The adult tracheostomy: a guide for the hospital at night doctor

With the introduction of the New Deal, European Working Time Directive, Modernising Medical Careers and the centralization of services there has been a major shift in the provision of hospital care out-of-hours. In an attempt to achieve rota compliance many hospitals have introduced a 'hospital at night' system, which consists of a team of on-site doctors and nurses covering multiple specialties. Ear, nose and throat surgery and head and neck surgery are specialized fields of surgery which, as a result of these changes, are now often covered out-of-hours by junior doctors who ordinarily work in other specialties and who have had very little exposure to ear, nose and throat or oral and maxillofacial surgery conditions and procedures. Studies confirming this have highlighted low levels of confidence in dealing with common ear, nose and throat emergencies (Davis and McDonald, 2006; Biswas et al, 2009).

This could be exacerbated by the fact that ear, nose and throat is often not covered extensively at undergraduate level (Mace and Narula, 2004; Newbegin et al, 2007). The second on-call doctor may cover multiple sites and is often non-resident on call. This can lead to junior doctors having to manage conditions and complications about which they feel they have little knowledge or experience.

Tracheostomy is a commonly performed procedure and is predicted to be performed more frequently as demand for intensive care services grows (Cox et al, 2004). There have been growing concerns regarding the management of tracheostomy-related emergencies (Mace et al, 2006; Casserly et al, 2007) and there is published evidence of insufficient knowledge of tracheostomy-related emergencies among non-ear, nose and throat health-care professionals (Mace et al, 2006).

This article highlights some tracheostomy-related complications and emergencies and outlines their management, so that the hospital at night doctor will have an increased level of knowledge and hopefully confidence when called to deal with these cases.

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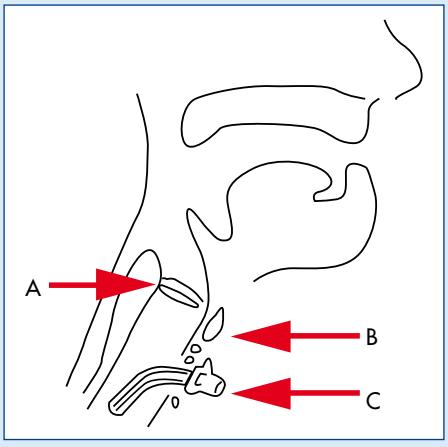
What is a tracheostomy?

A tracheostomy is a procedure to open the trachea, so that a patient can breathe through a tube placed through the opening in the neck (*Figure 1*). There are two main techniques used to perform the procedure.

Surgical tracheostomy

An incision is made through the skin down to the strap muscles. The strap muscles are retracted laterally and the thyroid isthmus either divided or moved out of the way by retraction superiorly or inferiorly. An incision is made into the trachea which may be a vertical slit (for children or emergencies), a window, or an inferiorly based flap in the tracheal wall (Bjork flap). The tracheal incision is made below the first tracheal ring to reduce the risk of developing tracheal stenosis. A tracheostomy tube is passed through the hole into the trachea and secured with tapes around the neck; in some cases the tube is sutured to the skin. Some surgeons place stay sutures through the trachea which they bring out of the wound and tape to the patient's neck, to facilitate re-passing of a tube should the tube become dislodged before a satisfactory tract has formed.

Figure 1. Schematic of tracheostomy. A = vocal cords; B = thyroid cartilage; C = tracheostomy tube.



Percutaneous tracheostomy

This is a newer technique, first described by Ciaglia et al (1985). A very small skin incision is made, and a needle is introduced through the wound into the trachea. A guide-wire is passed through the needle, the needle is removed and a guiding catheter is then threaded over the wire. The aperture is dilated using graded dilators passed over the guiding catheter, and then a tracheostomy tube is inserted. This technique has been modified and adapted by different practitioners over the years, but the broad concept remains the same.

Mini-tracheostomy

A mini-tracheostomy is the formation of an opening through the cricothyroid membrane. Patency is maintained with a narrow bore, uncuffed tracheostomy tube (Minitrach, Portex) or a large bore cannula. A mini-tracheostomy can be used to allow efficient airway toilet for treatment of sputum retention or to relieve life-threatening upper airway obstruction when endotracheal intubation is unsuccessful.

