	19.8
	Mean: 17.08%	Median: 18.1%	SD: 4.51%

tracheostomy tube placement and ventilation tube placement was 19.8 months with a standard deviation of 16.1 months.

### 3.1. Patient demographics

When comparing patient demographics between the operative (tracheostomy plus otologic intervention) and non-operative (tracheostomy alone) groups, no statistically significant difference was noted with regards to gender or race. Age at time of tracheostomy was also evaluated in the operative vs. non-operative groups. Notably, those patients with an ear procedure had an average age of 23.0 months at the time of tracheostomy compared to an average age of 52.5 months in the non-operative groups ( $p = 0.0016$ ).

Those patients undergoing an ear procedure were more likely to reside at home than an institution ( $p = 0.003$ ). Of patients in the operative group, 97% resided at home, compared to 72% of the non-operative group. Fully adjusted odds ratio demonstrated that patients living at home were fifteen times more likely to have an ear procedure than those living in an institution (95% CI 1.84–124.46%).

### 3.2. Comorbid conditions

Twenty seven percent of patients in the operative group were noted to be premature (<36 weeks) as compared to 41% in the non-operative group ( $p = 0.12$ ). Multivariate analysis evaluating prematurity as a risk factor for placement of ventilation tubes demonstrated preterm babies who subsequently required a tracheostomy to be four times less likely to require ventilation tube placement as compared to the term population (adjusted OR 95% C.I 0.088–0.67%).

Other co-morbidities for the operative and non-operative group were recorded and grouped into one of four categories: craniofacial, neurologic, cardiopulmonary and airway. Patients in the operative group were more likely to have a craniofacial comorbidity (35.1%) as compared to patients in the non-operative group (12.5%,  $p = 0.0011$ ). Children with craniofacial comorbidities demonstrated risk for requiring an otologic operative intervention greater than three times that of patients without craniofacial co-morbidities (Adjusted OR 3.06, 95% CI 1.12–8.39%). There was no statistically significant correlation between tracheostomy patients with neurologic, airway, and/or cardiopulmonary comorbidities and middle ear disease requiring operative intervention.

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