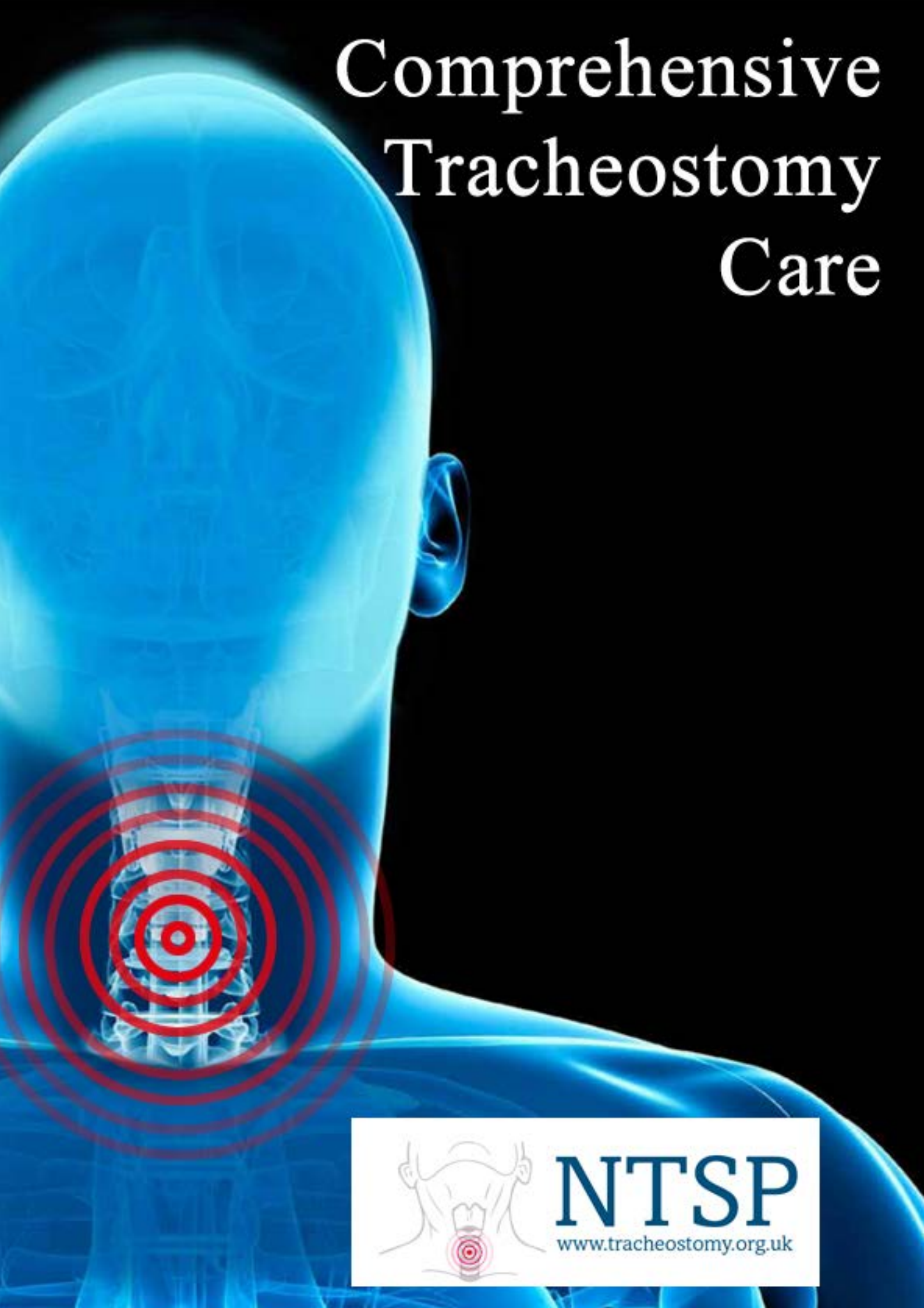
Comprehensive Tracheostomy Care



NTSP

www.tracheostomy.org.uk

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For Emma, Cerys and Bethan – thanks for the love, support, patience.

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Introduction

This manual is a resource developed by the UK National Tracheostomy Safety Project (NTSP) to help promote and facilitate the safe management of tracheostomies and laryngectomies. The scope includes hospital in-patient specialist areas such as critical care, head & neck units and specialist wards, but are also applicable to more general wards, outpatient and community settings. The majority of the content is for adult patients with a new paediatric chapter developed with colleagues from Great Ormond Street Hospital.

We have attempted to make the resource a 'one stop shop' covering all aspects of tracheostomy and laryngectomy management by collecting together resources from surgical, anaesthetic, nursing, intensive care and allied health backgrounds, along with guidance from key national stakeholder organisations. These include the Difficult Airway Society, Intensive Care Society, the Royal College of Anaesthetists, ENT UK, British Association of Oral and Maxillofacial Surgeons, College of Emergency Medicine, Resuscitation Council UK, Royal College of Nursing, Royal College of Speech and Language Therapists, Association of Chartered Physiotherapists in Respiratory Care, British Laryngological Association, Faculty of Intensive Care Medicine, National Association of Laryngectomy Clubs and the National Patient Safety Agency.

We have also reviewed many local, regional, national and international guidelines, policies and resources during the preparation of this manual. Many such groups and have previously developed excellent resources for the care of 'neck breathers' but these were often focussed on specific areas of practice. We have also received many hundreds of comments on draft resources and further advice from around the world. We are grateful to the many individuals who have contributed to this project in this way and have acknowledged as many as possible where appropriate.

This unique document has been developed by consulting as widely as possible, across traditional professional boundaries using expertise and existing guidance from around the world. The manual attempts to pull together the different pieces of the jigsaw that already existed, as well as devising new resources where we felt they were needed. Previous work is referenced and accredited where appropriate, and we grateful for the many permissions to use other materials that have been granted. This manual is supported by our website www.tracheostomy.org.uk which contains many new educational resources, e-learning packages and videos. We have included hyperlinks where relevant to the specific sections of the website and our resources.

This guidance is applicable for a novice first responder looking after a patient with a tracheostomy or laryngectomy for the first time through to an airway expert secondary responder.

You are welcome to use and adapt these resources as you wish. Please reference them accordingly (NTSP Manual 2013. www.tracheostomy.org.uk).

We hope you find these resources useful. Please contact us if you have any further comments or resources that you feel would add to this project. We are particularly interested to hear if the emergency algorithms have been used successfully.

Dr Brendan McGrath

Consultant in Anaesthesia & Intensive Care Medicine
University Hospital of South Manchester
On behalf of the Working Party of the National Tracheostomy Safety Project

This project would not have been possible without the valued time and contributions of a great many people. We have endeavoured to list as many as we can in this section. We have also been granted permission to use images, documents, videos and resources from may sources. Where requested, appropriate acknowledgement is made here.

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CSP: Mrs Cathy Sandsund (ACPRC Research Officer), Mr David McWilliams (ACPRC Critical Care Champion)
RCN: Sr Rachel Binks (Chair, Critical Care Steering Committee)
CEM: Prof Jonathan Benger (Chair, Clinical Effectiveness Committee and Emergency Airway Lead)
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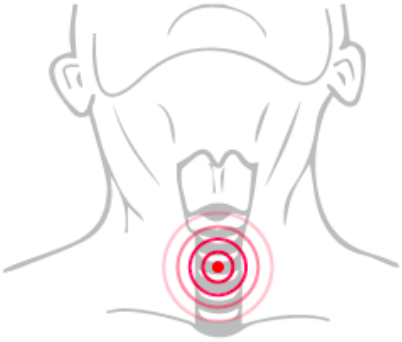
Competing interests

The National Tracheostomy Safety Project has received funding from the ICS and assistance from the RCoA (allowed use of in-house programmers) specifically to contribute towards the e-learning for healthcare modules that were developed as part of this project.

The project has also received sponsorship from the following companies: Smiths-Medical (Portex), Cook, Kapitex, Ambu a-Scope, Olympus, Astellas Pharma and Pfizer. This sponsorship has specifically been used to reduce the cost of medical, nursing and allied health staff attending our tracheostomy safety courses and has not influenced the production or development of these resources. No individual or organisation has benefitted financially from this project.



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Disclaimer

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Every effort has been made by the authors to use materials and sources that are reliable and provide information that is compatible with the standards generally accepted at the time of publication. Because of the nature of medical practice, we recommend that the reader always consults current research and institutional policies before performing clinical procedures. The authors accept no responsibility for the persistence or accuracy of URLs for external content referred to in this publication.

NTSP, November 2012.

How the NTSP resources were developed

These NTSP resources are for medical, nursing, allied health staff and students. There are resources for patients available separately.

This project started with a group of 4 Intensive Care Doctors working in Manchester, UK, who wanted to improve the management of patients with tracheostomies. We had identified recurrent themes common to tracheostomy and laryngectomy emergencies and recognised that in order to improve care, educational resources and innovative ways to teach them were urgently required. We initially sought the help of other colleagues in Critical Care, Anaesthesia, ENT surgery and Maxillofacial surgery, forming a multi-disciplinary, multi-site working party to develop these resources. This group grew to incorporate input from nursing, physiotherapy and speech therapy colleagues, along with patients and patient groups and other medical and allied health professionals. A short video describing the origins of the project can be viewed by clicking here.

We have focussed our attentions in two key areas: The emergency management algorithms and improving routine care by developing educational resources aimed at preventing neck-breathing patients developing life-threatening emergencies.

We developed and tested our emergency guidance with high fidelity simulators using specific scenarios to ensure that nursing staff, doctors and allied health professionals could follow our algorithms. We have also introduced this guidance in a number of different Trusts in the UK and developed the project incorporating multi-site, multi-speciality peer review and feedback.

The resources are supported by an extensive e-learning package, developed in partnership with the UK Department of Heath's e-Learning for Healthcare project and the Royal College of Anaesthetist's e-Learning in Anaesthesia project. We have provided as much information as possible in video, diagram and schematic format, with many links from the text of this manual direct to YouTube videos and the resources of this site. This was in response to feedback received when we started to disseminate this information more widely. A lot of tracheostomy-related procedures are best learned when you can actually see someone doing it – either at the bedside locally, or via some of the videos we have provided. The resources in the manual have arisen from extensive collaboration between local, national and international stakeholder groups and have built on previously published guidelines, resources and expert opinion. We saw our role as putting together the

individual pieces of the jigsaw that often existed in respect to specialised areas of tracheostomy and laryngectomy care.

The various resources have been peer reviewed by a number of different processes, including open peer review of draft resources posted on our website and the websites of a number of partner organisations. The emergency guidelines, algorithms, bed-head signs and supporting manuscript have been endorsed by Difficult Airway Society, Intensive Care Society, the Royal College of Anaesthetists, ENT UK, British Association of Oral and Maxillofacial Surgeons, College of Emergency Medicine, Resuscitation Council UK, Royal College of Nursing, Royal College of Speech and Language Therapists, Association of Chartered Physiotherapists in Respiratory Care, National Association of Laryngectomy Clubs and the National Patient Safety Agency. There have also been contributions from The British Laryngological Association and the Faculty of Intensive Care Medicine. The NTSP manual has been reviewed by many of the groups above either formally or informally and also revised by a multidisciplinary NTSP editorial board. Finally, the e-Learning for Healthcare resources have been reviewed by e-Learning Anaesthesia at the Royal College of Anaesthetists.

Full details of the literature review process and development of these guidelines are described in McGrath *et al* manuscript in *Anaesthesia* 2012 Sep;67(9):1025-41

Executive summary

This section details the main points of this document. Further explanation can be found in the relevant sections. Many of the recommendation originate from the NPSA multi-professional external reference group comprising representatives from key 'National Bodies' and expert clinicians. Recommendations are also included from *Irish* and *Scottish* best practice circulars.

Key Issue

A patient with a tracheostomy or laryngectomy is at risk of death or harm if inappropriate or inadequate care is provided. This patient group requires airway devices to be safely inserted, securely positioned and appropriately cared for, in order to continue to provide the patient with a patent airway. Failure to do so may lead to a displaced or blocked tube, which if not dealt with immediately, may be fatal within minutes.

Action

1. **Leadership**
    a. Identify a clinical lead in each NHS Trust or institution to co-ordinate the management of patients with tracheostomies.
    b. Trusts must have a local policy in place, which outlines the expected management of patients with a tracheostomy or laryngectomy.

2. **Environment**
    a. Identify appropriate environments in which to manage patients with tracheostomies and laryngectomies.
    b. Identify a comprehensive risk assessment of the patient that is agreed locally to determine the dependency of the patient, the level of the observation and visibility required.
    c. The frequency of risk assessment should be determined by the patient's condition, clinical environment, staffing levels, skills and competence. The risk assessment must be retained in the patient record as appropriate.
    d. Trusts who are unable to develop systems to reduce risks effectively in all clinical areas should consider identifying designated areas where the risks are reduced.

3. **Equipment**
    a. Equipment for the management of the tracheostomy including suction should be kept near the patient at all times.
    b. Equipment should be checked, as a minimum on a daily basis.
    c. Emergency equipment must remain immediately available at the bedside and accompany the patient if they leave their base location.
    d. All tracheostomy tubes used should have a removable inner cannula. Exceptions to this must be clearly documented in the patient's medical record and a date for review determined.
    e. The inner cannula should be regularly checked and cleaned as this greatly reduces the risk of a tracheostomy tube becoming blocked.

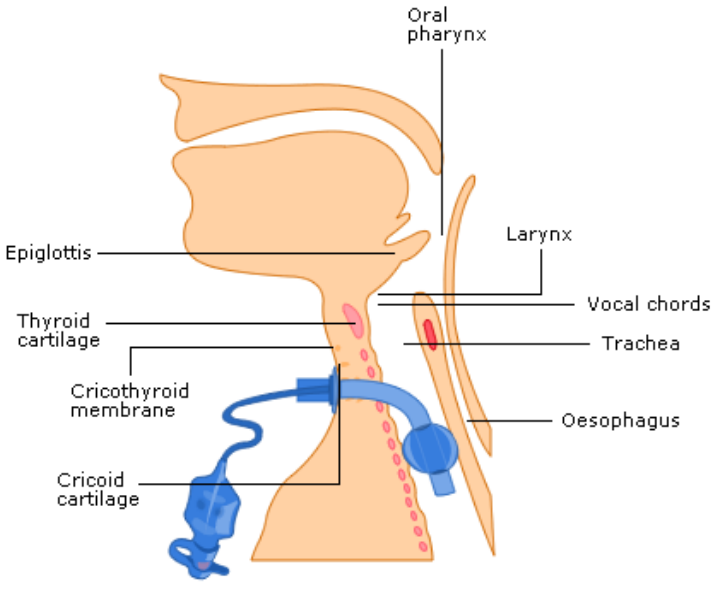
4. **Staffing**
    a. Patients with tracheostomies must be cared for by staff that have been appropriately trained and are currently considered competent in tracheostomy care.
    b. Staff must be able to access appropriate training and support in order to deliver appropriate care and to be able to identify risk factors and how to initiate management of complications. All training received should be documented.
    c. Trusts must ensure that training programmes are in accordance with best evidence-based guidelines on the management of a tracheostomy.
    d. Tracheostomy training and support is locally coordinated by the clinical lead.
    e. Staff escorting the patient outside of the clinical area must be competent in dealing with suctioning and in managing a tracheostomy emergency.

5. **Knowledge**
    a. All staff caring for patient with tracheostomies and laryngectomies must be competent to do so, both in routine care and in the emergency situation. This includes designated wards and clinical areas, and also acute services such as acute medical units and emergency departments who may be expected to see tracheostomy complications.
    b. These recommendations can be extended to carers outside of the hospital environment, in nursing homes, patient's own homes and to those responding to patients who are community based.
    c. Emergency algorithms should be taught, displayed and used to manage tracheostomy or laryngectomy emergencies
    d. Essential information can be displayed at the bedside to assist in managing an emergency at which the attending staff may not know the history of the patient.

What is a tracheostomy

Tracheostomies are performed in head and neck surgical practice, with over 5,000 procedures performed yearly in England. We estimate around 10-15,000 percutaneous tracheostomies are performed each year in England's critical care units, although the actual figure is unknown at the time of writing. Tracheostomies are also becoming more commonplace on the general wards of the hospital. This is partly due to pressures on intensive care beds and the increasing drive to de-escalate care quickly, along with increasing numbers of patients benefiting from temporary tracheostomy. These groups include those with chronic respiratory or neurological problems. Increasing numbers of patients with tracheostomies are being cared for on wards outside the specialist ward (typically ENT or Maxillofacial wards, or sometimes neurosurgical or neurology wards) or critical care infrastructure.

