Tracheostomies for the non-expert 1: indications and techniques

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 first part looks at indications and techniques.

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. This first part looks at updates from current literature, national and international tracheostomy projects, anatomy, physiology, techniques and types of tracheostomy. The second part covers the principles of routine care, weaning and emergency management.

Reports of complications and harm in the literature

The National Patient Safety Agency reported 968 tracheostomy-related incidents from 2005–7 of which a high proportion (75%) led to actual harm (McGrath and Thomas, 2010). In a number of cases, lack of staff competency contributed to avoidable morbidity and mortality. The National Patient Safety Agency figures are most certainly a gross underestimation of actual events. Similar themes were raised in the 4th National Audit Project (NAP 4), a UK-wide snapshot of major airway complications (Cook et al, 2011a). Over 50% of serious airway complications in the critical care setting involved tracheostomies (Cook et al, 2011b). Obesity was also highlighted as an emerging concern with a high proportion of tracheostomy-related incidents occurring in patients with raised body mass indices.

The National Confidential Enquiry into Patient Outcome and Death (NCEPOD) report reviewed the care of patients who underwent a tracheostomy across 150 trusts in England, Wales and Northern Ireland over a 3-month period in 2013 (McGrath and Wilkinson, 2015). A questionnaire was completed by local staff documenting the patient journey post-tracheostomy. NCEPOD received completed questionnaires for 2199 patients, from which 426 were selected for casenote review at random. Advisors graded the quality of care from 'good practice' to 'less than satisfactory'. On critical care units, room for improvement in clinical or organizational care was identified in 75% of cases, but care was only considered less than satisfactory in 2% of cases. In the ward setting, 59% of cases had shortcomings in clinical or organizational care and 2% of cases were managed unsatisfactorily. Broad suggestions for improving care included use of checklists for all tracheostomy insertions, adequate provision of emergency airway equipment and capnography at point of care, training in avoidance and management of complications, and the importance of multidisciplinary involvement to optimal aftercare, communication and discharge planning.

National and international projects

The UK's multidisciplinary National Tracheostomy Safety Project was devised and established in 2010 in response to the need for better tracheostomy care. Five key issues for action in improving the management of neck breathing patients were identified: leadership, environment, equipment, staffing and knowledge. The National Tracheostomy Safety Project (2013) has developed comprehensive resources and algorithms to help standardize and improve care. The Global Tracheostomy

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Collaborative (http://globaltrach.org/), launched in 2014, provides an international forum for sharing best practice to help minimize avoidable adverse events.

Historical background

The tracheostomy (from the Greek 'tracheo arteria' rough artery and 'stoma' opening/mouth) is one of the oldest documented surgical procedures, featuring on Egyptian tablets from 3600 BC and in a Hindu text from 2000 BC. It was during the polio epidemic of 1952 that the new intensive care units in Scandinavia developed the technique to successfully ventilate patients with bulbar failure. The anatomy relevant to tracheostomy is shown in *Figure 1*.

Indications

Tracheostomy insertion can be an elective or emergency procedure and for temporary or long-term systematic use (*Table 1*).

Evidence for optimal timing of insertion of tracheostomy is lacking. A Cochrane review into efficacy and safety of early (<10 days) *vs* late (>10 days) tracheostomy insertion in critically ill patients and a subsequent randomized controlled trial (tracheostomy insertion <4 days *vs* >10 days from start of mechanical ventilation) could not conclude any mortality differences between these groups (Gomes Silva et al, 2012; Young et al, 2013).

Technique

Whichever technique is used for tracheostomy insertion, a checklist should be used to facilitate communication of critical steps and contingency planning. Comparisons of techniques for insertion of tracheostomy are summarized in *Table 2*.

Surgical

Surgical tracheostomy is usually performed in the operating theatre with the patient under general anaesthesia or under local anaesthetic alone if general anaesthesia is considered unsafe. Following skin incision, strap muscles and thyroid isthmus are retracted and tissues down to the second and third tracheal rings are dissected (De Leyn et al, 2007). There are variations in types of skin and tracheal incisions and safety sutures (*Table 3*).

Percutaneous

In the NCEPOD report two thirds of tracheostomies were inserted percutaneously. Percutaneous tracheostomy insertion is a relatively quick bedside procedure that uses a seldinger technique (needle into trachea, wire threaded through needle, dilation of tract over guidewire) familiar to most anaesthetists and intensivists. A bronchoscope inserted via the endotracheal tube enables a second clinician to confirm the correct and optimal insertion point of the needle and guidewire (and later the tracheostomy tube) as close to the '12 o'clock' position as possible. The bronchoscope can also be used to aspirate blood within the trachea.

Figure 1. Anatomy relevant to tracheostomy.

