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Predictors of Clinical Outcomes and Hospital Resource Use of Children After Tracheotomy

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Abstract

OBJECTIVES—The objectives are to describe health outcomes and hospital resource use of children after tracheotomy and identify patient characteristics that correlate with outcomes and hospital resource use.

PATIENTS AND METHODS—A retrospective analysis of 917 children aged 0 to 18 years undergoing tracheotomy from 36 children's hospitals in 2002 with follow-up through 2007. Children were identified from ICD-9-CM tracheotomy procedure codes. Comorbid conditions (neurologic impairment [NI], chronic lung disease, upper airway anomaly, prematurity, and trauma) were identified with ICD-9-CM diagnostic codes. Patient characteristics were compared with in-hospital mortality, decannulation, and hospital resource use by using generalized estimating equations.

RESULTS—Forty-eight percent of children were 6 months old at tracheotomy placement. Chronic lung disease (56%), NI (48%), and upper airway anomaly (47%) were the most common underlying comorbid conditions. During hospitalization for tracheotomy placement, children with an upper airway anomaly experienced less mortality (3.3% vs 11.7%; $P < .001$) than children without an upper airway anomaly. Five years after tracheotomy, children with NI experienced

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greater mortality (8.8% vs 3.5%; P .01), less decannulation (5.0% vs 11.0%; P .01), and more total number of days in the hospital (mean [SE]: 39.5 [4.0] vs 25.6 [2.6] days; P .01) than children without NI. These findings remained significant (P < .01) in multivariate analysis after controlling for other significant cofactors.

CONCLUSIONS—Children with upper airway anomaly experienced less mortality, and children with NI experienced higher mortality rates and greater hospital resource use after tracheotomy. Additional research is needed to explore additional factors that may influence health outcomes in children with tracheotomy.

Keywords

tracheotomy; children; mortality; hospitalization; health services; outcomes

Children experiencing potential life-limiting respiratory compromise may require tracheotomy for survival. In the past, tracheotomy indications were principally acute upper airway compromise secondary to infection, such as epiglottitis and croup.¹ Currently, tracheotomy is performed more often in children who require prolonged mechanical ventilation (MV), who have upper airway anomalies, or significant comorbid conditions including neurologic impairment (NI) and chronic lung disease.^{1–4}

Children with tracheotomy are at risk for mortality. The nation-wide mortality rate during hospitalization for tracheotomy is 7%.^{5,6} Single-institutional studies have revealed 9% to 15% mortality rates up to 10 years after tracheotomy.^{7–10} It is believed the vast majority of deaths are not tracheotomy-related, but rather because of the child's underlying chronic diagnoses.^{7,8,10–15} Identification of the diagnoses and other patient characteristics associated with mortality in children with tracheotomy has not been performed.

Children with tracheotomy are at risk for frequent hospitalizations. One study reported that 11% of children required 4 or more hospitalizations within 6 months after tracheotomy.¹⁶ The reasons for frequent hospitalization have not been described. Tracheotomy-related complications and predisposition for respiratory infections may lead to frequent hospitalizations.^{1,16–20} The impact of the child's comorbid conditions on hospital resource use has not been evaluated.

Most single-institutional studies in children with tracheotomy contain sample sizes that limit the ability to evaluate risk factors for poor outcomes.^{14,15,17,18,21} Outcomes from single-institutions may be influenced by center-specific care practices, including which children are offered tracheotomy, timing of tracheotomy, posttracheotomy discharge planning, readmission policies, and palliative care decisions.^{22–27} The objectives of this study are to (1) describe the health outcomes and hospital resource use of a large, multi-institutional cohort of children after tracheotomy and (2) identify comorbid conditions and other patient characteristics that correlate with poor health outcomes and greater hospital resource use.

PATIENTS AND METHODS

Study Design and Setting

This is a longitudinal, retrospective analysis of the Pediatric Health Information System (PHIS).²⁸ PHIS is an administrative database containing hospitalization data from 36 freestanding US pediatric hospitals from 2002 to 2007. All hospitals are affiliated with the Child Health Corporation of America (Shawnee Mission, KS). Data quality and reliability are maintained through a joint effort between the Child Health Corporation of America and Thompson Health care (New York, NY). Children are followed across multiple admissions to the same hospital by using a unique patient identifier.