Why do patients have a tracheostomy?

A tracheostomy can be performed for a variety of reasons, e.g. to obtain an airway in cases of upper airway obstruction caused by infection, trauma, malignancy or a foreign body. In the critically ill patient tracheostomies can be performed to allow airway access for secretion removal and to

avoid oropharyngeal and laryngeal injury from prolonged translaryngeal intubation (Esteller-More et al, 2005). Benefits of tracheostomy over long-term intubation include easier nursing care, and the patient is able to take oral nutrition and may be able to speak (Rumback et al, 2004). Less sedation and analgesia is required (Nieszkowska et al, 2005) and the reduced airway resistance is thought to aid the weaning process (Diehl et al, 1999).

Tracheostomy is widely used in the treatment of malignancy of the oral cavity and upper aerodigestive tract, where it is expected that post-surgical oedema may lead to airway compromise.

It is important to know the indication for the tracheostomy, as this will affect possible methods to maintain oxygenation should the tube become dislodged. If the tracheostomy was performed for airway obstruction it is unlikely that oxygenation from the mouth end will be adequate. If the tracheostomy was performed because of difficult intubation or for prolonged intubation, it may be possible to achieve adequate oxygenation through bag-mask ventilation or airway manoeuvres and facial oxygen.

Types of tracheostomy tube

Tracheostomy tubes come in a number of forms. They can be cuffed or uncuffed – cuffed tubes can be identified in situ as they will have a piece of tubing and an air reservoir with a valve attached to allow for inflation, deflation and cuff pressure monitoring. Patients requiring positive pressure ventilation will generally have a cuffed tube in situ.

Tubes can be fenestrated or unfenestrated. Fenestrated tubes have holes in the posterior wall of the intratracheal component of the tube allowing air to pass from the lungs, up the trachea and between the vocal cords. This allows the patient to talk while the tracheostomy is in place.

Tubes can have an inner tube – a second, removable tube which is inserted down the tracheostomy tube and locked into place (*Figure 2*). The main advantage is that the inner tube can be removed to clear any obstruction within the tube, such as blood clots or crusted secretions, without removing the whole tracheostomy. The inner tube can then be cleaned and replaced or a new inner tube secured in place. This has lead to many hospitals using this type of tube as a first choice tube. The disadvantage of an inner tube is that it reduces the internal diameter of the tracheostomy tube and so can increase the work of breathing.

General care of the tracheostomy patient

The tracheostomy is the patient's airway and should be treated with respect and care. A patient with a tracheostomy receiving supplementary oxygen or nebulized medication should have these administered via the tracheostomy. Owing to the loss of the humidification effect of the nose and mouth, these patients should receive humidified oxygen.

Tracheostomy tubes may require regular suction using flexible suction catheters to clear secretions. Suctioning should be performed using aseptic technique with the patient upright. The suction catheter should have a diameter no greater than half the internal diameter of the tracheostomy tube. Patients with a high oxygen requirement may require pre-oxygenation before suctioning. Any difficulty in passing the suction catheter should raise the possibility that the tracheostomy tube may be partially blocked, displaced or poorly orientated and should prompt further action (see below).

