The Ventilator Liberation Process: Update on Technique, Timing, and Termination of Tracheostomy

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Tracheostomy is one of the most commonly performed procedures in the ICU. Despite the frequency of the procedure, there remains controversy regarding selection of patients who should undergo tracheostomy, the optimal technique, timing of placement and decannulation, as well as impact on outcome associated with the procedure. A growing body of literature demonstrates that percutaneous tracheostomy performed in the ICU is a safe procedure, even in high risk patients. Advances in techniques, together with adjuncts to improve visualization, seem promising and likely to further improve the safety of the technique. Although there was initial enthusiasm in support of early tracheostomy to improve patient outcomes, repeated studies have been unable to produce robust benefits. The question of optimal timing and location of decannulation has not been answered, but there is some reassurance that in aggregate, across a variety of ICUs, patients do not appear to be harmed by transfer to ward with tracheostomy. Future research into techniques, timing, and termination of tracheostomy is warranted. *Key words: tracheostomy; decannulation; intensive care.* [Respir Care 2012;57(10):1626–1634. © 2012 Daedalus Enterprises]

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Introduction

Tracheostomy is one of the most commonly performed procedures in the ICU, being performed in 8–24% of patients for prolonged respiratory support or weaning.[1-3] The frequency of tracheostomy use in critically ill patients has increased over the last decade.[3,4] Ease of performing a percutaneous tracheostomy, combined with the reality that use of tracheostomy permits transfer to ward or step-down units, may account for the increased and more frequent use of tracheotomies in critically ill patients. Despite the frequency of the procedure, there remains controversy regarding selection of patients who should undergo tracheostomy, the optimal technique, timing of placement and decannulation, as well as impact on outcome associated with the procedure.

Research into timing, technique, and removal is a challenging undertaking. Large observational studies used to compare groups (eg, early vs late tracheotomy, percutaneous vs open procedure, and ICU vs floor decannulation) can be conducted with little cost, yet require sophisticated statistical techniques to control for confounding factors, indication bias, and survivor bias. Alternatively, randomized controlled trials prospectively allocate patients to different treatment strategy groups, thereby ensuring that differences between groups are due to chance and not systematic bias. Yet this approach also has inherent problems, including patient enrollment, especially if physicians lack equipoise, indications for the procedure are controversial, or eligibility requires prediction about a patient's future clinical status.

In this review we will provide an update on the literature that attempts to address these questions and provide a framework for the clinician to interpret existing and future studies in the quest to provide the best evidence-based care.

Indications for Tracheostomy and Patient Selection

Tracheostomy has traditionally been performed to bypass upper-airway obstruction. Tracheostomy prevents laryngeal or upper airway damage from prolonged translaryngeal intubation, allows easy/frequent access to the lower airway for suctioning, and provides a stable airway in a patient who requires prolonged mechanical ventilation. Compared with endotracheal tubes (ETTs), tracheostomy reduces resistive and elastic work of breathing, with resulting reduction in airway resistance and intrinsic PEEP.[5,6] Tracheal stenosis is a known risk of long-term intubation, however, and has also been associated with tracheostomy Tracheal stenosis resulting from endotracheal intubation versus tracheostomy does appear to differ in mechanism, morphology, and location.[7] Tracheal stenosis from prolonged endotracheal intubation can occur anywhere from the ETT tip to the glottic/subglottic area, but the most common site is where the cuff has been in contact with the mucosa (one third of cases). The primary postulated mechanism is loss of regional blood flow due to cuff pressure on the tracheal wall. In contrast, tracheal stenosis following tracheostomy most commonly results from abnormal wound healing, with excess granulation tissue around the tracheal stoma site. Cartilage damage, which can occur during tracheostomy placement or from mechanical leverage due to unsupported ventilator attachments, can also cause necrosis. Wound sepsis has also been suggested as a causative factor in stomal stenosis following tracheostomy

Additional proposed advantages of tracheostomy include easier mouth care, earlier enteral feeding, earlier mobilization, improved comfort, and decreased sedative use. Despite benefits of tracheostomy and improvements in technique, tracheostomy is not without risk. Complications related to tracheostomy include bleeding, wound infection, tracheal stenosis, and, occasionally, death. Consequently, appropriate selection of patients who should undergo tracheostomy is important.

