Safety and Efficiency of Interventional Pulmonologists Performing Percutaneous Tracheostomy

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Key Words

Interventional pulmonology • Percutaneous tracheostomy • Surgical tracheostomy

Abstract

Background: The steady rise in the number of critically ill patients in the USA has led to an increase in the need for tracheostomies in patients requiring chronic ventilatory support. There is a matched need for experienced operators to safely and efficiently perform these procedures. **Objectives:** We evaluated the effects on procedural outcomes and efficiency of percutaneous dilatational tracheostomy (PDT) placement in the medical intensive care unit (MICU) by the surgical team (ST) or interventional pulmonologists (IP). The IP team joined the PDT team in September 2007 and became primarily responsible for all PDT in the MICU. **Methods:** A retrospective analysis of prospectively collected data of patients who received PDT in the MICU by ST and IP from September 2007 to August 2010 was made. Outcomes including safety, efficacy, and procedural efficiency were compared. **Results:** One hundred seven patients underwent bedside PDT in the MICU during this period. Forty-three procedures

(40.2%) were performed by the ST and 64 procedures (59.8%) were performed by IP. There was no statistical difference between the incidence of airway injury and infection between the two procedural groups. There were no deaths related to the performance of PDT in our series. PDT was completed within 48 h of request in 100% of IP patients and 95% of ST patients ($p = 0.08$). **Conclusions:** There were no statistical differences in PDT between the ST and IP groups when comparing complications. There was a trend towards an increased efficiency in time to PDT after consultation within the IP PDT group. Trained IP can safely and effectively perform PDT.

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Introduction

Percutaneous dilatational tracheostomy (PDT) was originally described in 1957 by Shelden et al. [1]; however, it did not become popular until it was described with the use of a commercially available kit in 1985 [2]. Multiple studies have demonstrated the advantages of PDT over surgical tracheostomy, such as decreased patient charge, procedure time, bleeding, overall postoperative compli-

cation rates, and stomal infection rates. It is also now well established that PDT has been found to be safe when compared to surgical tracheostomy [3–7].

The steady rise in the number of patients requiring medical critical care in the USA has led to an increase in the need for tracheostomies in patients requiring chronic ventilatory support [8]. There is a matched need for experienced operators to safely and efficiently perform these procedures. Studies on PDT have demonstrated safe procedural performance by surgeons, anesthesiologists, medical intensivists, and neurointensivists [9–11]. The American College of Chest Physicians has published recommendations for competency regarding training and credentialing for the performance of PDT, suggesting a minimum of 20 PDT be performed to achieve competence [12]. However, these recommendations are largely based on expert opinions and consensus as there appear to be no data available regarding the performance of PDT by interventional pulmonologists (IP). IP physicians receive one additional year of intense training after completion of an Accreditation Council for Graduate Medical Education (ACGME)-certified 3- to 4-year pulmonary and critical care fellowship, they receive advanced training in complex airway diseases, including tracheal diseases, and they are well trained for performing PDT and managing long-term complications associated with tracheostomy such as tracheal stenosis, granulation, and tracheomalacia [13].

Prior to September 2007, all tracheostomies were performed by either otorhinolaryngology (ORL) or general and trauma surgeons either at the bedside or in the operating room in our large tertiary academic care center. In September 2007, IP joined a multidisciplinary tracheostomy team and was primarily responsible for all medical intensive care unit (MICU) bedside PDT placements. In this report, we evaluated the effects of a paradigm shift in surgeons performing PDT in the MICU from the surgical team (ST) to IP and performed the first study to date comparing the safety and efficiency of PDT performed by IP. We sought to compare outcomes of airway injury, infection, mortality, efficiency, procedure time, and length of stay.