Complications and management

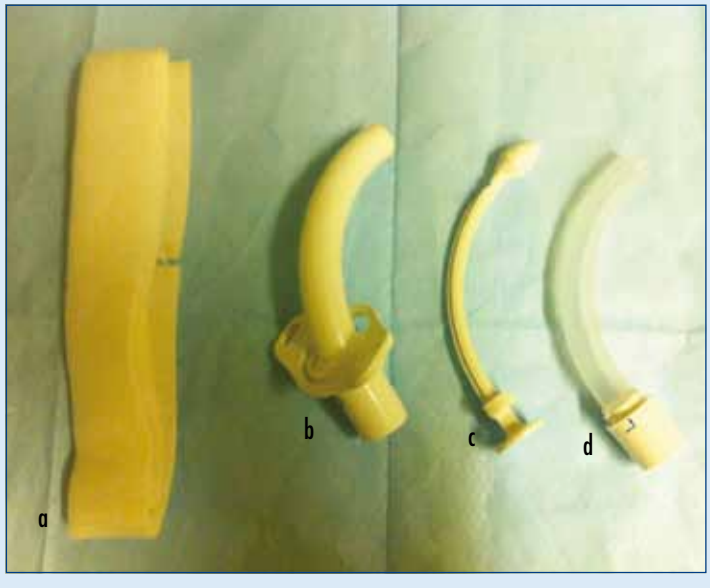
Haemorrhage

Peristomal bleeding or haemoptysis in a tracheostomized patient should prompt a full clinical assessment to ascertain the underlying cause. The differential diagnosis of the bleeding depends on the lag time between tracheostomy placement and bleeding (Bradley, 2009). Bleeding within 48 hours is termed 'early', bleeding after this period is termed 'late' (Kapural et al, 1999).

Early bleeding is generally caused by trauma to the anterior jugular or thyroid vessels, bleeding from skin edges, systemic coagulopathy, erosions secondary to tracheal suction or bronchopneumonia. Patients are usually haemodynamically stable allowing identification of the problem (Bradley, 2009). Mild oozing can be managed by assessing the need for resuscitation and presence of a chest infection, light packing around the tube with adrenaline-soaked gauze or local pressure. If the tracheostomy tube is cuffed, this should be inflated to the correct pressure to prevent aspiration of blood by the patient and airway suction should be performed to prevent clots obstructing the tube. Any underlying coagulopathy should be treated and the patient reviewed at regular intervals. If bleeding persists or is more than a minor ooze, examination with a flexible endoscope may be required or return to theatre to obtain haemostasis.

Haemorrhage occurring 3 days–6 weeks after tracheostomy should be considered to indicate tracheo-innominate artery fistula until proven otherwise (Nelems, 1981). Warning signs of impending bleeding from a tracheo-innominate fistula include a sentinel bleed (premonitory minimal bleeding) and pulsation of the tracheostomy which coincides with the heartbeat (Bradley, 2009). A high index of suspicion should be maintained and more than 10 ml of blood 48 hours post-tracheostomy should prompt investigation to establish the cause (Jones et al, 1976). Late haemorrhage can also be a result of granulation tissue, tracheobronchitis and malignancy; bleeding occurring more than 6 weeks

Figure 2. a. Tracheostomy tie. b. Uncuffed non-fenestrated tracheostomy tube. c. Tube introducer. d. Inner tube.



post-procedure is rarely related to tracheo-innominate artery fistula (Bradley, 2009).

If you encounter what you feel is a sentinel bleed or mild to moderate active bleeding from a tracheostomy, seek senior surgical input as a matter of urgency.

Barotrauma and pneumothorax

Pneumothorax can occur following tracheostomy. Direct injury of the pleura, air dissecting through the deep layer of middle cervical fascia leading to pneumomediastinum which can lead to a pneumothorax if the air ruptures into the mediastinal pleura, and pneumothorax resulting from rupture of an alveolar bleb are thought to be possible mechanisms (Berg et al, 1988). Signs of pneumothorax include tachycardia, desaturation, dyspnoea, chest pain, decreased breath sounds and subcutaneous emphysema. If the patient is stable, a chest radiograph should be obtained. Small pneumothoraces can be treated with supportive measures and observation, larger pneumothoraces can require insertion of a chest drain.

Subcutaneous emphysema can occur following a surgical tracheostomy if the skin sutures around the tracheostomy tube are too tight, preventing any air leak escaping. In this case the skin sutures should be removed. Following a percutaneous tracheostomy surgical emphysema can occur via air leakage through the anterior or posterior tracheal wall, or via a fenestrated tracheostomy tube (Fikkers et al, 2004). In cases of surgical emphysema all patients should be investigated for a pneumothorax.

