Tracheostomies for the non-expert 2: routine and emergency care

Recent reports have emphasized shortcomings in routine and emergency care leading to adverse outcomes in patients with tracheostomies. This two-part article provides a guide to the principles of care for staff looking after adult patients with tracheostomies in the hospital. The second part looks at routine and emergency care.

Patients with tracheostomies are a vulnerable group of hospital inpatients. They frequently have underlying comorbidities, limited reserves and the potential for deterioration. Furthermore, recent enquiries have revealed variation and shortcomings in the management of patients with tracheostomies, contributing to adverse outcomes. It is increasingly recognized that delivery of optimal care requires multidisciplinary commitment to developing local evidence-based protocols and training programmes in order to foster knowledge acquisition, leadership, teamwork, situational awareness and patient safety.

An estimated 15 000 surgical and percutaneous tracheostomies are performed in England annually. Patients with tracheostomies tend to have significant underlying comorbidities and limited reserves which can contribute to rapid and catastrophic deterioration (McGrath and Wallace, 2014). Unfamiliar airway anatomy, physiology, equipment and nomenclature can further challenge attending health-care professionals.

This two-part article introduces some of the key concepts in tracheostomy management for the non-expert on the wards. The first part (vol 77(1), 2016, p. 14) looked at updates from current literature, national and international tracheostomy projects, anatomy, physiology, techniques and types of tracheostomy. This second part covers the principles of routine care, weaning and emergency management.

Routine care

The presence of a tracheostomy causes physiological changes in the airway. Some changes are beneficial such as reduction in respiratory dead space and thus work of breathing. Others are detrimental, for example loss of the natural humidification process of the upper airway, disrupted mucosal blanket and impairment of cough and swallow reflexes. Many features of good routine care aim to offset these negative physiological changes and avert complications (Dawson, 2014). Each patient should have an individualized care plan on which the daily checks are documented.

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Suctioning

Regular suctioning is a standard of care, the frequency of which will be determined by the patient's clinical state. A suction catheter no greater than 50% of the inner diameter of the tracheostomy tube should be used in order to enable continued ventilation and limit mucosal damage during suctioning. A 12-French gauge catheter is suitable for tracheostomy tubes greater than 7 mm ID. During shallow suctioning the catheter is only passed up to the distal tip of the tracheostomy. In patients unable to propel secretions to the tracheostomy tip, deep suctioning, where the catheter is passed down to the carina, may be necessary. A maximum negative pressure of -150 mmHg (-20 kPa) should be used to reduce risk of mucosal trauma. Suctioning is not without risk and can precipitate desaturation, bleeding and cardiac arrhythmias.

Some tracheostomy tubes have an inbuilt sub-glottic suction port enabling aspiration of debris that would otherwise accumulate on top of the cuff and predispose to development of ventilator-associated pneumonias (*Figure 1*).

Figure 1. Subglottic suction: enables aspiration of debris on top of cuff to reduce tracking and soiling of trachea and help prevent ventilator-associated pneumonias.

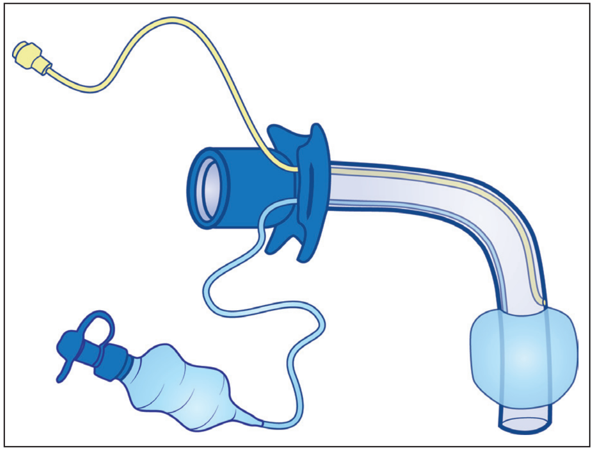


Figure 2. **a.** Swedish nose. **b.** Passive humidification devices for self-ventilating patients not requiring oxygen. **c.** Buchanon bib.