This has implications for the safety of patients who may be cared for on wards without the necessary competencies and experience to manage this challenging cohort and local measures need to be in place to ensure that safe routine and emergency care can be provided. This manual has evolved to provide information to those caring for patients with temporary or permanent tracheostomies either regularly or occasionally. It aims to provide basic background information and the rationale for tracheostomy care.



What problems can occur with tracheostomies?

Whilst tracheostomies are increasingly commonplace, patient safety incidents associated with their use are unfortunately also increasing. Over 1,700 incidents were reported to the NPSA between 1st January 2005 and 31st December 2008, including over 30 deaths. We know from research with the NPSA that when a clinical incident occurs relating to a tracheostomy, then the chance of some harm occurring is between 60 and 70%, depending on the location in which that the patient is being cared for. (see links to these abstracts for NPSA papers Thomas 2009; McGrath 2010)

Incidents may be classified as:

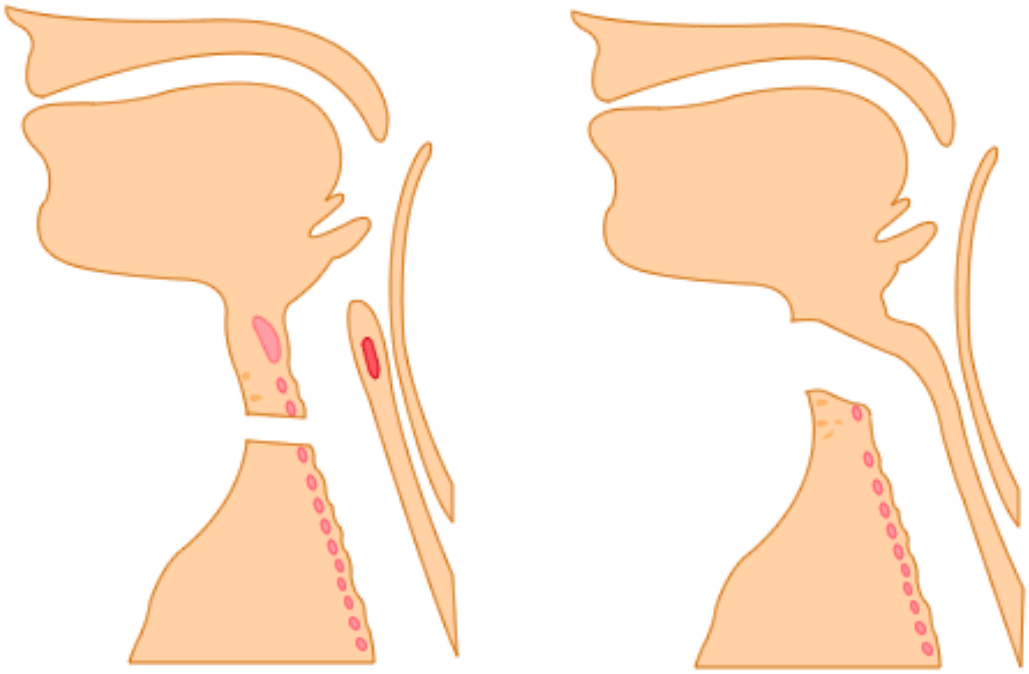
- Incidents at the time of performing the tracheostomy (e.g. airway loss, damage of adjacent structures, bleeding)
- Blockage or displacement of the tracheostomy tube after placement
- Equipment incidents (usually lack of equipment or inappropriate use)
- Competency (skills and knowledge) incidents
- Infrastructure (staffing and location) incidents
- Late complications (e.g. Tracheomalacia, stenosis, infection of stoma)

The majority of these incidents are due to the same recurring themes and the resources we have developed as part of this project are specifically aimed at addressing these.

There is more detail of tracheostomy and laryngectomy problems in the complication, red flags and emergency management section.

What is a laryngectomy?

The larynx (voice box) can be involved in oral, pharyngeal or laryngeal carcinomas. These are usually squamous cell carcinomas and can be treated by radiotherapy and surgery, depending on the site and the general condition of the patient. Surgical resection of the tongue base or epiglottis may not necessarily involve removal of the larynx and is sometimes referred to as a *supraglottic laryngectomy*. It is sometimes possible to resect only one half of the larynx for localised disease with a *hemilaryngectomy.* However, if a *total laryngectomy* is required, this involves complete surgical removal of the larynx which disconnects the upper airway (nose and mouth) from the lungs. This is a permanent and irreversible procedure (although partial laryngectomies are possible). The trachea is transected (cut) and then the open end is stitched onto the front of the neck. Once this has been performed, the patient will never be able to breathe or be oxygenated or ventilated through the upper airway again. An animation showing the difference between a tracheostomy and a laryngectomy can be found by clicking here.



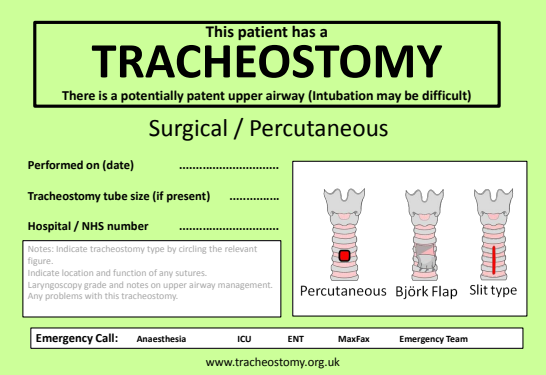
The figure above shows a laryngectomy on the right and a tracheostomy on the left. The left hand figure still has a potentially patent upper airway. Remember though that tracheostomies are often performed because of actual or anticipated difficulty with the upper airway, so upper airway patency cannot be guaranteed.

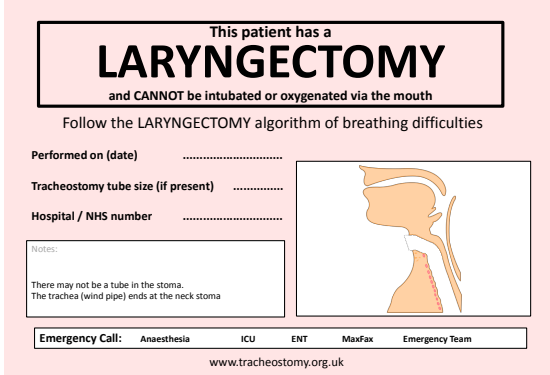
What problems can occur with laryngectomies?

The laryngectomy patient has had the normal upper airway humidification mechanisms bypassed in the same way as a tracheostomy patient has. They

are at risk of blockage of the trachea with secretion or blood. The airway is often more secure than with a temporary tracheostomy as the trachea is stitched onto the front of the neck. It can still become compromised however, particularly within a few days of surgery. Laryngectomy stomas are usually simple open stomas without a tube inserted. There are a variety of covers, valves and humidification devices available, which can make distinguishing between a tracheostomy and laryngectomy very difficult. Tubes are sometimes inserted into laryngectomy stomas, especially when they have just been created, the patient needs invasive ventilation or requires repeated suctioning. Tracheostomy tubes are usually used, although specific laryngectomy tubes are available. The use of bedhead signs to alert staff that a patient does not have an upper airway are extremely useful, especially is the patient cannot tell you themselves due to acute illness or not being able to talk following a laryngectomy.

One of the commonest problems with a laryngectomy, particularly in an emergency, is that responders fail to appreciate that the patient has actually has their larynx removed. It can be difficult to tell the difference at the bedside between a laryngectomy and a surgical tracheostomy, particularly close to major surgery. There are many incident reports of patients following a laryngectomy who are mistakenly given oxygen via the face or who have had attempts at managing their upper airway fail because there is no connection between the face and lungs. Likewise, we know of situations where following radical head and neck surgery, carers have failed to manage a patients upper airway after *assuming* that they had had a laryngectomy when in fact they had not. We have developed colour coded 'bed head' signs and algorithms to immediately distinguish laryngectomies from tracheostomies as recommended by the NPSA and ICS. These are discussed in detail in the emergency algorithm section.





The green bedhead sign is paired with the green emergency algorithms and indicates a (potentially) patent upper airway which can be used in an emergency. The red bedhead sign is paired with the red laryngectomy algorithm. The signs also allow details of the nature and date of the tracheostomy to be recorded, along with details of the airway, and whom to call (and how) in an emergency.

Indications for a tracheostomy

The classical indication for a tracheostomy is upper airway obstruction and this is why the first recorded tracheostomies were performed. However, in modern medical practice, the indications have widened both for temporary and permanent tracheostomy. Indications can be considered as:

- To secure and maintain a patent airway in upper airway obstruction (actual or potential).
- To secure and maintain a safe airway in patients with injuries to the face, head or neck and following certain types of surgery to the head and neck.
- To facilitate the removal of bronchial secretions where there is poor cough effort with sputum retention.
- In an attempt to protect the airway of patients who are at high risk of aspiration, that is patients with incompetent laryngeal and tongue movement on swallowing e.g. neuromuscular disorders, unconsciousness, head injuries, stroke etc.
- To enable long-term mechanical ventilation of patients, either in an acute ICU setting or sometimes chronically in hospitals or in the community.
- To facilitate weaning from artificial ventilation in acute respiratory failure and prolonged ventilation.

Because of the nature of underlying medical conditions that often lead to a tracheostomy, patients who receive a tracheostomy often have poor survival prospects. A review of over 23,000 American inpatient records where a tracheostomy was performed demonstrated that only 80% survived to hospital discharge, with as few as 60% surviving if they had significant co-morbidities (Shah *et al Laryngoscope 2012*).

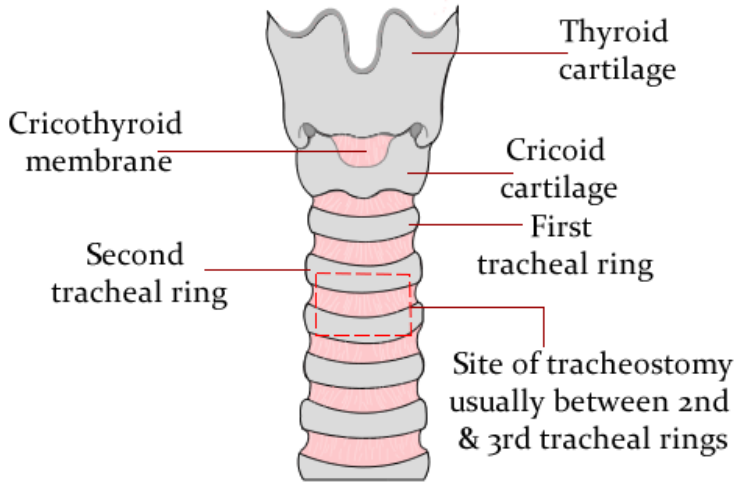
There is no convincing data that can guide clinicians as to the timing of tracheostomy. For specific circumstances such as extensive elective head and neck surgery, the decision is straightforward. However, balancing the risks of managing an airway with prolonged endotracheal tube (ETT) intubation versus the risks of tracheostomy (procedural and post-placement) is difficult and must be made on an individual basis.

Risks of prolonged ETT
Unpleasant to tolerate
Prolonged sedation required
Difficult to re-institute respiratory support without re-intubation
Upper airway trauma
Damage to vocal cords
Breaches larynx, risks aspiration
Blockage and displacement

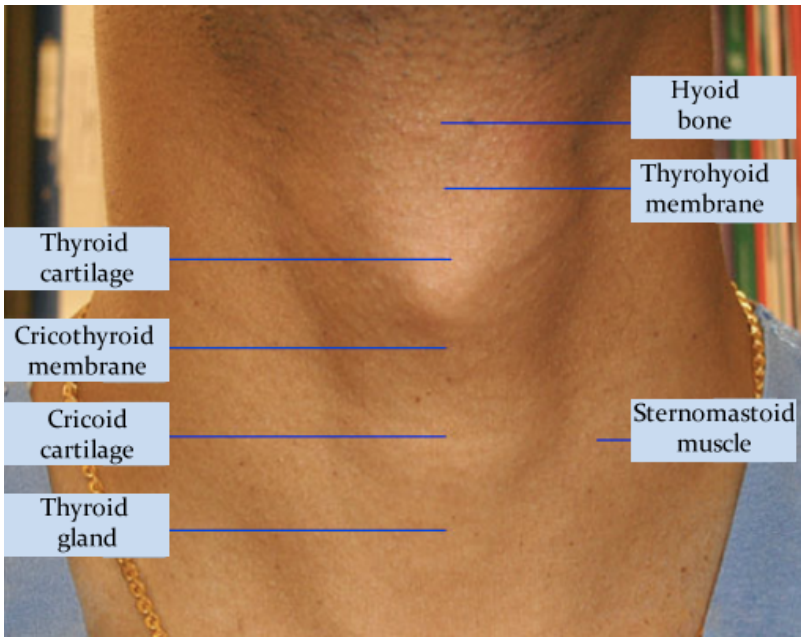
Risks of tracheostomy
Invasive procedure
Bleeding and airway loss during procedure
Stoma infection or breakdown
Scarring, tracheomalacia, stenosis
Blockage and displacement
Damage to adjacent structures

Anatomy relevant to tracheostomy

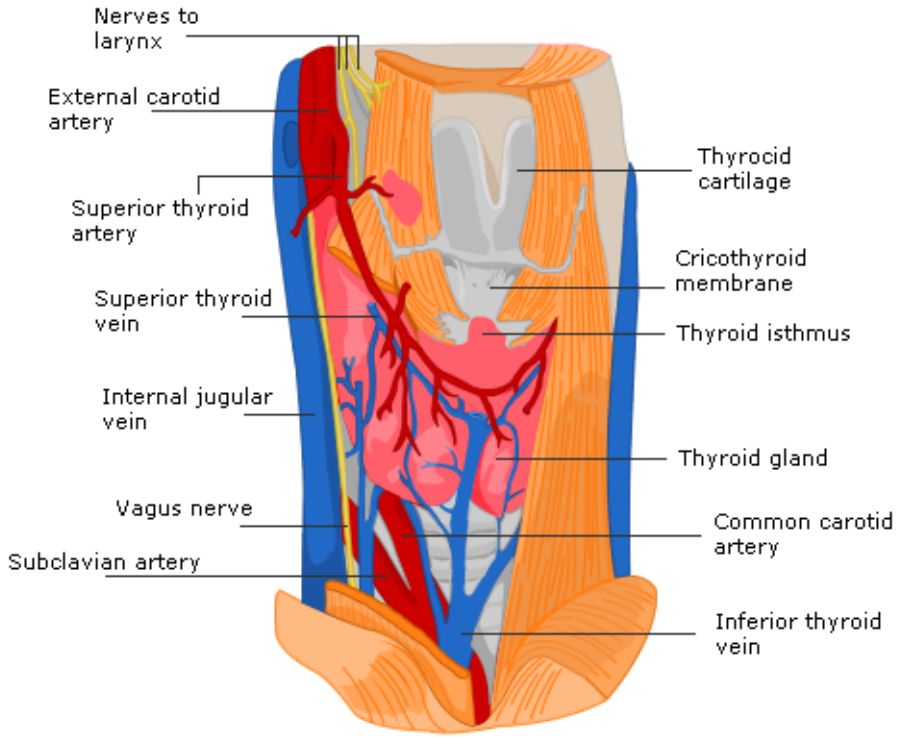
A tracheostomy is an artificial opening made into the trachea through the neck. This may be temporary or permanent. A tracheostomy tube is usually inserted, providing a patent opening. The tube enables air-flow to enter the trachea and lungs directly, bypassing the nose, pharynx and larynx.