Infection

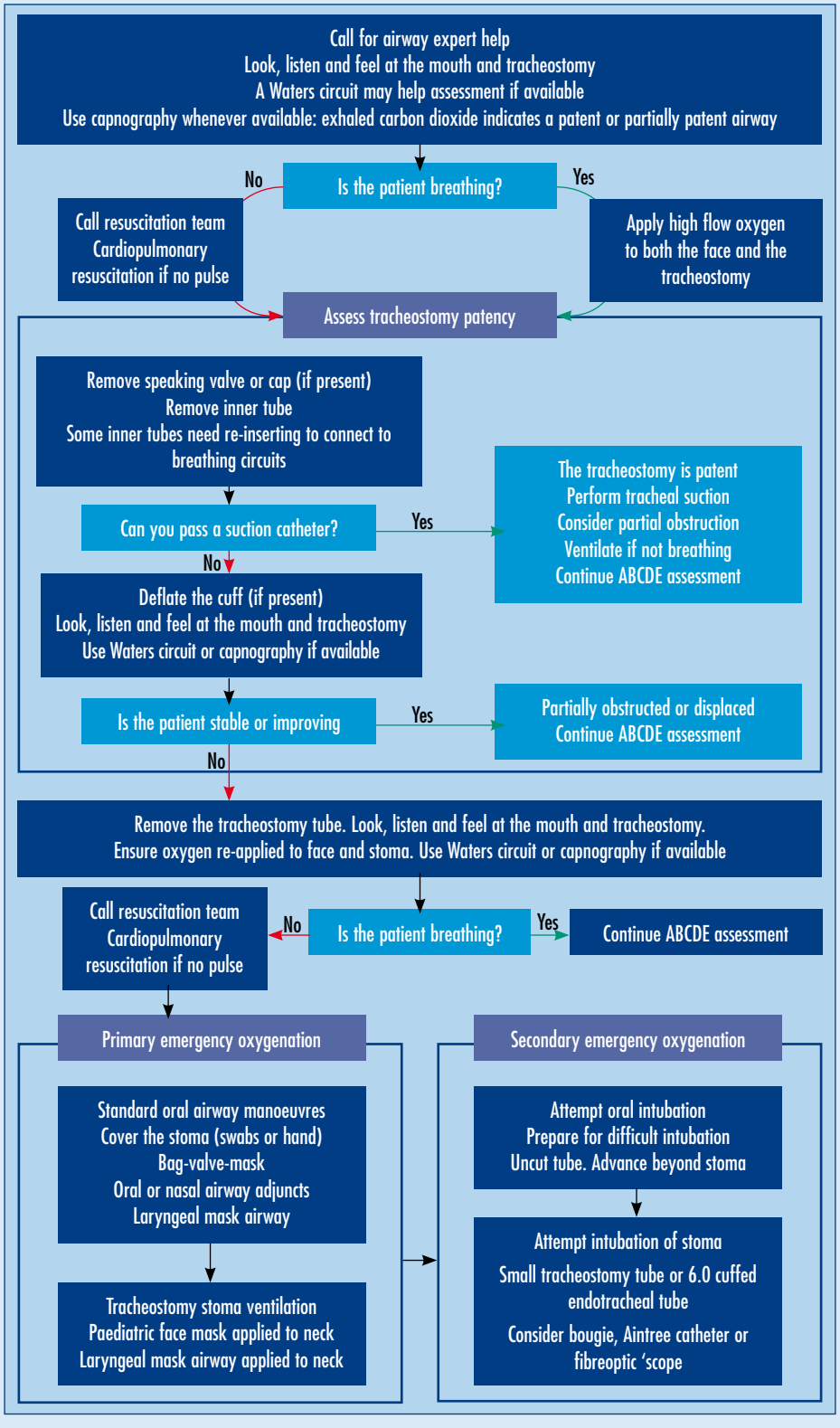
A tracheostomy is considered a clean-contaminated wound. Severe wound infection is rare. All tracheostomies should be attended to with strict local hygiene. Transient tracheitis and stomal cellulitis may occur and require aggressive local wound care (Goldenberg et al, 2000). Pneumonia may arise as a result of aspiration of infected secretions and requires appropriate antibiotics. Severe infections such as mediastinitis, clavicular osteomyelitis and necrotizing fasciitis are rare but have been reported after tracheostomy (Wang et al, 1989).

