Perspectives
Recovery Strategies from the OR to Home

ABSTRACT

A tracheostomy is performed in over 50% of ventilator-dependent patients. Some of the benefits attributed to tracheostomy versus prolonged intubation include improved patient comfort such as potential for speech and ability to eat orally, more effective airway suctioning, decreased airway resistance, accelerated ventilator weaning, and reduced ventilator-associated pneumonia. Disadvantages to the procedure are perioperative complications, long-term airway injury, and cost. In his article, Dr. Op't Holt describes two types of tracheostomy procedures, the effect of timing of tracheostomy, weaning from ventilation, the cost of care, and the incidence of nosocomial pneumonia related to tracheostomy.

With the increased population of older adults and newer technology available in hospitals, attitudes toward subjecting the elderly to surgical procedures are changing. The number of elderly patients who undergo noncardiothoracic surgery is projected to increase from 7 million to 14 million over the next 30 years. In her article, Ms. Sorenson stresses the importance of preoperative screening to identify potential age-associated problems and the creation of a plan to address problems should they arise during or after surgery.

Respiratory Care in Compromised Patients

Tracheostomy in the Mechanically Ventilated Patient

CONTINUING EDUCATION FOR RESPIRATORY THERAPISTS
CRCE

by Tim Op't Holt EdD, RRT, AE-C, FAARC

Tracheostomy is a common procedure in the intensive care unit (ICU), often performed to facilitate long-term mechanical ventilation and tracheobronchial hygiene. There has been much discussion about the type of tracheostomy procedure (percutaneous dilational versus open surgical), the effect of timing of tracheostomy on length of stay, weaning from ventilation, cost of care, and the incidence of nosocomial pneumonia related to tracheostomy.

Indications

The major indications for tracheostomy are upper airway obstruction, facilitation of prolonged mechanical ventilation, and pulmonary hygiene. A recent review[1] of tracheostomy rates among 17,523 ICU patients, of whom 4,146 underwent tracheostomy, found a range of 0-59 tracheostomies per 100 patients, with a mean rate of 19.6%. Tracheostomy was more likely to be performed in older patients and those with preexisting chronic conditions (e.g., COPD, stroke, coronary artery disease, and neurologic disease).

According to May and Bortner, "A tracheostomy should be performed only after the clinical benefits and risks for the individual have been considered, not because a certain number of days of intubation have elapsed."[2] Factors to consider in switching from an endotracheal tube (ETT) to a tracheostomy include the projected time the patient will need an artificial airway, the patient's tolerance of the endotracheal tube, the patient's overall condition, the patient's ability to tolerate a surgical procedure (or the alternative percutaneous technique, discussed below), and the relative risks of continued tracheal intubation versus tracheostomy.[3]

Two techniques are commonly used: the open surgical technique and the percutaneous dilational technique. The percutaneous technique has several advantages over the open surgical technique, including a smaller skin incision, less tissue trauma, fewer wound infections and less bleeding. The percutaneous procedure is performed at the bedside, which eliminates the need for transport to the operating room and associated costs and hazards of such transport. The percutaneous procedure is also performed faster and decreases the use of valuable operating room resources. These techniques, performed by the surgeon or intensivist, are described elsewhere.[2,4,5]

There are many advantages to the tracheostomy over prolonged endotracheal intubation. Following the procedure, the tube tract will mature. This means that if the tracheostomy tube should come out of the trachea, it can be easily replaced at the bedside by the respiratory therapist or nurse. Since the tube does not contact or traverse the vocal cords, there is no damage to these structures. The tracheostomy tube is placed lower in the airway than an ETT, so a suction catheter can go farther into the airway for more effective suctioning. There is a lower incidence of tube obstruction, especially since the inner cannula may be removed and replaced as

Continued on page 4

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Postoperative recovery in elderly patients: *Implications for respiratory care*

by Helen M. Sorenson, MA, RRT, CPFT, FAARC

Surgical intervention for a variety of medical conditions has a role in treating geriatric patients. Cardiopulmonary disease, cancer, gastrointestinal disorders, and age-associated diseases can be effectively treated or alleviated with surgery. Given the increased population of older adults and newer technology available in hospitals, attitudes toward subjecting the elderly to surgical procedures have become more liberal. While survival may be the ultimate goal, improving quality of life and functional capacity may be far more important to the elderly. Preoperative screening can identify potential age-associated problems, allowing a plan to be put in place to address them should they arise during or after surgery. Attention to some of the details covered in this article may make a difference in the percentage of older adults who both survive and thrive after an operation.