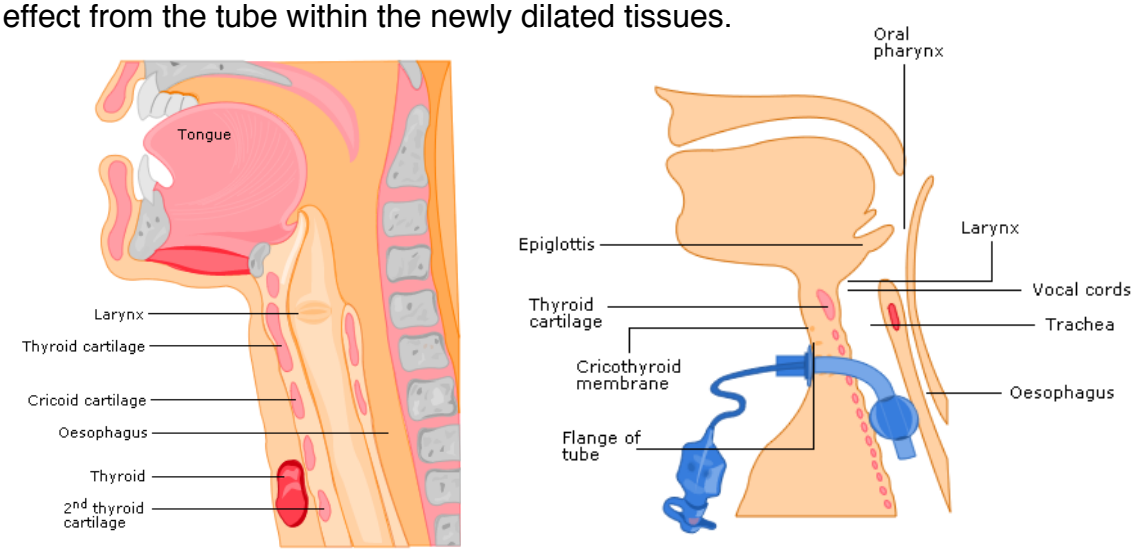
There are a variety of tracheostomy techniques but they all aim to enter the trachea around the gap between the second and third tracheal rings. Emergency access to the airway can be achieved through the relatively avascular cricothyroid membrane. This is reasonably anterior in the neck and close to the surface, and can be identified by feeling for the 'dent' below the 'Adam's Apple' or thyroid cartilage. The further down the neck towards the chest you palpate, the deeper into the neck the trachea goes. In some patients it is difficult to feel the trachea at all.



There are many important structures that lie in the neck in close proximity to the trachea. These can be damaged or cause haemorrhage whilst performing a tracheostomy.

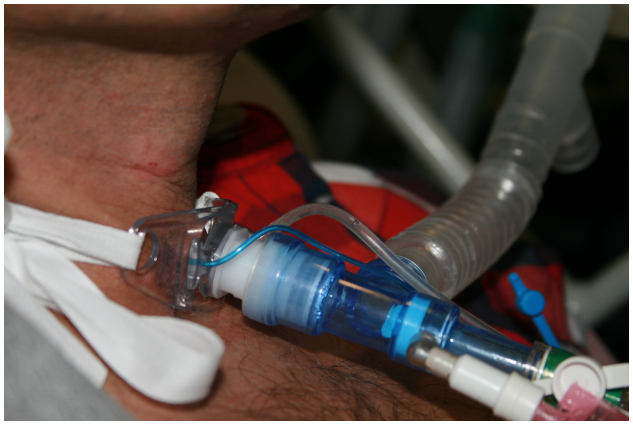


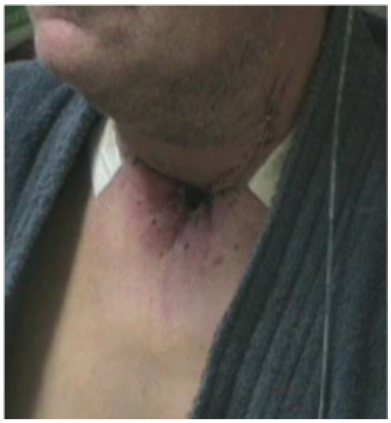
The diagram above highlights some of the important structures relevant to tracheostomy. These are shown in the lateral views below. The thyroid isthmus is often resected during a surgical tracheostomy, but this is not possible during a percutaneous procedure. Similarly, bleeding vessels are more amenable to ligation and diathermy using a surgical technique. The percutaneous technique probably causes less tissue trauma and may make bleeding less likely, but the only way to stop any resultant bleeding is by applying pressure. This can be externally applied or caused by a tamponading effect from the tube within the newly dilated tissues.



Note the position of the flange of the tracheostomy tube. This should be flush with the skin on the front of the neck. In large or obese patients, it can be seen that the distance between the skin and the trachea can be significant. This may require specialist tracheostomy tubes to ensure a safe and correct 'fit.'

The anatomy relevant for laryngectomy is similar, except that the result is an end stoma: the trachea terminates at the front of the neck and is no longer in continuity with the upper airways. The left-hand image below shows a patient with a tracheostomy tube in a tracheostomy stoma, whilst the right-hand image shows a newly created, open laryngectomy stoma, with no tube in situ. It can be very difficult to tell the difference, especially if you are not familiar with laryngectomies. Bedhead signs have an important role here.





Types of tracheostomy

Tracheostomy may be temporary or long term/permanent, and may be formed electively or as an emergency procedure. They may also be classified by their method of initial insertion – either surgical or percutaneous.

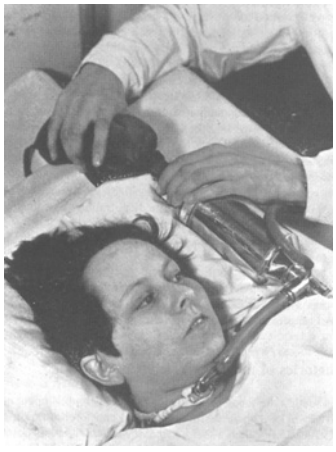
Temporary – will be formed when patients require long/short term respiratory support or cannot maintain the patency of their own airway. They can also provide a degree of 'protection' of the airways against aspiration if the swallowing or neurological control mechanisms of the larynx or pharynx are damaged (commonly in head injuries or neurological diseases). Certain maxillofacial or ENT surgical procedures require a temporary tracheostomy to facilitate the procedure. These tubes will be removed if and when the patient recovers.

Long term/permanent – are used when the underlying condition is chronic, permanent or progressive. This includes carcinoma of the nasooropharynx or larynx. Dependent on the stage of the disease either a tracheostomy or a laryngectomy will be performed. Some patients need chronic respiratory support or long term airway protection and this requires a long term/permanent tracheostomy.

Techniques for inserting a tracheostomy

Tracheostomy is one of the oldest recorded surgical procedures, depicted on Egyptian tablets dated from around 3,600 BC. The earliest publication is in the Rigveda, a sacred Hindu book published around 2000 BC. Asclepiades of Persia (100 BC) and Alexander the Great (350 BC) are described as early practitioners, with other sporadic anecdotal accounts, including Hippocrates concluding that they were dangerous. Antonio Musa Brasavola, an Italian physician, is widely credited with performing the first (well documented) successful tracheotomy. He published his account in 1546. The patient, who suffered from a laryngeal abscess and recovered from the procedure. The same cannot be said for George Washington who died in 1799, probably from upper airway obstruction due to epiglottitis or an abscess. His physicians considered a tracheostomy but were reportedly reluctant to 'have a go' on someone so eminent! The famous surgeon Chevalier Jackson described modification to the procedure in 1909 making it safer to perform with markedly reduced long-term complications, especially for children. The image shows Chevalier Jackson demonstrating a tracheostomy on a rag doll in his car, around 1925. A video can be viewed here.

The 1952 polio epidemic saw tracheostomies used in the first intensive care units in Copenhagen, Denmark. Bjørn Ibsen pioneered this technique and thus allowed positive pressure ventilation to be delivered to patients and reduced mortality from bulbar polio from around 85% to less than 15%. The image shows a patient from the Copenhagen polio epidemic being ventilated via a tracheostomy.



Procedures, techniques, ananesthesia and devices have evolved significantly since 1952. There are two main techniques used to perform a tracheostomy: surgical or percutaneous.

Surgical tracheostomy

This technique is usually carried out in an operating theatre where conditions are sterile and lighting is good. It is possible to perform a surgical tracheostomy at the bedside in the ICU. General anaesthesia is commonly used, however surgical tracheostomies can also be carried out under local anaesthetic. A surgical opening is made into the skin and the tissues of the neck are dissected down to the trachea. The trachea is entered by forming a slit or a window into which a tube is placed. The tube may then be sutured to the skin and/or secured with cloth ties or a holder.


Surgical dissection through the tissues of the neck

Surgical tracheostomies may be formed as part of ENT or Maxillofacial surgical procedures, usually during face and neck dissections for tumour removal. Importantly, in procedures where surgical removal of the larynx is undertaken, a laryngectomy stoma is created. This means that there is no connection from the mouth or nose to the trachea. Detailed descriptions of surgical techniques are beyond the scope of this manual.

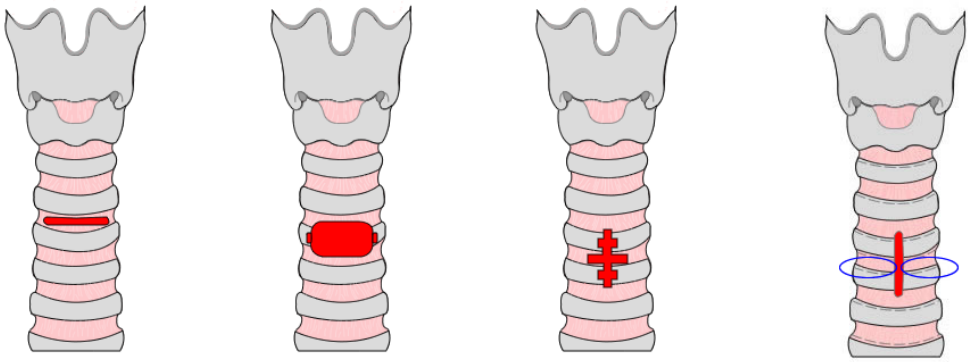
Types of surgical tracheostomy

The incision in the anterior tracheal wall may be one of the following:

1. **Horizontal slit** - a horizontal or T-shaped tracheal opening through the membrane between the second and third or third and fourth tracheal rings (Fig 1 overleaf). With this incision, a silk stay suture can be placed through the tracheal wall on each side and taped to the neck skin on either side. This facilitates tube replacement by pulling the trachea anteriorly and widening the opening should the tube dislodge in the immediate postoperative period. These sutures are removed after the first tracheostomy tube change, usually 5-7 days postoperatively once the newly formed tract from the skin to the trachea becomes more established.

2. **Window.** Removal of small anterior portions of the tracheal rings can create a more permanent stoma, like the 'window' shown in Fig 2.

3. **Vertical slit** - A U- or H-shaped tracheal opening can be made and the tracheal flaps can be tacked to skin edges with absorbable sutures to create a semi-permanent stoma (Fig 3a). Sutures can be placed in each tracheal flap and taped to the chest and neck skin, facilitating replacement of a displaced tube in postoperative care (Fig 3b). Pulling on these sutures widens the tracheal opening. Most modern adult surgical tracheostomies will be performed in this way, with the sutures remaining for approximately 1 week until the tract is formed.



Figures: 1 2 3a 3b

4. **Björk flap** A different type of surgical tracheostomy is the Björk flap where a 'ramp' of trachea is sutured to the skin which allows easier replacement of tracheostomy tubes (Fig 4). There may be a suture to the skin here too, but this is to hold the 'ramp' in place, rather than to be used to elevate the trachea for a tracheostomy tube change. If Björk flap sutures are pulled, they may tear the 'ramp' and occlude the stoma. Björk flap tracheostomies are not commonly performed, but if they are done in your hospital, you need to know what the bits of suture coming out of the stoma will do when pulled!

5. **Sutures** Fig 5 shows a Björk flap with a 'flap suture' to the skin (blue) and slit-type tracheostomy with 2 stay sutures (purple) to the skin. Sutures may be at the top and bottom of the incision too. These can be used to manipulate the trachea.

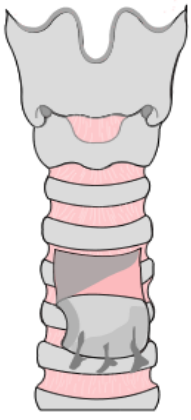


Fig 4

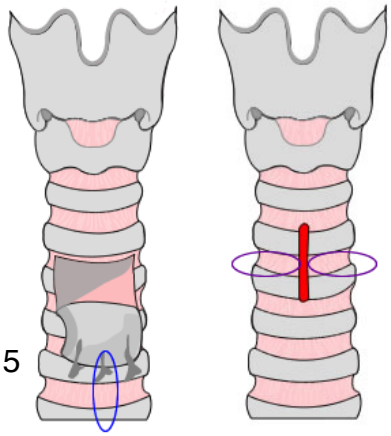
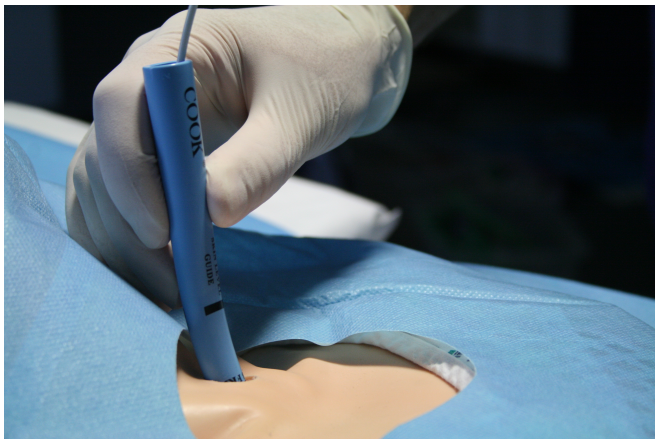


Fig 5

Percutaneous tracheostomy

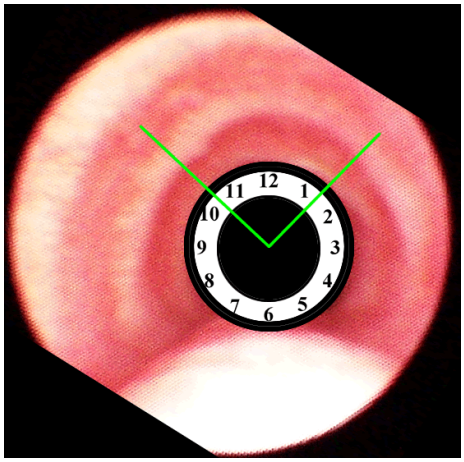
This is the most commonly used technique in critical care as it is simple, relatively quick and can be performed at the bedside using anaesthetic sedation and local anaesthetic. Moving critically ill patients to the operating theatre can be challenging, so a safe, bedside procedure often makes this the technique of choice in the critically ill. The procedure involves the insertion of a needle through the neck into the trachea followed by a guide-wire through the needle. The needle is removed and the tract made gradually larger by inserting a series of progressively larger dilators over the wire until the stoma is large enough to fit a suitable tube (Seldinger technique). The tube is then secured by cloth ties, sutures or a holder. Click to see videos of a percutaneous tracheostomy insertion: Video 1, Video 2, Video 3.

There is les dissection and cutting than with a surgical technique and this may cause less tissue trauma and bleeding. The tissues are stretched or dilated.



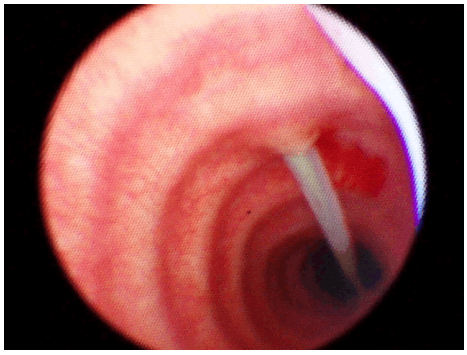
However, the only way to stop any bleeding if it does occur is via the tamponading effect of the tube in the stretched tract. Most centres will opt for a surgical tracheostomy if a patient has bleeding problems or a large vessel near the puncture site as this allows more options for controlling potential bleeding (diathermy, ligation). Some patients do not have an easily palpable trachea. A surgical approach may be safer for these patients also. It is possible to perform hybrid techniques where a small amount of blunt dissection is performed prior to puncturing the trachea with a percutaneous set, or following formal surgical exposure, a percutaneous set is used to enter the trachea if the trachea is difficult to access.

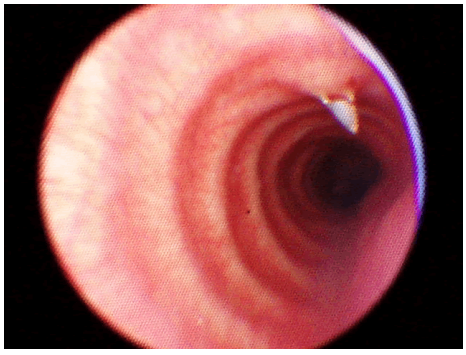
To ensure correct needle placement within the trachea, the procedure is often guided by a suitable fibreoptic endoscope inserted into the airway. This technique has a number of advantages:



1. Confirmation of an appropriate entry point in the anterior trachea. Between 11 and 1 o'clock is ideal, although the closer to 12 o'clock, the better. The image shows the needle visualized entering the trachea as viewed from inside the endotracheal tube.