Tube obstruction

The tube can be partially or completely obstructed as a result of mucus plugs, blood clots, displacement of the tube or tube impingement on the posterior tracheal wall (Goldenberg et al, 2000) or by a tracheal flap falling into or being displaced into the lumen. Tube obstruction is a respiratory emergency and usually presents as acute dyspnoea. The prime concern is to maintain an airway and adequate oxygenation (*Figure 3*).

Immediate treatment measures which should be performed by the first doctor to examine the patient should include sitting

Figure 3. Protocol for emergency tracheostomy management for a patent upper airway. From McGrath et al (2012).



the patient upright, applying high flow oxygen via both the face and tracheostomy, removing the tracheostomy inner tube and calling for senior help. Removing the inner tube is a simple intervention which could easily save a life. If the obstruction is within the tracheostomy tube itself than removing the inner tube should alleviate the obstruction. If the inner tube is clear the obstruction may be further into the airway and deep suctioning should be performed with a flexible suction catheter. If suctioning through the tube does not re-establish an adequate airway senior anaesthetic and ear, nose and throat or oral and maxillofacial surgery help should be sought immediately as an airway must be secured and the tube may need to be replaced. If the tube is cuffed then the balloon should be deflated, this may allow some air to pass around the tube and may help in maintaining oxygenation. A flexible nasendoscope can be passed down the tube to ascertain the cause and level of the obstruction.

Once a tracheostomy tube has been in-situ for over 7 days a good tract should have formed and removal of the tracheostomy tube to allow suction directly into the mature stoma could be attempted, but this should only be attempted by staff with experience in tracheostomy care or in extremis. Removal of a tracheostomy tube from an immature tract could cause complete loss of airway and should only be performed in extreme cases or when adequate support is available to ensure a safe airway (see below).

Tube displacement and loss of airway

One of the most hazardous complications is inadvertent decannulation occurring before the tract between the skin and trachea has matured. Several factors can predispose a patient to tube displacement: loosening of the straps or sutures holding the tube in place, excessive coughing or movement by the patient, postoperative swelling, tube length and thickness of neck.

If the tract is not yet mature, the tissue planes collapse upon each other when the tracheostomy tube is coming out and this can lead to loss of airway, respiratory arrest and death. It is very important not to panic. Call for immediate help. The prime objective is to maintain an airway and adequate oxygenation. An airway can be secured by either orotracheal intubation or replacement of the tracheostomy tube. Blind forceful attempts at tube re-insertion in the early postoperative period can result in the creation of a false passage (Casserly et al, 2007). If the patient has no upper airway obstruction simple airway manoeuvres may maintain adequate ventilation. If this is unsuccessful bag-valve-mask ventilation can be performed. If an attempt at re-cannulation is made there are some tips which can make this safer and easier. Many surgeons place tracheal stay sutures circumferentially around the cartilaginous rings and tape these to the chest. Traction on these sutures will spread the skin edges and bring the stoma up to the level of the opening in the skin. A tracheal dilator (*Figure 4*) should be kept by the bed of all tracheostomy patients, this is used to open the stoma and allow insertion of a tracheostomy tube or an endotracheal tube.

If re-cannulation fails administer oxygen via the stoma or a facemask. If respiratory or cardiac arrest occurs begin cardiopulmonary resuscitation and await the resuscitation team and airway experts. **BJHM**

Figure 3 *is reproduced from McGrath et al (2012) by kind permission of the Association of Anaesthetists of Great Britain & Ireland/Blackwell Publishing Ltd. Conflict of interest: none.*

Berg LF, Mafee MF, Campos M, Applebaum EL (1988) Mechanisms of pneumothorax following tracheal intubation. *Ann Otol Rhinol Laryngol* **97**(**5**): 500–5

Biswas D, Rafferty A, Jassar P (2009) Night Emergency cover for ENT in England: a national survey. *J Laryngol Otol* **123**(**8**): 899–902

Bradley PJ (2009) Bleeding around a tracheostomy wound: what to consider and what to do? *J Laryngol Otol* **123**(**9**): 952–6

