Medical High Dependency Unit series, Article 4: Tracheostomy management

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Abstract

The number of patients with tracheostomies managed within high dependency units is increasing. National audits have suggested that the care of these patients could have been improved upon with a significant minority of cases resulting in death or serious adverse events. Because of this, it is crucial that staff working within medical high dependency units have a good understanding of the indications for and techniques of insertion of tracheostomies. In addition, knowledge of the various tube types and ancillary equipment is mandatory. Ideally, care should be standardised across hospital sites and all staff trained to deal with routine and basic emergency care using national guidelines. It is fundamental that medical staff without expertise in the advanced management of emergencies are aware of the equipment required and who to contact within their hospital should such procedures be necessary. Temporary tracheostomies should be removed at the earliest opportunity under the guidance of the teams responsible for their insertion.

Keywords

Tracheostomy, Medical High Dependency.

Key points

- Patients with tracheotomies are often cared for on medical high dependency units.
- The various indications for placement, equipment used and details of timing and technique of placement are all vital to understand when managing these patients routinely and in emergency situations.
- There has been significant work done on a national level to provide education and safety guidance and this is freely available via the national tracheostomy safety project website.
- Thorough routine care of tracheostomies will reduce frequency of emergency events and minimise patient harm.
- A logical approach is essential in the event of a tracheostomy emergency and requires good knowledge of the potential issues including tube dislodgement, occlusion and bleeding.

Introduction

The use of tracheostomies in the management of critically ill patients increased markedly following the creation of a percutaneous Seldinger technique of insertion which was first described in 1985.[1] As a result, it is now relatively common for medical high dependency units (HDUs) to care for patients with a tracheostomy after stepdown from intensive care. These patients tend to require higher levels of nursing care even once their critical illness has settled due to the extensive rehabilitation needs and therefore spend a significant period of time in HDU. In addition, a recent NCEPOD report[2] describing tracheostomy management suggested cohorting patients with artificial airways into specific areas of a hospital. On this basis many institutions choose to manage all the non-ventilated tracheostomies in high dependenc units. Furthermore, due to advances in healthcare and the greater expectations of society there are increasing numbers of patients living in the community with tracheostomies or laryngectomies intermittently requiring hospital admission. These patients are often admitted to HDU purely because they are front of neck breathers. For all these reasons it is crucial that staff working within medical HDUs are adequately trained in the routine care and emergency management of tracheostomies. Unfortunately, recent evidence suggests there is room for improvement in 60% of cases.[2]

What is a tracheostomy?

A tracheostomy is created surgically by opening the front of the neck and creating a stoma connecting to the anterior trachea. The stoma is then maintained by the insertion of a tracheostomy tube. As a result of this newly created opening there are two potential routes for gas to flow in and out of the lungs: via the nose and mouth or via the front of the neck. This must be distinguished from a laryngectomy (see table 1) during which the larynx is removed and the trachea is surgically anastomosed to the front of the neck meaning that airflow to and from the lungs is only possible via one route. Knowledge about individual patients' airways is crucial since some

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Table 1. Differences between tracheostomy and laryngectomy

Tracheostomy	Laryngectomy
Surgical defect created in anterior trachea	Larynx removed and trachea anastomosed to anterior neck
Usually temporary	Permanent and irreversible
Upper airway often patent	Dependent on stoma for breathing
Speech possible via normal larynx (if cuff on tracheostomy deflated)	Speech possible via a surgically created tracheo-oesophogeal fistula and valve

patients with a tracheostomy will have an inadequate upper airway due to stenosis or malignancy for example and in effect need treated in the same manner as a patient with a laryngectomy. This has significant implications for emergency management.

Indications

Tracheostomies are performed for multiple reasons, the most common being for the management of patients requiring prolonged ventilation within intensive care (usually longer than 7 -10 days). Most of these patients will have failed a trial of extubation within the intensive care unit. The benefits of a tracheostomy for such patients include increased comfort and the reduced requirement for sedation; reduced trauma to the oropharynx and larynx as a result of the endotracheal tube; a theoretical reduction in the dead space and airway resistance because the patient is breathing through a shorter tube;[3] and the potential ability to speak and eat with a tracheostomy. For patients with a high secretion load but relatively preserved oxygenation a tracheostomy will facilitate expedited transfer to a level 2 bed since the airway allows continued bronchial toilet.