Identification of patients who will benefit from tracheostomy remains a challenge. The goal is to identify the patients who will require prolonged mechanical ventilation as early as possible, while avoiding performing tracheostomy in patients who are easily liberated from the ventilator. For patients at high risk of death the clinician should strive to have clear communication regarding treatment preferences. When confronted with prolonged mechanical ventilation without an improvement in prognosis, many patients would choose to avoid treatment that merely prolongs suffering.

Technique: Surgical Versus Percutaneous

Tracheostomy was traditionally performed in the operating room, using an open surgical approach. In 1985, Ciaglia et al[8] introduced the bedside percutaneous tracheostomy, which could be preformed at bedside without complex equipment. This technique involves the use of blunt dilatation to open the pre-tracheal tissue for passage of the tracheostomy tube. Percutaneous tracheostomy has since become an increasingly popular choice, with the majority of tracheostomies in many ICUs being performed this way.[9,10] Surgical tracheostomy is reserved for difficult or emergency cases, when percutaneous tracheostomy is contraindicated or has failed.

Several studies have examined the question of whether percutaneous tracheostomy is as safe as a traditional surgical tracheostomy However, it must be kept in mind that there are a variety of different techniques for performing percutaneous tracheostomy, which can vary widely in ease of use and in their reported type and rate of complications. A number of factors must be taken into account when deciding whether a percutaneous approach is appropriate for any given patient. The following are some commonly proposed relative contraindications for performing percutaneous tracheostomy: Absolute: Need for emergency airway in a patient with a tracheal tumor and in children < 12 years old, due to risk for injury with softer cartilaginous tracheal tissue. Relative contraindications include: important coagulopathy, active infection over neck, unstable cervical spine, morbid obesity, anatomic distortion of neck, previous neck surgery or radiation, traumatic injury or burn to neck, high PEEP/F_{IO_2}, elevated intracranial pressure. Relative contraindication decreases with increasing operator experience and use of imaging adjuncts (bronchoscopy, ultrasound imaging of neck). Irrespective of technique, there is need for skilled operators, given the limited physiologic reserve of many critically ill patients.

The purported advantages of percutaneous tracheostomy include that it is relatively simple to perform and has a shorter procedure time; bedside procedure eliminates the time, cost, and morbidity associated with transport of a critically ill patient. Nonetheless, these advantages are not important if the procedure itself is associated with increased morbidity. Two recent meta-analyses have examined the safety and benefits of percutaneous tracheostomy, compared to surgical tracheostomy.[11,12] A meta-analysis by Delaney et al[11] of 17 randomized controlled trials found a reduced overall incidence of wound infection with percutaneous tracheostomy. There were equivalent rates of bleeding and perioperative and long-term complications. In addition, a subgroup analysis in which percutaneous tracheostomy was compared with surgical tracheostomy performed in the operating room showed a reduction in bleeding and reduction in mortality with percutaneous tracheostomy. A meta-analysis by Higgins and Punthakee[12] of 15 prospective randomized controlled trials reached a similar conclusion. There was reduced wound infection and scarring with percutaneous technique, and no difference in complications for false passage, hemorrhage, subglottic stenosis, or death, with overall complications that trended toward favoring the percutaneous technique. There was, however, an increase in the complication of decannulation/obstruction for percutaneous tracheostomy, compared with surgical tracheostomy.

Another question regarding the use of percutaneous tracheostomy is its safety in the "high risk" patient (ie, patients with cervical spine injury, requiring increased ventilatory support, obese, or with coagulopathy). Kornblith et al[13] recently reported experience with 1,000 percutaneous tracheostomies performed in the surgical ICU. Forty-eight percent of the patients were considered high risk and divided into risk categories, including 27% in a cervical collar or halo, 15% with an $F_{IO_2} > 50\%$, 11% with PEEP > 10 cm H_2O, and 10% on systemic heparin infusion. Complications occurred in only 1.4% of patients, with 1.2% in normal risk and 1.7% in high risk. Early complications included tracheostomy tube misplacement requiring operative revision, bleeding requiring intervention, infection, and procedure failure requiring cricothyrotomy. Late complications included persistent stoma requiring operative closure and subglottic stenosis. Of note, there were no deaths attributed to percutaneous tracheostomy.