Assessing risk before surgery

Awareness in the preoperative period of potential hazards can make a difference in the incidence of morbidity and mortality in elderly patients following surgical procedures. A systematic literature review[1] for the American College of Physicians, published in 2006, focused on clinical risk factors for the development of postoperative pulmonary complications. Risk factors were classified as either patient-related or procedure-related. The following patient-related risk factors for the development of postoperative pulmonary complications were supported with good evidence: advanced age, American Society of Anesthesiologists (ASA) class-II or higher morbidity, functional dependence, chronic obstructive pulmonary disease (COPD), and congestive heart failure (CHF). Other studies have implicated smoking as a risk factor for impaired postoperative pulmonary function.[2,3]

The American College of Physicians review[1] also considered procedure-related risk factors. Good evidence supports an increased risk of developing postoperative pulmonary complications with the following procedures: abdominal aortic aneurysm (AAA) repair, nonresective thoracic surgery, abdominal and vascular surgery, neurosurgery, head and neck surgery, emergency surgery, general anesthesia, and prolonged surgery. A recent report[4] of a case-control study revealed that older (≥70 years) patients who underwent right-sided pneumonectomy for lung cancer had about three times greater risk for postoperative mortality when compared to younger (approximately 59 years) patients with comparable disease and comorbidities.

Many laboratory test results have been considered as markers of risk for postoperative pulmonary complications, but good evidence exists only for a serum albumin level of < 35 g/L.[5] A low serum albumin level indicates poor nutritional status, which increases risk for complications.

While pulmonary function, specifically the ratio of forced expiratory volume in one second (FEV1) to forced vital capacity (FVC), has been studied as a marker of increased risk,[6,7] insufficient evidence supports the use of preoperative spirometry as a risk-stratification tool.[1]

Table: **Factors that increase risk of postoperative pulmonary complications in the elderly patient**

Preoperative
- Poor nutritional status (albumin <35 g/L)
- Advanced age
- Comorbid disease (COPD, CHF)
- Functional dependence
- History of smoking
- ASA class-II or higher morbidity

Perioperative
- Type of surgery (AAA repair; thoracic, abdominal, vascular, or head/neck surgery; neurosurgery)
- Prolonged (>3 hours) surgery
- Emergency surgery
- General anesthesia
- Inadequate perfusion, fluid management, temperature regulation, or oxygenation

Postoperative
- Hypothermia
- Hypoxemia
- Hypovolemia
- Poor pain control
- Surgical site infections
- Nasogastric tube placement
- Long-acting neuromuscular blockade

Preoperative planning

While not directly related to postoperative pulmonary complications, failure to initiate preoperative planning would be a mistake. Planning in addition to risk assessment can ultimately reduce or eliminate the development of major postoperative pulmonary complications. Some things to consider:

- Risk increases with age. Operative mortality for patients ≥80 years is more than twice that for patients 65 to 69 years old.[8]
- Elective surgery, though not always possible, is associated with better outcomes than emergency surgery in older patients.[8,9]
- The type of surgery performed stratifies the risk. Carotid endarterectomy and nephrectomy would be considered low-risk procedures, while mitral-valve replacement, esophagectomy, and pneumonectomy place patients at higher risk.[8]
- The location of the surgical procedure, be it at an ambulatory surgical center, outpatient hospital, or physician office, is also a factor; risk increases with surgery at a physician's office or outpatient hospital.[10]
- For elderly patients, risk increases with prior hospitalization and the invasiveness of the surgery.[10]
- Surgical site infections (SSI) can delay postoperative recovery. One of the independent risk factors in the development of SSI is COPD as comorbidity.[11]

Knowing other independent risk factors associated with an increased incidence of SSI in older adults may be beneficial in developing interventions to prevent wound infections.[11] Preoperative antibiotic use is controversial. It has been recommended that clinicians reserve preoperative antibiotic therapy for patients with infection suggested by a change in the character and amount of sputum.[1] A recent article[12] looked at preoperative antibiotics and mortality in the elderly; it noted that,

when patients underwent general surgery, the odds of dying within 60 days were less than half in those treated with preoperative antibiotics within 2 hours of incision.

Perioperative (intraoperative) monitoring

What happens during surgery is going to affect patients in the postoperative period. Potential intraoperative risk factors include temperature regulation, perfusion, type of anesthesia, duration of anesthesia, duration of surgery, fluid management, and oxygenation.