A tracheostomy may also be inserted as an emergency or urgently for patients presenting with an obstructed upper airway. Patients may also require the procedure in order to protect the airway if they are obtunded as a result of central nervous system pathology or have a bulbar palsy. There is also a small but enlarging group of patients who require a tracheostomy for long-term ventilation due to neuromuscular pathology.

The continuing presence of these indications must be considered over time to allow appropriate and timely decannulation (see below).

Variables

Not every tracheostomy is the same and the differences must be appreciated to allow optimal management.

Indication

As described above there are various reasons that a patient may require a tracheostomy. This is of vital importance when planning where to manage the patient and in dealing with emergency complications. For example, if the only indication for the device is to allow regular suctioning of secretions, removal of a dislodged or malpositioned tube in an emergency can occur with minimal concern because the patient will be able to breathe normally at least for a short time via their patent upper airway. On the other hand, if the tracheostomy was inserted to manage an obstructed upper airway removal of the tracheostomy in an emergency is more likely to require urgent reinsertion; this latter case clearly requires more expertise in the event of an emergency and as such might be managed in an area where expert help can be sought rapidly.

Surgical technique

When managing patients with a tracheostomy it is important to know the method of insertion which may be via a percutaneous or surgical technique. The percutaneous technique allows the procedure to be performed at the bedside thus reducing the risks associated with the transfer of ventilated patients and also the costs associated with the use of theatre resources. Less tissue dissection is involved and thus there is less bleeding perioperatively, a lower incidence of wound infection and better cosmesis. The downside of this less invasive technique is that the stoma is apt to close should the tracheostomy become dislodged within the first week of insertion. Because this is now a mainstream skill of the intensivist, surgical tracheostomies are usually reserved for patients with difficult anatomy. Most surgical cases are performed in theatre with the tracheostomy tube being placed under direct vision. Access to the lumen of the trachea is achieved via a vertical or a transverse incision. Stay sutures placed in the trachea on either side of the stoma facilitate replacement of the tracheostomy tube using the sutures to gently pull the trachea to the skin surface and open the stoma. It is important to differentiate between stay sutures and sutures attached to a Bjork flap which is a flap of anterior trachea sutured to the skin of the neck. Tension on the sutures attached to this flap might pull through the trachea. The Bjork

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Figure 1. Tracheostomy tubes (left to right): Adjustable flange reinforced tube; cuffed tube with subglottic drainage port; cuffed tube; uncuffed tube with colour-coded fenestrated inner cannula.



Figure 2. Inner Cannulas: inner cannula for adjustable flange tube (left); uncuffed fenestrated tube, unfenestrated inner cannula, fenestrated inner cannula (centre back to front); cuffed tube with inner cannula which requires insertion to connect to 15mm connection port (right).

flap allows easier replacement of the tracheostomy tube since the stoma is held open and is sometimes preferred in cases whereby loss of the trans-tracheal route to the airway might be disastrous.

Tracheostomy tubes

There are several types and manufacturers of tracheostomy tubes and it is important to have an understanding of the tube a patient possesses (Figure 1). The dimensions of tracheostomy tubes are given by their inner diameter, outer diameter, length, and curvature. Clinicians should be aware that different manufacturers produce tubes which at first sight are similar in size but have differences in tube length between tubes with the same inner diameter or have different internal diameters despite having the same outer diameter for example. It is increasingly recommended that tracheostomies with an inner cannula should be used since this allows intermittent cleaning of the internal lumen of the device without changing of the tube. It should be noted though that some manufacturers produce a tube in which the 15-mm attachment (for connection to a ventilator or self-inflating bag) is on the inner cannula such that if the inner cannula is inspected in an emergency it must be replaced to connect a capnograph or to provide ventilation via an ambu bag or alternative (Figure 2). Other manufacturers have the 15-mm attachment on the outer lumen therefore allow connection to a ventilator or self-inflating bag whether the inner lumen tube is in place or not. The downside of the use of inner cannula is that they may increase the work of breathing due to the reduced internal diameter of the device. For patients with large necks, tubes with extra proximal length have been created. An alternative to this is the use of an adjustable flange tracheostomy tube. This ability to adjust is particularly helpful where there is likely to be progressive swelling of the neck including burns and states of high capillary leak. A further point to consider when managing tracheostomy tubes is that they can be angled or curved. Different tubes will fit different patients.

