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Developing a percutaneous dilatational tracheostomy service by medical intensivists: Experience at one academic Institution ☆

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ABSTRACT

Purpose: Percutaneous dilatational tracheostomy (PDT) is increasingly becoming the preferred method, compared with open surgical tracheostomy, for patients requiring chronic ventilatory assistance. Little is known regarding the process involved to incorporate PDT as a standard service in the medical intensive care unit. In this report, we describe our experience developing a "PDT service" led by medical intensivists.
Materials and methods: With support from our leadership and surgical colleagues, we developed a credentialing and training process for medical intensivists, formulated a bedside team to perform PDT, refined our technique, and maintained a patient data registry for quality improvement.
Results: To date, our service includes 4 medical intensivists with PDT privileges. Over a 4-year period, we performed 171 PDTs for patients in the medical intensive care unit after 12.1 ± 8.2 days of mechanical ventilation. Our procedure-related complication rates are similar to other reports. No patient required emergent open surgical tracheostomy, and there were no deaths related to PDT. We required minimal to no backup support from our surgical colleagues in performing PDT.
Conclusions: We successfully developed a medical intensivist-driven PDT service, sharing our unique successes and challenges, to facilitate the care of our patients requiring prolonged ventilator support.

1. Introduction

A 75-year-old man is admitted to the medical intensive care unit (MICU) with intracerebral hemorrhage. A decision to perform tracheostomy is made by the primary team on day 5, and a surgical consult is placed. The tracheostomy is not performed until day 14 for various logistic reasons: operating room scheduling conflicts, consulting surgeon's availability, and/or relative contraindications with certain aspects of the patient's clinical status, for example, low grade fever and leukocytosis.

Since Ciaglia et al [1] described a new technique for the percutaneous placement of a tracheostomy tube by means of guidewire insertion and use of serial dilators in 1985, percutaneous dilatational tracheostomy (PDT) has become an increasingly popular method of establishing an airway for patients in need of chronic ventilator assistance [2]. It can be performed safely and efficiently at the bedside by intensivists, circumventing a number of challenges that may delay optimal care as highlighted by the case above [3]. We describe the introduction, implementation, and development of a PDT service by medical intensivists in our ICU, report our outcomes, and discuss the successes and challenges encountered.

2. Methods

2.1. Setting

Our PDT service was developed at an 815-bed tertiary care university teaching hospital with more than 1200 annual admissions to the MICU. Our MICU is a closed service with 2 teams, supervised by 2 attending medical intensivists, 1 or 2 critical care fellows, and 8 residents. Our daily patient census approximates 24 to 32 patients. The nurse to patient ratio is 1:2 to 2:1, depending on patient acuity level.

2.2. Training and credentialing the medical intensivists in the PDT service

We began our efforts to develop a "PDT service" by medical intensivists in December 2008 when one of the coauthors (HBN) completed an external training course, "Percutaneous Tracheostomy," Science Care, Phoenix, AZ. The course included 8 hours of didactic

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lectures and hands-on skills training on fresh cadavers. After the course, HBN began performing PDTs under the supervision of 2 acute care surgery (and critical care) attendings at our institution. A credentialing process was also developed, with the support from the chairs of Department of Medicine and Department of Surgery. In May 2010, our medical staff approved credentialing requirements for intensive care physicians to perform PDT in adult patients. Briefly, credentialing requires that the physician (1) completes a critical care fellowship, (2) be board certified or demonstrates equivalent competence in medical or surgical critical care, (3) completes a course that includes a minimum of 3 hours of hands-on performance of PDT, and (4) successfully performs a minimum of 10 PDT cases under the supervision of qualified physician(s) with privileges in PDT. We a priori determined that 10 cases were the minimum to achieve PDT competency based on recommendations by the European Respiratory Society and the American Thoracic Society [4]. HBN completed these requirements with 19 PDT cases and received PDT privileges in July 2010.

2.3. Requesting the PDT service

The decision and timing to perform a PDT for a patient are left to the clinical judgment of the primary team. If the primary attending intensivist does not have privileges to perform PDT, a consult request is forwarded to an intensivist with the privilege. The PDT intensivist may be the attending on the sister MICU team, the in-house pulmonary consultant, or a privileged intensivist involved in other academic/clinical activities at the time. The PDT attending then evaluates the patient and assembles the PDT team, which additionally includes a bronchoscopy attending, a bronchoscopy technician, a respiratory therapist to manage the endotracheal tube (ETT) and ventilator, and a nurse.

A critical care fellow is often involved in performing the PDT, organizing the team, obtaining patient consent, and setting up equipments and procedural medications. Another fellow may also be involved in performing the bronchoscopy with the bronchoscopy attending.