All patients undergoing major surgery are routinely monitored. For older patients, electrocardiogram (ECG), blood pressure, and oxygen saturation should be monitored during any procedure. Blood pressure measurements are recommended every 5 minutes.[13] For frail individuals, a thin layer of padding may be used under the cuff to protect the skin. The ECG should be configured to observe both p waves and the lateral wall of the left ventricle.[13] Pulse oximetry may not be easy due to poor perfusion and/or cold extremities. Using probe sites other than fingers and toes is possible with newer technology and should be considered. Anesthesia/sedatives should not be administered unless there is a satisfactory pulse oximeter reading.[13]

Maintaining adequate body temperature in elderly patients during surgery is challenging. Significant hypothermia may develop during a long surgical procedure, dropping core temperatures to between 32.25°C and 35.03°C. Older adults have a lower baseline temperature to begin with, and mechanisms used to increase body temperature are often blunted in the elderly. Severe hypothermia is associated with cardiac arrhythmias. Even hypothermia in the range of 31.69°C to 32.25°C can lead to ventricular fibrillation and subsequent death.[14] Measures that can be taken to maintain a reasonable body temperature in older surgical patients include warming all fluids, maintaining the operating room at a reasonable temperature, keeping abdominal viscera in the abdominal cavity as long as possible, and, if needed, using warm normal saline for lavage.

Choice of anesthetic agents and techniques has been the topic of many articles. In general, older adults require less medication to achieve the same level of sedation.[14,15] Pain perception is altered with aging,[14] but pain is not less common or less important and must still be addressed. Muscle relaxants are often used by anesthesiologists to control muscle tone. All of the agents available may result in an increased duration of action, but doses are not significantly altered.[14] General versus regional versus neuraxial (blocking spinal-cord nerves) anesthesia in older patients has also been debated in many publications. Spinal anesthesia is the most easily mastered and is often selected for older patients.[13] The belief that regional anesthetics should be safer for older patients is not supported by most major studies. According to Roy, there is a developing consensus that overall perioperative care, not just the choice of anesthetic technique, is more likely to have a positive impact on the elderly surgical patient.[16] Surgical procedures that require general anesthesia, are prolonged (>3 hours) with the patient supine, and involve an abdominal incision can result in a reduced functional residual capacity (FRC) and increased airway resistance.

Combining the aging pulmonary physiology with pulmonary consequences of surgery can result in hypoventilation, small airway closure, hypoxemia, secretion retention, and pulmonary infections.[17] Oxygenation must be addressed. Patients with clinically significant cardiac or pulmonary disease should receive oxygen during surgery. Hypoxia may impair wound healing and cognitive functioning, especially in the elderly.[18]

Fluid management is also important. Patients on preoperative fluid restrictions are more likely to be underhydrated when they come into surgery, but overhydration is just as problematic. Excess fluid in an elderly patient, when renal failure is present, can result in pulmonary edema. Dehydration, on the other hand, can precipitate renal failure. Intraoperative blood loss places older adults at increased risk for postoperative delirium; such delirium is noted most frequently when the hematocrit has dropped to <30%.[19]

Postoperative care

Normal age-related pulmonary changes such as reduced lung elasticity, decreased vital capacity, loss of diaphragmatic strength (up to 25% in adults >70 years),[13] and increased chest-wall resistance tend to hasten the development of ventilatory failure in elderly postoperative patients. The use of anesthetic and analgesic agents during and after surgery further depresses the respiratory drive, often resulting in the need for mechanical ventilation in the postoperative period. Because hypothermia can depress respiration and the cough reflex, elderly patients should not be extubated until their body temperature is within 0.5°C of their baseline core temperature.[14]

While data related to the effect of age on outcomes of mechanical ventilation are inconclusive, evidence does suggest that patients over age 70 years are more likely to become ventilator dependent.[20] Although not always a desired procedure, placement of a tracheostomy may allow the ventilator-dependent patient to live outside the hospital, or in some cases may facilitate liberation from the ventilator. Documented[21] benefits of tracheostomy include reduction of dead space, decreased work of breathing, enhanced secretion removal, oral hygiene, reduced laryngeal damage, decreased glottic and tracheal ulceration, the potential for oral nutrition, and better communication with family and caregivers. On the downside, not all elderly patients enjoy a lengthy survival postprocedure. A small retrospective case review of 19 elderly patients who underwent tracheostomy for long-term mechanical ventilation revealed that 14 died within 40 days of surgery.[22] It is important to note that many patients were excluded from the study, including those undergoing tracheostomy for upper-airway obstruction or in conjunction with head and/or neck cancer.