Severe respiratory failure requiring high amounts of PEEP or F_{IO_2} are often considered a contraindication to percutaneous tracheostomy placement, since loss of high PEEP during placement could result in alveolar collapse and jeopardize oxygenation. However, patients with severe respiratory failure may be most likely to benefit from the advantages of early tracheostomy, since they are often ventilated for long periods. Studies on percutaneous dilational tracheostomy often exclude patients with high PEEP requirements, although there is some literature suggesting that percutaneous tracheostomy can be performed safely in patients with high PEEP without substantial deterioration in gas exchange.[14]

Coagulopathy is another contraindication to percutaneous tracheostomy that has undergone recent investigation. In a retrospective analysis of 483 patients who underwent percutaneous tracheostomy during a 7 year period, 34% met one of 3 diagnostic criteria for coagulopathy (an abnormality in either prothrombin time ≥ 1.3 international normalized ratio, partial thromboplastin time ≥ 1.3 international normalized ratio, or platelet count $\leq 80 \times 10^9$ cells/L), and 6.6% met 2 or 3 of these criteria. Bleeding occurred in 1.04% of patients, none of whom met 2 or more diagnostic criteria.[15] Another study of 60 patients with severe liver disease undergoing percutaneous tracheostomy compared patients with or without refractory coagulopathy.[16] Refractory coagulopathy was defined as international normalized ratio > 1.5 and platelet count $\leq 50 \times 10^9$ cells/L on the day of tracheostomy and for the 72 hours afterward despite clotting support. There was no difference in the number of adverse events between groups. Only one patient in the coagulopathy group had severe bleeding, but did not require open intervention.

Technique

The classic "Ciaglia" technique uses multiple dilators of sequentially increased size to produce dilation of the tracheal stoma. This technique has been associated with posterior tracheal wall tears and tracheal ring fractures. More commonly, a single dilator technique is used. The single step dilator is made of softer material, called hydrophilic coating, which when wet minimizes friction in an effort to avoid tracheal injury. Use of a single dilation technique is faster, which minimizes hypercarbia/hypoxemia, has flexible dilator bends to follow the guide wire, and avoids the aerosolization of blood and secretions as dilators are changed.

A systematic review by Cabrini et al[17] examined data from 1,130 patients in 13 randomized trials that evaluated different techniques and devices for performing percutaneous tracheostomy in the ICU. The techniques in these studies included multiple dilator, single-step dilatation, guide wire dilating forceps, rotational dilation, retrograde tracheostomy, and balloon dilation techniques. The different techniques and devices appeared largely equivalent, with the exception of retrograde tracheostomy, which was associated with more severe complications and more frequent need of conversion to other techniques, when compared with guide wire dilating forceps and single-step dilatation techniques. In addition single-step dilatation technique was associated with fewer failures than rotational dilation, and fewer mild complications in comparison with balloon dilation and guide wire dilating forceps. Among the 6 analyzed techniques, single-step dilatation technique appeared the most reliable in terms of safety and success rate.

Adjuncts to Improve the Safety of Bronchoscopic Guidance

Endoscopy using a fiberoptic scope that passes through the tracheal tube may be beneficial to guide correct placement of the introducer needle, guide wire, and tracheostomy tube during percutaneous tracheostomy placement. Many practitioners perform percutaneous tracheostomy using bronchoscopy, believing that it increases safety. Direct visualization may reduce posterior tracheal wall damage and tube misplacement. However, the presence of the fiberoptic scope may impair ventilation, therefore increasing the risk of hypoxia and hypercarbia. In a recent retrospective review by Jackson et al[18] of 243 trauma patients undergoing percutaneous tracheostomy, one third were performed with bronchoscopy and two thirds without, and they failed to find a difference in complication rates. There were no differences between the groups in Abbreviated Injury Score by region, Injury Severity Score, probability of survival, ventilator days, ICU stay, or overall hospital stay. There were 16 complications: 5 in the bronchoscopy group and 11 in the no bronchoscopy group. There were no differences in early or late complications between the 2 groups. One major complication occurred, with loss of airway and cardiac arrest, in the bronchoscopy group. The authors concluded that bronchoscopy guidance may not be routinely required, but can be used as an adjunct in selected "high risk" patients such as those with cervical spine fixation, obesity, or difficult anatomy.

