Tracheostomy tubes are placed for a variety of reasons, including failure to wean from mechanical ventilation, inability to protect the airway due to impaired mental status, inability to manage excessive secretions, and upper-airway obstruction. A tracheostomy tube is required in approximately 10% of patients receiving mechanical ventilation and allows the patient to move to a step-down unit or long-term care hospital. The presence of a tracheostomy tube in the trachea can cause complications, including tracheal stenosis, bleeding, infection, aspiration pneumonia, and fistula formation from the trachea to either the esophagus or the innominate artery. Final removal of the tracheostomy tube is an important step in the recovery from chronic critical illness and can usually be done once the indication for the tube placement has resolved. Key words: mechanical ventilation; tracheostomy; decannulation; speaking valve; noninvasive ventilation; long-term care hospital. [Respir Care 2010;55(8):1076–1081. © 2010 Daedalus Enterprises]
decannulation guidelines make it difficult to predict weaning outcomes of individual patients. Clinically stable patients undergoing prolonged mechanical ventilation usually begin the weaning process by spending increasing amounts of time on a spontaneous breathing trial via humidified tracheostomy mask. Therapist-driven weaning protocols, such as those involving spontaneous breathing trials or decreasing levels of pressure support, have been implemented in the post-acute-care setting and have been shown to shorten the time taken to wean patients from prolonged mechanical ventilation.

Not all patients are suitable for a weaning protocol, and some need an individualized approach given the complexity of the patient population. The presence of respiratory muscle weakness, slow recovery from chronic critical illness with multi-organ dysfunction, anxiety from prolonged ventilator dependence, chronic anemia, or cardiac dysfunction may necessitate a more gradual weaning strategy. One method involves gradually decreasing the amount of pressure-support ventilation prior to withdrawal of full ventilator support. All patients undergoing weaning from mechanical ventilation should be carefully monitored using continuous pulse oximetry and cardiac telemetry.

A system for patient assessment prior to decannulation is outlined in Figure 1. Once a patient demonstrates the ability to tolerate a tracheostomy mask, it is important to establish that the upper airway (ie, glottis, vocal cords, and subglottic space) is patent. The presence of a tracheostomy tube can cause complications that may result in upper-airway obstruction. The upper airway can be checked noninvasively by fully deflating the cuff on the tracheostomy tube opening to deflect air through the upper airway and vocal cords, allowing phonation. Alternatively, tracheostomy tube manometry may be used to obtain objective measurements of airway pressures during the use of a speaking valve or cap. This technique helps identify patients who can tolerate occlusion of the tracheostomy tube and also those who may benefit from having a tracheostomy tube with a smaller external diameter.

If the patient is unable to phonate, has stridor or labored breathing, or manifests any respiratory distress, a thorough endoscopic examination of the airway, including the vocal cords and subglottic space, is recommended. If the airway patency is compromised by stenosis, granulation tissue, or abnormal vocal cord movement, otolaryngology should be consulted for further evaluation and treatment. The initial tracheostomy tube placed can be up to 8 mm inner diameter to facilitate fiberoptic bronchoscopy. If no pathology is found on endoscopy, the tube may be downsized and changed to a tight-to-shaft (fully deflated) cuff to enhance air flow around the occluded tube.

Mechanical ventilation impairs communication between the patient and caregivers and family, and reduces quality of life. In particular, a tracheostomy tube diverts air flow away from the vocal cords and results in aphonia. A substantial percentage of patients recovering from chronic critical illness also suffer from depression, which may influence their perception of mechanical ventilation and treatment decisions. Allowing a patient to regain the function of speech can significantly improve quality of life in patients who require prolonged mechanical ventilation. In a spontaneously breathing patient who tolerates occlusion of the tracheostomy tube as described above, a one-way speaking valve may be placed onto the tracheostomy tube with a fully deflated cuff. This allows for air flow into the tube during inspiration; however, air flow now exits through the upper airway and vocal cords upon exhalation, producing speech (Fig. 2). For those patients who still require full mechanical ventilation and are unable to wean, either an “in-line” speaking valve or volume-compensation speech may be used to allow phonation.