Casserly P, Lang E, Fenton JE, Walsh M (2007) Assessment of healthcare professionals knowledge of managing emergency complications in patients with a tracheostomy. *Br J Anaesth* **99**(**3**): 380–3

Ciaglia P, Firsching R, Syniec C (1985) Elective percutaneous dilational tracheostomy A new simple bedside procedure; preliminary report. *Chest* **87**(**6**): 715–19

Cox CE, Carson SS, Holmes GM, Howard A, Carey TS (2004) Increase in tracheostomy for prolonged mechanical ventilation in North Carolina, 1993-2002. *Crit Care Med* **32**(**11**): 2219–26

Davis SJ, McDonald S (2006) Covering ENT out of hours: how confident are senior house officers? *J Laryngol Otol* **120**(**7**): 587–90

Diehl JL, El Atrous S, Touchard D, Lemaire F, Brochard L (1999) Changes in the work of breathing induced by tracheotomy in ventilator-dependent patients. *Am J Respir Crit Care Med* **159**(**2**): 383–8

Esteller-More E, Ibanez J, Matino E, Adema JM, Nolla M, Quer IM (2005) Prognostic factors in laryngotracheal injury following intubation and/or tracheotomy in ICU patients. *Eur Arch Otorhinolaryngol* **262**(**11**): 880–3

Fikkers BG, Van Veen JA, Kooloos JG et al (2004) Emphysema and pneumothorax after percutaneous tracheostomy. *Chest* **125**(**5**): 1805–14

Goldenberg D, Ari EG, Golz A, Danino J, Netzer A, Joachims HZ (2000) Tracheotomy complications: A retrospective study of 1130 cases. *Otolaryngol Head Neck Surg* **123**(**4**): 495–500

Jones JW, Reynolds M, Hewitt RL, Drapans T (1976) Tracheo-inominate artery erosion: successful surgical management of a devastating complication. *Ann Surg* **184**(**2**): 194–204

Kapural L, Sprung J, Gluncie I et al (1999) Tracheo-innominate artery fistula after tracheostomy. *Anaesth Analg* **88**(**4**): 777–80

Mace AD, Narula AA (2004) Survey of current undergraduate otolaryngology training in the United Kingdom. *J Laryngol Otol* **118**(**3**): 217–20

Mace AD, Patel NN, Mainwaring F (2006) Current standards of tracheostomy care in the U.K. *Otolaryngologist* **1**: 37–9

McGrath BA, Bates L, Atkinson D, Moore JA (2012) Multidisciplinary guidelines for the management of tracheostomy and laryngectomy airway emergencies. *Anaesthesia* **67**(9): 1025–41

Nelems JM (1981) Tracheo-inominate artery fistula. *Am J Surg* **141**(**5**): 526–7

Newbegin RM, Rhodes JC, Flood LM, Richardson HC (2007) Student-selected components: bringing more ENT into the undergraduate curriculum. *J Laryngol Otol* **121**(**8**): 783–5

Nieszkowska A, Combes A, Luyt CE et al (2005) Impact of tracheotomy on sedative administration, sedation level, and comfort of mechanically ventilated intensive care patients. *Crit Care Med* **33**(**11**): 2527–33

Rumback MJ, Newton M, Truncale T, Schwartz SW, Adams JW, Hazard PB (2004) A prospective, randomized study comparing early percutaneous dilational tracheotomy to prolonged translaryngeal intubation (delayed tracheotomy) in critically ill medical patients. *Crit Care Med* **32**(**8**): 1689–94

Wang RC, Perlman PW, Parnes SM (1989) Near-fatal complications of tracheotomy infections and their prevention. *Head Neck* **11**(**6**): 528–33

Figure 4. Tracheal dilators.

Further resources

The National Tracheostomy Safety project website (tracheostomy.org.uk) has video resources demonstrating some of the techniques mentioned in the article.

KEY POINTS

- When dealing with tracheostomy-related problems, seek senior help early.
- Follow the airway, breathing, circulation approach for the assessment of tracheostomy patients.
- Simple interventions can buy time to allow more senior or specialized help to arrive.