Other features of a tracheostomy tube to consider are the presence or absence of a cuff or fenestrations and the use of subglottic suctioning. Cuffed tracheostomy tubes are generally necessary to permit ventilation as the cuff allows transmission of high airway pressures. The cuff also serves to protect the airway from micro-aspiration. As the patient is weaned from the ventilator the cuff may be deflated intermittently to allow air flow through the glottis thus reducing the work of breathing and enabling speech. Once a patient is liberated from a ventilator and moved to lower intensity care it is often prudent to change the tube to an uncuffed version for the above advantages and because the absence of a cuff reduces the risk of airway obstruction. Therefore most, but not all, patients on medical HDU will have an uncuffed tube. A fenestrated tube has an additional opening in the posterior portion of the tube which permits greater airflow through the natural airway. Tracheostomy tubes that provide a suction port above the cuff are also available.

Tracheostomy adjuncts (Figure 3)

A 'T-piece' is a T shaped adapter connected to the tracheostomy tube with one limb open (acting as a reservoir for oxygen) and the other limb attached to a source of humidified gas. During inspiration the patient breathes fresh gas from the reservoir; the expired gases then fill the reservoir; these expired gases are then washed out at end expiration. Too short a reservoir tube and the patient will entrain air; too long a reservoir and the patient will rebreathe carbon dioxide.

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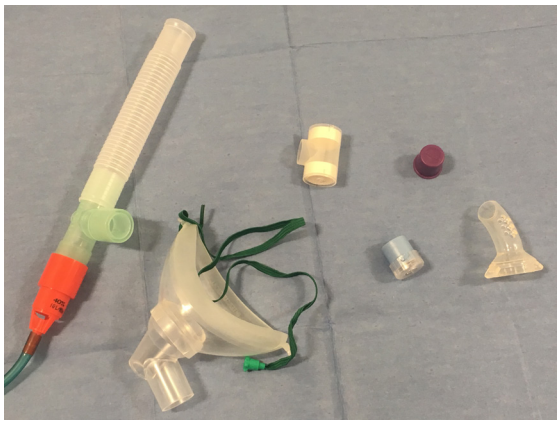

Figure 3. Adjuncts (left to right): T-piece with oxygen supply via venture device; tracheostomy mask; HME; speaking valve; tracheostomy cap; laryngeal tube.

A tracheostomy mask is similar to an oxygen mask and sits over the tracheostomy. It is important that the mask is rigid if the cuff of the tracheostomy is to remain inflated as occlusion of the opening to the tracheostomy could result.

A speaking valve is a one-way valve that sits on the proximal end of the tracheostomy tube. It allows airflow during inspiration but occludes during expiration forcing gas flow through the larynx thus allowing speech. It is crucial to appreciate that the cuff must be deflated when the speaking valve is placed: if not the patient will progressively gas trap and suffer a cardio-respiratory arrest. Speaking valves may cause rapid fatigue because of the increased work of breathing through the valve and so staff using the device must be cognizant of this.

A *'*Swedish no*se'* is a form of heat and moisture exchange (HME) filter which is placed on the end of the tracheostomy tube. It can be connected to a source of oxygen. This device is usually used just prior to decannulation when the secretion load and oxygen requirement is low.

Routine tracheostomy care

The NCEPOD report[2] revealed that over two thirds of hospitals had wards which received less than 2 patients with tracheostomies per month. On this basis the report mandated training for all staff caring for patients with tracheostomies. The National Tracheostomy Safety Project[4] recommends that patients with a tracheostomy should have the details of that tracheostomy clearly displayed at the bedside. Any patient with a tracheostomy should also have equipment available at the bedside which includes: an emergency algorithm to act as an aide memoir for staff; a Mapelson C circuit to attach to the device to assess whether or not airflow is occurring through the tracheostomy tube; a non-breathing mask to be applied to the upper airway in all emergencies in case the tube has been dislodged and the patient can breathe through their mouth; suction catheters to both remove secretions and assess the patency of the tracheostomy; a 10ml syringe in order to deflate the cuff of the tube; scissors and a stitch cutter to allow removal of sutures or tube tie should the tracheostomy become partially dislodged; tracheal dilators to aid re-insertion of a new tube (generally this is in the realms of an ENT surgeon); a spare tracheostomy tube of the same size and a size smaller so that experts may be able to change the tube; an airtight occlusive dressing to apply to the front of the neck should the tracheostomy be removed to allow breathing through the upper airway; and finally a paediatric face mask which allows controlled ventilation via the stoma (again this is the premise of an expert). In addition, it is vital that these patients and their care-providers have emergency access to capnography and fibreoptic bronchoscopes to allow confirmation of tube position.