The complications following a tracheostomy may also be problematic for the elderly. Studies show that 50% to 70% of older patients develop a significant infection after a tracheostomy[23] and as many as 77% aspirate secretions.[24] It has been demonstrated that obese older adults had improved survival after placement of a tracheostomy; however, patients between the ages of 70 and 75 years with bullous emphysema were poor candidates for permanent tracheostomies.[22] Tracheostomy ties should be longer and wider to prevent trauma within skin folds. Commercially available tube holders incorporate stretch material to accommodate any edema around the neck. An extension piece can help obese patients and helps to prevent pressure ulcers from occurring under the tracheostomy tie.[25]

Careful consideration must be given to pain management in the postoperative period. Consequences of untreated pain are tachycardia, increased oxygen consumption, and possible myocardial ischemia.[14] Anticipated pain can lead to splinting and poor inspiratory effort, increasing the risk of atelectasis and postoperative pneumonia.

Morphine is a pain reliever commonly used outside the operating room and is often administered via patient-controlled analgesia (PCA). PCA is useful in elderly patients who can understand instructions and know how to use the button before the pain becomes intense. In a randomized trial[26] comparing conventional intramuscular injections and PCA in frail elderly men, PCA gave better pain control with fewer complications, less sedation, and better patient satisfaction.

Of interest is a small study[27] examining the effect that warm blankets had on pain perception. Based on the assumption that adequate rest in postoperative patients promotes healing and reduces length of stay, 49 older adults who were complaining of pain, discomfort, cold, and anxiety were assessed for their level of discomfort before and 1 hour after application of a warmed blanket. The level of discomfort after receiving the blanket was significantly less ($p < 0.001$).

Adequate pain management and adequate oxygenation have been shown in two independent studies to reduce the incidence of postoperative delirium.[27,28] Because postoperative hypoxia can result in both transient and long-term cognitive dysfunction after both cardiac and noncardiac surgery, oxygen therapy should not be withheld. Research[29,30] indicates that a normal PaO_2 for a healthy older adult is about 83 mm Hg with a lower limit of SpO_2 at about 94%. Patients should not be discharged from the recovery room until their corrected arterial saturation is similar to their preoperative level.[14]

For decades, respiratory therapists have been delivering hyperinflation therapy to postoperative patients. Good evidence[31] indicates that lung-expansion interventions (e.g., incentive spirometry, deep-breathing exercises, continuous positive airway pressure) reduce the risk of postoperative pulmonary complications. Fair evidence[32] suggests that selective, rather than routine, use of nasogastric tubes after abdominal surgery reduces pulmonary complications associated with aspiration, and short-acting rather than long-acting neuromuscular blockade reduces postoperative pulmonary edema.

Conclusion

The ever-expanding population of older adults will result in an increased amount of surgical procedures being performed on geriatric patients. The number of elderly (>65 years) patients who undergo noncardiothoracic surgery is projected to increase from 7 million to 14 million over the next 30 years.[33] Surgery can potentially be debilitating for older adults. The good news is that many postoperative pulmonary complications are preventable. With advances in medicine, technology, and risk stratification, the future looks good for older surgical patients.

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Tracheostomy in the Mechanically Ventilated Patient– continued

needed. Replacement of the inner cannula also eliminates biofilm, a leading cause of ventilator/airway-associated nosocomial pneumonia. Since the tube does not traverse the mouth, there is no damage to the palate, lips, or teeth, and oral care is much easier. Patients with a tracheostomy are more comfortable; they do not gag, so less sedation is needed. They are able to communicate better, since they are able to mouth words. In addition, a speaking valve such as a Passy-Muir valve may be employed to allow speech by patients with intact gag reflex. The glottis is competent, so there is less risk of aspiration and less risk of nosocomial pneumonia. Swallowing is preserved, so oral feeding is possible, which is preferred for optimal nutrition. Since the tube is shorter and may be larger in diameter, there is less resistance to gas flow, less dead space, and decreased work of breathing. Many believe there is more rapid weaning, which is discussed below.

Percutaneous versus surgical: complications and outcomes

Higgins et al[6] performed a meta-analysis to determine if there were any differences in complications between percutaneous and surgical tracheostomies. In their study of 15 papers with 973 patients in which there were 490 percutaneous tracheostomies and 483 surgical tracheostomies, pooled odds ratios revealed statistically significant results against percutaneous tracheostomy for the complication of decannulation/obstruction ($p = .009$). There were significantly fewer complica-

tions in the percutaneous group related to wound infection (p = .0002) and scarring (p = .01). They also found that the weighted mean difference for the cost of the percutaneous procedure was $456 less than the surgical technique (95% CI = -$482 to -$430), and it took less time (p <.0001). There was no difference in hemorrhage, stenosis, death, or false passage.