Damage to the fiberoptic scope during bronchoscopy has been reported occurring in 4 of the first 30 cases performed in one institution.[19] Transillumination with external laser light or use of rigid bronchoscopy for percutaneous tracheostomy has been suggested to reduce this costly equipment complication.[19,20]

Ultrasound Imaging of the Neck

While bronchoscopy may be helpful for guidance of wire and tube placement during percutaneous tracheostomy, it does not identify the vascular structures and the thyroid gland in the neck region. Ultrasound imaging of the neck prior to the procedure may be useful by allowing visualization of anterior neck structures and the depth and angulation of the trachea. In addition, it may be useful to guide needles and dilators away from at-risk structures and to reduce complications linked to local organ lesions (punctured vessels, a punctured thyroid). Bedside real-time ultrasound guidance with visualization of needle path is routinely utilized for other procedures such as central venous catheterization, and may enhance the safety and accuracy of percutaneous tracheostomy without causing airway occlusion or hypercarbia. In a small study of 13 mechanically ventilated patients with acute brain injury requiring tracheostomy, Rajajee et al[21] evaluated the feasibility of performing percutaneous tracheostomy under real-time ultrasound guidance. The trachea was punctured under real-time ultrasound guidance to visualize the needle path while using the acoustic shadows of the cricoid and the tracheal rings to identify the level of puncture. After guide wire passage the site and level of entry were verified using the bronchoscope, which was then withdrawn. Following dilatation and tube placement, placement in the airway was confirmed using auscultation and "lung sliding." Bronchoscopy and chest x-ray were then performed to identify any complications. Thirteen patients successfully underwent ultrasound guided percutaneous tracheostomy. Three patients were morbidly obese, 2 were in cervical spine precautions, and one had a previous tracheostomy. In all 13 patients bronchoscopy confirmed that guide wire entry was through the anterior wall and between the first and fifth tracheal rings. There was no case of tube misplacement, pneumothorax, posterior wall injury, substantial bleeding, or other complications during the procedure.

In another recent study, Guinot et al[22] evaluated the feasibility and rate of complications of ultrasound-guided percutaneous tracheostomy in a prospective study of 26 critically ill, obese patients, compared with 24 non-obese patients. Obesity was defined as a body mass index of at least 30 kg/m^2. The median body mass index was 34 kg/m^2 in the obese patient group and 25 kg/m^2 in the non-obese group. The median times for tracheostomy were similar (10 min in the obese subjects vs 9 min in the nonobese subjects). Ultrasound-guided percutaneous tracheostomy was possible in all enrolled patients, and there were no surgical conversions or deaths. The overall complication rates were similar in the obese and non-obese patient groups, and most complications were minor (hypotension, desaturation, tracheal cuff puncture, and minor bleeding), with no differences between obese and non-obese groups. Although these studies show promise, larger studies are required to further define the safety and relative benefits of this technique.

Laryngeal Mask Airway for Percutaneous Tracheostomy

Some complications during percutaneous tracheostomy may be due to poor visualization of tracheal structures. Linstedt et al[23] performed a prospective randomized study to compare laryngeal mask airway (LMA) and ETT as the ventilatory device during percutaneous tracheostomy, with respect to visualization of tracheal structures, quality of ventilation, and airway related complications. Sixty-six patients were randomized to LMA ($n = 33$) and ETT ($n = 30$) groups. The quality of ventilation and visualization of tracheal structures (thyroid, cricoid, and tracheal cartilages) was rated on a 4 point scale: very good (1), good (2), difficult (3), and not possible (4) with LMA/ETT. A rating of 4 required the alternative airway. The visualization of tracheal structures was better with the LMA, with ratings of very good/good in 94% of patients with an LMA, compared with 66% of patients with an ETT. Visual control during puncturing of the trachea was also better with the LMA, with very good/good ratings in 97% of patients using an LMA, and in 77% of patients with an ETT. Blood gas analysis during percutaneous tracheostomy showed a decreased P_{aO_2} in both groups and an increased P_{aCO_2}, which was more pronounced with an ETT, compared with an LMA. Two patients in the ETT group were accidentally extubated, and in another patient the bronchoscope was damaged because of insufficient visualization of the tracheal puncture site.