Humidification of gases is crucial for all patients with a tracheostomy or laryngectomy in order to prevent sputum retention and tracheal mucosal damage. This is necessary since the body's usual mechanisms for humidifying and filtering gas - present in the upper airways - have been bypassed. Mechanisms available included heated humidification systems which deliver gas saturated with water at body temperature and heat and moisture exchanger (HME) devices which contain a hydrostatic membrane which traps moisture on exhalation and moistens the gas on inspiration as it passes through it and into the airways. The Intensive Care Society suggests a step-wise approach to humidification dependent on individual patient need.[5]

Like humidification suctioning via the stoma aids in the prevention of sputum retention and occlusion of the tracheostomy. The downsides of suctioning include mucosal injury, desaturation and introduction of infection. For this reason the regularity of suctioning must be individualised to the patient. Placement of a suction catheter through the tracheostomy tube also confirms patency of the tube.

Ideally patients managed outwith critical care should have the cuff deflated or have a cuffless tube, however this is not always possible due to oropharyngeal secretions or the need for long-term ventilation for example. In these cases, measurement of cuff pressure should occur at least every 8 hours and the pressures should not exceed 25cm H2O; this should lead to reduction in the long-term incidence of stenosis due to mucosal ischaemia.

As with suctioning, regular changing and or inspection of the inner cannula should occur frequently to prevent occlusion. Tracheostomy tubes

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are packaged with 2 inner lumens and therefore there is always a spare available which can be used while the original tube is being cleaned. The frequency of cannula review is dependent on need but should be undertaken at least 8 hourly.

The first tracheostomy tube change should be undertaken by the operating team and usually takes place no earlier than 7 days following insertion of the tube. Though there is little evidence to guide timing; replacement of the tube earlier than one week risks loss of the patent stoma particularly in percutaneously placed devices. Capnography should be available to confirm positioning as should rapid access to a fibre optic scope. For this reason the first change should be undertaken within the critical care environment.

Despite optimal preventative measures, tracheostomy emergencies will continue to occur. It is vital that emergencies are prepared for via local education and training as well as through adequate availability of emergency equipment as described previously.

Emergencies and complications

With close adherence to the above routines occurrence of emergencies can be kept to an absolute minimum and even where these do occur appropriate and rapid action will be taken to ensure no morbidity or mortality occurs as a result.

Emergencies and complications that are encountered include:–

Tube dislodgement

There were 14 cases of displaced tracheostomy that occurred within intensive care reported during a national audit of airway complications.[6] Strikingly, half of these patients died. Significant factors associated with death included lack of access to capnography and the placement of inappropriately sized tubes in obese patients. When a tube is completely dislodged and clearly separate from the patient then recognition is easy. The temptation to replace the tube blindly must be avoided as this can lead to the creation of a false passage which, particularly if it then has positive pressure ventilation applied to it, can result in surgical emphysema and complete inability to oxygenate the patient. If a tracheostomy has been placed percutaneously within 7 days it is likely a tract will not have reliably formed; in this situation it is prudent to occlude the stoma with an occlusive dressing and manage the upper airway in the standard fashion since the tracheostomy can be repositioned under anaesthesia if it is still required. If the tracheostomy has been present for longer than 7 days or was created surgically it may be replaced with the assistance of Intensive Care specialists or ENT surgeons who have the equipment and expertise to safely do this. Partial dislodgement or displacement is more difficult to recognise since the tube remains attached to the patient. The tracheostomy tip may be the within subcutaneous tissues of the anterior neck or abutting the posterior tracheal wall. Under such circumstances: the patient will suffer symptoms and signs of respiratory distress; there will be no movement of air via the device; an inability to pass a suction catheter and no capnography trace present. It is recommended that all staff caring for patients with a tracheostomy or laryngectomy are knowledgeable of standardised algorithms which ensure a systemic approach to the assessment and management of these life-threatening scenarios.[7]

Tube Blockage

Another early complication of tracheostomy insertion is blockage of the tube due to secretions or blood clots. Humidification, as well as regular suctioning and assessment of the inner cannula should minimise the risk of the tube becoming occluded. In an emergency, suctioning followed by changing of the inner cannula should invariably resolve the issue.[7] Once again staff familiarity with standardised algorithms ensures rapid resolution of problems.

Since it is not always clear in an emergency situation whether tube blockage, tube displacement or indeed a non-airway issue is the cause of sudden deterioration algorithms have been created to allow rapid identification and resuscitation regardless of the aetiology of the emergency. The most commonly used algorithm is available via the NTSP website and a simplified version is outlined in *figure 4*.