Methods

A retrospective analysis of prospectively collected data was performed to compare safety. After institutional review board (IRB) approval, we retrieved data of all patients who underwent PDT in the MICU between September 2007 and August 2010. Patients who received open tracheostomy or were admitted from an

outside hospital with a tracheostomy in place were excluded. Data regarding patient characteristics included age, sex, reasons for tracheostomy, and acuity of the patient. The All Patient Refined Diagnosis Related Groups (APR-DRG) score was used to help assign patient acuity and varied on a categorical score of 1–5, with 1 being the least sick and 5 being the sickest. Outcomes of PDT were measured in terms of complications, efficiency, time taken for the procedure, anesthesiologist's time, and length of stay.

Prior to September 2007, all tracheostomies were performed by either ORL or general and trauma surgeons either at the bedside or in the operating room in our large tertiary academic care center. In September 2007, IP joined a multidisciplinary tracheostomy team made up of ORL, general and trauma surgery, anesthesia and critical care, and a full-time dedicated tracheostomy nurse practitioner (NP). The IP team was responsible for all bedside PDTs in the MICU after September 2007. Predetermined coverage by the ST was arranged in the event the IP team was unavailable. When a patient in the MICU was deemed to require a tracheostomy by the attending intensivist, a multidisciplinary PDT team consult was requested.

The NP on the multidisciplinary PDT team first evaluated the patient to determine if he or she was an adequate bedside PDT candidate and then obtained consent from families. The same NP evaluated all patients considered for PDT independent of the unit or specialty service who would perform the tracheostomy. Once the IP or ST confirmed the eligibility of the patient for a bedside percutaneous tracheostomy, the tracheostomy coordinator scheduled the tracheostomy with an anesthesiologist who was part of the tracheostomy team. After a surgical time-out was performed, patients were placed on full ventilatory support with an FiO_2 of 1.0 during the procedure. Anesthesia was left to the discretion of the attending anesthesiologist, but generally the procedure is performed with total intravenous anesthesia and muscle relaxation. All PDTs were performed with bronchoscopic visualization. The tracheostomy was placed using a Seldinger technique and Blue Rhino tracheostomy insertion kit (Cook Medical, Inc., Bloomington, Ind., USA) by the attending IP. PDT was performed between the second and third cartilaginous rings, identified from anatomical landmarks, through a 10- to 15-mm vertical incision.

Complications comprised airway injury, infection, bleeding, and mortality. Airway injuries referred to damage to the posterior wall of the trachea. Minor bleeding was defined as not requiring further intervention, whereas major bleeding required suturing, packing, or blood transfusions. Localized infection was defined as stomal infections consistent with a clinical diagnosis of cellulitis by the attending intensivist, which required the administration of antibiotics. Procedure mortality was defined as death due to tracheostomy within 24 h of tracheostomy.

As the percutaneous tracheostomy team performs procedures on Monday, Wednesday, and Friday, efficiency was defined as completion of bedside tracheostomy within 48 h of the procedure request. Procedure time was defined as the time from incision to securement of the tracheostomy tube, and anesthesiologist's time was defined as the time from induction to securement and bronchoscopic confirmation of tracheostomy tube placement. We collected data on the performance of tracheostomy related to the time of initial request as a measure of efficiency. Length of stay included the measurement of ICU and length of hospital stay.

STATA 11.0 was used for analysis of data. Means and standard deviations were calculated for parametric data, and percentages

for counts. Categorical data were compared between IP and ORL using χ^2 or Fisher's exact tests. Continuous data were compared using t tests. $p < 0.05$ was considered statistically significant.

Results

One hundred seven patients underwent bedside PDT in the MICU from September 2007 to August 2010. Sixty-four procedures (59.8%) were performed by IP and 43 procedures (40.1%) were performed by the ST. Age and sex did not differ significantly between the IP and ST patients (table 1). The reasons for tracheostomy included chronic ventilator dependence (93.5%), airway protection (3.7%), chronic aspiration (1.0%), and chronic hypoxia (1.0%). There was no significant difference in the reasons for tracheostomy between IP and ST patients ($p = 0.22$). Although the majority (>99%) of APR-DRG scores were 4 or 5, there was no significant difference between procedural team groups ($p = 0.54$).