Study Participants

Children aged 0 to 18 years old undergoing tracheotomy in 2002 were identified from *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9-CM) procedural coding 31.1 or 31.2 (tracheotomy operation).

Main Outcome Measures

In-hospital mortality, decannulation, and tracheotomy complications were determined during each hospitalization in the 5-year follow-up period. Decannulation was defined with ICD-9-CM code 31.72 (“closure of external fistula of tracheotomy”), 97.37 (“removal of tracheotomy”), or 31.75 (“reconstruction of the trachea”) in a child with an existing tracheotomy, excluding any children with a tracheotomy-related ICD-9-CM code after decannulation suggesting the tracheotomy tube remained in situ. This exclusion reduced the likelihood of falsely identifying decannulation in a child who underwent tracheotomy revision or temporary removal.

Tracheotomy complications were identified from ICD-9-CM diagnosis codes for tracheotomy infection (519.01), tracheostomy-related hemorrhage or tracheoesophageal fistula (519.09), tracheal stenosis (519.02), and unspecified tracheostomy complication (519.00).

Hospital resource use in the 5-year follow-up period included the number of hospitalizations, total number of days spent in the hospital, length of stay per hospitalization, and readmission within 30 days of a previous admission.

Patient Characteristics

The comorbid clinical conditions evaluated were upper airway anomaly, trauma, prematurity, chronic lung disease, NI, and “other,” as categorized in previous studies in children with tracheotomy.^{15,29} Conditions were identified by ICD-9-CM codes for each child on the basis of previous studies^{30–33} and the tabular index of ICD-9-CM diagnostic coding. NI included static and progressive, central and/or peripheral neurologic diagnoses such as cerebral palsy (CP) and muscular dystrophy. Upper airway anomalies included diagnoses such as subglottic stenosis and laryngotracheomalacia. Chronic lung disease included diagnoses such as bronchopulmonary dysplasia and cystic fibrosis.

The child’s hospital discharge disposition³⁴ and use of ventilatory support²⁹ were also evaluated as correlates of health outcomes. Each child was categorized by their disposition at hospital discharge across multiple hospitalizations: (1) always discharged to home; (2) always discharged to a postacute nursing care or rehabilitation facility; or (3) alternating between home and a postacute facility across multiple hospital discharges.³⁴ Ventilation support was defined as the use of MV, bilevel positive airway pressure (BiPAP) or continuous positive airway pressure (CPAP) ventilation during subsequent hospitalizations after tracheotomy placement.²⁹ MV, BiPAP, and CPAP use were identified from respiratory supply charges. Children were categorized by their ventilation need across multiple hospitalizations: always required; never required; or sometimes required ventilatory support.

Demographic variables at tracheotomy placement included age (<1 year, 1–12 years, 13 years), gender, race/ethnicity (white non-Hispanic, black, Hispanic, other), and insurance type (public, private, self-pay).²⁸

Hospitalization Characteristics

Hospitalization characteristics evaluated in the 5-year follow-up period were admission type (elective versus nonelective), the major diagnostic category (MDC) of the principal reason

for admission, use of intensive care, and admissions specific for tracheitis (ICD-9-CM diagnostic codes 464.1, 464.2, 476.1, and 491.8). Elective admissions were not associated with an emergency department visit, transfer from another acute care facility, or “urgent/emergent” label.²⁸

Statistical Methods

We used generalized estimating equations to compare patient characteristics with each dichotomous outcome (intentional decannulation, in-hospital mortality, and readmission within 30 days of a previous hospital discharge), ordinal outcome (number of hospital admissions after tracheotomy), and continuous outcomes (total number of hospital days, length of stay per admission). We clustered data within each hospital to account for potential center-specific care attributes that may influence outcomes. Covariates with a *P* value of .1 in bivariate analyses were entered into multivariate analysis by using a backward elimination process. Statistical Analysis Software (SAS Institute, Inc, Cary, NC) was used for all analyses.

RESULTS

Nine hundred seventeen children underwent tracheotomy in 2002. Ninety-two percent (*n* = 846) survived the tracheotomy admission and were followed through 2007 (*n* = 796) or until in-hospital death (*n* = 50). Median age at tracheotomy was 0.5 years (inter-quartile range: 0.2–6.3 years). Fifty-nine percent were male, 45% were white non-Hispanic, and 54% used public health insurance.