Emergency Percutaneous Tracheostomy

Percutaneous tracheostomy has traditionally been considered an elective procedure, but is increasingly being used in emergency situations when attempts at oral tracheal intubation have failed.[24,25] Studies to evaluate the efficacy of establishing definitive airway are lacking. Until these are done, the cricothyroidotomy remains the standard of care. With the reduction in surgical tracheostomies there is an issue of competence with this technique, especially in the emergency setting.

Timing of Tracheostomy

Despite substantial investigation, the optimal timing of tracheotomy (early vs late) for critically ill patients requiring mechanical ventilation continues to be debated. Limitations of study designs, heterogeneous patient populations, and different end points have made interpretation of study results challenging. There is no consensus on the definition of early tracheostomy. Times vary between day 2 and day 10 post mechanical ventilation.

A study by Rumbak et al[26] resulted in early enthusiasm for the benefits of early tracheostomy in a medical ICU population. In their study, 120 medical ICU patients were randomized to either early percutaneous tracheotomy, within 48 hours of intubation, or delayed tracheotomy, at days 14–16. Time in the ICU and on mechanical ventilation, and the cumulative frequency of pneumonia, mortality, and accidental extubation were documented. Early groups showed significantly less mortality, pneumonia, and accidental extubation, compared with the prolonged delayed group. The early tracheotomy group spent less time in the ICU and on mechanical ventilation. There was also significantly more damage to mouth and larynx in the prolonged intubation group. A few limitations of this study deserve consideration. In this study the determination of "projected to need ventilation support for > 14 days" was made by clinicians and lacked specific objective criteria, making it difficult to determine precisely which patients should be selected for early tracheostomy based on these results. The second limitation was the use of an Acute Physiology and Chronic Health Evaluation II score > 25 as an inclusion criteria, limiting the generalizability of the survival benefits seen in this study to ICU patients who are less severely ill. There were high incidences of preexisting community-acquired and aspiration pneumonia in both groups, and the diagnosis of ventilator-associated pneumonia (VAP) may be misleading and not truly reflect an advantage of early tracheostomy. Finally, patients in the early group were liberated from the ventilator only a few days after placement of the tracheostomy tube. It could be argued that these patients did not require a tracheostomy.

Clec'h et al assessed the effect of a tracheostomy on mortality, allowing for the probability of getting a tracheostomy.[1] In this prospective observational cohort study of 2,186 unselected patients requiring mechanical ventilation for > 48 hours in 12 medical or surgical ICUs, 8.1% received a tracheostomy (the majority surgical, rather than percutaneous technique). Two models of propensity scores for tracheostomy were built, using multivariate logistic regression. After matching on these propensity scores, the association of tracheostomy with outcomes was assessed using multivariate conditional logistic regression. Results obtained with the 2 models were compared. Both models led to similar results. Tracheostomy did not improve ICU survival. There was no difference whether tracheostomy was performed early (within 7 d of ventilation) or later (after 7 d of ventilation). In fact, tracheostomies appeared to be associated with increased post ICU mortality, especially in patients discharged with the tracheostomy remaining in situ.

In another study to determine whether earlier tracheostomy is associated with greater long-term survival, Scales et al performed retrospective cohort analysis of 114 acute care hospitals.[27] All adult mechanically ventilated ICU patients who received tracheostomy between April 1, 1992, and March 31, 2004, excluding extreme cases (< 2 or ≥ 28 d) were included. Tracheostomy timing was classified as early (≤ 10 d) versus late (> 10 d), with mortality measured at multiple follow-up intervals. Proportional hazard analysis was used, in which tracheostomy was treated as a time-dependent variable to adjust for measurable confounders and possible survivor treatment bias. In addition, stratification, propensity score, and instrumental variable analyses were used to adjust for patient differences. A total of 10,927 patients received tracheostomy during the study, of which one third ($n = 3{,}758$) received early and two thirds late ($n = 7{,}169$). Patients receiving early tracheostomy had lower unadjusted 90-day, 1-year, and study mortality than patients receiving late tracheostomy. Multivariable analyses treating tracheostomy as a time-dependent variable showed that each additional delay of 1 day was associated with increased mortality, with a relative risk increase of 3.9%; the number needed to treat was 71 patients to save one life per week delay. This analysis suggests a relatively minor potential survival benefit from early tracheostomy and fails to provide guidance in patient selection for tracheostomy.