2.4. Patient selection

Generally, a patient expected to be on prolonged mechanical ventilation or with chronic illness, such as obstructive sleep apnea or a neuromuscular disorder, would be an appropriate candidate for PDT. The timing of PDT is truly not as important as the clinical condition of the patient at the time of PDT. We consider an optimal candidate for PDT to be a patient with (1) fraction of inspired oxygen (Fio_2) less than 0.5, positive end-expiratory pressure (PEEP) less than 8 cm H_20, plateau pressure less than 30 cm H_20; (2) not requiring high-dose vasoactive agent, such as norepinephrine >10 μg/min and/or more than 1 vasopressor; (3) absence of uncontrolled dysrrhythmia; (4) absence of severe acidosis; (5) absence of active bleeding; (6) international normalized ratio less than 1.5, platelet count $>100 \times 10^9$/L, partial thromboplastin time less than 45 seconds; and (7) optimal neck anatomy, such as easily palpable tracheal rings, no pulsation at the sternal notch suggestive of prominent innominate artery, no active infection at the PDT site, and no gross neck deformity.

2.5. The PDT procedural technique

Our technique is in accordance to the guidelines for the performance of PDT [4]. Mechanical ventilation is controlled, and Fio_2 is increased to 1.0. Sedation is initiated, and neuromuscular blockade is administered when the Richmond Agitation Sedation Scale goal of negative 4 to 5 is achieved [5]. We only administer 1 appropriate dose of intravenous rocuronium or vecuronium. Vital signs are then monitored to titrate our continuous sedation during the procedure to heart rate less than 100 beats per minute and systolic blood pressure less than 140 mm Hg.

The patient is placed in supine position with the neck extended, prepared, and draped in typical sterile fashion. Anatomic landmarks are identified by palpation. We also use ultrasonography to identify and avoid any large blood vessels near the tracheostomy site. We then complete a procedure checklist immediately before beginning the PDT (Fig. 1). This list includes an "advanced airways toolbox" in anticipation of a difficult airway. The toolbox contains direct laryngoscope and blades, ETTs, oropharyngeal, and nasal airways of varying sizes, Glidescope (Verathon, Inc., Bothell, WA) video laryngoscopy, intubating laryngeal mask airway, and a surgical tracheostomy kit.

Local anesthesia is applied. A 1 to 1.5 cm vertical, midline incision is made between the cricoid cartilage and the sternal notch. Blunt dissection of pretracheal tissue is performed, until tracheal rings are easily palpated deep to the incision. The bronchoscopist then deflates the cuff of the ETT and withdraws it with the end of the tube to the subglottis using endoscopic visualization. The cricoid and tracheal rings are identified and mutually agreed upon by both proceduralists. Using the Ciaglia Blue Rhino Kit (Cook Medical Inc, Bloomington, IN) single dilator technique, the tracheostomy tube is inserted into the desired ring space under continuous bronchoscopic guidance. We use a Shiley 8 disposable cuffed tracheostomy tube (Covidien, Inc., Mansfield, MA) in most instances. The tracheostomy tube is then sutured and secured with a tie available in the kit. A chest radiograph is obtained postprocedure.

2.6. Maintaining a PDT data registry

We developed a data registry to record the patient cases for the purpose of quality improvement and data analysis. After a PDT was performed, the patient name and medical record number were entered in the registry. The patient chart was then retrospectively reviewed to obtain data such as demographics, comorbidities, laboratory test values, ventilator settings and treatments received at the time of the PDT procedure, the first tracheostomy tube change, ICU and hospital length of stay, complications, and disposition. No real-time data entry or day-to-day hospital follow-up was required. This registry was approved by our institutional review board with waiver of informed consent.

3. Results

To date, our service includes 4 medical intensivists with PDT privileges, who perform nearly all PDTs required in our MICU. From January 2010 to 2014, 171 cases were performed. Among these, 170 cases completed the PDT, and 1 case was discontinued due to major bleeding. Average duration of mechanical ventilation preprocedure was 12.1 ± 8.2 days (Table 1). At the time of the procedure, 28.2% of patients required vasopressors.

3.1. Periprocedure complications

Periprocedure complications are highlighted in Fig. 2. *Major bleeding* was defined as that which caused hemodynamic compromise, did not improve with conservative measures, required transfusion, surgical intervention, or termination of the procedure. One patient had major bleeding, which was found to be from a thyroid gland injury, and we now avoid by use of ultrasound (US). Ring fracture occurred in 8.8% of our cohort. Unfortunately, we do not have long-term data to assess the incidence of tracheal stenosis and determine its correlation with ring fracture.

One patient experienced a hypoxemic event requiring oral reintubation. Inadequate cuff seal was noted, possibly due to tracheomalacia. Attempts at repositioning the same tube and replacing with a Shiley XLT lead to desaturation. After the airway was secured via transoral intubation, a Bivona no. 7 tube (Bivona silicone tracheostomy tube with hyperflex adjustable flange; Smiths Medical ASD Inc, Gary, IN) was successfully inserted through the created stoma over a tube exchange catheter. Good seal was noted on cuff inflation.

One patient had transient loss of airway, when the ETT was accidentally withdrawn proximal to the vocal cords. The patient was

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