To perform the percutaneous technique, the midline neck structures (thyroid and cricoid cartilages, sternal notch) must be palpable; otherwise the procedure will be blind, making the percutaneous method less safe. Contraindications to the use of the percutaneous technique are morbid obesity, repeated tracheostomy, high positive end expiratory pressure, severe coagulopathy, and unusual neck anatomy.[4] However, a chart-review study[7] of percutaneous tracheostomy in 143 morbidly obese patients (body-mass index >35) determined that the procedure was safe.

It is puzzling that Higgins et al found a greater incidence of decannulation/obstruction with the percutaneous technique. Our experience has shown that the same tracheostomy tube is used regardless of technique. With appropriate tube securing, there should be no difference in decannulation. Since a tracheostomy tube with a removable/disposable inner cannula is used, it is unclear how there could be an increase in obstruction. Perhaps the authors of the studies used in this analysis used dissimilar tracheostomy tubes between the two tracheostomy techniques. In Rana's review[4] of these two techniques, it was determined that perioperative complications were more common during percutaneous than surgical tracheostomy (10% vs. 3%), whereas there were more complications postoperatively following surgical tracheostomy (10% vs. 7%).

Timing of tracheostomy and outcomes

There is considerable debate about whether the timing of a tracheostomy speeds the process of liberation from the ventilator, or if tracheostomy decreases the incidence of nosocomial pneumonia (so-called ventilator-associated pneumonia), decreases ICU length of stay, etc. An examination of several reviews, meta-analyses, and retrospective and prospective studies yields varied results, depending on method, outcome variable, and patient population. For example, in one study,[8] tracheostomy had no positive impact on survival when performed on unselected mechanically ventilated patients. The timing of tracheostomy (early versus late) made no difference in mortality. The risk of pneumonia was not modified by tracheostomy, and tracheostomy increased length of mechanical ventilation and ICU and post-ICU stays. In addition, tracheostomy increased post-ICU mortality in patients weaned from mechanical ventilation who did not have their tracheostomy reversed prior to discharge. The authors noted that it was not that the tracheostomy tube increased length of stay and mortality, but rather that patients with a greater severity of illness were likely to undergo tracheostomy. Patients undergoing tracheostomy required a greater use of resources after leaving the ICU, so it was concluded that every effort be made to wean the patient from mechanical ventilation without tracheostomy. In an observational study[9] of 5,081 patients in 361 ICUs over 12 countries, it was found that patients with a tracheostomy had a longer length of stay in the ICU and in the hospital; ICU mortality was lower in patients with a tracheostomy, but there was similar hospital mortality among those with and without a tracheostomy.

Tracheostomy can reduce the work of breathing, improve oral and tracheobronchial hygiene, and improve patient comfort and communication. In patients with severely limited reserves, tracheostomy may provide enough relief from secretion accumulation and the increased work of breathing that weaning may be easier and faster. We have seen on many occasions rapid weaning and ICU discharge only because a tracheostomy provides a patent airway, especially in patients with altered mental status who cannot otherwise maintain a native airway. However, most of these patients require increased intensity of post-ICU airway care and are prone to infection.

Early tracheostomy is supported by those who cite the risks to the patient of prolonged intubation, such as sinusitis, soft-tissue irritation, poor oral hygiene, discomfort, and the need for additional sedation. In 1989, the American College of Chest Physicians recommended[10] tracheostomy after 21 days of intubation. In an analysis of 992 intubated trauma patients, Goettler et al[11] developed a system to rate a patient's risk for tracheostomy that included factors such as Glasgow coma scale, injury severity score, anatomic injury scores, and age, and they concluded that patients with >90% risk for tracheostomy undergo early tracheostomy (within 72 hours of admission). However, in a systematic review and meta-analysis, Dunham[12] concluded that early tracheostomy had no influence on mortality, pneumonia or laryngeal pathology rates in trauma patients. Furthermore, he found that patients with severe brain injury may be more rapidly liberated from mechanical ventilation with early tracheostomy. This is consistent with our own observation. If a patient with severe brain injury can breathe, and a patent airway is maintained with a tracheostomy, there are fewer ventilator and