From September 2007 to August 2010, only 6 patients who were assessed by the tracheostomy team NP for tracheostomy did not meet the criteria for a bedside PDT approach. Three patients were then assessed by IP and three were assessed by the ST due to predetermined coverage that had been arranged. There was 100% concordance between the independent assessments of the NP, IP, and ST groups that all six patients were not safe candidates for a bedside PDT approach. All six patients underwent open tracheostomy in the operating room uneventfully.

There was no statistical difference between the incidence of airway injury and infection between the two procedural groups ($p = 0.41$ and $p = 0.99$, respectively). There was one major bleeding complication in the IP group. This complication was immediately recognized after the introducer needle was inserted through a dilated anterior jugular vein in a patient with severe pulmonary hypertension prior to subsequent dilation with the punch dilator or Blue Rhino. As part of the multidisciplinary PDT team organization, there is urgent surgical backup available for any member of the team. As such, the patient was immediately transferred to the operating room with conversion to an open tracheostomy by the ST in order to control bleeding. The ST then proceeded with the open tracheostomy without further complications. There were no deaths related to the performance of PDT in our series.

PDT was completed within 48 h of request in all patients within the IP group, whereas 95.4% (41/43) of the patients within the ST group received their PDT within

Table 1. Characteristics of the study population

Characteristics	IP (n = 64)	ST (n = 43)	p value
Mean age $\pm$ SD, years	53.20 $\pm$ 16.78	61.65 $\pm$ 15.47	0.009
Males, n (%)	36 (56.25)	16 (37.21)	0.05
Females, n (%)	28 (43.75)	27 (63.79)	
Reasons for tracheostomy, n (%)			
Chronic ventilator dependence	63 (98.44)	37 (86.05)	
Aspiration	0	1 (4.65)	
Airway protection	1 (1.56)	3 (6.98)	
Chronic hypoxia	0	1 (2.33)	
Acuity			
APR-DRG score, n (%)			
1	0	0	0.54
2	1 (1.56)	0	
3	1 (1.56)	0	
4	32 (50)	26 (60.47)	
5	30 (46.88)	17 (39.53)	

48 h of request ($p = 0.08$). Mean procedural times were less for PDT performed by IP when compared to the ST; however these times were not statistically significant. The procedural operating time for IP was 27 ± 14.130 min and with ORL it was 30.17 ± 19.65 min. The procedural time for anesthesia was 36.69 ± 15.78 min in the IP group and 37.8 ± 19.34 min in the ST group. The length of stay in the MICU or the hospital was not significantly different between groups. The mean length of stay in the MICU for IP was 36.29 ± 33.05 days versus 28.0 ± 11.44 days for the ST. The mean length of hospital stay for IP was 54.17 ± 41.68 days versus 42.28 ± 18.17 days for the ST.

Discussion

We conclude that bedside PDT can be performed both safely and efficiently by IP. When compared to bedside PDT performed by our surgical colleagues, there was no statistical difference between groups regarding mortality, bleeding, infection, or airway injury. Data continues to demonstrate that, in the appropriate population, critically ill patients requiring tracheostomies can undergo these procedures at the bedside using a percutaneous dilational technique. Many reports have demonstrated its safety, along with other benefits such as decreased procedural time, infection rates, bleeding, ventilator days, and ICU costs.

Table 2. Complications in IP and ST groups

Complications	IP (n = 64)	ST (n = 43)	p value
Airway injury, n (%)			
No injury	63 (98.44)	43 (100)	0.41
Minor injury	0	0	
Major injury	1 (1.56)	0	
Infection			
No infection	61 (95.31)	41 (95.35)	0.99
Local infection	3 (4.69)	2 (4.65)	
Mortality			
Death due to procedure	0	0	–
In-hospital mortality	16 (25)	12 (27.91)	0.74

IP physicians receive extensive advanced training in complex airway management and are trained to safely perform bedside PDT. Although other nonsurgical specialties such as anesthesia critical care and neurocritical care have also demonstrated an acceptable safety profile in this arena, it seems plausible that the additional training for IP can further strengthen this safety profile. After completion of an internal medicine residency followed by a pulmonary and critical care fellowship, IP fellows complete an additional year which is focused on the management of complex airways and includes training with ORL and anesthesiology. The fact that there were equal numbers of patients independently evaluated by IP and the ST who were referred and underwent open tracheostomy after the team deemed the patient an unsatisfactory bedside PDT candidate, as well as equivalent APR-DRG scores, shows that there was no difference in the assessment modalities between the two groups. This study adds further safety data to the literature suggesting that, with appropriate and well-organized support, nonsurgical specialties such as IP can safely perform bedside PDT.