Endoscopic inspection of the airway, although not essential prior to decannulation, can be helpful. In one study, 67% of patients with tracheostomies were found to have airway abnormalities during airway endoscopy. Findings included tracheal granulomas, tracheomalacia, tracheostenosis, and vocal cord dysfunction. Inspection of the airway with the tracheostomy tube removed allows for visualization of the subglottic space and stoma. This is performed by retroflexing a fiberoptic rhinolaryngoscope into the subglottic space. Some of the abnormalities visualized, such as minor mucosal trauma from the tracheostomy tube or suction catheter, may not be clinically important and usually do not prevent decannulation. It has been demonstrated that patients who successfully pass a
tracheostomy-tube-occlusion protocol can be safely de-
cannulated without first undergoing fiberoptic bronchosc-
opy. It is our current practice to routinely inspect the
stoma, trachea, subglottic space, and vocal cords either at
the time of a tracheostomy tube change or prior to decan-
nulation (Fig. 3). The procedure is safe, requires only top-
ical anesthesia, and in a substantial number of patients
identifies pathology that warrants further otolaryngology
or thoracic surgery input prior to safe decannulation.

Managing Accidental Decannulation

Accidental tracheostomy decannulation is well described
in the pediatric population, but less well recognized in the
adult population. It may be uneventful if the tracheostomy
tube has been in for some time, the tract has matured, and
the tube can be easily replaced. However, accidental de-
cannulation may result in serious consequences if the tra-
cheostomy tube was recently placed or if the patient has a
“difficult” airway. We have explored factors associ-
ated with accidental decannulation and have found it may
be related to altered mental status, increased secretions,
patient turning, lack of clinically indicated restraints, or a
poorly secured tracheostomy tube (Table 1) (unpublished
data). Education of staff regarding risk factors for acci-
dental decannulation along with targeted high-risk-patient
monitoring can be effective tools in decreasing the acci-
dental decannulation rate in a long-term care hospital. Iden-
tification of patients with difficult airways, having a spare
tracheostomy tube at the bedside, and use of an algorithm
for orotracheal intubation may reduce the morbidity and
mortality associated with accidental decannulation (Fig. 4).

The length of time a tracheostomy tube has been in
place is an important variable in deciding how to best
proceed after an accidental decannulation occurs. The tra-
cheocutaneous tract of a “fresh” tracheostomy tube takes
up to 7 days to fully form. If during tube reinsertion the
caudal turn is done prematurely, the tube may be inad-
vertently placed into the anterior mediastinal space, by-
passing the airway. This is more likely to occur if the
change is being performed within 7 days of placement.
Patients with an increased neck circumference or short
neck are higher risk of this occurring. Therefore, when an
accidental decannulation occurs within 7 days of place-
ment, translaryngeal intubation may be needed to secure
the airway. In some settings, a skilled provider may be
able to rapidly reinsert the tracheostomy tube into the air-
way with fiberoptic guidance and avoid the need for trans-
laryngeal intubation. Tracheostomy tubes that have been
in place for more than 7 days can usually be easily rein-
serted and placement confirmed with fiberoptic inspection
of the airway.

Table 1. Conditions Associated With Accidental Tracheostomy
Decannulation

<table>
<thead>
<tr>
<th>Condition</th>
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<tbody>
<tr>
<td>Altered mental status</td>
</tr>
<tr>
<td>Increased pulmonary secretions</td>
</tr>
<tr>
<td>Patient changing position in bed</td>
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<tr>
<td>Lack of clinically indicated limb restraints</td>
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<tr>
<td>Inadequately secured tracheostomy tube</td>
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</table>

Fig. 2. Biased closed position speaking valve. A: Upon inspiration
the valve opens and air passes through the speaking valve, down
the tracheostomy tube and into the lungs. B: At the end of inspira-
tion the speaking valve returns to a closed position and all ex-
haled air is redirected through the upper airway, passing through
the vocal cords and allowing the patient to speak. (Courtesy of
Passy-Muir.)

Fig. 3. Fiberoptic inspection of the trachea (A) and the subglottic
space and vocal cords (B) prior to decannulation.
Post-Decannulation Monitoring

Prior to a patient undergoing decannulation it is important to assess a number of factors to ensure readiness. These include level of consciousness, cough effectiveness, volume of pulmonary and oral secretions, oxygen requirements, swallowing function, and ability to tolerate tracheostomy tube occlusion (Table 2). When the evaluation is complete and the patient is ready for decannulation, the tracheostomy tube is removed and the stoma is covered with sterile gauze. Following decannulation, the patient requires continuous telemetry and oximetry monitoring for at least 24 hours to monitor for unexpected airway compromise. For a patient living at home with a tracheostomy the process of decannulation and subsequent monitoring is best performed during a brief hospital admission.

