



Indications of pediatric tracheostomy over the last 30 years: Has anything changed?



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ABSTRACT

Importance: Recent reports have shown that the indications for pediatric tracheostomy have evolved over time.

Objective: To review the indications for pediatric tracheostomy over the last 30 years.

Design: Retrospective chart review.

Setting: Tertiary referral children's hospital.

Participants: Patients who underwent tracheostomy.

Intervention: Surgical tracheostomy placement.

Main outcomes and measures: Medical records for patients who underwent surgical tracheostomy over the 30-year study period (1984–2014) were reviewed. Patient characteristics including age, gender, birth-weight, gestational age and death were collected and compared with the primary indication for tracheostomy using bivariable analysis.

Results: Five hundred and one patients met inclusion criteria. The most common primary indications for tracheostomy were cardiopulmonary disease (34%) and neurological impairment (32%), followed by airway obstruction (19%), craniofacial (11%), and traumatic injury (4%). Over the last five years (2010–14) cardiopulmonary disease became the most common indication for tracheostomy.

Conclusions: and **Relevance:** The indications for pediatric tracheostomy have evolved over the past 30 years. Infectious causes of airway obstruction and tracheostomy have almost disappeared. Tracheostomy is now most commonly performed in very premature patients with cardiopulmonary or neurological impairment who require prolonged ventilator support.

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1. Introduction

Pediatric tracheostomy is one of the oldest surgical procedures and its application dates back to ancient Greece. Not more than 40 years ago, pediatric tracheostomy was primarily considered an emergency procedure for acute upper airway obstruction caused by infectious causes, such as diphtheria or epiglottitis [1,2]. Over time, both the indication and incidence of pediatric tracheostomy have undergone a substantial shift [3,4]. With the introduction of

vaccines against *Corynebacterium diphtheria* and *Haemophilus influenza*, the number of emergent procedures has reduced dramatically [5].

Despite a decrease in emergent tracheostomies, the incidence of tracheostomies in children has not fallen; instead, it has risen especially in tertiary institutions [6,7]. This has largely been attributed to increased survival of patients in pediatric and neonatal intensive care units (ICUs) [8,9]. As a result, pediatric tracheostomy is now most commonly performed in children with chronic ventilator dependence, congenital or acquired upper airway anomalies and neurological impairment [3,4].

The objective of this study is to review the changing indications for tracheostomy in a large cohort of pediatric patients over the past three decades.

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2. Material and methods

The BCH Institutional Review Board approved this study and its guidelines were followed. A retrospective chart review was performed on pediatric patients who had a tracheostomy during the 30-year study period (between 1984 and 2014) at Boston Children's Hospital (BCH). Patients were excluded if they were older than 18 years of age at the time of tracheostomy or if they had incomplete medical records. Patient charts were reviewed for the following variables: gestational age, birth weight, gender, age at the time of tracheostomy, primary indication for tracheostomy, procedure type (emergency vs. elective) and mortality.

The primary indication for tracheostomy was categorized into 5 separate groups: 1) cardiopulmonary, 2) craniofacial anomalies, 3) neurological impairment, 4) traumatic injury, and 5) airway obstruction. The breakdown of conditions included in each category is depicted in Table 1.

Chi-square test or Fisher's exact test was used to compare patient's characteristics and outcomes between indication groups. Kruskal-Wallis test was used to compare age at tracheostomy among indication groups. Wilcoxon rank-sum test was also conducted for pairwise comparisons. Bonferroni correction was applied to adjust for multiple comparisons. To assess whether there were any changes in indications over time, we examine indications for tracheostomy during three specific time periods (1984–2004; 2005–09; and 2010–14). Analyses were conducted using SAS version 9.3 and R statistical software.