Another recent trial by Trouillet et al[28] evaluated early percutaneous tracheotomy in patients in a cardiac surgical population. In their prospective, single-center trial, 216 adults requiring mechanical ventilation for 4 or more days after cardiac surgery were randomized to immediate early percutaneous tracheotomy or prolonged intubation with tracheotomy 15 days after randomization. The primary end point was the number of ventilator-free days during the first 60 days after randomization. Secondary outcomes included 28-, 60-, or 90-day mortality rates; duration of mechanical ventilation, ICU and hospital stay; sedative, analgesic, and neuroleptic use; VAP rate; unscheduled extubations; comfort and ease of care; and long-term health-related quality of life and psychosocial evaluations. There was no difference in ventilator-free days during the first 60 days after randomization between the early percutaneous tracheotomy and prolonged intubation groups, or in 28-, 60-, or 90-day mortality rates. The durations of mechanical ventilation and hospitalization, as well as the frequencies of VAP and other severe infections, were also similar. However, early percutaneous tracheotomy was associated with less intravenous sedation, less haloperidol use for agitation or delirium, fewer unscheduled extubations, better comfort and ease of care, and earlier resumption of oral nutrition. Long-term psychosocial evaluations and health related quality of life were similar between the groups.

In the largest randomized controlled trial to study the timing of tracheotomy in the management of patients with acute respiratory failure, Terragni et al[29] randomized 419 patients in 12 Italian ICUs to early (6–8 d) versus late (13–15 d) tracheotomy. Patients with worsening respiratory conditions or worse Sequential Organ Failure Assessment score and no evidence of pneumonia after 48 hours of inclusion were randomized. VAP was observed in 14% of patients in the early group and 21% of patients in the late group, which did not reach statistical significance. However, early tracheostomy was associated with more rapid liberation from the ventilator and a shorter ICU stay, but the timing of tracheotomy did not influence hospital stay, admission to long-term care, or survival. Patients in the early intervention group were more likely to undergo tracheotomy than those in the late intervention group, and thus were more exposed to operative complications. The authors conclude that tracheotomy should not be performed earlier than after 13–15 days of mechanical ventilation.

Additional strengths of this study include the multicenter design and the explicit protocol for patient enrollment. Perhaps the most important finding was that, despite this prediction, a substantial number of patients were successfully managed without tracheostomy. However, a lower than expected incidence of VAP left the study underpowered to detect a significant difference in VAP between the treatment groups.

A recent meta-analysis and systematic review by Wang et al[30] examined all randomized controlled trials, comparing important outcomes in ventilated critically ill patients who received an early or late tracheostomy. Seven trials with 1,044 patients were analyzed. Early tracheostomy did not significantly reduce short-term or long-term mortality or the incidence of VAP in critically ill patients. In addition, the authors did not find a markedly reduced duration of mechanical ventilation, ICU or hospital stay, or rate of complications. This meta-analysis is limited by heterogeneity of the studies in terms of definition of early versus late tracheotomy, targeted population, and limited number of randomized controlled trials

The Intensive Care Society of the United Kingdom recently completed a multicenter randomized controlled trial (TracMan) evaluating the timing of tracheostomy in critically ill patients (http://www.tracman.org.uk). Specifically, "early" tracheostomy was performed on day 1–4 post admission to ICU, compared with "late" tracheostomy performed after day 10 post admission to ICU (if still required). The type of tracheostomy used (percutaneous or surgical) was entirely up to the recruiting unit. Although the study awaits final publication, the results presented suggest a reduction in sedative use with early tracheostomy, but no increase in survival.

Decannulation

Little evidence is available to guide the optimal timing of tracheostomy tube removal. The tracheostomy tube should be removed as soon as possible once the patient has demonstrated adequate respiratory drive, good cough, and the ability to protect the airway. There is a tendency to leave the tube in too long while awaiting the "perfect" time to decannulate.

A substantial failure rate of decannulation has been reported in some studies. In one study of 823 decannulation decisions there was a failure rate of 4.8% requiring stoma recannulation or endotracheal intubation.[31] The primary reason for decannulation failure was inability to mobilize secretions. Sixty percent of these patients failed within 24 hours.