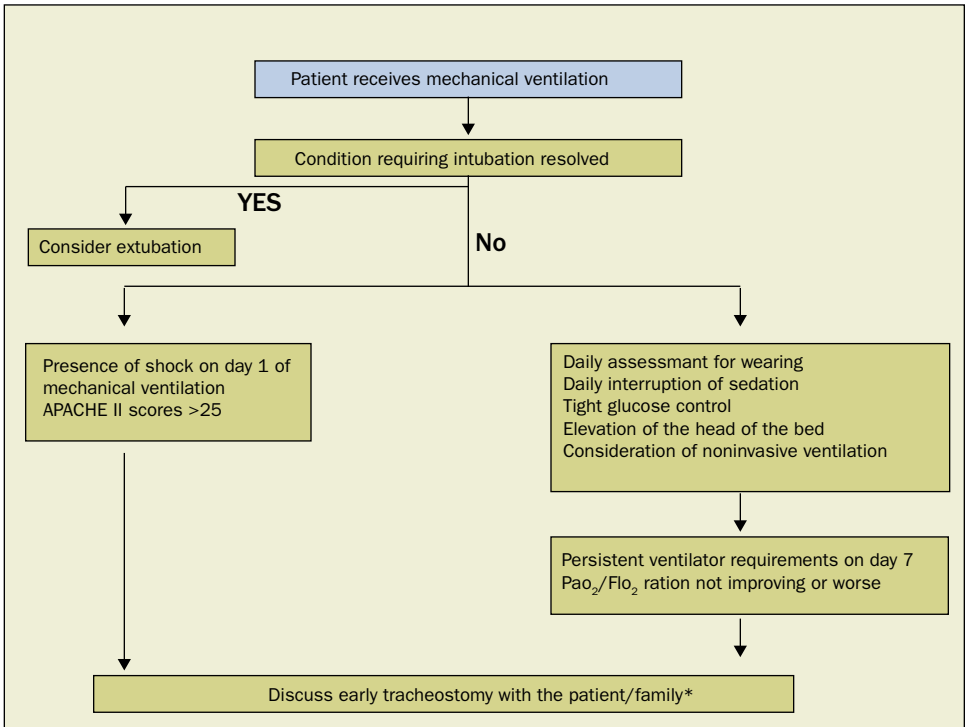

Figure 1. Approach to the timing of tracheostomy in critically ill patients on mechanical ventilation

Table 1. **Potential obstacles to successful clinical studies on tracheostomy and weaning**

- Inability to blind investigators (and clinicians) as to groupings
- Bias of clinicians managing patients
- Inability to predict which patients will require prolonged ventilatory support
- Varying weaning protocols
- Varying criteria for weaning success and failure
- Funding and reimbursement factors
- Varying specialties performing procedure
- Varying levels of training and experience among operators

ICU days. Clearly, this is a topic of interest, as an additional prospective study[13] confirmed the results of both the Goettler and Dunham papers. This study enrolled 60 trauma patients and was stopped at the interim analysis, since there was no difference in length of ventilator support, frequency of pneumonia, or death.

On the other hand, Arabi et al[14] found that duration of mechanical ventilation was significantly shorter ($p < .0001$) with early tracheostomy (<7 days from admission) than later tracheostomy (>7 days from admission) in a group of 136 trauma patients who underwent tracheostomy. These patients were matched for injury severity score (ISS), Acute Physiology and Chronic Health Evaluation (APACHE II) scores, and Glasgow Coma Scale (GCS) scores. The time from tracheostomy to weaning was the same, as was the number of days from tracheostomy to discharge; what delayed discharge was the delay in tracheostomy. Rana's review[4] of several studies of the timing of tracheostomy, including that of Arabi, concluded that the duration of mechanical ventilation and the total cost of hospitalization were significantly lower when tracheostomy was performed early rather than late (5.9 versus 16.7 days of ventilation). In the only study specifically of patients in the medical ICU, Rumbak et al[15] showed that the length of ICU stay, days of ventilation, and mortality were significantly lower in their early percutaneous tracheostomy group (<48 hours or 14-16 days). Furthermore, in a recent Cochrane meta-analysis, Griffiths et al[16] found that with early tracheostomy there was no difference in mortality or risk of hospital acquired pneumonia, and there were significantly fewer ventilator and ICU days. Patients who had an early tracheostomy underwent less sedation and had increased mobility.

The APACHE II score seems to be a good predictor of the need for tracheostomy during the first several days of ventilation. The combination of a score >25 and shock at the time of admission is a predictor of poor outcome, and early tracheostomy should be discussed with the patient and/or family (Figure 1). This is consistent with Heffner's conclusion[17] that critically-ill patients should first undergo stabilization and a trial of therapy to determine if extubation will be likely within the first several days of ventilation. If the patient remains dependent on the ETT for a week, tracheostomy should be considered, and the decision will be based on the likelihood of benefit and the anticipated duration of need for ventilation.