A patient may exhibit reduced voice quality due to airflow diversion through the healing stoma on exhalation. Vocalization may be enhanced by gently placing 2 fingers over the gauze-covered stoma during speech to minimize leak and maximize air flow to the vocal cords. Vocalization will usually return to normal once the stoma has closed completely. The tracheostomy stoma heals by secondary intention within 5–7 days in the majority of patients. However, tracheostomy-stoma-closure rates are variable and closure may occur in a single day or may take weeks. A persistent tracheocutaneous fistula may remain in some patients and may require surgical closure. In a substantial number of patients a linear scar approximately one inch in size remains following decannulation. This scar may be cosmetically bothersome and contribute to dysphagia from

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Table 2. Patient Assessment Prior to Decannulation

<table>
<thead>
<tr>
<th>Resolution of condition that necessitated tracheostomy tube</th>
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<tr>
<td>Adequate level of consciousness</td>
</tr>
<tr>
<td>Effective cough</td>
</tr>
<tr>
<td>Ability to manage secretions</td>
</tr>
<tr>
<td>Adequate oxygenation</td>
</tr>
<tr>
<td>Swallowing function</td>
</tr>
<tr>
<td>Ability to tolerate tracheostomy-tube occlusion</td>
</tr>
</tbody>
</table>

Data from Reference 20.

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Table 3. Failure to Decannulate: Alternative Interventions

| Long-term tracheostomy tube with inner cannula |
| Sleep-apnea tube                               |
| Surgical treatment for tracheal obstruction    |
| Vocal cord surgery                             |
| Noninvasive ventilation with a capped tracheostomy tube |
| Placement of an airway stent for tracheomalacia |

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skin adherence to the trachea, and may be amenable to surgical correction.22

Decannulation Failure and Alternatives to Decannulation

The acceptable decannulation failure rate is reported to range from 2–5%.23 Failure may be apparent within 48–96 hours, and a stoma that has not fully closed may be reopened using serial dilators, or a mini-tracheostomy may be placed for suctioning and short-term ventilation.19 Despite being fully weaned from mechanical ventilation and tolerant of capping of their tracheostomy tubes, a subset of patients may not be safe for decannulation. Table 3 lists some of the alternative options available to patients who cannot be successfully decannulated.

Some individuals have significant and persistent orotracheal secretions or are at risk for aspiration and therefore may benefit from a tracheostomy tube.24 These patients may be safe for home discharge with either a long-term tracheostomy tube with an inner cannula or a sleep-apnea tube to maintain a route for suctioning. Surgical approaches, such as injection laryngoplasty, may be useful in treating vocal fold paralysis or dysfunction.25 Patients with chronic obstructive or restrictive lung disease may be successfully weaned off mechanical ventilation during the day, but may still require nocturnal ventilation via tracheostomy to manage nocturnal hypoventilation and improve respiratory muscle function. Patients with obstructive sleep apnea and underlying COPD (the so called “overlap syndrome”) may develop respiratory failure with hypercapnia.26 These patients may be successfully transitioned to noninvasive positive-pressure ventilation at night via a nasal or full-face mask with a capped tracheostomy tube (Fig. 5) and ultimately decannulated.27,28

Tracheobronchomalacia is an abnormal collapse of the tracheal and bronchial walls and can contribute to symp-
toms such as dyspnea, cough, wheezing, the inability to clear secretions, recurrent infections, and persistent respiratory failure. Dynamic airway collapse is increasingly identified via bronchoscopy in patients with underlying COPD and chronic respiratory failure, and may be amenable to stenting to improve respiratory function.29,30 A multidisciplinary approach is usually needed to optimize airway function in those patients who fail decannulation.

Summary

Decannulation is usually well tolerated. A systematic approach to patient evaluation, along with judicious use of airway endoscopy, can help identify barriers to decannulation. Following decannulation, patients require close monitoring to identify signs of airway compromise. Practice guidelines may help improve quality of care and help optimize outcomes following tracheostomy decannulation.

REFERENCES