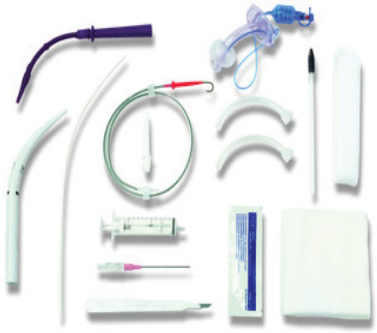
2. Confirms appropriate entry site between second and third tracheal rings. May be able to guide the needle to reduce the risk of tracheal ring fracture.
3. Ensuring that the needle does not pass through the posterior tracheal wall, risking paratracheal or oesophageal insertion.
4. Ensure that the guidewire is appropriately placed.
5. Confirmation of eventual successful placement of the tracheostomy tube within the tracheal lumen
6. Allows aspiration of blood promptly from the airway.

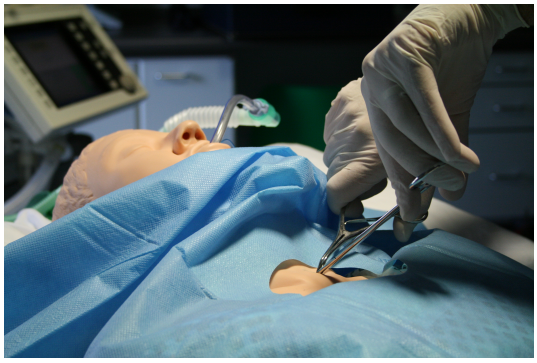




The left-hand image above show correct placement of a needle and guidewire within the trachea. The image to the right shows a puncture site that is probably too lateral (towards 3 o'clock). The images are both slightly rotated, with the true posterior (back) wall of the trachea laying in the bottom right hand corner of each image.

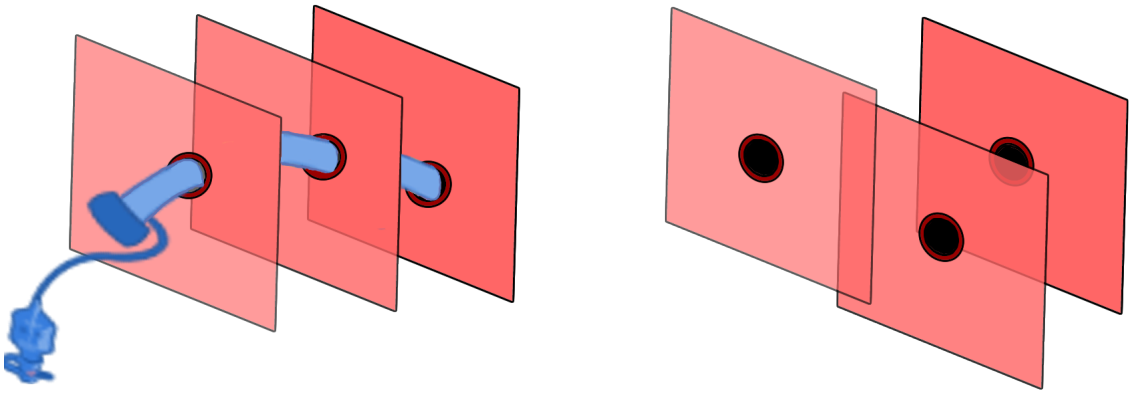
Introducing a bronchoscope into the airway does have its drawbacks. Depending on the size of the endoscope, an endotracheal tube of at least 7 mm internal diameter is usually required. This doesn't leave much room for ventilation and a degree of hypoventilation can be expected during the procedure. There is also the risk of damaging the endoscope during initial puncture of the trachea, although disposable endoscopes are now available which may address part of this problem.





A big difference with percutaneous tracheostomies in the first few days after the stoma is created is that the tract will take 7-10 days to mature, compared with 2-4 days for a surgical tracheostomy. If a tracheostomy tube becomes displaced in this early period, the tissues are likely to 'spring' back into their original places, whereas the cut and sutured surgical tract is more

likely to remain patent. This has implications for attempting to re-insert a new tracheostomy tube into a newly created percutaneous stoma. Despite the wealth of literature and claims about the various benefits of one technique over another, most clinicians from all specialties will agree that after the first week or so, what you have is a tracheostomy stoma and it doesn't really matter how it was formed. Better follow up of tracheostomies may reveal subtle differences in the future.



The figure above demonstrates how once a percutaneously inserted tracheostomy tube becomes displaced, the recently dilated tissues can 'spring' into their original positions, making reinsertion difficult.

Performing a tracheostomy

Preparation

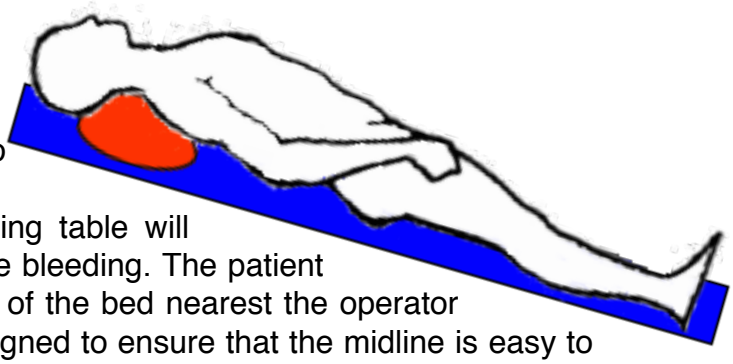
Whatever the technique, preparation is essentially the same. Checklists can reduce the potential for performing the wrong procedure on the wrong patient at the wrong time, and should be used. Consent can be difficult in patients who lack capacity, either through chronic or critical illness. Ideally, documented discussions about the risks and benefits of tracheostomy should take place whilst capacity remains, although this can be difficult in this cohort.

Review recent blood results and the drug regimen to ensure that clotting indices are within acceptable limits and that the patient has not received anti-coagulant medication. It is important to assemble the key personnel and equipment that will be required before commencing the procedure. As with all airway interventions, unexpected and time-critical complications may occur at any time. Critical care patients who are dependent on high fractions of inspired oxygen or high ventilation pressures are less likely to tolerate the hypoventilation and de-recruitment that inevitably occurs during a tracheostomy. Careful assessment of individual risks should be undertaken.

Positioning

Access to the patient's trachea can be made easier by positioning the patient

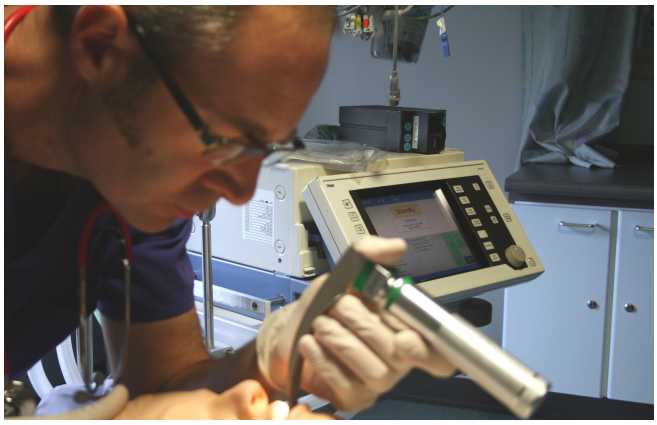
appropriately, to bring the trachea more anteriorly in the neck. Care must be taken with patients who have a potentially instable neck or raised intra-cranial pressure. Pillows or support behind the shoulders will allow the neck to extend as shown in the image.



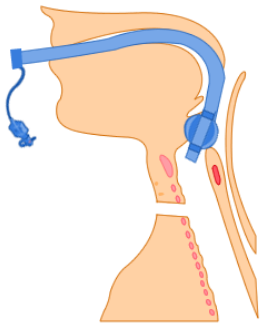
Tilting the whole bed or operating table will drain neck veins and may reduce bleeding. The patient should be positioned at the side of the bed nearest the operator with the head, neck and torso aligned to ensure that the midline is easy to identify. Finally, appropriate lighting should be used, especially for surgical procedures.

Anaesthetic considerations

Tracheostomy may be performed under local anaesthesia alone. This usually includes a vasoconstrictor such as adrenaline to reduce bleeding. If the patient has impending upper airway obstruction, positioning may be very difficult, as the patient is likely to be distressed. Sedation should be avoided if possible in an attempt to maintain the patency of the upper airway.



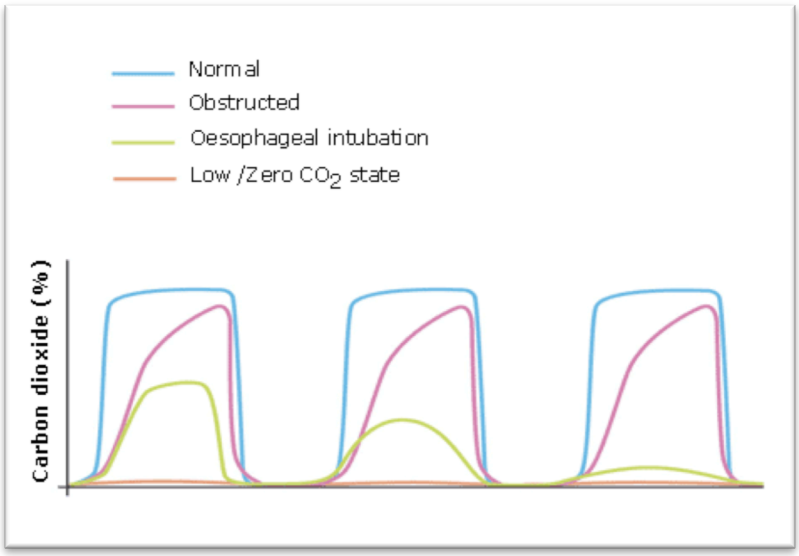
If the patient is already ventilated, then some form of airway management will have occurred already, although this may not be definitive. A suitable intravenous sedative and analgesic combination should be administered and a neuromuscular blocking agent is usual. Tracheostomy is stimulating and significant doses of short acting opiates and hypnotics are often required. These should be titrated carefully in the critically ill.



The upper airway can be managed with a simple facemask, supraglottic airway device (such as laryngeal mask airway LMA) or more usually endotracheal tube. For percutaneous procedures, a suitable endoscope is usually employed to visualise entry of the needle into the trachea. This may necessitate changing of

the current airway device (e.g. to a larger diameter endotracheal tube). An endotracheal tube will need to be withdrawn from the surgical field prior to tracheal incision and insertion of the tracheostomy tube. All airway manipulations are more difficult with the neck extended and so experienced personnel with the appropriate difficult airway equipment should manage the upper airway. It is always prudent to perform direct laryngoscopy once the patient is in the position for the tracheostomy to view the airway. Remove any secretions above the tracheal cuff prior to deflating or manipulating the endotracheal tube. Gastric feed will also need to be stopped and aspirated prior to planned airway manipulations as per local guidelines. The image shows an endotracheal tube viewed at direct laryngoscopy. The tube is usually withdrawn until the cuff sits above the vocal cords. The tube is now very precarious and care must be taken to ensure it remains in position, especially whist performing endoscopy.

Routine monitoring utilising **capnography** is essential for any airway manipulation. Capnography will give immediate information about tube displacement from the upper airway and will confirm correct placement and adequate ventilation when the tracheostomy tube is inserted.



Finally, it is usual to pre-oxygenate the patient prior to any airway manipulations. This may be difficult in the critically ill, but increasing ventilation times and pressures, along with the inspired fraction of oxygen will offer a degree of protection against the hypoxia which may rapidly develop when

ventilation is interrupted or compromised during manipulation of the airway devices.

Because of the potential problems both anaesthetising for and performing a tracheostomy, practice on a suitable simulator is advocated before undertaking supervised practice with patients.

Physiological changes with a tracheostomy

As well as changing the airway anatomy, the airway physiology is altered when a patient has a tracheostomy inserted. Depending on the type of tube and presence of a cuff, the upper airway may be isolated completely. The tracheostomy will generally remain until the indication for insertion has resolved. In some instances however, the tracheostomy will be permanent. A laryngectomy is a permanent surgical change to the airway anatomy. Some of the physiological changes are advantageous to us as clinicians treating these patients. Others necessitate extra vigilance and care.

Upper airway anatomical dead space can be reduced by up to 50%

This can be advantageous when weaning patients from mechanical ventilation. The dead space takes no part in gas exchange and adds to the work of breathing. Reducing this can help patients with critical respiratory reserves get off a ventilator.

The natural warming, humidification and filtering of air that usually takes place in the upper airway is lost

This is one of the biggest dangers with a tracheostomy or laryngectomy. Secretions will become thick and dried and can easily obstruct a stoma or tube. This situation is made worse if there are copious secretions.

The patient's ability to speak is removed

This is a big problem for the patient and can lead to distress and anxiety. Sometimes, we can use aids like speaking valves to help patients vocalise, but attentive and nursing staff are probably the most valuable source of help. Communication boards can be useful too.

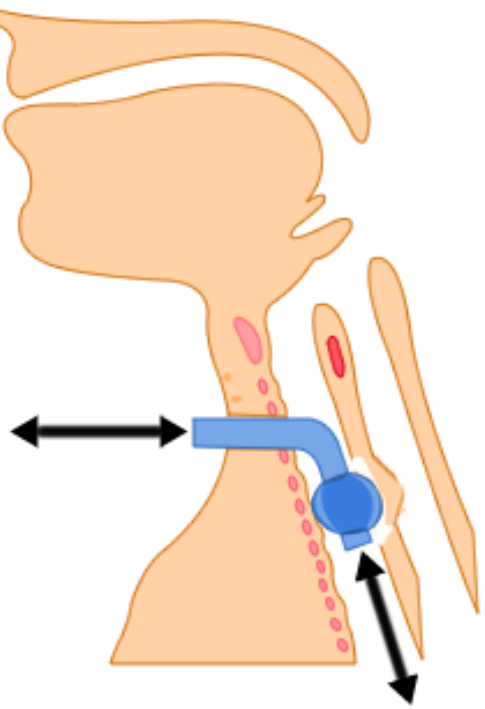
Sense of taste and smell can be lost

This can reduce appetite and general wellbeing of the patient. Patient's report this as a significant problem which can be easy to overlook when managing their 'medical' problems.

Altered body image
This is an important factor as it can have a major psychological impact. If possible the patient should have careful preoperative explanation. If this is not possible the patient must receive explanation and support postoperatively. Inform the patient that scarring will be minimal when the tracheostomy is removed and the stoma has healed and, that speech will return (as long as the vocal cords remain intact). On average the stoma will close and heal within 4-6 weeks. However this may vary from patient to patient depending on factors affecting wound healing.

The ability to swallow is adversely affected
Most people with a new tracheostomy will have a naso-gastric tube or similar feeding route and regimen established. The cuff of the tracheostomy or the tube itself interferes with the swallowing mechanics of the larynx. These muscles can waste if not used (during prolonged ventilation) and require careful rehabilitation and assessment. The Speech and Language Therapist (SALT) is an essential member of the multi-disciplinary team.

The image below shows an inflated tracheostomy tube. The cuff is pressing on the oesophagus behind the trachea, offering a physical obstruction to swallowing. The tracheostomy tube tethers the anterior structures of the neck and limits the amount of movement of the larynx and upper airways that is required for normal, safe swallowing.