Chronic lung disease was the most common clinical condition associated with tracheotomy placement (56%), followed by NI (48%), and upper airway anomaly (47%). Sixty percent had 2 or more conditions. NI and chronic lung disease were the most commonly paired conditions. Seventeen percent used ventilatory support (CPAP, BiPAP, or MV) across all hospitalizations. Ten percent were always discharged to a postacute care facility (Table 1).

Clinical Outcomes

Of the children admitted for tracheotomy, 7.7% died. The in-hospital mortality rate for children who survived the tracheotomy admission was 5.9% within 5 years. During hospitalization in the follow-up period, 8.8% of children were decannulated and were not readmitted to a PHIS hospital for tracheotomy tube replacement. In the follow-up period, 18.7% of all children experienced a tracheotomy-related complication. Hemorrhage/tracheoesophageal fistula was the most common complication (53.5%) (Table 2).

Hospital Use

In the 5-year follow-up period, the mean number of hospitalizations experienced per child was 3.8 (SD: 4.4; range: 0–34). The mean number of total days spent in the hospital was 32.3 days (SD: 65.9; range: 0–862). Forty-five percent of children experienced hospital readmission within 30 days of a previous admission (Table 3). Total aggregate charges for the hospitalizations were \$529 million, which was 3.1% of charges for all children hospitalized in the study period.

Most admissions were respiratory-related (46.1%) followed by otolaryngologic (13.8%) and digestive (9.2%) on the basis of the MDC at admission. The majority (74.4%) of admissions were nonelective. Of the total number of admissions, 43.4% were associated with ICU services and 16.4% were associated with tracheitis.

Patient Characteristics and Clinical Outcomes

Underlying Clinical Condition—Children with an upper airway anomaly experienced a lower in-hospital mortality rate (3.3% vs 11.7%, $P < .001$) during admission for the tracheotomy procedure compared with children without an upper airway anomaly. In the 5 years after tracheotomy, children with NI experienced a higher in-hospital mortality rate (8.8% vs 3.5%; $P = .001$) and less decannulation (5.0% vs 11.0%; $P = .002$) compared with children without NI. These findings remained significant ($P < .01$) in multivariate analysis (Table 4). The other clinical conditions were not associated with in-hospital mortality in bivariate analysis ($P > 1.0$).

Hospital Discharge Disposition—In the 5 years after tracheotomy placement, children who were always discharged to a postacute care facility experienced a higher in-hospital mortality rate (12.5% vs 4.9%; $P = .02$) compared with children who were always discharged to home. This finding remained significant ($P = .01$) in multivariate analysis (Table 4).

Patient Demographics—Female patients had higher in-hospital mortality rates during the admission for tracheotomy placement, but this finding was not statistically significant at the $P = .05$ level (9.7% vs 6.4%; $P = .07$). Children aged ≤ 1 year old experienced the highest in-hospital mortality rate (9.5%) during admission for the tracheotomy procedure compared with children aged 1 to 12 years old (5.5%) and adolescents (4.9%) ($P = .05$). These findings were significant ($P = .05$) in multivariate analysis. In-hospital mortality and decannulation did not vary according to insurance type in bivariate analysis ($P > .3$).

Patient Characteristics and Hospital Resource Use

Underlying Clinical Condition—Children with NI experienced greater length of stay (mean [SE]: 10.3 [0.7] vs 6.8 [0.5] days; $P < .0001$) and total hospital days (mean [SE]: 39.5 [4.0] vs 25.6 [2.6] days; $P = .003$) compared with children without NI. These findings remained significant ($P < .001$) in multivariate analysis (Table 5). The other clinical conditions were not associated with hospital resource use in bivariate analysis ($P > 1.0$).

Ventilation Support—Children always using ventilation support across multiple hospitalizations experienced lower number of admissions (mean [SE]: 0.7 [0.2] vs 5.6 [0.3]; $P < .001$), lower total hospital days (mean [SE]: 10.0 [3.4] vs 47.9 [4.1] days; $P < .001$), and less readmission within 30 days (13.7% vs 64.4%; $P < .001$) compared with children who sometimes used ventilation support. However, these children experienced longer length of stay per hospitalization (mean [SE]: 14.6 [2.3] vs 8.7 [0.6] days; $P = .001$). These findings remained significant ($P < .01$) in multivariate analysis (Table 5).

