Pediatric Long-Term Endotracheal Intubation and Role for Tracheostomy: Patient and Provider Factors

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Abstract

Tracheostomy provides an alternative to long-term intubation in patients with respiratory failure, but there is little guidance for its use in pediatric patients. Our study used provider surveys of pediatric intensive care physicians managing patients intubated longer than 14 days to evaluate accuracy of physician estimates for total intubation time and the impact of medical history and illness category on determining tracheostomy placement. Providers' ability to estimate length of intubation was found to be highly inaccurate. With delayed tracheostomy conferring increased risk and mortality, better recommendations regarding indication and timing of pediatric tracheostomy placement are needed.

Keywords

- pediatric
- tracheostomy
- intubation

Introduction

Tracheostomy provides an alternative to endotracheal intubation for individuals with prolonged respiratory failure. Though relatively common in adult critical care, tracheostomy use is far less frequent in pediatric critical care (PICU).^{1,2} This may be attributed in part to pediatric specific difficulties for tracheostomy placement including lack of institutional and community resources for tracheostomy management and the need for the use of an operating room for placement. Complications of tracheostomy can include bleeding, pneumothorax, pneumomediastinum, recurrent laryngeal nerve injury, infection, tracheomalacia, accidental decannulation, trachea-esophageal fistula, and difficulty swallowing. Despite these concerns, tracheostomy placement has not been shown to contribute to overall patient mortality in PICU patients.³ Potential advantages associated with tracheostomy include reduced risk of laryngeal injury from the long-term presence of an endotracheal tube, decreased use of systemic sedation, and shorter

overall length of stay (LOS). In the absence of consensus guidelines for timing or indication for pediatric tracheostomy in critical illness, provider attitudes, and patient prognosis are assumed to greatly influence the decision to proceed with tracheostomy.² This is evidenced by lower rates of tracheostomy in patients with infectious or cardiovascular disease and other disease states in which the condition is usually expected to fully resolve. In contrast, patients with multiple reintubations, trauma, chronic respiratory, and neurologic conditions are considered for tracheostomy much earlier due to the likely longer-term nature of the underlying disease state.⁴ This study used surveys of PICU physicians caring for long-term intubated (LTI) patients, which we defined as intubation lasting longer than 14 days to evaluate accuracy of physician estimates for total intubation time, as well as the impact of past medical history and illness category on the frequency of tracheostomy placement. Long-term intubation has been defined in various studies of children and adults for lasting anywhere from 3 to 21 days. Fourteen days of intubation was used to define LTI in

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this study because it was thought that this allowed for rapidly reversible conditions to have resolved and thus would represent a group of patients who had not immediately responded to intubation and mechanical ventilation.

Methods

The study was conducted at the Children's Hospital at the University of Oklahoma Medical Center in Oklahoma City, Oklahoma, United States, which is a tertiary pediatric referral hospital and the largest pediatric hospital in the state of Oklahoma. To be eligible for inclusion into the study, patients were admitted to the PICU, aged 0 to 17 years, intubated for at least 14 days with the absence of tracheostomy on admission. Recruitment for the prospective cohort study occurred over a 12-month period from May 2015 through May 2016. After receiving institutional review board approval, informed consent for participation was obtained from all eight PICU physicians and all eligible patients' parent or guardian.

Demographic and diagnostic data were abstracted from the patients' chart to compile descriptive statistics. To assess provider attitude and accuracy, PICU physicians completed a survey on the patient's 14th day of intubation (►Appendix A). To discern the difference between the provider's estimate of intubation duration and actual intubation length and to calculate a measure of provider estimate accuracy, survey data was compared with outcomes documented in the patient's medical chart. Within the Oklahoma City, Oklahoma community, there are significant resources to support pediatric tracheostomy including a Children's Hospital with surgical and pulmonology resources and a dedicated children's rehabilitation hospital. Concerns by providers regarding the long-

term management of the tracheostomy were evaluated as part of the provider survey. A 95% confidence interval (CI) for the true difference and multivariable logistic regression models were used to test provider accuracy and controlling for potential covariates. Interclass correlation (ICC) and 95% CI were calculated based on single rating ($k = 2$ for ICC between physician estimated and actual intubation time), absolute agreement and a two-way mixed effects model.

Results

During the 12-month study period, there were a total of 1,122 PICU admissions; 591 medical (53%) and 531 surgical (47%). Of these patients, only 34 children (3%) met all inclusion criteria including endotracheal intubation for greater than 14 days (►Fig. 1). The majority of LTI study participants were less than 1 year of age ($n = 8$, 76%; ►Fig. 2). Of the LTI patients, cardiac disease (57%) was the most common primary diagnosis followed by respiratory disease (26%) and the average length of intubation was 25 and 21 days respectively (►Fig. 3).