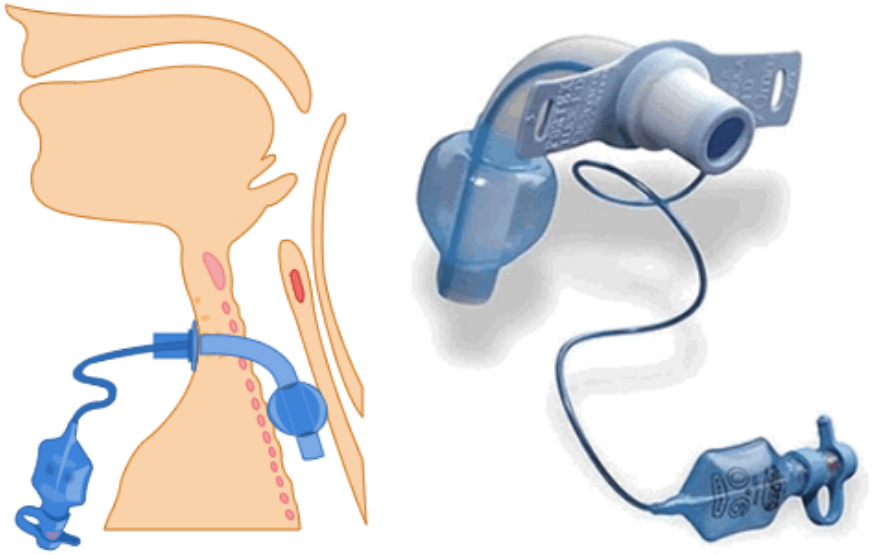


Different types of tracheostomy tubes

The different types of tubes available can seem confusing. Essentially tubes can be described by the presence or absence of a cuff at the end, by the presence or absence of an inner cannula, or by the presence or absence of a hole or 'fenestration.' Tubes can finally be made of different materials and be different diameters and lengths. Most modern tubes are made from medical grade polyvinyl chloride, polyurethane, silicone or a combination of these materials. Some are lined with special films to reduce the 'biofilm' that may develop inside the lumen. There are illustrations and diagrams of the different functions of the range of tubes available via the e-learning section of the website www.tracheostomy.org.uk. Alternative, narrated presentations can be found by clicking here: Explanations of these different types of tubes and cuffs.

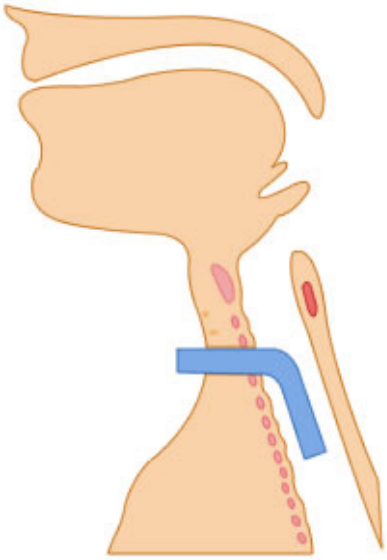
Cuffed Tubes

Cuffed tubes have a soft balloon around the distal end of the tube which inflates to seal the airway. Cuffed tubes are necessary when positive pressure ventilation is required or in situations where airway protection is essential to minimize aspiration of oral or gastric secretions (although all cuffs are not an *absolute* barrier to secretions). If the tracheostomy tube lumen is occluded when the cuff is inflated, the patient will not be able to breathe around the tube, assuming the cuff is correctly positioned and inflated within the trachea.

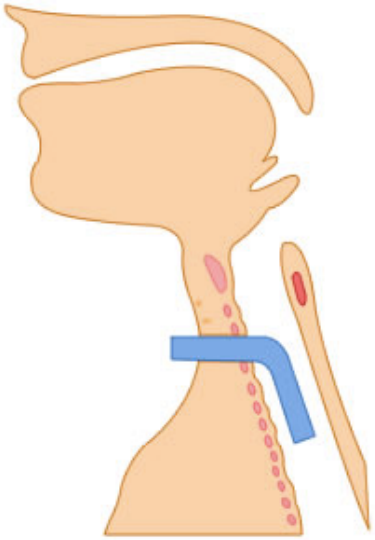


Un-cuffed Tubes

Un-cuffed tubes do not have a cuff that can be inflated inside the trachea and tend to be used in longer-term patients who require on-going suction to clear secretions. These tubes will not allow sustained effective positive pressure ventilation as the gas will escape above the tracheostomy tube. It is essential that patients have an effective cough and gag reflex to protect them from aspiration, as there is no cough to 'protect' the airway. Un-cuffed tubes are rarely used in acute care.



Another type of un-cuffed tube is the minitrach tube. These are typically 4 mm internal diameter and have no cuff. They are primarily designed to allow airway toilet (suction) but can facilitate delivery of oxygen. They are too small to provide any ventilation or removal of carbon dioxide and so can only be considered an emergency method of oxygenation. Minitrachs are sometimes used when preparing to decanulate a patient. The minitrach can remain in the stoma and keep it patent in case a tracheostomy tube needs to be re-inserted. Minitrachs can also be inserted through the cricothyroid membrane. Specialised insertion kits are available for this, either electively or in an emergency.



Fenestrated Tubes

Fenestrated tubes have an opening(s) on the outer cannula, which allows air to pass through the patient's oral/nasal pharynx as well as the tracheal opening. The air movement allows the patient to speak and produces a more effective cough. However, the fenestrations increase the risk of oral or gastric contents entering the lungs. It is therefore essential that patients who are at high risk of aspiration or on positive pressure ventilation do not have a fenestrated tube, unless a non-fenestrated inner cannula is used to block off the fenestrations (see figures).

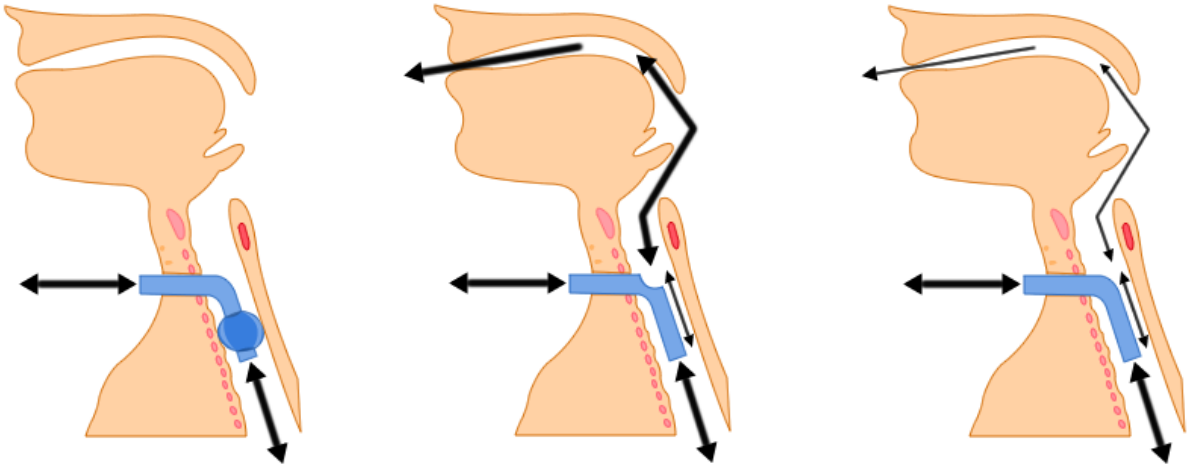
Suctioning with a fenestrated tube should only be performed with the non-fenestrated inner cannula in situ, to ensure correct guidance of the suction catheter into the trachea.

The upper type of inner tube (below right) has a fenestration in it, which lines up with the fenestration in the outer tube. Air can then flow through the tube as before, but in addition, some air can flow through the holes and out through the patient's mouth. This air flow to the upper airway allows the patient to talk. If positive pressure needs to be given to the patient to aid ventilation, for example in the event of a cardiac arrest or worsening respiratory function, then the tracheostomy inner tube without the fenestrations should be fitted, this then allows positive pressure airflow to enter the lungs rather than escaping through the mouth.

The lower inner tube (right) has no hole (or fenestration) and so air flow is allowed straight through the tube from one open end to the other. When this is in situ, minimal amounts of air pass through the patient's upper airway. This inner tube should be in place when the patient is suctioned as there is a small risk of a suction catheter passing through the fenestration and damaging the tracheal mucosa.

Fenestrated tubes can be cuffed or un-cuffed. The various inner tubes are shown.

The images below demonstrate different airflow patterns with different tubes inserted. There are video demonstrations available by clicking here.



Single Cannula Tubes

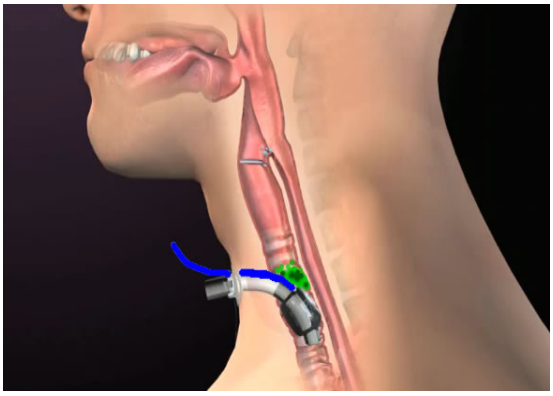
Single cannula tubes are traditionally the first tube to be sited in a critical care area. The system is less complicated than a double cannula tube and is usually for temporary use only. These tubes can be cuffed or un-cuffed. The larger inner diameter of the single cannula tube allows lower inflation pressures to be used when the patient is ventilated, as the larger diameter offers lower resistance to gas glow. The Intensive Care Society in their 2008 guidance have recommended that these tubes are not used routinely in critical care owing mainly to concerns about them becoming occluded with secretions, and the difficulty in cleaning this type of tube. Indeed, without a removable inner cannula, if these tubes do become blocked, often the only way to unblock them is to change the whole tube. Depending on the nature of the stoma and the condition of the patient, this can clearly be hazardous.

Double Cannula Tubes

Double cannula tubes have an outer cannula to keep the airway open and an inner cannula which acts as a removable liner to facilitate cleaning of impacted secretions. Some inner cannula are disposable, others must be cleaned and re-inserted. Patients discharged from a specialist area with a tracheostomy should have a double lumen, ideally un-cuffed cannula in place. This type of tube is the safest to use outside the specialist environment, although to reduce the incidence of tube occlusion, the inner cannula must be regularly cleaned. If an un-cuffed tube becomes blocked, it is more likely that a patient can breathe past the tube via their upper airway, making these tubes inherently safer for non-specialist locations. If there is a high risk of aspiration or need for long-term ventilation, then a cuffed tube may be required long-term. Regular care of the inner tube will prevent build up of secretions and reduce the risk of tube blockage as shown in the image. The inner tube should be removed and cleaned in sterile water every 6-8 hours, or more frequently if heavy secretion load. A spare inner tube should be kept in a clean container at the patient bedside when not in use. It should be noted that some designs of tracheostomy tube require the inner cannula to be in situ before the tracheostomy can be connected to an anaesthetic breathing circuit. It is essential that you understand the equipment being used in your place of work. Videos showing inner tube care can be found here, with YouTube videos from the NTSP here.

Tubes with sub-glottic suction

As part of a bundle of care, subglottic suction may reduce the incidence of a ventilator associated pneumonia occurring in those patients who require mechanical ventilation via a tracheostomy tube. Tubes are now available from various manufacturers which will allow continuous or intermittent suction from any material that accumulated above the inflated cuff of a tracheostomy tube. Again, when the patient leaves the specialist environment, these tubes should be changed for more simple devices. The extra tubing can potentially confuse carers and there is at least one report of the subglottic suction port being connected to enteral feed in error!



Adjustable Flange Tracheostomy Tubes

These tubes are used in patients who have an abnormally large distance from their skin to their trachea, and a standard tube would not fit properly. There are now dedicated kits for inserting these tubes. Standard tubes may not be the correct size for many critical care patients and increasing numbers may require these tubes. Clinical examination, ultrasound and endoscopic inspection before and after a tracheostomy procedure may help to decide which patients require these types of tubes.

Particular indications for an adjustable flanged tube are:

- Patients with very large neck girth including the obese
- Oedema caused burns classically or a capillary leak syndrome (sepsis etc)
- Actual or anticipated oedema after surgical procedures (including tracheostomy itself)

It is essential to review the position of the flange (hence the length of the tube) on a daily basis. If the patient has neck swelling, as this worsens or resolves, the flange may need adjusting. Adjustable flange tracheostomy tubes are more difficult to use and are associated with additional complications, some of which may be life threatening. Only use an adjustable flange tracheostomy tube when it is essential to do so. Patients within a ward area will not usually have an adjustable flange tubes. Newer adjustable flange tracheostomy tubes can have an inner tube.

Choice of tracheostomy tube

The UK Intensive Care Society produced guidance on tracheostomy care in 2008 which included information on the choice of tracheostomy tube. This is summarised below with expansion in some sections.

An important consideration is whether to use a tracheostomy with an inner tube from the time of initial percutaneous tracheostomy, which may be performed for weaning on the ITU. It is increasingly recognised that tube obstruction can occur in critical care areas as well as on the wards and the ICS recommend that these easily cleanable tubes should be used where possible as standard to reduce the risks of obstruction. The disadvantage is that these tubes have a reduced internal diameter which has implications for gas flow. There is also the problem of repeated disconnection from a ventilator which can cause de-recruitment of the lung, with disadvantages for gas exchange in the critically ill. These factors have to balanced against the increased risks of tracheostomy tube obstruction with single lumen tubes, and the possibility of requiring a tube change if the patient is to be moved to a non critical care area. A tracheostomy tube should not be changed for 7-10 days if possible after a percutaneous procedure.

Factors influencing temporary tracheostomy tube choice

Respiratory function

Most temporary tracheostomies inserted to assist with ventilation will be inserted whilst a patient is in an intensive care unit and still requiring some degree of positive pressure ventilation. This will require the use of a cuffed tracheostomy tube (although it is recognised that long term mechanical ventilation can be delivered through an uncuffed tube in certain circumstances).

Abnormal airway anatomy

Upper airway endoscopy following percutaneous insertion suggests that a standard tracheostomy tube may be anatomically unsuitable in as many as one third of adult patients. Obese patients may require a tube with an extended proximal length, whilst patients with fixed flexion abnormalities may not easily accommodate tubes with a fixed angulation. Airway pathology Localised airway pathology such as tracheomalacia, granuloma formation etc

may on occasion necessitate the use of a tracheostomy tube that has a longer distal length than standard.

Compromised airway, protection and weaning problems

Patients can be weaned to decannulation without any need to change to change from the cuffed tracheostomy tube that was initially inserted. In some cases however, it may be useful to consider options such as downsizing, to an un-cuffed or fenestrated tube, or a tube with the option for sub-glottic aspiration of airway secretions. The introduction of a speaking valve may also aid swallowing and secretion control (see next section).

Speaking

Consideration of whether the patient is able to speak, whether it is desirable for them to speak (laryngeal training) or indeed if they want to attempt speech can dictate the type of tube inserted. If the patient has significant 'mouth breathing' then they may benefit from a smaller tube to allow more air to pass around the tube. If a larger tracheostomy tube is required or desired (e.g. the patient requires intermittent cuff inflation and mechanical ventilation) then a fenestrated tube may be a better choice.

Obstructed / absent upper airway

Patients with an obstructed or absent upper airway are at particular risk should a tracheostomy become obstructed or misplaced. This has implications for both the choice of tracheostomy tube as well as the method by which the stoma is fashioned.

Clinical environment

Obstruction of a cuffed tracheostomy tube is a potentially life threatening emergency. Wherever possible a dual cannula tube (i.e. a tube with an inner cannula) should be used, particularly for patients cared for outside of a specialist environment who may not have immediate access to clinicians with emergency airway skills. Ward staff can change inner tubes easily and quickly to relieve obstruction with secretions.

The location that patients will be managed in will also influence the choice of tube. Simpler tubes without additional subglottic suction ports and channels will reduce the potential for confusion. If the patient is going to be discharged to a facility outside of a hospital environment, then consideration should be made to how easily the carers can manage with the device that is inserted. This will include balancing the risks of using a cuffed tube.

Tubes from different manufacturers

There are many different manufactures of tracheostomy tubes and devices around the world, some with significantly different internal and external diameters, and some tubes have significantly different lengths and angulations (see the image below comparing 2 tubes). The table and images below demonstrates some key measurements from a selection of tubes widely

available in the UK. (ID/OD – internal/outer diameter, lengths in mm). It can be seen that even with the same 'size' tubes, there can be significant differences in the diameter of the internal diameter.

A comprehensive list of the various sizes of many of the world's tracheostomy and laryngectomy tubes can be found in Linda Morris' book, *Tracheostomies – the complete guide (*Chapter 4) Springer 2010.

Manufacturer / tube	ID without inner	ID with inner	OD	Length
Shiley DCT	n/a	7.6	12.2	79
Kapitex Tracheotwist	n/a	8.0	11.4	76
Portex Blue Line Ultra	8.0	6.5	11.9	75.5

This section covers some of the daily considerations for neck breathing patients, their carers and medical and nursing teams. This section covers:

- Daily checks
- Humidification
- Suctioning
- Stoma care & securing the tube
- Management of the inner cannulae
- Oral care & Swallowing
- Cuff management
- Tube changes
- Weaning, down-sizing, caps & speaking valves and planning for decannulation
- Decannulation
- Bedside equipment
- Laryngectomy humidification
- Speech after laryngectomy
- Patient information sheets

Daily checks

There should be a detailed plan of care for all patients with a tracheostomy. A suggested care plan is provided in this manual, but local policies may already be in place. The care plan should be reviewed on a daily basis and updated if there is any change.