Hospital Discharge Disposition—Children always discharged to a postacute care facility experienced lower number of acute-care admissions (mean [SE]: 0.4 [0.1] vs 5.4 [0.4]), less readmission within 30 days (11.3% vs 63.1%; $P < .001$), and lower total hospital days (mean [SE]: 9.9 [3.6] vs 56.5 [4.4] days) compared with children discharged to both home and postacute facilities across multiple hospitalizations. However, these children experienced longer length of stay per hospitalization (mean [SE]: 27.8 [8.8] vs 10.4 [0.8] days). These findings remained significant ($P < .001$) in multivariate analysis (Table 5).

Patient Demographics—Children aged ≤ 1 year old experienced the highest number of admissions (mean [SE]: 4.3 [0.3]) and children aged ≥ 13 years old experienced the lowest number of admissions (mean [SE]: 2.4 [0.3]; $P < .001$). Children aged ≤ 1 year old had more readmissions within 30 days (52.0%) compared with children age ≥ 13 years old (31.2%; $P < .001$). These findings remained significant ($P < .05$) in multivariate analysis (Table 5).

Female gender was associated with greater length of stay (mean [SE]: 9.8 [0.8] vs 7.5 [0.5] days; $P = .008$) and total hospital days (mean [SE]: 40.2 [3.9] vs 27.0 [2.3] days; $P = .0004$) compared with male patients. Female patients experienced more hospitalizations, but this finding was not statistically significant at the $P = .05$ level (mean [SE]: 4.2 [0.3] vs 3.6 [0.3]; $P = .07$). Greater length of stay and total hospital days for female patients remained significant ($P < .001$) in multivariate analysis. Hospital resource use did not vary by insurance type ($P > .1$) in bivariate analysis.

DISCUSSION

To our knowledge, this is the first multi-institutional study in children with tracheotomy reporting differences in clinical outcomes and hospital resource use based on the child's comorbid clinical conditions. Children with upper airway anomaly experienced lower in-hospital mortality rates at tracheotomy placement. Children with NI experienced both higher in-hospital mortality rates and greater hospital resource use 5 years after tracheotomy. These findings remained significant after controlling for important cofactors including ventilation support, use of postacute care facilities after hospital discharge, age, and gender.

This is the also the first study to document the substantial hospital use of children 5-years after tracheotomy. With an average length of stay exceeding 8 days, admissions for children with tracheotomy rank among the longest hospitalizations experienced by all children, including those with severe sepsis, Kawasaki disease, and hydrocephalus.^{32,35–42} The impact of these lengthy hospitalizations is magnified by high readmission rates.^{16,43,44} We observed high 30 day readmission (52%) in children aged ≥ 1 year old after tracheotomy. Prolonged hospital stay posttracheotomy for caregiver tracheostomy care teaching may decrease readmission after discharge.^{16,26} We evaluated this possibility in a posthoc analysis and observed no correlation between increased posttracheotomy hospital stay and readmission (data not shown).

The association of NI with a higher in-hospital mortality rate and hospital resource use is supported by previous studies. Some children with severe NI and low expected survival may undergo tracheotomy as part of a palliative treatment plan with expected mortality.^{27,45} Children with NI because of CP experience a higher mortality rate after musculoskeletal operations.⁴⁶ Children with CP experience hospitalizations that are 2 days longer, on average, than children without CP.⁴² Comorbid conditions, including respiratory insufficiency, are considered a major reason for the higher mortality rate and greater hospital resource use in children with CP.^{42,46–48}

The observation that children with NI are less likely to be decannulated is supported by previous literature. Decannulation is indicated if airway secretions are well-controlled and chronic MV is not needed.⁴⁹ Children with NI are at risk for dysfunctional swallow, gastroesophageal reflux, and impaired cough and/or respiratory insufficiency which may prevent decannulation.^{48,50–52} NI constitutes the majority of primary diagnoses in children with tracheotomy and chronic ventilation needs.²⁹