Some studies have reported higher mortality in patients with tracheostomies on the ward[31,32]; thus, decannulation prior to ICU discharge has been advocated by some. It may simply be that patients with increased severity of illness and comorbidities are those that will still have their tracheostomies in place on ICU discharge. It would therefore not be surprising that they would experience higher mortality. A number of factors influence the decision to decannulate prior to ward transfer; therefore, controlling for these confounding factors would be necessary to make a valid assessment of the impact of decannulation on ward mortality. In a recently published study, Fernandez et al[33] performed a prospective multicenter observational study in which a propensity score was used to account for treatment-indication bias (ie, to decannulate versus not) and confounding variables. Variables associated with ICU decannulation, including non-neurologic disease, vasoactive drugs, parenteral nutrition, acute renal failure, and good prognosis at ICU discharge, were included in a propensity score model for decannulation. After adjustment for the propensity score and Sabadell score, the presence of a tracheostomy cannula was not associated with any survival disadvantage.

Several studies suggest that post ICU tracheostomy follow-up by a multidisciplinary team resulted in more timely decannulation and reduced hospital stay and adverse events.[34,35] A recently published study by de Mestral et al[36] had similar findings of decrease in incidence of tube blockage and calls for respiratory distress on the wards. Additionally, there was a significantly larger proportion of patients who also received speaking valves after implementation of the team, a trend toward decreased time to first tube downsizing, and decreased time to decannulation.

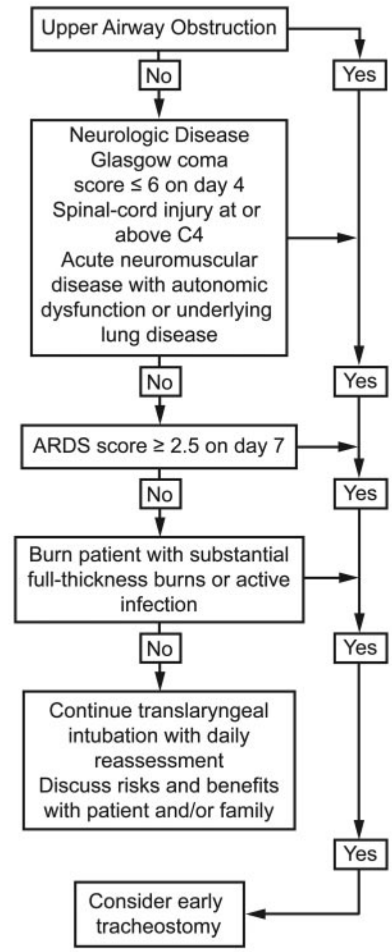

Figure. Algorithm for early tracheostomy. (From Reference 40.)

Summary

A growing body of literature demonstrates that percutaneous tracheostomy performed in the ICU is a safe procedure, even in high risk patients. Advances in techniques, together with adjuncts to improve visualization, seem promising and likely to further improve the safety of the technique

The optimal timing of tracheostomy (early vs late) for critically ill patients remains unclear. Although there was initial enthusiasm in support of early tracheostomy to improve patient outcomes, repeated studies have been unable to produce robust benefits. Whether this is because early tracheostomy truly does not improve outcome, whether our inability to select a patient's need for prolonged intubation is inadequate, or whether other coinciding interventions such as protocolized weaning and reduced sedation have a larger impact on overall outcome is unclear.

The decision to perform a tracheostomy remains one of clinical judgment to determine which patients have the potential to benefit from a tracheostomy and when it should be performed. Patients with severe trauma; those with burns to the face, neck, and upper airway; and those with neurological injury unable to protect their airway are more easily identified as candidates for early tracheostomy.[37] Several studies have proposed scoring systems for prediction of prolonged intubation, which may provide a basis for future research into the benefits of early tracheostomy.[38,39] Durbin et al recently proposed an algorithm that incorporates this literature to identify patients who may benefit from early tracheostomy, which might be used as a foundation for future studies (Figure).[40]

The question of optimal timing and location of decannulation has not been answered, but at least there is some reassurance that, in aggregate, across a variety of ICUs, patients do not appear to be harmed by transfer to ward with tracheostomy. This is in contrast to previous studies, which suggest increased risk with this practice. However, the study should not be interpreted to suggest that transfer of patients with tracheostomy is safe in general. Future research should focus on defining which combination of patient characteristics and ward conditions are required for this practice to be safe.[41] In addition, we should determine the optimal time and environment for decannulation. There is increasing evidence that successful implementation of ICU outreach and tracheostomy might provide a way to improve the outcome of these patients.

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