The patient with a tracheostomy needs diligent observation and assessment. The nurse caring for the patient is responsible for this, seeking advice from other professionals as appropriate.

Patient assessment
At the start of each shift the Staff Nurse caring for the patient with a tracheostomy should carry out a full assessment of the patient, which should include:

- Why does the patient have a tracheostomy?
- When was the tracheostomy performed? Was it surgical or percutaneous (may have implications for ease of re-insertion) and does the patient have a larynx? (i.e do they have a communication between the oral airway and the lungs?) Bed-head signs should be available at the patients' bed space to quickly and easily communicate this information.
- Type and size of tracheostomy tube & availability of spare & emergency equipment
- Cough effort
- Ability to swallow, including any SALT assessments
- Sputum characteristics (Colour, Volume, Consistency, Odour)
- Check and change inner cannula for any build up of secretions (see later)
- Check tracheostomy holder is secure and clean
- Check stoma dressing is clean
- Routine observations

This assessment should be documented on the care plan at the start of every shift.

Humidification

It is mandatory that a method of artificial humidification is utilised when a tracheostomy tube is in situ, for people requiring oxygen therapy – 'dry' oxygen should never be given to someone with a tracheostomy or laryngectomy. The type of humidification will be dictated by the needs of the patient.

During normal breathing, inspired air is warmed, filtered and moistened by ciliated epithelial cells in the nose and upper airways. However, these humidifying functions are bypassed by a tracheostomy tube or laryngectomy and air inspired will be cold and dry. Inadequate humidification can result in a number of physiological changes which can be serious to the patient and potentially fatal, including:

- Retention of viscous, tenacious secretions
- Impaired mucociliary transport
- Inflammatory changes and necrosis of epithelium
- Impaired cilia activity
- Destruction of cellular surface of airway causing inflammation, ulceration and bleeding)
- Reduction in lung function (e.g. atelectasis/pneumonia)
- Increased risk of bacterial infiltration.

As a result, humidification must be artificially supplemented to assist normal function and facilitate secretion removal. **Failure to adequately humidify could result in tube or stoma blockage as secretions become dry and viscous, forming a crust around the tracheostomy.**

The assessment of a patient with a tracheostomy should include management of their secretions and should identify the effectiveness and adequacy of the current humidification of that patient. Maintaining systemic hydration is also important and a dehydrated patient is at a greater risk of developing problems due to thick and dry secretions.

A tracheostomy tube can become completely blocked by thick secretions, leading to a respiratory arrest but this can be prevented by regular and effective assessment of the patient's humidification, regular inner cannula care and suctioning. Warning signs can be identified which will allow for an appropriate change in management and this should prevent tube blockage.

Patient assessment should include:

- Frequency of suctioning and/or cleaning or inner cannula
- Tenacity of secretions
- Evidence of airflow via tracheostomy
- Respiration rate

- Use of accessory muscles
- Patient coughing (ineffective or excessive)
- Requirement for supplementary oxygen

High risk patients include those with reduced or thickened secretions and those with a longer length and/or single lumen tube. These patients should be cared for with extra vigilance in order to minimize the risk of tube blockage.

Methods of artificial humidification

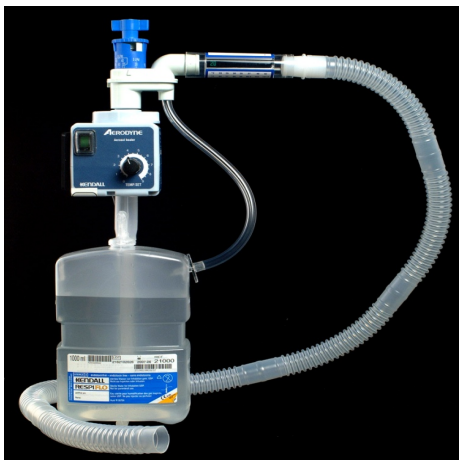
The chosen method of humidification will:

- Provide adequate humidification of chest secretions
- Help maintain body temperature
- Be convenient and cost effective
- Be physically suited to the patient

Consideration should be made relating to the potential infection risk of each device. Any chosen device should be used in accordance with the manufacturer's guidelines and staff trained and assessed as competent in its use.

Heated Humidification

Heated Humidification operates actively by increasing the heat and water vapour content of inspired gas. Gas can be delivered fully saturated at core temperature, depending on the system employed. A heater and water bath system is shown to the right. These systems indicated for tracheostomy patients requiring mechanical ventilation or oxygen therapy for ≥ 96 hours. This type of humidification is more effective than HME filters for those patients receiving artificial ventilation and should be used if the HME is not adequate.



Cold Humidification

Cold humidification bubbles gas through cold water, but only delivers a relative humidity of around 50% at ambient temperatures. For tracheostomy patients on high inspiratory flow rates of oxygen with tenacious secretions or patients complaining of subjective dryness, a heated device is indicated.

Note: Condensation from heated or cold humidification should be considered infectious waste and disposed of according to hospital policy using strict universal precautions. Because condensate is infectious waste, it should never be drained back into the humidifier reservoir.

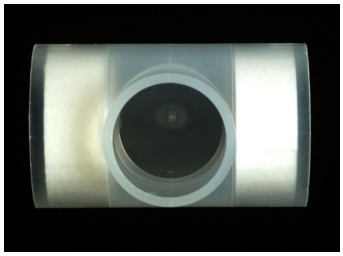
Saline Nebulisation

The nebuliser unit (right) converts saline into a supersaturated aerosol of liquid droplets which penetrates the lung moistening the airways. It may be indicated in tracheostomy patients who are mechanically ventilated, receiving oxygen therapy or self-ventilating on air.

Saline nebulisers help to reduce the viscosity of secretions which makes them easier to remove by suction or cough. Saline nebulising involves administration of 5 to 10mls 0.9% sterile normal saline into the nebuliser unit 2-4 hourly or as required. Nebulisers must be connected to a gas source with a flow rate of 6-8 litres/minute (or follow manufacturer's guidelines). Remember if the patient is requiring supplemental oxygen, then the gas driving the nebuliser should be oxygen and not air. Ensure nebulisation is given via the tracheostomy (not the face mask!). A nebuliser can be attached to tracheostomy mask or T-piece circuit.

Heat Moisture Exchanger (HMEs)

HMEs consists of rolls of metal gauze or a condenser element like propylene sponge/fibre sheet/corrugated paper. These products are placed either directly onto the end of the tracheostomy tube or can be placed into a breathing circuit. They conserve heat and moisture on expiration via tube. They need to be checked regularly to ensure they are not occluded by secretions which may obstruct the airway. They require checking regularly and must be changed at least every 24 hours. Some product ranges also offer oxygen delivery inlets, suction ports. Heat moisture devices are available as small cylinder or nozzles which attach directly to tracheostomy tubes allowing for patient mobility and may have speaking valves incorporated in them.



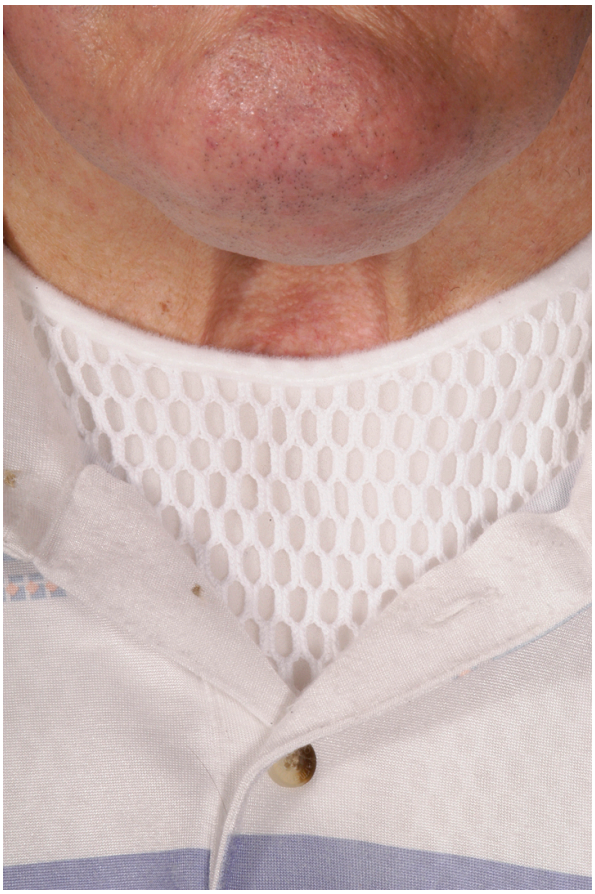
Images: Thermovent (above)
HMEs for anaesthetic circuits (centre)
'Swedish nose' (right)

Stoma filters or bibs

This group of humidification devices contains a foam layer which absorbs moisture from the patient's expired gases. They are predominantly used for

established tracheostomy patients and are often favoured by patients as they are less bulky and conspicuous and are able to completely obscure the tube from sight.

The image shows a ‘Buchannon bib’. These can be used by tracheostomy or laryngectomy patients and come in a variety of styles and designs. Some can disguise the stoma completely and the patient just appears to be wearing a scarf or cravat (see images below)



Mucolytics

This group of medications reduce the ‘thickness’ of secretions by breaking down some of the bonds that exist between the mucus. They are indicated when the patient has excessively thick secretions that are difficult to expectorate. Examples include hypertonic saline or acetylcysteine (via nebuliser), carbocisteine (via mouth) or DNA-ases such as dornase alfa (used in conditions such as cyctic fibrosis)

Hydration

Ensuring that the patient is adequately hydrated is essential in managing the secretion load of a patient. This can be enteral, intravenous or even subcutaneous.

Documentation

- Record the method of humidification in use in the patients care plan or clinical record as per local procedure.
- Record evidence of evaluation and instigation of action taken in the patients care plan or clinical record as per local procedure.
- Record signature for accountability of care for each shift as per local procedure.
- Record date and time that devices are changed and/or are due to be changed.

Humidification ladder

The level of humidification required by patients will change depending on their clinical state, level of respiratory support required and their degree of hydration. If the current degree of humidification is not adequate enough, then the patient should be 'stepped up' to the next level. Patients with tracheostomies and laryngectomies are incredibly vulnerable to complications due to inadequate humidification and its importance in preventing tracheostomy-related complications cannot be emphasised enough. This becomes even more important if the patient is unwell, dehydrated and has purulent secretions.

The humidification ladder

Heated water bath (active humidification)

- Ventilated patient with thick secretions
- Self-ventilating patient (on oxygen) with thick secretions

HME for breathing circuit

- Ventilated patient with minimal secretions (replace every 24 hrs)
- Monitor effectiveness (less likely to be effective if required for more than 5 days)

Cold water bath

- Self ventilating patient (on oxygen)

HME (Buchanon bib, Swedish nose)

- Self ventilating patients (no oxygen)

Add saline nebulisers or mucolytics and ensure adequate hydration if secretions aren't improving.

Other methods of improving secretions

Mobilisation

There is good evidence, borne out by expert opinion and commentary, that mobilising patients will help to improve the clearance of secretions. Mobilisation should be encouraged for all patients with an airway stoma. The assistance of physiotherapists is essential for patients who cannot mobilise independently, or who are sedated and/or ventilated. These interventions can be combined with aggressive chest physiotherapy.

There is evidence that patient movements and interventions can be associated with an increased of tracheostomy tube displacement, but others have clearly shown that careful mobilisation of even the most dependant patients can be achieved safely, without increasing the risks of tube displacement, whilst reducing the risks of pneumonia and shortening time receiving invasive ventilation.

Instilled saline

This practice is advocated by some when secretions prove difficult to manage. There is no clear evidence for benefit or harm. Saline is probably most effective when directed using a broncho-alveolar lavage, which is appropriate for discrete areas of mucus plugging, especially if associated with distal collapse or consolidation. Bronchoscopy may require sedation, but is technically straightforward via a tracheostomy in experienced hands.

Suctioning

Suctioning the airway is an essential part of routine care of the tracheostomy and laryngectomy patient. Sputum is continually produced in health and our native airways deal with this load without any difficulty. If there is an infection or the sputum load increases, there is an increased risk of the secretions causing problems such as airway obstruction of consolidation in the lung. These problems are compounded if the patient cannot cough effectively, the inhaled gases are not adequately humidified, the patient is on a ventilator or the presence of a tracheostomy or laryngectomy compromises the bodies ability to deal with the secretions.

The health of the lower respiratory tract is usually maintained by its mucus blanket. Mucus produced in the trachea and bronchi is transported up to the larynx by the ciliated mucosa of the trachea. The mucus blanket is disturbed following tracheostomy for several reasons.

- The loss of normal humidification from the nasal airway
- The post-surgical inflammation produces a more tenacious mucus blanket
- The presence of the tracheostomy tube paralyses the cilia in contact with it
- The loss of a normal cough from bypassing the larynx

This results in the tracheal mucus collecting at the lower end of the tracheostomy tube. The amount of mucus build up and the problems it causes will vary between patients and with the duration of the tracheostomy. Some patients may be able to project the mucus through the tube by forced expirations, but most often it must be removed by suctioning the trachea via the tracheostomy tube. Suctioning is not a benign process and may cause hypoxia, cardiac arrhythmias, trauma, atelectasis and infection.

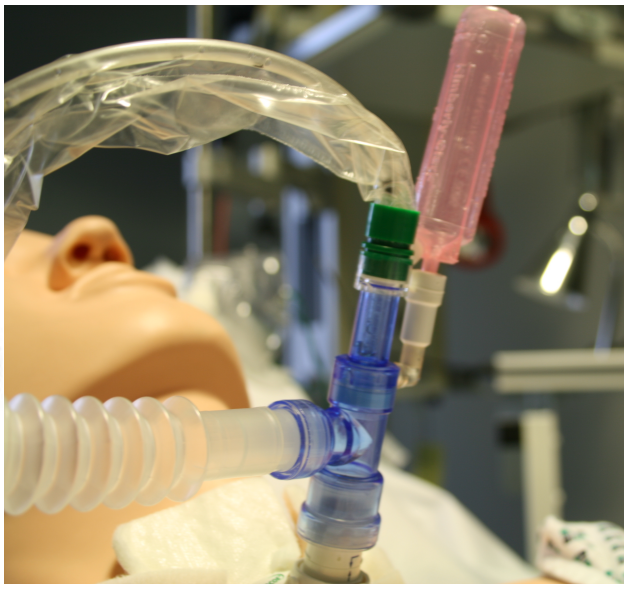
Types of Tracheal Suctioning

Most patients only need routine tracheostomy suction and this should be limited to the lumen of the tube. If the suction catheter is passed deeper into the normal trachea it can further paralyse the cilia and aggravate the problem. In some patients with chest problems the tracheostomy will have been performed to give access to the lower respiratory tract. In such patients deep bronchial suction may be required. Frequency of routine tracheostomy suction varies considerably between patients depending on their clinical status.

Suctioning systems can be ‘open’ or ‘closed’. Open suction involves using single-use catheters inserted via the open end of the tracheostomy tube. Closed suction systems allow the same catheter to be used multiple times. They are especially useful if the patient is connected to a breathing circuit of a ventilator as repeated disconnection of the circuit is not required. Closed systems are cleaned following use with sterile saline and the systems are

usually changed every 72 hours, or according to manufacturers instructions. They do add a degree of weight to the breathing circuit and the constantly attached suction tubing risks getting caught accidentally, which may increase the risk of inadvertent disconnection or tube displacement.

The images below show a selection of ‘open’ suction catheters and a ‘closed’ suction system, as described above. Note the inverted red saline ampule.



Patient assessment

In order for the practitioner to assess whether the patient requires suctioning, with an awake, co-operative patient, it may be possible to firstly encourage them to cough up the secretions, thereby reducing excessive suctioning. Support the patient in a position that will aide coughing (unless contra-indicated) and address any factors that may reduce the effectiveness of coughing such as pain or hydration status.

Indications that the patient may require suctioning include:

- Noisy and or moist respirations
- Increased respiratory effort
- Prolonged expiratory breath sounds
- Restlessness
- Reduced oxygen saturation levels
- Increased or ineffective coughing
- Increased use of intercostal muscles
- Patient request
- More sinister signs of airway obstruction such as hypoxia and cardiovascular changes

Sedated or ventilated patients may have deep secretions which may not lead to some of the signs described above. These secretions may need to be mobilised by physiotherapy and attention to humidification before suctioning becomes effective.

