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Factors associated with 30-day all-cause hospital readmission after tracheotomy in pediatric patients



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ABSTRACT

Objective: To determine factors associated with post-tracheotomy hospital readmission within 30 days of discharge.

Methods: Children 18 years and younger who underwent tracheotomy at Children's Hospital Los Angeles (CHLA) between 1/1/2005 and 12/31/2013 with at least 30 days of follow-up at CHLA were identified through ICD-9 procedure codes. Patient characteristics and covariates were obtained by linking manual chart review and administrative data. We used multivariate logistic regression to identify the independent association between risk factors and the primary outcome of 30-day all-cause same-hospital readmission.

Results: Of the 273 patients included, the median age at admission was 6 months [interquartile range (IQR): 1–51 months]. Among this primarily male (60.8%) and Hispanic (66.3%) cohort with a high proportion of discharge on positive pressure ventilation (47.1%), the 30-day readmission rate was 22% (n = 60). Of the readmissions, 92% (n = 55) were unplanned and 64% (n = 35) were associated with acute respiratory illnesses. Multivariate regression analysis demonstrated that, among patients ≤ 12 months, discharge on positive pressure ventilation [adjusted odds ratio (aOR) = 2.88, 95% confidence interval (CI) = 1.19–6.97] was associated with increased odds of readmission, while gastrostomy tube placement during the tracheotomy hospitalization (aOR = 0.42, 95% CI = 0.19–0.96) and prematurity (aOR = 0.35, 95% CI = 0.15–0.83) were associated with decreased odds of readmission. In patients > 1 year of age, increased length of hospitalization (aOR = 1.01 per hospital day, 95% CI = 1–1.02) and presence of comorbid malignancy (aOR = 6.03, 95% CI = 1.25–29.16) were associated with increased odds of readmission.

Conclusions: Over one-fifth of children undergoing tracheotomy had an unplanned hospital readmission within 30 days after discharge. Because the majority of readmissions were unplanned and due to acute respiratory illnesses, future research should investigate how discharge procedures and improved care coordination may lower readmission rates in high-risk patients (e.g., patients discharged on positive pressure ventilation).

1. Introduction

Pediatric patients with tracheostomy are medically complex and high utilizers of health care resources who require the care of multidisciplinary tracheostomy teams during their hospitalizations. These teams include the consultant services of otorhinolaryngologists, critical care specialists, neonatologists, pulmonologists, and general pediatricians, as well as the expertise of nurses, therapists, and equipment specialists [1]. On average, while hospitalized, these patients have 9.3 physician-led services and 4.3 non-physician-led services involved in their care [1]. Given their medical complexity, patients with tracheostomy are at increased risk for morbidity, including hospital

readmissions. According to 2013 data from the Healthcare Cost and Utilization Project on tracheostomy placement in 7856 adults, nearly 23% of patients were readmitted within 30 days [2]. In studies of pediatric patients, readmission rates were 26.8–45% at 30 days [3–5], 50% at 3 months [6], 63% at 6 months [6], 50–76% at 1 year [7,8], and 56% at 2 years [9]. In previous investigations of readmissions among pediatric patients with tracheostomies, respiratory complications and infections were the most common reasons for readmission, contributing to 41–75.3% of readmissions [3,7–9].

Given the current data available on tracheostomy readmissions, there is a paucity of research on risk factors, comorbidities, or patient characteristics associated with readmission following tracheostomy

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placement in a general pediatric population. Overall, patients who undergo tracheotomy face the risk of developing procedure-related complications and present an opportunity for planned intervention to decrease negative outcomes and readmissions [10]. Thus, the objectives of this study were to determine rates of readmissions among pediatric patients and identify characteristics and potentially modifiable or preventable risk factors associated with 30-day all-cause hospital readmissions among pediatric patients undergoing tracheotomy at our institution.

2. Materials and methods

2.1. Setting and participants

This is a retrospective cohort analysis of 273 pediatric patients who underwent tracheotomy placement at Children's Hospital Los Angeles (CHLA), an urban academic pediatric hospital, between January 1, 2005 and June 30, 2013. We included all patients 18 years old and younger discharged with an *International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM)* procedure code consistent with tracheotomy (ICD-9: 31.1, 31.2, 31.21, 31.29) who were discharged from the hospital and who had at least 30 days of follow-up at CHLA. Patients who were over 18 years old, died, or were decannulated during index hospitalization were excluded from the study. Additionally, we excluded one patient who had a 606-day length of stay, given that this patient's stay was an extreme outlier value.

2.2. Main outcome variable

Through manual chart review, we defined the main outcome, 30-day all-cause hospital readmission, as any hospital admission within 30 days following discharge after tracheotomy. Two investigators (H.Y. and C.R.) independently identified readmission diagnoses and classified readmissions as planned or unplanned.