3. Results

A total of 456 patients met inclusion criteria. The median age at tracheostomy was 0.7 years (IQR 0.3, 3.8 years; Table 2). The most common primary indications for tracheostomy were cardiopulmonary disease (32%) and neurological impairment (31%), followed by airway obstruction (20%), craniofacial anomalies (12%), and traumatic injury (4%; Fig. 1). The age at tracheostomy was significantly younger in patients who had a tracheostomy for airway obstruction, cardiopulmonary or craniofacial anomalies when compared to patients with neurologic impairment or traumatic injury ($p < 0.001$; Fig. 2). Two hundred and two patients (45%) were premature and 84 (19%) were very low or extremely low birth rate. Gastrostomy (g-tube) placement was necessary in 71% of the entire cohort; it was performed most frequently in patients with craniofacial anomalies, neurologic impairment, and traumatic injury when compared to the other groups ($p < 0.001$). Three hundred and one patients (66%) required ventilator support following tracheostomy. Over the last 30 years, there were 2 tracheostomy-related

deaths (0.4%) and 64 deaths unrelated to tracheostomy (14%), most commonly in the cardiopulmonary group.

The primary indications for tracheostomy have changed over the last 30 years (Fig. 3). Over the last 5 years (2010–14), cardiopulmonary disease became the most common indication for tracheostomy. The proportion of patients who had a tracheostomy for cardiopulmonary disease increased from 13% in 1984–2004 to 29% in 2005–09, and 39% in 2010–14 ($p < 0.001$); whereas the proportion of patients who had a tracheostomy for neurological impairment declined from 46% in 1984–2004 to 34% in 2005–09, and 26% in 2004–14 ($p = 0.003$). There was no significant change over the study period for proportion of patients who had a tracheostomy for airway obstruction, craniofacial anomalies, or traumatic injury.

4. Discussion

The indications for tracheostomy in the literature vary depending on the origin of the reports and timeframe of the literature review [2,6,8,11–14]. One of the earliest studies reported that between 1988 and 1998, neurologic impairment and prolonged ventilation were the most common indications for tracheostomy [2]. A more extensive review of 37 years from Turkey found that, although upper airway obstruction was the most common indication between 1968 and 2005, there was also an increase in the number of tracheostomies performed for prolonged ventilation during the late period of their study [8]. Similarly, two series between 1996 and 2001 from France [14] and 1991 and 2003 from Singapore [13] also found that more tracheotomies were being performed for prolonged intubation.

In the more recent literature, the indications for pediatric tracheostomy have changed [2,4–6,9,10]. Our study showed that the most common overall indications for pediatric tracheostomy are cardiopulmonary disease (32%) and neurological impairment (31%). We also found a significant increase in the number of tracheotomies being performed for cardiopulmonary reasons during the last 5 years. Similar to our findings, another study reported neurological anomalies (38.9%) and cardiopulmonary disease (21.2%) as the most common indications for pediatric tracheotomies [4]. In another retrospective review, prolonged intubation (35%), upper airway obstruction (28%), neurologic disorders and craniofacial anomalies (12% for each indication) were reported as the most common indications for tracheostomy [6]. This changing profile of indications for pediatric tracheostomy is not limited to the North American patient population. Recently, similar reports have been published from the United Kingdom, where the indications have changed from infectious causes to airway

Table 1
Conditions included in each indication category.

Airway obstruction	Cardiopulmonary disease	Craniofacial anomalies	Neurologic impairment	Traumatic injury
Bilateral Vocal Cord Paralysis	Prematurity, BPD	Micrognathia, Retrognathia	Arnold-Chiari malformation	Drowning
Subglottic Stenosis (grade 3–4)	Congenital heart disease	Choanal atresia	Brain Tumor	Fall
Tracheobronchomalasia	Congenital lung disease	Pyrimfom aperture stenosis	Central respiratory dysfunction	Ingestion of corrosive material
Vascular Malformation	Pulmonary hypertension	AVM	Cerebral Palsy	Laryngotracheal trauma
Laryngeal cleft	Restrictive lung disease	CHAOS	Encephalopathy	Motor Vehicle Accident
Complete tracheal ring	Chronic lung disease	Apert's	Guillane- Barre	Maxillofacial fractures
Laryngeal stenosis	Pneumonia	CHARGE	Neuromuscular Diseases	Smoke inhalation injury
Laryngeal web		Crouzon	Seizure	
Subglottic Hemangioma		Di George	Spinal muscular atrophy	
NF teratoma		Noonan	Other	
Rhabdomyosarcoma		Pfeiffer		
		Pierre-Robin Seq		
		Treacher-Collins		
		Velocardiofacial		

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