Inner cannula

Double lumen tubes with a removable inner cannula enable regular cleaning to prevent secretion build up and obstruction. In addition, cleaning can reduce the microbial load that predisposes to nosocomial infections. Washing the inner tube at least 8-hourly with sterile water is recommended. Frequent breathing circuit disconnections in patients requiring significant ventilatory support may be detrimental and the balance of risks should be assessed on an individual basis. The inner tube should always be removed to rule out or overcome obstruction in a patient with signs of respiratory distress.

Humidification

Humidification is an important aspect of routine care to compensate for loss of natural mechanisms and avoid complications such as secretion retention, mucosal inflammation, bacterial translocation, atelectasis and impaired thermoregulation. Active humidification can be achieved with hot or cold-water baths. Heat and moisture exchange filters inserted into breathing circuits of ventilated patients or Swedish noses or Buchanon bibs in self-ventilating patients who are not requiring oxygen, can provide passive humidification (*Figure 2*). Optimizing systemic hydration, nebulization, mobilization and physiotherapy may also improve secretion consistency and management.

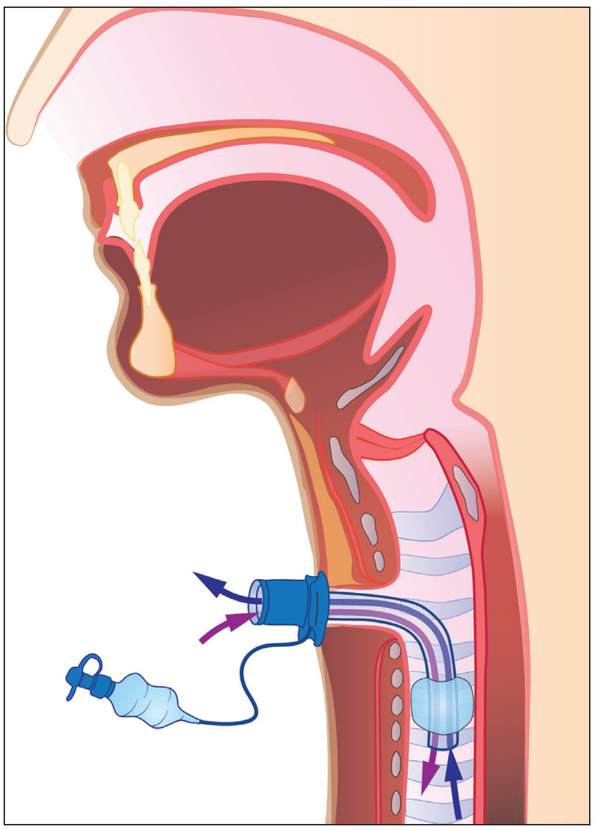
Cuff management

A cuffed tube enables isolation of the trachea in order to deliver positive pressure ventilatory support or protection from aspiration (*Figure 3*). Management of cuff pressure is a balance of risks. Too low a pressure leads to an unsealed, unprotected airway, too high risks mucosal ischaemia and sequelae such as tracheal stenosis, malacia and fistulae. Cuff pressure should be monitored 8-hourly and the minimum pressure to achieve an adequate airway seal used. Normal mucosal capillary pressure is 25 mmHg and sustained pressure above this should be avoided. In a critically ill hypotensive patient the threshold for mucosal ischaemia will be lower and should be taken into account. An audible cuff leak raises the possibility of inappropriate tracheostomy size, cuff damage or tube dislodgement. Once the patient does not require a sealed airway and has intact airway reflexes the cuff should be deflated and the tube changed for an uncuffed version in the longer term (Mitchell et al, 2013).

Swallowing and speech and language therapy

Laryngeal movement and coordinated swallow are impaired by the presence of a tracheostomy, particularly with a large or cuffed tube. An inflated tracheostomy cuff compresses the oesophagus posteriorly impeding oral intake. Prolonged

Figure 3. With tracheostomy cuff inflated, the trachea is isolated from the upper airway.