2.3. Patient characteristics and covariates

We obtained information on covariates through a combination of manual chart review of the electronic medical record's admission and operative notes by using medical record numbers and, through the patient's medical record number, linked CHLA discharge diagnosis data from the Pediatric Health Information System (PHIS) database [11]. The PHIS database contains inpatient data from over 45 freestanding children's hospitals across the United States and provides up to 41 discharge ICD-9 codes. Data abstracted through manual chart review included patient demographics, such as admission age at hospitalization where tracheotomy placement occurred (in months/years), sex, race/ethnicity (defined as Hispanic, non-Hispanic White, non-Hispanic Black, or other), insurance status (private or public), and prematurity (defined as < 37 weeks gestation). Additional data gathered included length of hospital stay during which initial tracheotomy placement occurred (in days) and discharge on chronic positive pressure ventilation.

To identify medical comorbidities associated with tracheotomy indications, we used ICD-9 codes obtained from CHLA-specific PHIS database contribution previously used in prior studies examining pediatric tracheotomy [12–18] as well as the malignancy complex chronic condition flag, as defined by Feudtner et al. [19] Specific medical comorbidities categories include upper airway obstruction/vascular anomaly (e.g., hemangioma, anomalies of aortic arch, subglottic stenosis, vocal cord paralysis), chronic lung disease (e.g., cystic fibrosis, bronchopulmonary dysplasia, chronic respiratory failure), neuromuscular disease (e.g., anoxic brain injury, hydrocephalus, demyelinating disorders, congenital brain or nervous system anomalies, encephalopathy, muscular dystrophies) and trauma (e.g., intracranial hemorrhage following injury, quadriplegia).

2.4. Statistical methodology

Descriptive statistics were used to assess the relationship between patient characteristics and readmissions within 30 days of discharge. Bivariate logistic regression analyses were used to estimate the relationship between the predictor and outcome variables through unadjusted odds ratios (uOR) with 95% confidence intervals (CI). Because of the distribution and effects of prematurity for participants less than 12 months and because of differential care locations for each age group (NICU versus PICU), we developed two models, one for patients ≤ 12 months and a second for those > 12 months. Our multivariate logistic regression analysis retained variables at the $p < 0.15$ level in bivariate analyses; this allowed for the identification of variables that, while not autonomously associated with the outcome variable, may be a confounder in the relationship between other predictor variables and the primary outcome. In addition to these variables, any demographic and/or covariates with medical reasons for being included in the final model were also retained. For the multivariate model, we collapsed the Race/Ethnicity data into Hispanic versus non-Hispanic. Adjusted odds ratios (aOR; 95% CI) were reported, with p -values < 0.05 considered statistically significant. All analyses were produced using SPSS Statistics for Windows, version 23. The study was approved by the Children's Hospital Los Angeles Institutional Review Board.

3. Results

Of the 273 patients meeting inclusion criteria, the median age of admission where tracheotomy occurred was 6 months (IQR = 1–51 months) and the median length of hospitalization was 74 days (IQR = 43–122 days). In our cohort, 61% ($n = 166$) of patients were male, 66% ($n = 181$) were Hispanic or Latino, and 88% ($n = 241$) had public insurance (i.e., Medicaid). With respect to medical comorbidities associated with indication for tracheotomy placement, over one-half of patients had underlying chronic lung disease (56.8%; $n = 155$), neuromuscular disease (54.2%; $n = 148$). Upon discharge, nearly half were discharged on positive pressure ventilation (47.1%; $n = 128$). Additional information for the entire cohort are presented in Table 1.

With respect to the primary outcome, in this cohort of 273 patients, 22% ($n = 60$) of patients had a hospital readmission within 30 days post-discharge following tracheotomy placement. Of these patients, 92% ($n = 55$) of readmissions were unplanned. Nearly 64% ($n = 35$) were due to respiratory infections, 20% ($n = 11$) had gastrointestinal diagnoses, 5.5% ($n = 3$) had tracheotomy complications, and 9% ($n = 5$) had non-respiratory infectious diagnoses.

3.1. Patients ≤ 12 months old

There were 166 patients ≤ 12 months old included in the cohort, 21.7% ($n = 36$) of whom were readmitted within 30 days following discharge after tracheotomy. Upon bivariate analysis, patient characteristics meeting *a priori* p -values for inclusion in the multivariate model included prematurity (uOR = 0.50, 95% CI = 0.23–1.08, $p = 0.08$), upper airway obstruction (uOR = 0.48; 95% CI = 0.23–1.04; $p = 0.06$), placement of a gastrostomy tube during the hospitalization where they underwent tracheotomy (uOR = 0.56, 95% CI = 0.27–1.18, $p = 0.13$), and discharge on mechanical ventilation (uOR = 1.83, 95% CI = 0.86–3.90, $p = 0.12$). Length of hospitalization (uOR = 1.00, 95% CI = 1.00–1.01, $p = 0.26$) and patient age (uOR = 1.01, CI = 0.90–1.13, $p = 0.88$) were not associated with increased odds of readmission.

In the multivariate logistic regression model shown in Table 2, demographic factors associated with increased odds of readmission included discharge on home positive pressure ventilation (aOR = 2.88, 95% CI = 1.19–6.97, $p = 0.02$). Patients who had a history of prematurity has decreased odds of readmission (aOR = 0.35, 95% CI = 0.15–0.83, $p = 0.02$), as well as patients with gastrostomy tube

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