Pierson's review[18] of tracheostomy and weaning considered many of the studies cited here, and my conclusions are consistent with his. He notes that studies of the effect of tracheostomy on weaning are subject to many methodological problems (Table 1) and the tendency to treat patients with a tracheostomy differently from those with an endotracheal tube. Healthcare professionals tend to look at a patient with a tracheostomy and have a "feeling" that he or she is ready for weaning, but we don't have that same opinion when we see an ETT. We proceed to promote spontaneous breathing trials more often when we see a tracheostomy tube than when we see an ETT. Based on these references, it appears that there is a benefit to early tracheostomy, when careful consideration is made regarding the patient's acuity and wishes, and the decision should never be arbitrary, based only on a finite number of ETT-dependent days. There seems to be a trend towards fewer ventilator days, length of stay, and a lower cost of hospitalization when tracheostomy is performed early.

Incidence of ventilator-associated pneumonia and tracheostomy

A 2004 evidence-based guideline[19] for the prevention of ventilator-associated pneumonia (VAP) did not recommend early tracheostomy as a way of preventing VAP. The authors stated that there was no difference in the incidence of VAP subsequent to early tracheostomy versus late tracheostomy, but that the trials they reviewed were methodologically flawed.

Subsequently, two studies of 856 patients and another review concluded that there was a decrease in VAP when tracheostomy was performed early. In a retrospective study by Möller et al,[20] the incidence of VAP was significantly higher in the late tracheostomy group (42.3% vs. 27.2%). In addition, the authors found that in the late tracheostomy group there was a decrease in ventilator days, ICU length of stay, and hospital length of stay. In a prospective study of VAP, Ranes et al[21] identified the factors associated with hospital mortality from VAP as diagnosis on admission, the need for vasopressors during hospitalization, and not undergoing a tracheostomy. Tracheostomy performed during the hospitalization was associated with better hospital survival. In a recent review, Leong and Huang[22] noted that some studies confirmed previous findings of a decrease in VAP, ICU length of stay, and days requiring mechanical ventilation, while others did not. Variability in patient population and defining early versus late contribute to the lack of consensus. Regardless, none of these studies concluded that late tracheostomy decreased the incidence of VAP.

Figure 2. Tracheostomy tube holder (courtesy of Dale Medical): Padded neck band circles the neck. Velcro-type tabs hold the neck band to the tracheostomy tube.

Securing the tracheostomy tube

Once through the trachea, the tracheostomy tube is often secured in place by suturing the flange of the tube to the skin. This is followed by tying the tube in place using cotton twill tape: The end of the tape is folded over onto itself and a short horizontal slit is made. The twill tape is threaded through the slot in the flange adjacent to the sutures (if present). The loose end of the tape is threaded through the slit. The loose end is then pushed under the patient's neck and threaded through the slot in the other side of the flange and tightened to allow a finger or two behind the tie. When the twill tape becomes soiled, it is replaced.

Another way of securing the tracheostomy tube is with a commercial device. These devices feature a padded neck band and Velcro-type tabs, so the therapist or nurse does not have to tie knots. The neck band is in two pieces. Each piece has a Velcro-type tab to place through one slot of the flange. The longer of the two neck bands is brought behind the patient's neck and is pressed onto the short neck band once tightened. One product features moisture-repellant neck bands and some elastic to allow for edema and coughing (Figure 2).

Conclusion

Following the initiation of mechanical ventilation, tracheostomy is performed in up to 59% of patients, with a reported mean of 19.6%. It is often performed to facilitate continued mechanical ventilation, to facilitate weaning and oral feeding, and is better tolerated by the patient than the endotracheal tube. The percutaneous route is preferred over the surgical route, as it is accomplished faster, at less expense and with fewer complications. There is considerable debate about the timing of tracheostomy —early versus late—and the outcomes of studies vary widely in terms of post-tracheostomy cost of care, days of mechanical ventilation, and days in the ICU. There is no clear consensus about the timing of tracheostomy, and there are obstacles to successful clinical studies on tracheostomy and weaning. It seems that early tracheostomy is associated with a decreased incidence of ventilator/artificial airway-associated pneumonia. The tracheostomy tube may be secured with sutures or a commercially available device that incorporates Velcro® to facilitate tube security. A tracheostomy should be performed only after the clinical benefits and risks for the individual have been considered, not because a certain number of days of intubation have elapsed.