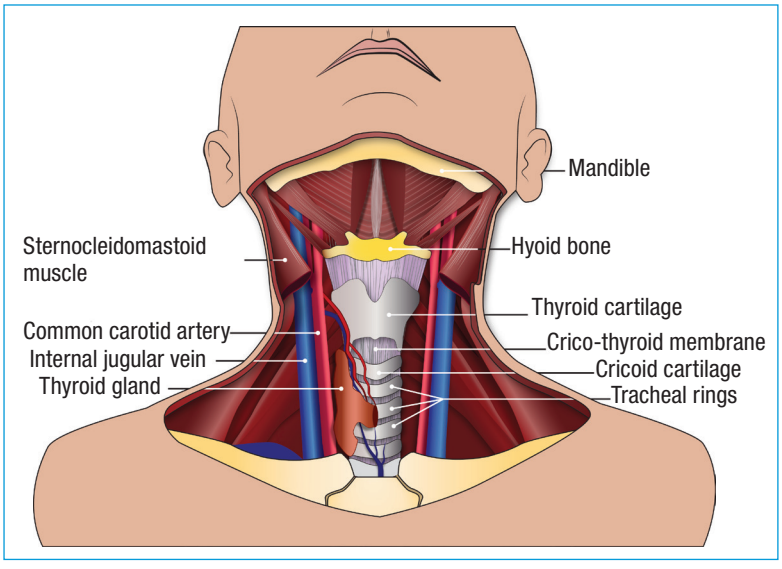


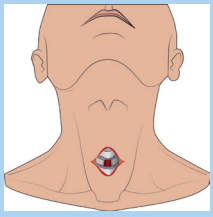
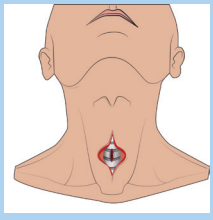
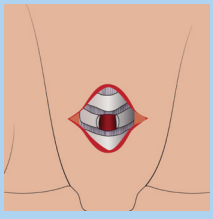
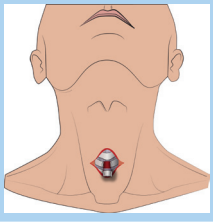
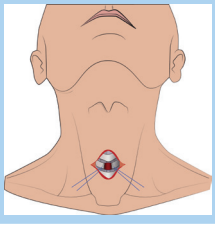
Table 1. Indications for tracheostomy

Indication	Examples of underlying cause	Urgency
Airway obstruction Actual or impending	Head and neck pathology (malignancy, infection) Trauma Post surgical	Emergency Semi-elective Elective
Respiratory failure Requirement for positive pressure ventilation	Respiratory or neurological disease Long-term ventilatory support Weaning from ventilation	Semi-elective Elective
Neurological failure or unsafe swallow Airway protection against oral or gastric aspiration	Low conscious level states Neuromuscular disorders	Semi-elective Elective
Secretion management	Copious secretions Weak cough	Semi-elective Elective

Table 2. Comparison of techniques for insertion of tracheostomy

Technique	Advantages	Disadvantages
Surgical	Optimal exposure of structures in anatomically challenging neck Ability to arrest bleeding Mature tract established more quickly (2–4 days)	Requires transfer of potentially critically ill patient to theatre suite (patient safety, cost and time implications)
Percutaneous	Quick Bedside Seldinger technique Dilation may minimize bleeding	Not appropriate if anatomy is grossly distorted or structures impalpable Inability to stop significant bleeding Maturation of tract takes longer (7–10 days)

Table 3. Tracheostomy techniques

Technique		
Horizontal slit		A horizontal slit is performed for elective tracheostomies allowing gradual dissection and preservation or transection of the thyroid isthmus
Vertical slit		A vertical skin incision maximizes tracheal exposure and is often favoured in emergency front of neck access ('slash tracheostomy') It provides rapid access to the trachea at the expense of preservation of underlying structures, e.g. the thyroid isthmus Vertical tracheal incision may be used in paediatric tracheostomy formation to preserve tracheal rings and reduce tracheal stenosis
Window		Part of the tracheal ring is removed during elective tracheostomy formation
Bjork flap		The flap of trachea produced by formation of the tracheal window is sutured on to the anterior neck skin surface creating a reliably maintained tract from skin to trachea and reducing risk of false passage formation
Stay sutures		Stay sutures can be tethered either side of the tracheal stoma and taped externally to the patient's chest wall. If the tracheostomy tube is dislodged and the tract lost, the sutures should be pulled to bring the trachea forward to the cutaneous surface and facilitate airway reinsertion

Types of tracheostomy

The variety of tubes and associated nomenclature can initially seem confusing (*Table 4*). Variations in tube design can be simplified as:

1. Cuffed or uncuffed
2. Single lumen or double lumen (presence of inner cannula)
3. Fenestrated or non-fenestrated (types of outer or inner cannula)
4. Variable length or 'adjustable flange'.

Sizing

The outer diameter of the tracheostomy tube should be two thirds to three quarters of the tracheal diameter and the tip should sit a couple of centimetres above the carina. Quoted tube size refers to the inner diameter (ID) and is typically size 8 (8 mm ID) for an adult female and size 9 (9 mm ID) for an adult male. It is important to remember that outer diameters may vary between manufacturers for the same ID. Standard tubes have a fixed distance from flange to the curve in their stem which may not be adequate to reach from skin to trachea in obese or critically ill patients with neck oedema (Mallick et al, 2008). Adjustable flange tubes enable variation of the flange to curve distance and may be increasingly necessary as body mass index rises globally. Access to a tracheostomy of the same size and the size below should be available at the patient's bedside in case of accidental decannulation (Mitchell et al, 2013).