Infection

As with any surgical wound the tracheostomy site may become infected. Invariably stomal infections can be managed with antibiotics. It is important to be alert to the possibility of development of necrotising infections and mediastinitis which have a high mortality. Tracheitis has been reported at a rate of 23 to 480 per 100, 000 procedures.[8]

Bleeding

Bleeding is a risk associated with tracheostomy from the moment the procedure is performed. Early bleeding is often related to bleeding at the wound edge. This can be managed with normalisation of coagulation and direct pressure at the site followed by transfer to theatre for definitive haemostasis by surgeons. Delayed bleeding is often caused by erosion of the tracheal tube through the trachea and into a vessel. Though uncommon the effects can be catastrophic. Immediate management should be to secure the airway with a cuffed tube placed distal to the erosion. Emergency anaesthetic assistance is advised since the easiest option is via the endotracheal

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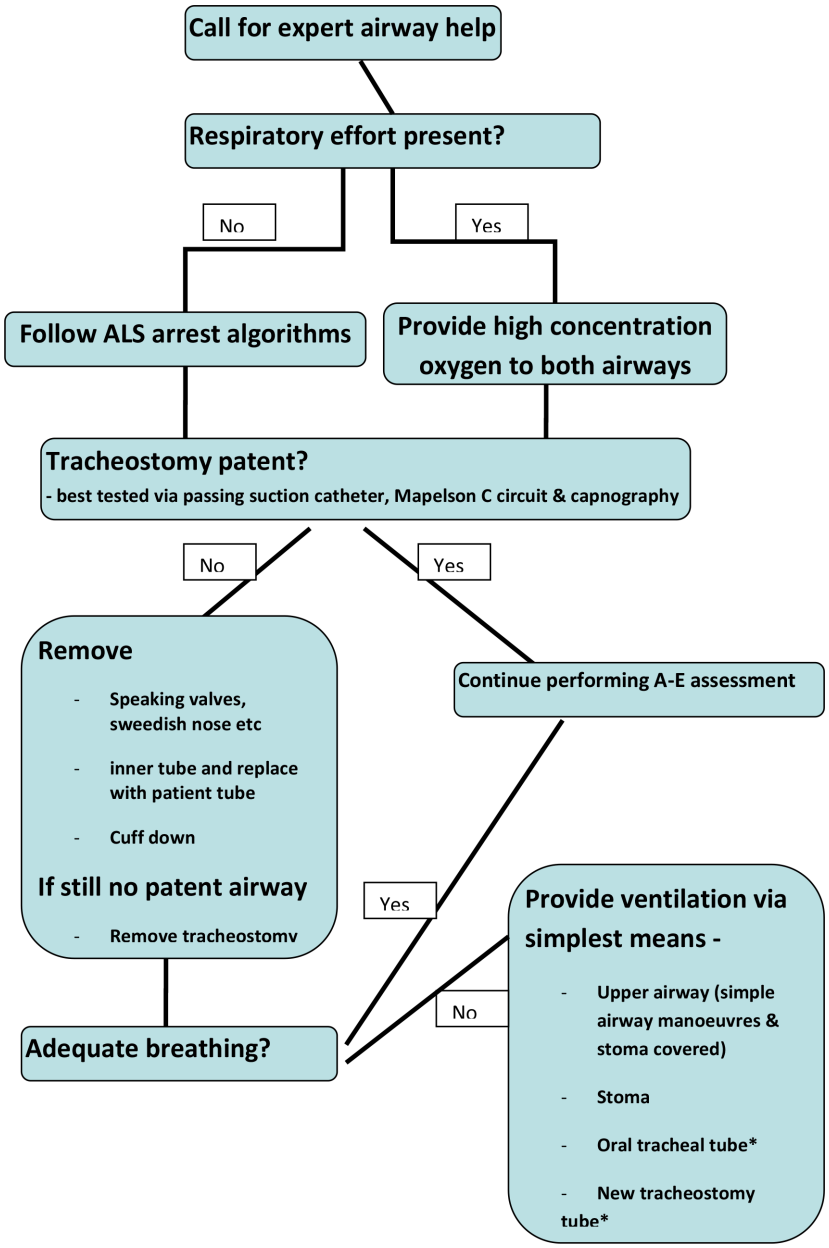

Figure 4. Tracheostomy emergency algorithm

route. If possible digital pressure compressing the vessel against the sternum may control bleeding pending the arrival of surgical support.

Tracheo-oesophogeal Fistula

Though rare this complication has a high mortality. Ensuring no injury to the posterior wall of the trachea during insertion and preventing excessive tracheal tube cuff pressures are the best means to prevent this occurrence.