Suction catheter selection

Tracheal damage and hypoxia may be caused during tracheal suction. This can be minimised by using the appropriate sized suction catheter. If the catheter is too large the suction it creates can cause damage. A large catheter will also occlude the tracheal tube which may cause hypoxia. It has been recommended that the diameter of the catheter should be no more than half the internal diameter of the tracheal tube. If the catheter is too small it will not be adequate to remove secretions so repeated attempts will be necessary which have also been shown to damage the trachea. A rough guide to choosing the correct size of catheter was proposed by Odell and others (1993):

(Size of endotracheal or tracheostomy tube – 2) x 2 = Correct French gauge

The table below illustrates this.

Inner diameter of tracheostomy tube (mm)	Suction catheter size (French Gauge or mm)	
	FG	(mm)
10 mm	14	(4.5)
9mm	12	(4)
8 mm	12	(4)
7 mm	12*	(4)
6 mm	10	(3.3)
5 mm	8	(2.6)

* It is more appropriate to use a size 12 catheter as although it is slightly larger than ½ diameter it is more effective for secretion removal.

The frequency of suctioning

There is no clear consensus on how frequently a patient should receive suctioning. This will be dictated by the various patient factors related to their ability to spontaneously clear their own secretions. Attempting tracheal suction at least once per 8 hours strikes a reasonable practical balance. This should ensure that the tube remains patent. Failure to pass a suction catheter is a 'Red Flag' warning that that tube may be blocked or displaced and should prompt assessment by an appropriately trained individual.

The depth of suctioning

Passing a suction catheter to the tip of the tracheostomy tube can be considered 'shallow' suctioning. This is often all that is required if the patient has reasonably loose secretions which can be coughed towards the end of the tube. Passing a suction catheter any further than this can be considered as 'deep' suctioning and may be required if more shallow suctioning does not clear the secretions adequately. Many authors advocate advancing the suction catheter through the tube until it reaches the carina (where resistance

will be encountered). The catheter should then be withdrawn slightly before suction in commenced. Clearly, the length of the tracheostomy tube in situ needs to be known so that the suction catheter is inserted to an appropriate distance. There is no clear message from the literature to guide suction technique, despite a Cochrane review.

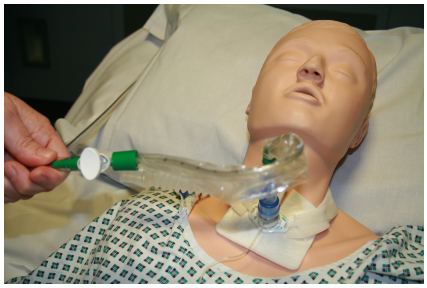
The pressures for suctioning

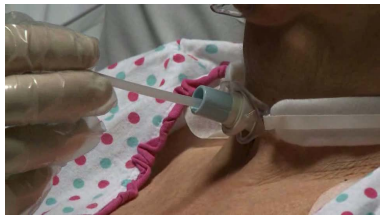
Choosing the correct pressure is a balance of effectiveness of clearing secretions against limiting the potential for damage, either by directly traumatising the tissues or by aspirating oxygen from the trachea and contributing to hypoxia. Pressures used effectively in the literature range from as little as -80 mmHg to -300mmHg. Most would agree that a pressure of no greater than -150 mmHg (-20kPa) is appropriate for most patients.

Equipment for suctioning

- 'Clean' disposable gloves as per local policy
- Protective eyewear
- Appropriately sized sterile suction catheters (See selection guide above)
- Sodium Chloride 0.9% ampoules (only for closed circuit units)
- Oxygen therapy – wall flow meter & tracheostomy mask - if necessary
- Oxygen saturation monitor – where appropriate
- Suction equipment (wall or portable unit)
- Disposable, sterile 'double' gloves can be used to keep the catheter tip sterile from the packet and allow easy disposal

Most closed suction systems allow the suction tubing from the wall mounted suction unit to be constantly connected to the catheter assembly. To prevent continuous suction being applied, there is a valve to stop the suction being applied (white lock between the green sections below, right). The tip of the catheter should always be in the withdrawn position when not being used, as shown below (the visible black marker indicates that the tube is withdrawn).





Summary

The table below summarises key actions related to suctioning and their rationales (adapted from NPSA expert working group)

Action	Rationale
Explain the procedure to the patient	Relieve patient anxieties
Consider analgesia prior to or following suctioning	Suctioning can be a painful procedure
Switch suction unit on and check that the suction pressure on circuit occlusion does not exceed-150 mm Hg or 20kPa pressure	To ensure the machine is working correctly. Too great a suction pressure can cause trauma, hypoxaemia and atelectasis
Wash hands, put on gloves, apron and goggles	Reduce the risk of cross infection
Ensure that an appropriate non-fenestrated inner tube is in place	Larger fenestrations allow the suction catheter to pass through, causing trauma to tracheal wall or giving the false impression that the catheter will not pass
Consider pre-oxygenation if receiving oxygen or ventilated	To prevent hypoxaemia
Remove tracheostomy devices prior to open suctioning	To allow access for sterile suction catheter tip
Connect suction catheter keeping catheter tip covered (sterile)	To reduce the risk of transferring infection from the hands to the suction tubing.
Place top ‘double’ glove on dominant hand	To aide removal and replacement of fresh gloves per each suction episode
Do not apply suction whilst introducing the catheter, or push against resistance at any time	Suctioning while introducing the catheter causes mucosal irritation, damage & hypoxia
Occlude suction port with gloved thumb and suction on removal of suction catheter (no need to rotate on removal as catheters have circumferential holes)	Prolonged suctioning can result in hypoxia and trauma
Period of suction should not exceed 10 seconds	To reduce risk of mucosal damage and hypoxaemia
Suctioning should be continuous not intermittent	Intermittent suctioning does not reduce trauma and is less effective

Observe the patient throughout the procedure to ensure their general condition is not affected.	Tracheal suction may cause vagal stimulation leading to bradycardia, hypoxia and may stimulate bronchospasm
For patients requiring oxygen therapy, reattach O_2 within 10 seconds.	To limit hypoxia
Remove the glove from the dominant hand by inverting it over the used catheter & dispose clinical waste bag	To minimise the risk of infection
Assess the patient's respiratory rate, skin colour and/or oxygen saturation to ensure they have not been compromised by the procedure and determine if they need further suction.	Suction should be performed only when needed and not as part of a routine, so that damage to the trachea is avoided
It is recommended that no more than 3 episodes of suctioning are carried out in succession	To limit side effects and maximise recovery period
Difficulties in suctioning tenacious mucus may be due to inadequate humidification. Try a more effective humidifier. Consider use of nebulizer, mucolytics and concurrent physiotherapy. Saline instillation may be useful in some situations such as deep bronchial suction and bronchial lavage.	
If O_2 delivery was increased, review for return to previous level.	To prevent unnecessary oxygen delivery
Flush through the connection tubing with the clean water. Empty water receptacle and ensure this is ready for further use. Wash hands.	To minimise the risk of infection
If the patient needs further suction, repeat the above actions using new glove & a new catheter	

Videos demonstrating open and closed suction techniques can be found by clicking the links below, and as part of the e-learning modules available at www.tracheostomy.org.uk.

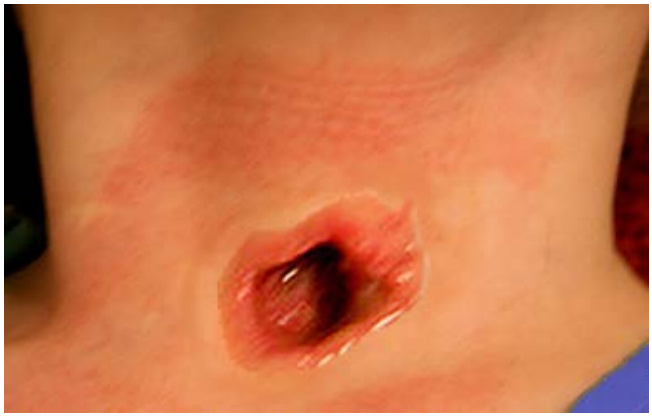
- Open suction
- Closed suction
- Assessment of patency of a laryngectomy stoma

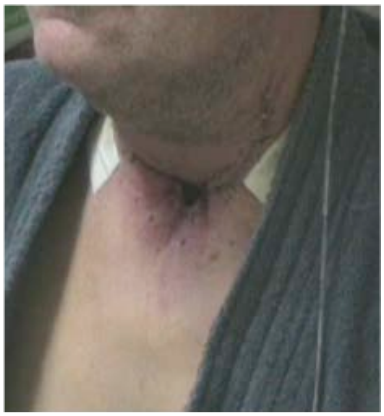
Stoma care and securing the tube

The management of a tracheostomy stoma depends to some degree on the type of surgical procedure used to create the tracheostomy tract. Traditionally tracheostomy was created through a linear incision in the front of the neck and commonly leads to a larger surface wound compared with percutaneous procedures. The stoma associated with a tracheostomy or laryngectomy can be considered as a full thickness, open wound, but one that is complicated by the moisture and mucus associated with respiratory secretions. When we add a large foreign body which slides about every time the patient moves, the potential for stoma problems is evident.

Secretions may ooze out of the surgical excision and stoma site which can result in wetness and cause irritation of the skin and can lead to skin maceration and/or excoriation. This moist environment may also act as a medium for bacterial growth and can prevent the stoma site from healing. The aim of stoma care is therefore to keep the area clean and dry, reducing the risk of skin irritation and infection.

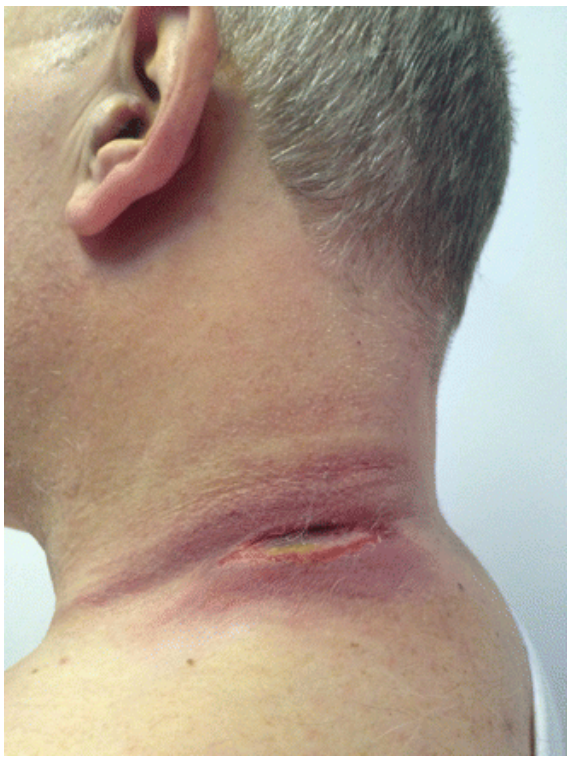
Various types of dressing are available for the stoma. Dressings placed at the tracheostomy site should always be pre-cut by the manufacturers to avoid loose fibres from a cut dressing edge entering into the airway. Thicker dressings will absorb more secretions (e.g. Lyofoam™ Allevyn™) than some of the thinner, less obtrusive varieties available (e.g. Metalline™).





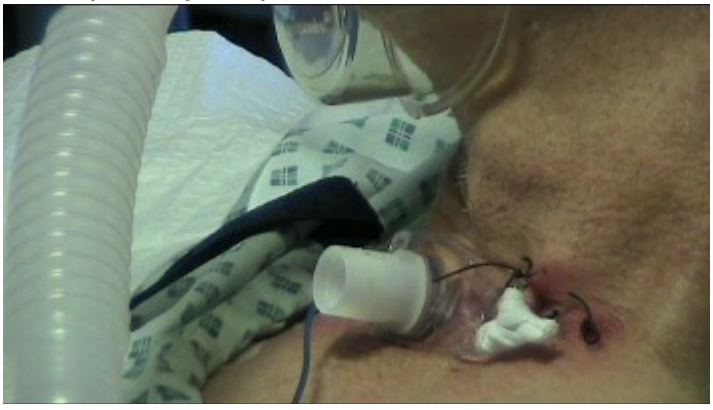
Strict management of these dressings is essential, as wound degradation will occur if wet or soggy dressings remain in contact with the surrounding skin. The tracheostomy wound should be inspected at least daily. Any pus should be swabbed and sent for microbiological culture. Excessive moisture or secretions may be due to an underlying respiratory infection that should be treated appropriately.

Inspection of the stoma should also include assessment of where the tapes or ties are in contact with the skin of the neck or face, including the back of the head. Sometimes, the patient's head position means that the tube will cause pressure areas on the skin of the neck or chest. Specialist advice and consideration of a different tube type may be required.



Securing the tube in position

Tracheostomy tubes can be secured with cloth or cotton ties, or Velcro holders. A balance must be struck between securing the tube in position and minimizing any risks of causing pressure ulceration (see image; with permission). One finger should be able to be inserted between the tape and the patient's skin to ensure the tube is adequately secured. Tube displacement is more common in the first few days following tracheostomy insertion. Consequently, many centres will suture the tube to the neck skin in addition to the tracheostomy tapes for the first 7-10 days until the tract becomes well established. This may make removing the tube in an emergency more difficult should it become partially displaced and is not mandatory. Suturing also may make cleaning under the tube more difficult. The bedhead sign should make clear what sutures are in situ and how long they should remain for. The sutures pictured here are inflamed and should be removed if the stoma has matured.



Patient assessment

When selecting the most appropriate technique and product for securing the tracheostomy tube, consideration must be given to the risk factors that each patient is exposed to. A tracheostomy tube that becomes displaced is at risk of causing significant respiratory difficulties and/or airway obstruction. It is, therefore, vital to ensure the tracheostomy tube is appropriately secured at all times. Patients at risk of their tube becoming displaced are:

- Agitated or confused patients
- Patients with ventilator circuits attached
- Patients with tapes that are too loose allowing excessive tube movement

Regular checks of the tapes will help prevent the tube becoming displaced. The patient who has undergone reconstructive surgery to the neck area which may include a skin and/or muscle flap may well require their tracheostomy tube to be secured without applying pressure to the delicate flap area. For these patients, the tube is likely to be secured to the area directly surrounding the tracheostomy, by sutures. Care must be taken to ensure these sutures adequately support the tube in place and prevent tube misplacement.

Equipment in addition to standard bedside equipment:

- Dressing trolley.
- Gloves, disposable apron, and protective eye wear.
- Sterile dressing pack.
- 0.9% sterile saline solution (warmed ideally)
- Sterile gauze squares
- Tracheostomy dressing (pre-cut)
- Tracheostomy securing device: either Velcro tube holder or cotton ties (2 pieces approx 50-80cm each)
- Blunt ended scissors
- Barrier cream
- Suction unit with appropriate suction catheters

Procedure

Two people should be present when changing the tapes to help prevent accidental decannulation. It should be clearly communicated throughout the procedure, which person is responsible for holding the tracheostomy tube. The procedure must be undertaken using an aseptic technique to prevent contamination and the risk of infection. Videos of dressing and tube tie changes can be found below, along with the e-learning sessions at www.tracheostomy.org.uk.

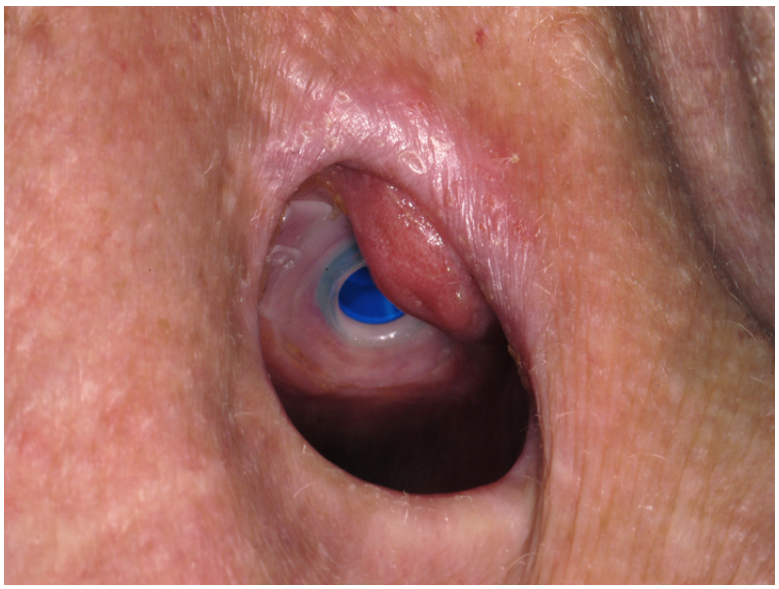
- Video of dressing and tube tie change
- Dressings and ties captivate presentation here

Documentation

Any dressing or tape change should be documented in the nursing and/or medical notes as appropriate. Any complication identified (e.g. infection and swabs taken) should be considered for further management and this also documented.