Six (18%) of the LTI patients eventually received a tracheostomy, the majority of whom were less than 1 year of age ($n = 4$; 66.7%). The mean length of intubation prior to tracheostomy was 27.5 days, with a range of 15 to 71 days. Final diagnoses of those who received a tracheostomy were surgical cardiac ($n = 3$, 50%), medical cardiac ($n = 1$, 17%), surgical noncardiac ($n = 1$, 17%), and medical noncardiac ($n = 1$, 17%). Four (70%) patients receiving tracheostomy were eventually discharged home on a long-term ventilator, all of which were surgical cardiac patients. Surgical cardiac patients also had a longer intubation time prior to tracheostomy compared with those

Fig. 1 Patient inclusions by diagnostic category.

Fig. 2 Age distribution of LTI patients. LTI, long-term intubated.

Fig. 3 Primary diagnosis categories in LTI patients. LTI, long-term intubated.

with all other diagnoses, 36 versus 23 days, which is consistent with previous studies.^{5,6} Tracheostomy recipients had no significant difference in morbidity or mortality compared with their long-term intubated counterparts during hospitalization based on abstracted chart review. Four patients who did not receive tracheostomy who were intubated greater than 14 days had signs of upper airway obstruction after extubation, one of these patients required reintubation.

When analyzing possible prognostic factors for tracheostomy, the number of extubation attempts did not predict eventual placement of a tracheostomy. In fact, 50% of tracheostomy patients underwent the procedure without any prior attempted extubation. There was also no significant difference between individual PICU physicians and rate of tracheostomy. On day 14 of patient intubation, 24% of physicians endorsed having considered tracheostomy and 29% reported the patient’s past medical history influencing their decision. When past medical history influenced their

decision to consider placement of tracheostomy, the three most common diagnostic categories were cardiac or pulmonary disease (40%), airway or structural abnormalities (20%), and no significant past medical history (20%).

Tracheostomy was being actively considered in eight patients (24%) at the time of physician survey. Of these eight patients, only four (50%) went on to eventually receive a tracheostomy. Early consideration generally occurred for patients who required a long-term artificial airway and in whom tracheostomy would potentially shorten total LOS. Other reasons providers gave for favoring tracheostomy placement included physician expectation of the need for long-term mechanical ventilation, known airway anomaly, and benefits, such as reduced total sedation and LOS. No physician voiced concerns regarding the long-term ability of the institution or family to manage the tracheostomy as a factor in offering tracheostomy. The most common reason providers gave for not considering early tracheostomy was

their expectation of successful extubation in the near-term (65%). For purposes of this study, near-term extubation refers to a likelihood of successful extubation in a short enough period as to make discussion of tracheostomy unnecessary, generally accepted to be 48 to 72 hours. Results of interclass correlation, evaluating reliability of physician estimated intubation time, and actual intubation time indicated poor reliability (ICC: 0.06; 95% CI: -0.29-0.41). The average physician underestimated total time of intubation by 6.6 days. Other reasons for not considering tracheostomy included high-risk underlying condition (condition that makes tracheostomy inappropriate, neutropenia) preoperative cardiac surgery and concerns for ability to manage tracheostomy long-term.

Discussion

The majority of study participants had underlying cardiac disease, accounting for 57% of the total study population and 67% of those receiving tracheostomy. Cardiac patients were more likely to have longer intubations prior to tracheostomy which is consistent with reports by Wakeham et al (2014), whose multisite review found general cardiac disease was associated with longer time to tracheostomy.⁴ In particular, surgical cardiac patients had the longest mean intubation prior to tracheostomy. This is likely attributable to the perceived reversibility of underlying disease and complication of future thoracic surgery after tracheostomy.

In 2017, a multicenter study examined postsurgical care of children with congenital heart disease (CHD). They reported the overall incidence of post-surgical tracheostomy to be 0.3 to 2.5%. For those who received a tracheostomy, greater in-hospital mortality occurred with those requiring extracorporeal membrane oxygenation, higher surgical risk CHD as defined by risk adjustment for congenital heart surgery (RACHS)-1, and later placement of the tracheostomy.⁵ Given that these findings determined delayed tracheostomy placement as a risk of higher mortality, further efforts to define indications and timing for tracheostomy, so as to minimize risk but maximize benefit of tracheostomy in congenital heart surgery are warranted. Unfortunately, a major obstacle to such efforts is the lack of standardization in regards to what constitute "prolonged intubation." The current definition varies anywhere from 72 hours to upwards of 21 days.^{4,6} In addition, variations in surgeon preferences, variation in severity of illness, and hospital resources confound comparisons between groups.