Tracheal Stenosis

Regarding long-term risks, longitudinal studies suggest tracheal stenosis is no more likely after tracheostomy than prolonged intubation.[9] Stenosis is the most significant long-term complication associated with tracheostomy however. Patients are usually asymptomatic until 50–75% of the trachea is occluded and stridor may occur when the tracheal diameter is 5mm.[10] Patients who are clinically asymptomatic at rest can develop significant symptoms under stress with an incidence for percutaneous tracheostomy quoted as 6–7%. Significant respiratory symptoms following discharge from critical care having had a tracheostomy warrant investigations and follow-up led by ENT surgeons.

Weaning and decannulation

Weaning from respiratory support should be initiated as soon as the tracheostomy has been

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inserted. Within Intensive Care this usually involves a stepwise reduction in pressure support and positive end-expiratory pressure. Once established on minimal ventilator settings the patient is transitioned to either a T-piece (with the tracheostomy cuff remaining inflated) or Tracheal mask (during which the cuff is deflated). Deflating the cuff is reliant on the patient being able to swallow their own saliva and having protective airway reflexes since aspiration pneumonia becomes a risk. Swallowing is assessed by Speech and Language specialists who may advocate videofluoroscopy or nasendoscopic examination in high risk patients. Other prerequisites for weaning include a patent upper airway, an adequate cough and a reducing secretion load. Each patient will undergo a bespoke weaning plan dependent on the experience of the attending clinicians and the individual patient needs but the process begins with cuff deflation. Provided deflation of the cuff does not lead to excess fatigue or aspiration of oropharyngeal secretions the duration of cuff deflation is steadily increased. Airflow through the upper airway can be improved by converting to a smaller, cuffless tube with fenestrations. This improves bulbar and glottis strength. At this stage the use of a speaking valve will further improve glottic strength and improve the psychological state of the patient as they improve their ability to communicate. Some units would advocate a trial with a tracheostomy tube 'cap' for a period prior to decannulation. By using the cap any upper airway obstruction is highlighted prior to removal of the tube. Usually the patient who can breathe spontaneously (with a respiratory rate less than 25) for 24 hours with the cuff of the tracheostomy tube deflated and comfortably converse with a speaking valve and who has a low oxygen requirement, a strong cough and minimal respiratory secretions will progress to decannulation without concern.

Conclusion

There are increasing numbers of patients with a tracheostomy managed within medical high dependency units. Evidence suggests that staff have previously been inadequately prepared to manage both the routine and emergency care of such patients. There are ever-expanding resources available to clinicians caring for this sub-group of patients. These should be used to facilitate the provisions of high quality standardised care throughout individual hospitals.

Conflict of Interest

Nothing to declare.

References

1. Ciaglia P, Firshing R, Syniec C; Elective percutaneous dilatational tracheostomy: a new simple bedside procedure. *Chest* 1985; **87:** 715–9.
2. On the right trach? A review of the care received by patients who underwent a tracheostomy. A report by the National Confidential Enquiry into Patient Outcomes and Death (2014).
3. Bersten AD, Rutten AJ, Vedig AE, *et al*; Additional work of breathing imposed by endotracheal tubes, breathing circuits, and intensive care ventilators. *Crit Care Med* 1989; **17:** 671–7.
4. McGrath BA; Comprehensive Tracheostomy Care: The National Tracheostomy Safety Project Manual (Advanced Life Support Group), 2014. London, Wiley-Blackwell.
5. Intensive Care Society (ICS). Standards for the Care of Adult Patients with a Temporary Tracheostomy. London: ICS, 2008.
6. Cook T, Woodall N, Frerk C; 4th National Audit Project of the Royal College of Anaesthetists, 2011: Major complications of airway management in the UK.
7. McGrath BA, Bates L, Atkinson D, *et al*; Multidisciplinary guidelines for the management of tracheostomy and laryngectomy airway emergencies. *Anaesthesia* 2012; **67:** 1025–41.
8. Dulgerov P, Gysin C, Perneger TV, *et al*; Percutaneous or Surgical Tracheostomy: A Meta-Analysis. *Crit Care Med.* 1999; **27:** 1617–25.
9. Heffner JE; Tracheotomy: indications and timing. *Respir Care* 1999; **44:** 807–815.
10. Eggert SM, Jerwood C; Percutaneous tracheostomy. *BJA CEPD Reviews* 2003; **3(5):** 139–142.

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