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1. **Which of the following are indications for a tracheostomy?**

   I upper airway obstruction
   II. facilitate long-term mechanical ventilation
   III. facilitate tracheobronchial hygiene
   IV. anorexia

   a. I, II, III only
   b. II, III, IV only
   c. I, II, IV only
   d. I, III, IV only

2. **According to a large, multicenter study, what percent of mechanically ventilated patients receive a tracheostomy?**

   a. 10%
   b. 20%
   c. 25%
   d. 30%

3. **Which of the following are advantages of a tracheostomy over endotracheal intubation?**

   I. absence of tracheal stenosis
   II. no vocal cord damage
   III. ability to suction deeper into the tracheobronchial tree
   IV. oral feeding is possible

   a. I, II, III only
   b. I, III, IV only
   c. I, II, IV only
   d. II, III, IV only

4. **Advantages of the percutaneous tracheostomy over the surgical tracheostomy include all of the following EXCEPT:**

   a. decreased incidence of decannulation
   b. cost less
   c. fewer wound infections
   d. takes less time

5. **Which of the following statements summarizes the literature on early versus late tracheostomy?**

   a. Early tracheostomy results in decreased length of hospital stay and cost.
   b. Results of studies on effect of early tracheostomy are varied and depend on patient acuity.
   c. Late tracheostomy decreases the risk of ventilator-associated pneumonia
   d. Early tracheostomy results in faster weaning from the ventilator in all instances.

6. **Nurses and respiratory therapists believe that patients with a tracheostomy can be weaned from the ventilator faster because:**

   a. the literature has substantiated that belief
   b. they look at a patient with a tracheostomy and have a "feeling" that he or she is ready for weaning
   c. that is their experience
   d. the patients tend to be less acutely ill by the time they receive a tracheostomy

7. **Studies of the incidence of ventilator or artificial airway associated pneumonia have concluded that:**

   a. there was a decrease in VAP when tracheostomy was performed early.
   b. there was a decrease in VAP when tracheostomy was performed late.
   c. VAP was not associated with the use of vasopressors.
   d. there is no relationship between VAP and the timing of tracheostomy.

8. **Which of the following are used to secure a tracheostomy tube?**

   I. cloth adhesive tape
   II. a commercial tracheostomy tube-securing device
   III. sutures
   IV. cloth twill tape

   a. I, III, IV only
   b. I, II, IV only
   c. I, II, III only
   d. II, III, IV only

9. **There is good evidence to support the use of which laboratory test as a marker of an increased risk for developing post-operative pulmonary complications?**

   a. arterial blood gases
   b. serum albumin
   c. FEV1/FVC
   d. serum potassium

10. **An independent risk factor for the development of a surgical site infection in older adults is a diagnosis of:**

    a. diabetes
    b. asthma
    c. arthritis
    d. COPD

11. **Consequences of untreated pain in the postoperative period may include all of the following EXCEPT:**

    a. increased VO2
    b. stroke
    c. increased heart rate
    d. increased atelectasis

12. **An oxygen saturation (SpO2) of 80% is adequate for the majority of elderly patients recovering from surgery.**

    a. true
    b. false

13. **Postoperative delirium may be reduced in older adults by assuring adequate:**

    I. pain relief
    II. hydration
    III. sedation
    IV. oxygenation
    V. secretion removal

    a. I, III
    b. I, IV
    c. II, III, IV
    d. All of the above

14. **Incentive spirometry as a means of preventing postoperative pulmonary complications:**

    a. should be considered in all elderly postoperative patients.
    b. has not been found to be effective in postoperative care.
    c. is too difficult for older adults to perform.
    d. is only useful if preoperative inspiratory capacity has been established.

What is the highest degree you have earned (circle one) ? 1. Diploma 2. Associate 3. Bachelor's 4. Master's 5. Doctorate

Indicate to what degree you met the objectives for this program: Using 1 = strongly disagree to 6 = strongly agree rating scale, please circle the number that best reflects the extent of your agreement to each statement.

	Strongly Disagree					Strongly Agree
1. Identify risk factors that could lead to ventilator associated death and injury.	1	2	3	4	5	6
2. Discuss strategies which will reduce the risk of ventilator associated death and injury.	1	2	3	4	5	6
3. Recognize risk factors for unplanned extubation in critically ill patients.	1	2	3	4	5	6
4. Describe strategies for prevention of unplanned extubation.	1	2	3	4	5	6

Mark your answers with an X in the box next to the correct answer

	A	B	C	D
1	☐	☐	☐	☐
2	☐	☐	☐	☐
3	☐	☐	☐	☐
4	☐	☐	☐	☐
5	☐	☐	☐	☐
6	☐	☐	☐	☐
7	☐	☐	☐	☐
8	☐	☐	☐	☐
9	☐	☐	☐	☐
10	☐	☐	☐	☐
11	☐	☐	☐	☐
12	☐	☐	☐	☐
13	☐	☐	☐	☐
14	☐	☐	☐	☐
15	☐	☐	☐	☐
16	☐	☐	☐	☐

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