Our study found no significant difference in morbidity or in-hospital mortality amongst patients requiring at least 14 days of intubation, irrespective of tracheostomy status. The majority of patients who required long-term intubation were less than 1 year old and were surgical cardiac patients. No single diagnostic group received a tracheostomy at a statistically significant higher rate than other diagnostic groups.

The study also found no difference between individual providers and eventual tracheostomy despite a wide range of provider ages (35-60 years of age) and wide range of provider experience (2-28 years in practice). As our study occurred at a single site, this finding can likely be explained by

shared PICU characteristics, group practice patterns, available resources, and similar providers' attitudes toward tracheostomy.⁴ However, our study showed that the most common reason providers gave for not considering tracheostomy at 14 days of intubation was the expectation of extubation in the near-term. This contrasts with our finding that provider estimates of time to extubation consistently underestimated the time until eventual extubation by nearly a week. Given that providers in this study could not accurately determine total length of intubation, more work to define target populations that would benefit from early tracheostomy is needed.

Physician attitude not only steers their clinical practice but also can influence parental decisions. Hebert et al found that when tracheostomy placement was discussed, physicians are nearly three times more likely to state benefits over risk with the most common being shortened LOS.⁷ The principles of informed consent and shared decision-making mandate an unbiased discussion of risk, benefits, and alternatives which is even more important in the absence of clearly defined indications for an intervention. Our study showed that only 50% of patients in whom providers considered tracheostomy went on to actually receive a tracheostomy. This would seem to indicate that this provider group had appropriate discussions with the medical decision makers to come to an agreed decision.

Generalizability of this study's findings is limited by being a single-center investigation and sample size but results do highlight findings that require further investigation. Additionally, reliance on single administration surveys and chart review make it difficult to assess the delay between decision to perform tracheostomy and completion which vary between institutions based on resources and staff. Future steps to develop clinical practice guidelines should include evaluation of a larger sample size or database that more robustly represents various pediatric age groups and diagnoses to evaluate the generalizability of these findings and the morbidity and mortality associated with both pediatric tracheostomy and long-term intubation.

Conclusion

Clinical practice guidelines are "systematically developed statements to assist practitioner and patient decisions about appropriate health care for specific clinical circumstances."⁸ In their absence, physicians must rely on clinical expertise and judgment to guide decision making. This study found great variability in the providers' ability to estimate length of intubation. However, the expectation of achieving near-term successful extubation was the most common reason for not considering tracheostomy and may have resulted in delay of the procedure. With delayed tracheostomy conferring increased patient risk and potential mortality, especially in surgical cardiac patients, this study reveals the need for better recommendations regarding indication and timing of pediatric tracheostomy placement in PICU patients with long-term intubations.

Conflict of Interest

None declared.

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Appendix A Provider survey

On day 14 of intubation for all patients in the PICU, the attending physician fills out the following survey.

According to records, your patient XXX, has been intubated for a total of 14 days during this stay in the PICU. Please fill out the following survey regarding your views on tracheostomy for this patient.

1. What is the patient's primary diagnosis?
2. Does the patient have any significant past medical history or diagnoses?
3. What is the estimated length of the patient's endotracheal intubation beyond the 14 days already intubated? (in days)
4. What is the patient's total expected length of mechanical ventilation?
5. Have you considered a tracheostomy for this patient? (yes/no)
6. If Yes to question 5, please mark any of the reasons below that influenced your decision for tracheostomy.
 - (a) Long-term ventilation expected
 - (b) Patient has known airway anomaly
 - (c) Trach will allow a benefit to ventilator management (total sedation, etc.)
 - (d) Trach will shorten total length of stay
 - (e) Underlying comorbidity or condition will require a long-term airway (please explain)
 - (f) Other (please explain):
7. If No to question 5, please mark any of the reasons below that influenced your decision against tracheostomy for the patient.
 - (a) Expect successful extubation soon
 - (b) Risk of tracheostomy high due to underlying condition
 - (c) Familial objection
 - (d) Concerns for long-term trach management (familial capability, etc.)
 - (e) Significant comorbidity or condition that makes placement of trach inappropriate (please explain):
 - (f) Other (please explain):
8. If Yes, have you consulted a surgical service for placement? (yes/no)
9. Does the patient's previous medical conditions or mental status affect your decision toward the use of a trach? If so, please explain.
10. Have you attempted extubation previously? (yes/no) How many times?
11. Having completed this survey, are you more likely to now consider tracheostomy for this patient? (yes/no)