The multidisciplinary PDT at the Johns Hopkins Hospital is comprised of ORL, anesthesiology and critical care medicine, trauma surgery, and IP. Apart from the physicians, there is a full time NP, a registered nurse, a respiratory therapist, speech-language pathologists, tracheostomy coordinators, and equipment specialists. In a collaborative manner, the team provides state-of-the-art care to patients who undergo PDT.

As the techniques for performing tracheostomies have changed, modifications have allowed for the safe placement of PDT routinely at the ICU bedside, leaving the operating theater open for more challenging airway patients. However, it is important that all patients consid-

Table 3. Other outcomes in IP and ST groups

Other outcomes	IP (n = 64)	ST (n = 43)	p value
Efficiency, n (%)			
Less than 48 h	61 (100)	41 (95.35)	0.08
Greater than 48 h	0	2 (4.65)	
Mean time $\pm$ SD, min			
Operating time	27 $\pm$ 14.13	30.17 $\pm$ 19.65	0.52
Anesthesiologist time	36.69 $\pm$ 15.78	37.8 $\pm$ 19.34	0.83
Mean length of stay $\pm$ SD, days			
ICU	36.29 $\pm$ 33.05	28 $\pm$ 11.44	0.39
Hospital	54.17 $\pm$ 41.68	42.28 $\pm$ 18.17	0.08

ered and evaluated for tracheostomy placement undergo a standardized evaluation to determine which patients are appropriate candidates for bedside PDT. As part of our multidisciplinary tracheostomy team, we identified the need for a systemic approach to these patients and a team-based program was instituted. The institution of this plan consisted of improving patient care by employing a dedicated staff of experts in their defined roles. Specifically, the protocols of this program have been designed to promote care, safety, and efficiency in the tracheostomy procedure which most certainly contribute to the safety profile in this group.

We also were able to identify a trend in the time from consultation to PDT performance in the IP group which we ascribe to the likelihood that our surgical colleagues may not have been as readily available to evaluate and perform these bedside procedures given scheduling demands in the operating room. The use of an IP-led tracheostomy team may help improve the efficiency of tracheostomy procedures. This has significant potential to decrease ventilator days and ICU and hospital costs, along with the avoidance of operating room scheduling and transport. Although, to date, there have been no conclusive studies to show that tracheostomy placement significantly lowers ventilator associated pneumonia rates or mortality, we are actively investigating the effects on patient-centered benefits such as sedation requirements, ability to phonate, and early ambulation in the ICU.

Our study was retrospective in nature, thus not allowing for randomization and leading to potential bias that is inherent within a retrospective study. Although there were no significant differences in complication rates, the study size is underpowered to detect a clinically significant increase between either group. In order to investi-

gate any potential bias related to the severity of illness of patients prior to PDT between IP and ORL performing bedside PDT, we used the APR-DRG coding system. This system allows for stratification of patients based on the comorbidities as defined by the DRG coding system. There appeared to be no significant difference in APR-DRG scores between groups.

In conclusion, bedside PDT can be performed both safely and efficiently by trained IP in a controlled environment with an appropriate multidisciplinary team equipped to deal with the multiple complexities that are inherent in caring for critically ill patients. There was no statistically significant difference between procedural complications or outcomes when compared to the proce-

dures performed by our ORL surgical colleagues or IP. There was a trend towards decreased procedural times along with increased efficiency in the IP group.

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Financial Disclosure and Conflicts of Interest

None of the authors have any disclosures on conflicts of interest.

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