Lower in-hospital mortality rates in children with tracheotomy and upper airway anomaly has not been reported. Children with airway malformations undergoing cardiac surgery without tracheotomy experience prolonged intensive care, hospital stay, and MV.⁵³ It is possible that tracheotomy in children with an upper airway anomaly overcomes the critical respiratory compromise caused by the anomaly and decreases the mortality risk. Children with other comorbid conditions leading to lower-respiratory insufficiency may not experience the same degree of benefit from tracheotomy.^{42,46–48}

Higher in-hospital mortality rates and greater hospital use in children aged 1 year old at tracheotomy have not been reported. In posthoc analyses, this finding was similar for infants aged 6 months old and 6 to 12 months old (data not shown). Many neonates undergoing tracheotomy experience lengthy pretracheotomy intubations and multiple failed extubations.^{54,55} They also have a higher incidence of comorbid conditions, such as gastroesophageal reflux and pulmonary hypertension.⁵⁴ As a result of advances in neonatal care, extremely premature and medically fragile neonates may survive to develop secondary illnesses, such as chronic lung disease, and require tracheotomy.^{56,57} Some neonates with severe underlying medical conditions and a poor prognosis may experience subsequent withdrawal of care and death.^{23–25} Nationally, infants account for a significantly higher number of hospitalizations compared with older children, presumably because of their increased susceptibility to acute illnesses.⁵⁸ All of these factors may contribute to higher mortality rates and greater hospital use observed in infants after tracheotomy.^{59,60}

One unexpected finding from this study is that female children with tracheotomy experienced greater length of stay and total days in the hospital. Female patients also had a higher mortality rate that approached statistical significance. Higher mortality rates among female infants and children undergoing cardiovascular surgery has been reported without a clear explanation.^{61–63} Female patients undergoing pediatric cardiac surgery had more significant comorbid conditions that may have influenced their outcomes.⁶³ The US infant mortality rate is higher for male patients than female patients.⁶⁴ We performed posthoc multivariate analyses to evaluate the interaction between gender, underlying clinical condition, mortality, and hospital resource use. No statistically significant gender interactions were observed, even among premature infants (data not shown).

Another interesting finding from this study is that children using ventilation support across all hospitalizations and children always discharged to a postacute care facility had significantly longer hospital stays but fewer readmissions. The limited availability of postacute facilities may explain the extended length of stay observed for some children as they awaited transfer.⁶⁵ Children always discharged to a postacute facility also had a competing risk of higher in-hospital mortality rates, which could explain their fewer readmissions. We performed a posthoc analysis of hospital use accounting for mortality in children always discharged to a postacute facility. The correlation with less hospital use remained unchanged (data not shown). Previous adult literature has described the importance of community nursing care toward reducing hospitalizations in chronically ill patients.^{34,66} Many children with tracheotomy and chronic ventilation support use rehabilitation, skilled-facility or home nursing care after acute-care hospital discharge.^{29,66,67} Although not determined from the present study, it is possible that these children experienced effective transitional nursing care that may have reduced the risk for readmission and subsequent acute-care hospitalization.^{34,67–69}

This study has several limitations. We were limited by the administrative data available in PHIS. The tracheotomy ICD-9-CM code 519.09 combines tracheotomy hemorrhage with the rare complication of tracheoesophageal fistula. Information on the true indication for tracheotomy placement, such as pulmonary toilet or prolonged ventilation, was not available through administrative data.⁷⁰ We could not determine the true clinical reason for a child's decannulation or mortality.

We could not evaluate important center-specific tracheostomy care practices that likely influence health outcomes.^{22–27} Information on reuse of tracheotomy tubes or frequency of tube changes were unavailable.^{71,72} Institutional care practices requiring ICU admission for children with tracheotomy may have influenced the observed ICU use in our study.

PHIS does not contain outpatient or community data. We were unable to determine true chronic, oxygen and/or ventilation dependency, or home nursing use.^{29,67} The true long-term community disposition of the children could not be determined. We could not identify children who experienced mortality at home or at another community setting. An increasing number of children with complex medical conditions may experience mortality outside of the hospital.⁷³

We could not identify children lost to follow-up from changing their inpatient care to a non-PHIS hospital. Children could have experienced intentional decannulation, tracheotomy tube replacement after decannulation, tracheotomy-related complications, or in-hospital mortality at a non-PHIS hospital during the follow-up period. Therefore, the rates of these clinical outcomes may be underestimated. The generalizability of the study findings is limited because PHIS does not contain data from community or nonfreestanding children's hospitals. Up to 30% of tracheotomy operations in children occur in community hospitals.⁶ However, the findings are applicable to freestanding children's hospitals, where a large proportion of children with tracheotomy likely receive their inpatient care.⁶