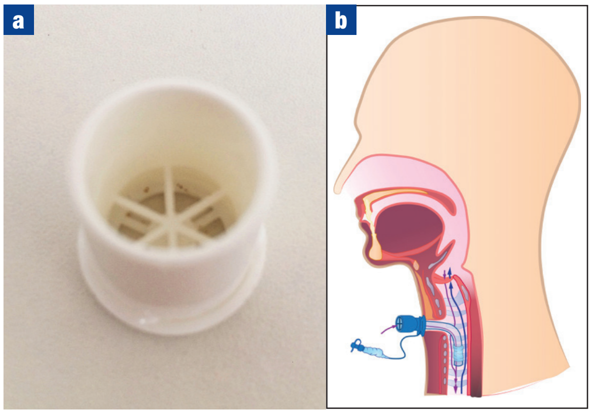


ventilation leads to laryngeal muscle disuse and wasting. Once the patient's general and respiratory status is improving, assessment of laryngeal function is an important component of rehabilitation and is frequently led by speech and language therapy. Swallow assessment involves a trial of cuff deflation followed by speaking valve placement to direct expired gas upward through the vocal cords (*Figure 4*). Laryngeal movement can be indirectly visualized by fibreoptic endoscopic evaluation of swallowing which may be more sensitive in detecting impaired swallow than clinical assessment alone (Hales et al, 2008). A stepwise strategy to reinstate laryngeal function should be documented with planned regular trials of cuff deflation, use of speaking valves, downsizing of tracheostomy tube or exchange to uncuffed fenestrated versions, specific exercises and use of thickened fluids to minimize aspiration. Signs of unsafe swallow include gurgling, coughing, desaturation or respiratory distress.

Tracheostomy change

Tracheostomy changes ought to be elective. The initial tracheostomy change should be considered as a critical step. Surgical tracheostomies should not be changed for at least 48 hours and percutaneous tracheostomies for 7–10 days following insertion because of the risk of an immature tract and difficult re-insertion. Indications for tube change include change of size or type (e.g. as part of the weaning process or to insert a cuffed tube if increased respiratory support is required), replacement of a faulty or dislodged tube or when manufacturers' maximum recommended duration of tube insertion has been reached (usually 30 days for double lumen tubes and 14 days for single lumen tubes). Tube changes can be performed using a rail-roading technique where a guidewire or bougie is inserted through the original tube to maintain the tract and enable the replacement tube to be inserted over it. A fibreoptic bronchoscope can be used to confirm correct placement of the tube within the trachea. If the tracheal stoma is well established and tubes have been changed without complication previously a blind technique might be appropriate. Loss of the tract to the trachea and blind insertion of the new tube can potentially create a false passage. If ventilation is attempted through the misplaced tracheostomy, surgical emphysema and airway occlusion can ensue.

Figure 4. Speaking valve: **(a)** a one-way valve allowing inspiration of gases via tracheostomy and **(b)** expulsion of gases via upper airway through vocal cords on expiration, generating voice.



Weaning and decannulation

Weaning is the gradual reduction in respiratory support, moving towards removal of the tracheostomy (decannulation) (*Table 1*). It is a multidisciplinary process which requires clear leadership from experienced, competent staff and patient participation to set and meet appropriate goals (Garrubba et al, 2009). Prerequisites for weaning include resolution of the underlying indication for tracheostomy and thorough clinical assessment often with fibreoptic endoscopic evaluation of swallowing to confirm acceptable secretion handling and bulbar function. Time to decannulation will be case dependent but is optimized by the presence of dedicated multidisciplinary teams and local protocols (Cetto et al, 2011).

Decannulation may be attempted once the patient has tolerated cuff deflation for at least 24 hours and tube occlusion does not lead to secretion aspiration or respiratory distress. Ideally decannulation should occur in daylight hours with optimal staffing levels and the ability to closely monitor the patient in the subsequent hours. An airtight dressing is placed over the open stoma. Bedside emergency equipment should be available in case of need to re-establish respiratory support for at least 48 hours following decannulation. The stoma takes approximately 10 days to heal over.