Conclusions

Tracheostomies are commonly performed in vulnerable patients in whom the potential for deterioration and significant morbidity and mortality has been captured by NAP4 and the recent NCEPOD report. Variation in tracheostomy insertion techniques and tubes can cause

Table 4. Types of tracheostomy tubes

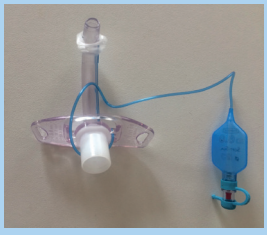
Tube type	Features and implications
Cuffed  Portex cuffed Blueline ultra	Soft inflatable cuff at distal end Enables isolation of trachea from glottis: ✓ Delivery of positive pressure ventilation ✓ Protection from aspiration (oral/gastric secretions) ✓ Reduced tracheal soiling thus minimizing nosocomial infections. Some tubes have sub-glottic suction ports for aspiration of debris on top of cuff ✕ Unable to vocalize with cuff inflated ✕ Unable to oxygenate from above with cuff inflated ✕ Tube dislodgement can lead to airway compromise ✕ Regular monitoring of cuff pressure is needed
Uncuffed  Portex Blueline ultra cuffless   Moore & Montgomery tracheostomy tubes	Smooth tracheostomy tube without cuff Trachea is not definitively isolated from upper airway: ✓ Enables upward movement of gas via glottis and vocal cords (vocalization, weaning) ✓ Facilitates swallowing ✓ Minimizes tracheal damage ✕ Unable to deliver positive pressure ventilation ✕ Airway not protected from aspiration – patient must have intact airway reflexes Specialized cuffless tubes ■ Moore tubes: flexible inert cuffless tubes (with interchangeable inner cannulae) for long-term use in patients post tracheal reconstruction or with tracheal stenosis ■ Montgomery T tubes: silicone tracheal stents used in ear, nose and throat surgery ✕ Unable to connect with catheter mounts or breathing circuits
Fenestrated  Portex Blueline ultra fenestrated  Shiley tracheostomy tube cuffless fenestrated	Opening in the outer tracheal cannula May be cuffed or uncuffed Inner tube can be non-fenestrated or fenestrated (interchangeable) Fenestrated inner ✓ Connection with upper airway to facilitated vocalization and weaning Non-fenestrated inner ✓ Ability to isolate trachea (if cuffed tube) to deliver positive pressure ventilation or protect from aspiration or injury during suctioning
Single lumen  Portex Blueline cuffed adjustable flange	Single large diameter tracheostomy tube ✓ Lower resistance to gas flow ✕ Limited ability to clean tracheostomy tube ✕ Risks secretion build up and obstruction ✕ If single lumen tube becomes blocked entire tracheostomy must be removed with risk of failed reinsertion if tract immature Single lumen tubes no longer advocated for use

Table 4. Types of tracheostomy tubes (continued)

Double lumen  Portex cuffed Blueline ultra	Outer tracheostomy cannula plus removable inner cannula ✓ Facilitates cleaning and maintenance of a patent airway ✓ If airway becomes blocked inner cannula can be removed while outer cannula maintains tract ✓ Spare inner tubes should be available at the bedside in case of blockage ✕ Inner tube reduces internal diameter and increases resistance to gas flow ✕ Some models of double lumen tube cannot connect to a breathing circuit if inner tube is removed, e.g. Shiley
Adjustable flange  Portex Blueline cuffed adjustable flange	Flange can be moved along length of tracheostomy stem to accommodate variation in distance between skin and trachea in patients with ✓ Increased body mass index ✓ Neck oedema ✓ Burns Improved tube position and reduced risk of dislodgement Likely to be increasingly required with obese population Double lumen adjustable flange tubes are now available and should improve safety profile further

confusion among medical staff and may contribute to the poor outcomes reported in the literature. A sound understanding of the implications of surgical and percutaneous techniques, cuffed and uncuffed, single and double lumen, fenestrated and unfenestrated and fixed or adjustable flange tubes will empower attending clinicians to appropriately assess and manage patients during routine care and also during an acute deterioration. Excellent verbal and written communication regarding tracheostomy timing, technique, tube size and type is critical and may be enhanced by positive multidisciplinary relationships, training and use of National Tracheostomy Safety Project bedside signs.

Building on an understanding of the anatomy, insertion techniques and tube types described in part 1, in part 2 the principles and standards of routine care, weaning, detecting airway problems and emergency management will be discussed. **BJHM**

Conflict of interest: none.

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.
- Tracheostomy insertion can be emergency or elective and for temporary or long-term use.
- An understanding of the differences between surgical and percutaneous techniques for tracheostomy insertion may be important for aftercare.
- An appreciation for the range of different tracheostomy tubes available and the implications of various features (whether tubes are cuffed or uncuffed, have inner cannulae, fenestrations or an adjustable flange) is vital in order to assess and manage patients in day-to-day and emergency settings.

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