Despite these limitations, this study adds to the existing literature by providing the first analysis of patient characteristics that correlate with both clinical outcomes and hospital resource use from a recent, multi-institutional cohort of children undergoing tracheotomy. The main findings may be used by neonatologists, pediatric intensivists, and otolaryngologists to better inform families on what to expect regarding outcomes and hospitalizations after a child's tracheotomy. Pediatric tracheotomy providers of all types may use the findings to explore additional factors that influence health outcomes and hospitalizations with more clinically detailed inpatient, outpatient, and community data.

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ABBREVIATIONS

MV	mechanical ventilation
NI	neurologic impairment
PHIS	Pediatric Health Information System
ICD-9-CM	<i>International Classification of Diseases, Ninth Revision, Clinical Modification</i>
CP	cerebral palsy
BiPAP	bilevel positive airway pressure
CPAP	continuous positive airway pressure
MCD	major diagnostic category

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WHAT'S KNOWN ON THIS SUBJECT

Most single-institutional studies in children with tracheotomy contain study population sizes that limit the ability to evaluate risk factors for poor outcomes. Outcomes reported from single institutions may be influenced by center-specific tracheostomy care practices.

WHAT THIS STUDY ADDS

This study adds to the existing literature by providing the first analysis of patient characteristics that correlate with both clinical outcomes and hospital resource use from a recent, multi-institutional cohort of children undergoing tracheotomy.

TABLE 1

Demographic and Clinical Characteristics of 917 Children Undergoing Tracheotomy in 2002

	Value
Demographic characteristic	
Age at tracheotomy, mean $\pm$ SD, y	3.8 $\pm$ 5.5
<1, %	57.1
1–12, %	29.5
13–18, %	13.3
Male, %	59.3
Race/ethnicity, %	
White, non-Hispanic	44.8
Black	24.1
Hispanic	15.4
Other	15.7
Insurance, %	
Public	54.0
Private/health maintenance organization	27.7
Self-pay	1.7
Other/unknown	16.6
Clinical characteristic	
Chronic lung disease, %	55.9
NI, %	47.6
Upper airway anomaly, %	46.7
Prematurity, %	17.0
Trauma, %	7.6
Other, % ^a	7.1
Ventilation support	
Sometimes ventilated ^b	57.6
Never ventilated ^b	25.2
Always ventilated ^b	17.2
Hospital discharge disposition, %	
Always home	71.6
Sometimes to a postacute care facility	18.8
Always to a postacute care facility	9.6

^aAside from “other,” the conditions are not mutually exclusive. “Other” represents children who did not possess an ICD-9-CM code for chronic lung disease, prematurity, neurological impairment, upper airway anomaly, or trauma.

^bIncludes the use of MV, CPAP, or BiPAP during hospitalization.

TABLE 2

In-Hospital Mortality, Decannulation, and Tracheotomy-Related Complications in 917 Children Undergoing Tracheotomy in 2002

	% (n)
Timing of in-hospital mortality	
0–7 d after tracheotomy	1.1 (10)
0–30 d after tracheotomy	4.4 (40)
During the hospitalization for tracheotomy	7.7 (71)
5 y after tracheotomy	13.2 (121)
Events associated with in-hospital mortality	
Decannulation	1.2 (2)
Tracheostomy stoma infection	7.4 (9)
Intentional decannulation	
During the hospitalization for tracheotomy	1.4 (13)
1 y after tracheotomy	3.6 (33)
3 y after tracheotomy	7.3 (67)
5 y after tracheotomy	8.8 (81)
Tracheotomy-related complications in the 5-y follow-up period	
% of children with a complication	18.7 (156)
Type of complication	
Hemorrhage or tracheoesophageal fistula ^a	53.5 (98)
Tracheotomy stoma infection	28.9 (53)
Tracheal stenosis	16.9 (31)
Unspecified	30.1 (1)

^aThe ICD-9-CM code for this complication does not separate tracheotomy hemorrhage and tracheoesophageal fistula.