Emergency management

Analysis of tracheostomy-related critical incidents revealed common themes and a lack of consistency in emergency management (Wilkinson et al, 2015). While improving routine care of the neck-breathing patient will prevent some patients from deteriorating acutely, emergencies will inevitably occur. Most tracheostomy-related airway emergencies are the result of a blocked or displaced tube. The UK National Tracheostomy Safety Project (2013) has developed pragmatic algorithms to guide emergency management (*Figure 5*). They have been rigorously trialled in high fidelity simulators and refined by open peer review. Evidence of deterioration or the presence of 'red flags' should prompt an early call for skilled help and a systematic assessment of the patency and adequacy of the tracheostomy (*Table 2*). Establishing a route of effective oxygenation is the priority. Changing to an alternative breathing circuit such as a 'Water's circuit' with capnography allows gentle compression of the bag and observation for signs of effective ventilation via the tracheostomy, such as chest movement and end tidal carbon dioxide (*Figure 6*).

If an effective breath is not achieved with the Water's circuit, no further ventilation attempts should be made as gas forced through a displaced tracheostomy into the soft tissues could cause surgical emphysema or dislodge an obstructing plug further down the airway, worsening airway compromise. The inner tube should be removed to check for obstruction. Passage of a suction catheter down the outer tube should be attempted. Failure to pass the catheter implies the tracheostomy is not functional (occluded or in the wrong place). Administration of oxygen via the oral route should be attempted early. If the tracheostomy tube is cuffed, this should be deflated in an attempt to allow oxygenation from above and around the tube. If oxygenation from above is not possible and it has been determined that oxygen cannot be delivered via the tracheostomy, the tracheostomy should be removed to improve the chance of oxygenation and allow insertion of an orotracheal airway.

The algorithm is a clinical decision-making tool which can empower the attending emergency team. By following the steps of the algorithm the team will either identify and rectify the source of the tracheostomy problem or conclude that it should be removed, increasing the chance of oxygenation via the oral route. It is essential to remember that if the patient has had a laryngectomy, there is no connection between the upper airway and the trachea and oxygenation is never possible via the oral or nasal route. There is an alternative algorithm for emergencies in laryngectomy patients.

The National Tracheostomy Safety Project have produced bedside signs that state simple, vital information about the insertion technique, date, size of tube and any previous difficulty at laryngoscopy (*Figure 7*).

These bedside signs can help the emergency team rapidly ascertain pertinent facts about the patient and immediately distinguishes between whether the patient has had a tracheostomy or laryngectomy.

Table 1. Stages and components of the weaning process

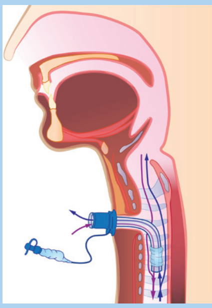
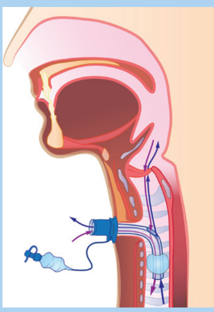
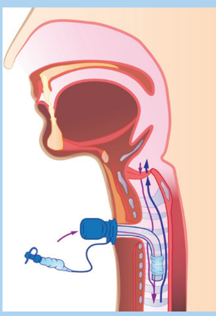
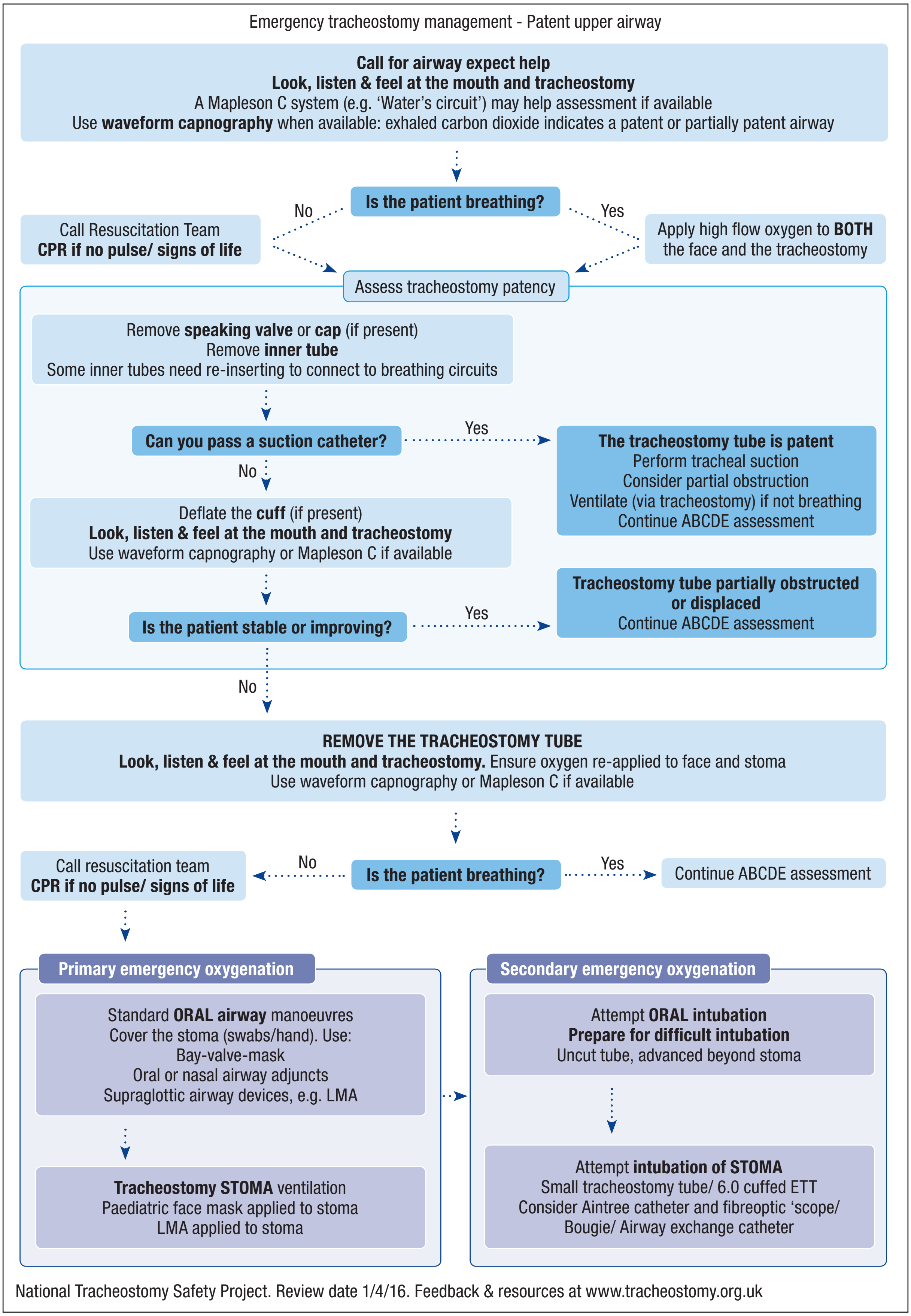
1. Cuff deflation Cuff deflation reconnects the upper airway with the trachea, enabling passage of gases around the tracheostomy The cuff should be deflated regularly and for increasing duration as tolerated		Observe for signs of respiratory or bulbar failure: ■ Hypoxia ■ Respiratory distress ■ Dysphagia ■ Secretion aspiration or drooling If present, reinflate cuff. Patient may not be ready for weaning
2. Encouraging airflow through upper airway Varying degrees of tracheostomy tube occlusion to increase gas flow via the upper airway in a controlled stepwise manner	 	 Fenestrated outer and inner tubes enable connection between trachea and upper airway  Speaking valve – one way valve closes to expiration driving gas upwards through vocal cords and upper airway to generate voice  Caps completely occlude tracheostomy: all inspiratory and expiratory gas flow is via the upper airway. Resistance and work of breathing will be increased
3. Tube size reduction Reducing the size of tracheostomy tube inside the trachea makes it easier for patient to breath around the tracheostomy		Large or cuffed tracheostomy tubes can be exchanged for ■ Uncuffed tube ■ Downsized (smaller ID) Tube may need to be downsized before patient can tolerate speaking valves and caps

Figure 5. National Tracheostomy Safety Project algorithm for emergency management of tracheostomy problems. CPR = cardiopulmonary resuscitation; ETT = endotracheal tube; LMA = laryngeal mask airway. From McGrath et al (2012).