TABLE 3**Hospital Utilization and Admission Characteristics of Children During the 5 Years After Their Tracheotomy**

	Value
Hospital utilization after tracheotomy	
No. of hospitalizations per child, mean $\pm$ SD	3.8 $\pm$ 4.4
Length of stay per hospitalization, mean $\pm$ SD, d	8.5 $\pm$ 18.7
Total No. of hospital days per child, mean $\pm$ SD	32.3 $\pm$ 65.9
Hospital readmissions	
Children with 1 readmissions in 30 d, %	45.1
Admissions with a readmission in 30 d, %	31.5
Admission characteristics of hospitalizations after tracheotomy, %	
Nonelective	74.4
Use of intensive care during the admission	43.4
Associated with tracheitis	16.4
Reason for admission (MDC), %	
Respiratory	46.1
Ear, nose, mouth, throat, and craniofacial diseases	13.8
Digestive	9.2
Nervous system	7.9
Circulatory	4.5
Infectious	3.2
Other ^a	15.3

^aIncludes 19 other categories.

TABLE 4

Multivariate Analysis of Patient Characteristics and Clinical Outcomes of Children 5 Years After Tracheotomy

Patient Characteristics	Clinical Outcomes, OR (95% CI)		
	In-Hospital Mortality		Decannulation
	During Admission for Tracheotomy Placement	During the 5-y Follow-up Period	
Clinical condition ^a			
NI	—	2.7 (1.4–5.4)	0.4 (0.2–0.8)
Upper airway anomaly	0.2 (0.1, 0.3)	—	—
Chronic lung disease	—	—	1.7 (1.1, 2.7)
Hospital discharge disposition			
Sometimes home ^b	—	0.5 (0.2–1.2)	—
Always home	—	0.4 (0.2–0.7)	—
Always to a postacute care facility	Reference	Reference	Reference
Demographics			
Age < 1 y ^c	3.8 (1.3–11.2)	—	—
Female vs male	1.6 (1.0–2.6)	—	—

The significant ($P < .1$) findings are shown from each model following backward elimination. OR indicates odds ratio; CI, confidence interval.

^aReference group is the absence of each clinical condition (for instance, the reference group for the odds ratios in children with NI is children without NI).

^bSometimes home includes children alternating between home and a postacute care facility across multiple hospital discharges.

^cReference group is children aged 13–18 years old.

TABLE 5

Multivariate Analysis of Patient Characteristics and Hospital Resource Use of Children 5 Years After Tracheotomy

Patient Characteristics	Hospital Resource Use After Tracheotomy			
	No. of Hospitalizations, RR (95% CI)	Length of Stay, RR (95% CI)	Total Hospital Days, RR (95% CI)	Readmission Within 30 d, OR (95% CI)
Clinical condition				
NI ^a	—	1.6 (1.3–1.9)	1.6 (1.3–2.1)	—
Ventilatory support ^b				
Sometimes ventilated	6.4 (3.6–11.3)	0.6 (0.4–0.9)	3.8 (1.8–7.7)	8.4 (4.0–17.6)
Never ventilated	2.8 (1.5–5.0)	0.5 (0.3–0.8)	1.5 (0.7–3.2)	2.4 (1.2–4.5)
Always ventilated	Reference	Reference	Reference	Reference
Hospital discharge disposition				
Sometimes home ^c	7.5 (3.9–14.5)	0.6 (0.3–0.9)	5.5 (2.3–13.2)	7.5 (3.7–15.1)
Always home	5.7 (3.0–10.9)	0.7 (0.4–1.2)	3.2 (1.4–7.1)	3.8 (1.7–8.4)
Always to a postacute care facility	Reference	Reference	Reference	Reference
Demographics				
Age, y				
<1 ^d	1.4 (1.1–1.8)	—	—	2.0 (1.1–3.7)
1–12 ^d	1.3 (1.0–1.7)	—	—	1.4 (0.7–2.5)
Female vs male	—	1.4 (1.2–1.7)	1.5 (1.2–1.9)	—

The significant ($P < .1$) findings from each model following backward elimination are shown. RR indicates rate ratio; CI, confidence interval; OR, odds ratio.

^aReference group is children without NI.

^bIncludes the use of MV, CPAP, or BiPAP during hospitalization.

^cSometimes home includes children alternating between home and a postacute care facility across multiple hospital discharges.

^dReference group is children aged 13 to 18 years old.