Conclusions

Tracheostomies are commonly performed in vulnerable patients. The potential for deterioration and significant morbidity and mortality has been captured by the 4th National Audit Project and recent National Confidential Enquiry into Patient Outcome and Death reports. Establishing high standards of routine care can avert potential complications. The widespread uptake of Difficult Airway Society guidelines is thought to have had a positive impact on emergency airway management. In this way the National Tracheostomy Safety Project algorithms should help to improve emergency care of the tracheostomy patient, by providing a systematic approach and a framework for multidisciplinary teaching and training. **BJHM**

Figure 5 *is reproduced from McGrath et al (2012) with permission from the Association of Anaesthetists of Great Britain & Ireland/Blackwell Publishing Ltd.*
Conflict of interest: none.

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Table 2. Red flags for tracheostomy problems

Problem with cuff	Vocalisation despite cuff inflation Need for frequent cuff reinflations or excess pressure Aspiration: gastric contents on tracheal toiletting
Problem with tube position	Surgical emphysema Unable to pass suction catheter Pain Visible displacement
Problem with ventilation May be caused by cuff problem, tube occlusion or dislodgment or underlying respiratory problem	Respiratory distress Loss of capnograph trace Desaturation Increasing ventilatory support Haemodynamic instability

Figure 6. Water's breathing circuit features a reservoir bag and adjustable pressure limiting valve to deliver breaths.

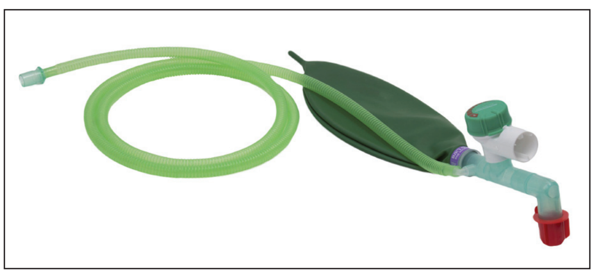
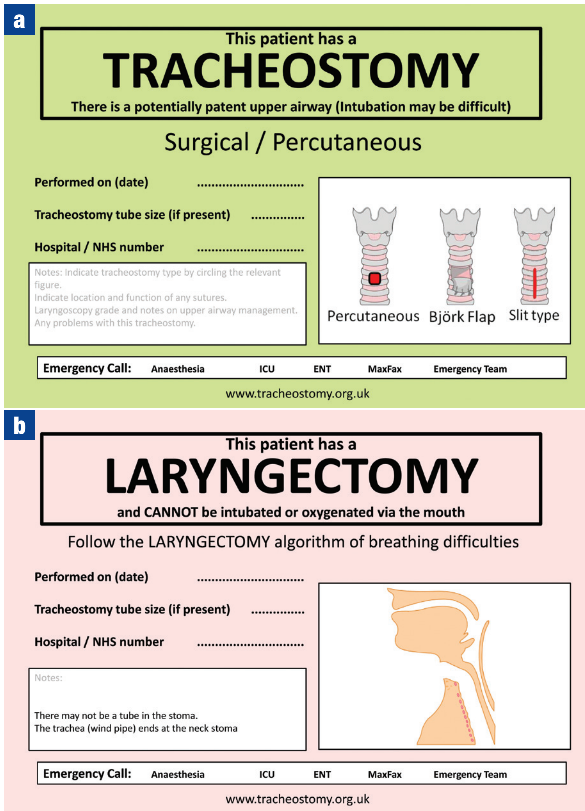


Figure 7. National Tracheostomy Safety Project bedside signs.



KEY POINTS

- Tracheostomies are often performed in vulnerable patients with limited reserves.
- Airway problems in a patient with a tracheostomy frequently lead to significant morbidity and mortality.
- The National Tracheostomy Safety Project has sought to standardize routine and emergency tracheostomy care to improve management and outcomes.
- A multidisciplinary team should coordinate and deliver care of patients with a tracheostomy.
- A sound understanding and delivery of good day-to-day care can reduce risk of acute deterioration.
- Members of the multidisciplinary team should be familiar with emergency algorithms and maintain competence through regular training.