Granulation tissue

Overgranulation or hypergranulation at the site of the tracheostomy can be caused by an ill-fitting tube, excessive movement of the tube and /or in response to an infection at the wound site. This tissue can cause bleeding or pain at the wound site and in severe cases make tracheostomy tube changes difficult.



A polyurethane dressing significantly reduces the rate of hypergranulation. Treatment may include local application of silver nitrate. This requires local skin to be protected with petroleum jelly, and may require repeat applications until the overgranulation tissue has shrunken sufficiently. This image shows granulation tissue visible around a TEP valve which is visible via the laryngectomy stoma.

Patients undergoing radiotherapy to the neck

Carrying out a tracheostomy dressing and tape change for a patient undergoing radiotherapy to the neck must be carried out with caution and particular consideration to the increased discomfort that the patient may experience.

Radiotherapy may cause radiotherapy burns, moist or dry desquamation and broken areas of skin. It is advisable to liaise with the radiotherapists to assess skin integrity and to advise on suitable skin treatments. Appropriate analgesia may also be required prior to tapes and dressing changes. It is also the practitioner's responsibility to identify appropriate timing of tapes and dressing changes and not to be considered simply routine care to avoid unnecessary discomfort or skin damage.

Summary

The table below summarises key actions related to stoma care and their rationales (adapted from NPSA expert working group)

Action	Rationale
Explain and discuss the procedure with the patient as appropriate.	Reduce anxiety and gain consent and co-operation
Wash hands and put on gloves, apron and eye protection if patient high risk	
Prepare sterile dressing trolley	Prerequisite for maintaining asepsis
Position the patient with their neck slightly extended. Remove any clothing that will impede procedure.	To help access to the neck area for the procedure.
Practitioner 1 holds the tracheostomy tube, whilst Practitioner 2 removes the tapes and dressing.	To stabilise the tracheostomy tube and reduce the risk of dislodgement of tracheostomy tube.
Discard old tapes and dressings into the waste bag.	
Assess the stoma for signs of infection, inflammation, or trauma, and record accurately on the appropriate documentation. Take a swab if there are any signs of infection: Sign of infection include: • Purulent discharge • Pain • Odour • Abscess formation • Cellulitis and discolouration	To assess for skin excoriation, haematoma, signs of infection. To facilitate early recognition and treatment of infection.
Observe for signs of Hypergranulation	Granulomas may cause scarring, bleeding, pain and cause difficulty at tube changes
Perform hand hygiene and Change gloves to proceed with aseptic wound care and dressing application	To adhere to aseptic technique
Sterile gauze squares soaked in saline should be used to clean the wound and around the tube to remove secretions and crusting. Gently pat dry	Saline is the preferred wound cleansing solution.

The tube should be held firmly throughout with minimal movement of the tube	Tube movement can cause coughing and discomfort and may increase the risk of accidental decannulation.
Apply a thin layer of barrier cream if the skin is at risk of excoriation from moisture from humidification and/or secretions.	To promote skin integrity.
Apply a clean tracheostomy dressing.	To bring secretions away from the wound, and also to provide comfort from the tube constantly resting on the neck.
Re-secure the tube using an appropriate tie. Allow 1 finger's distance between the tie and the neck skin	Secure the tube effectively

Management of the inner cannulae

Most tubes are available with removable and therefore cleanable inner cannuale. Designs and materials are improving all of the time and a tube with an inner cannula does not necessarily mean that the internal diameter (and subsequent resistance to air flow) is as compromised as it perhaps used to be with previous designs. Cleaning aims to remove secretions from the inner cannula to reduce the risk of potential obstruction with sputum and reduce the risk of infection. Secretions can adhere to the internal lumen of a tracheostomy tube and severely reduce the inner lumen diameter over time. This potentially can increase the work of breathing and/or obstruct the patient's airway.

The inner cannula should be removed and inspected at least once per 8 hour shift or if the patient shows any signs of respiratory distress. For a patient undergoing mechanical ventilation, it may not be safe to repeatedly disconnect the ventilator circuit and change the inner tube routinely. Cleaning or changing an inner tube should always represent the best balance of risks to the patient. If an inner tube is not changed, then it should be clearly documented and communicated, along with the rationale.

There is debate within the literature on the most appropriate cleaning solution to be used in the context of inner cannula care. A wide variety of solutions are used across health care including tap water, sterile water, sterile saline and hydrogen peroxide 10w/v (3%). Evidence to support the use of tap, sterile water or other solutions is equivocal and therefore local policies are highly likely to vary in their recommendations. This is acceptable from a patient safety perspective but local practice should be influenced by the available water supply and quality, types of tubes used and patient condition. For most obtunded or acutely unwell hospital inpatients, sterile water would seem more appropriate.

It is important to note that the central rationale for cleaning of inner cannula is to mechanically remove debris which may physically obstruct a patients airway. A secondary outcome of mechanical cleaning is a reduction in the numbers of microbes present.

Inner cannulae can be cleaned at the patient's bedside.

It should be noted that there can be significant differences between the different manufacturer's tubes. Kapitex and Shiley tubes commonly require an inner cannula to be in place so that the tubes can be connected to a 15mm standard anaesthetic breathing circuit. It is therefore essential that patients with these types of tubes in situ have a spare inner tube with them at all times. Videos demonstrating these differences can be accessed by clicking here.

Disposable inner cannulae are also available from some manufacturers and can improve the ease and subsequent compliance with inner tube care. There is an associated cost and environmental consideration but this may be expected to improve with newer material technologies.

Equipment in addition to standard bedside equipment includes:

- Clean, disposable gloves
- Clean and dry replacement inner cannula
- Tracheostomy cleaning devices (sponges or brushes)
- Fragrance free detergent
- Cleaning solution: tap water, sterile water or sterile saline (refer to local guidelines from infection control department)
- Clean and dry covered container for spare inner cannula

Procedure

Cleaning an inner tube is a relatively straightforward procedure. The inner cannula is removed and inspected. If clean, it can simply be replaced. If it needs to be cleaned then a spare tube should be inserted at this point. Patients will therefore have one inner tube in situ and one at the bedside being cleaned or drying. Dedicated cleaning packs are commercially available which makes cleaning quicker and easier (and often more likely to occur).

The tubes should be visibly clean and this can usually be achieved with saline and a foam brush or gauze. Abrasive wire brushes may cause scratch marks on the inside of the tubes and risk colonisation. The tubes are then left to dry in a suitable container. It is essential that the tubes do not sit in water as this may lead to bacterial growth.

Disposable inner tubes are increasingly available and affordable.

Videos demonstrating changing an inner cannula can be accessed by clicking the links below, or by visiting the e-learning section of the website www.tracheostomy.org.uk.

- YouTube video of inner tube changes
- Narrated e-learning link (requires flash player)

Documentation

Documentation should include accurate records of inner cannula care in the required format within the patient's record as per local guidance. Ensure handover of all information, reporting any problems in changing the inner cannula or missing inner cannulas.

Summary

The table below summarises key actions related to stoma care and their rationales (adapted from NPSA expert working group)

Action	**Rationale**
Explain and discuss procedure with the patient as appropriate	To relieve patient anxieties and gain patient consent and co-operation.
Clean hands and apply appropriate PPE	To reduce the risk of cross infection
Perform tracheal suction if necessary	To ensure airway is clear prior to procedure commencing
With one hand stabilise the outside of the tracheostomy tube. Remove inner tube with the other hand	Removal of the inner tube with minimal movement of the tube on inner cannula removal
If the inner tube is clean and clear of secretions, simply reinsert	No further cleaning required
If there is difficulty in removing the inner tube call for help from an appropriately trained healthcare professional.	Dry tenacious secretions or granulation may prevent the inner tube from being removed which requires prompt attention
If inner tube requires cleaning, replace with clean/spare inner cannula whilst cleaning is taking place	The tracheostomy tube should always have an inner cannula in place to prevent tube blockage.
If the inner tube is fully or partially blocked with secretions, flush with locally agreed cleaning solutions and if necessary use a tracheostomy cleaning sponge or brush	To remove debris that may block the tube this may become a source of infection. Cleaning devices should be used with caution and care not to cause abrasion to inner surface of inner cannula.
If tube is coated with dried- on secretions, it may need to be disposed of and a	Excessive cleaning can damage the cannula and they

replacement cannula placed at bedside	should not be left to soak as it is an infection risk.
Rinse the inner cannula through with sterile water	To remove secretions and reduce infection risk
Shake excess water off inner cannula and place in covered clean container to dry prior to re-use	To ensure a clean and dry inner cannula is available for use.
Ensuring the cannula is locked into place as per the manufacturer's instructions	To prevent the cannula dislodging
Observe secretions amount and consistency	To observe for signs of infection or inadequate humidity

Oral care & swallowing

Oral care is important as it has a role to play in preventing healthcare associated infections. Dental plaque and the oropharynx can become colonized by bacteria and a 'biofilm' can develop on the inside of airway devices. Secretions can also pool in the subglottic region. Normal oral airflow is disrupted when gas is directed through the tracheostomy and this leads to reduced evaporation of oral secretions, which subsequently accumulate in the mouth.

Patients who are able to should be encouraged to maintain their own oral hygiene by using a toothbrush and using mouthwashes. Incapacitated patients should have a daily assessment of their buccal mucous membranes to observe for bacterial, viral or fungal infections, skin tears or ulceration.

Aspirated infective saliva can contribute to respiratory problems. If the patient has a dry mouth then consider artificial saliva.

Any obvious dental problems should be assessed promptly by an oral hygienist. There is an increasing amount of data in the literature which suggests that simple measures such as teeth cleaning and intermittent removal of oral secretions can have a significant impact on hospital-acquired infections such as ventilator-associated pneumonia.

Specific oral care measures

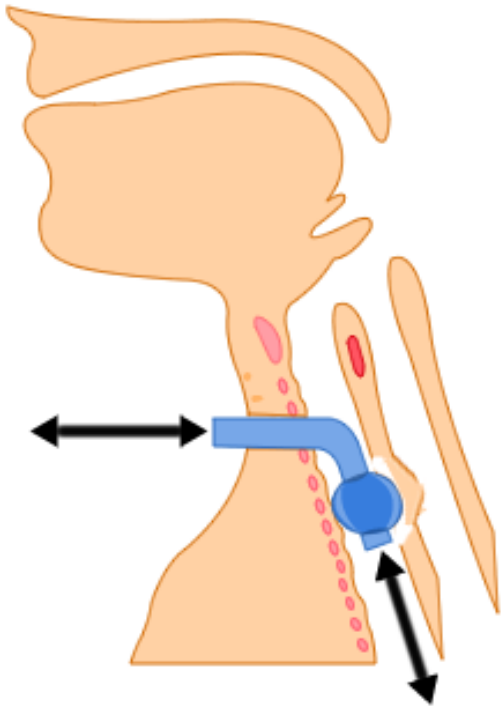
- Encourage self-care when possible
- Patient's teeth should be brushed with toothbrush and toothpaste at least twice a day.
- Chlorhexidine mouth washing twice per day (not immediately after tooth brushing)
- There is no reason why patients with tracheostomies can't wear their dentures.
- Showering is permitted

Dedicated commercial oral care packs are available which may improve compliance with mouth care bundles.

Swallowing

Most people with a new tracheostomy will have a naso-gastric tube or similar feeding route and regimen established. The cuff of the tracheostomy or the tube itself interferes with the swallowing mechanics of the larynx. These muscles can waste if not used (during prolonged ventilation or immobility) and require careful rehabilitation and assessment. The Speech and Language Therapist (SALT) is an essential member of the multi-disciplinary team.

The image below shows an inflated tracheostomy tube. The cuff is pressing on the oesophagus behind the trachea, offering a physical obstruction to swallowing. The tracheostomy tube tethers the anterior structures of the neck and limits the amount of movement of the larynx and upper airways that is required for normal, safe swallowing.



Patients with a tracheostomy tube are at high risk of developing swallowing difficulties, although some patients can swallow normally. The patient's underlying medical condition may compound swallowing difficulties. Assessment of the safety of the swallow is necessary as swallowing difficulties (dysphagia) can result in aspiration and the complications arising from this. A patient with a tracheostomy tube may have difficulty swallowing secretions as well as food and drink.

It is possible to eat and drink with an inflated tracheostomy tube cuff in situ. It may be appropriate to embark on a trial of enteral oral intake if the patient's general clinical condition allows. There are a number of predictors of tracheostomy-related swallowing problems. The presence of any of the following should prompt referral to an appropriate SALT team:

- Following head & neck surgery
- Lower cranial nerve palsies (bulbar palsies)
- Clinical signs of aspiration (associated with attempted oral intake)
    - Coughing
    - Desaturation
    - Suctioning of particulate matter from the tracheostomy
- Weak, 'wet' or gurgly voice heard during trials of cuff deflation.

Any formal assessment of swallowing will include a trail of cuff deflation (if present) to assess the function of the larynx. The parent team should have adequate knowledge of the individual patient's condition, including indication for the tracheostomy, current nutrition and respiratory status and weaning plan before assessment. Those caring for the tracheostomy patient must also have a sound understanding of the signs of swallowing difficulties and must be able to take necessary actions in the event of an emergency.

Since the process of assessing the safety of the swallow is not without risk the screening, assessment and management of dysphagia must be carried out by an appropriate dysphagia-trained practitioner.

Assessment tools

Assessment usually involves attempting to normalize as much swallowing physiology as possible before examining and assessing how the patient manages trials of swallowing. This can be clinical assessment, or direct visual assessment using a suitable endoscope. Videos of fibreoptic endoscopic evaluation of swallowing (FEES) tests are housed within the e-learning modules at www.tracheostomy.org.uk.

Ideally the patient will have the cuff deflated and be wearing a speaking valve during assessment of secretion tolerance and oral intake. This is to help restore more normal physiology to the upper airway and provide the practitioner with more clinical indicators of swallow safety.

The use of 'blue dye' to test swallowing and aspiration is not generally supported by evidence due to a high false negative rate. The patient must be deemed safe at tolerating their secretions before assessing for tolerance of oral intake. Aspiration of secretions is significantly linked to aspiration of oral intake. Patients that are nil by mouth or are at risk of aspiration should have a strict program of oral care in place as discussed above, to help reduce the incidence of infection.

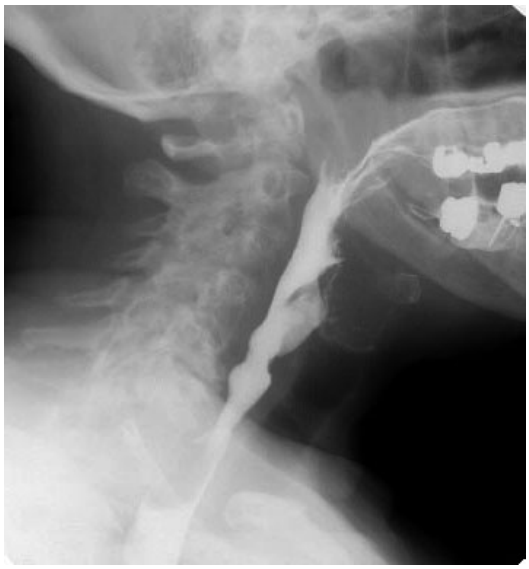
The following are the ideal circumstances under which to assess the swallow for tolerance of secretions and oral intake:

- The patient should be alert
- The patient should be sat upright (if medically able)
- The oral cavity should been clean and clear
- The tracheostomy tube cuff should be deflated (if present)
- A speaking valve should be attached

Signs of dysphagia to be aware of during and after assessment/intake are:

- Coughing or choking (NB patients may 'silently' aspirate)
- Increased work of breathing
- Fatigue
- Change in the voice quality e.g. sounds wet
- Noteworthy decrease in 0_2 saturation levels and/or change in skin pallor
- Deteriorating chest status
- Increase in frequency of suctioning required
- Evidence of aspirated material on suctioning
- Loss of saliva or food/fluid from the mouth

- Holding of saliva or food/fluid in the mouth
- Patient reports difficulty swallowing



Video fluoroscopy is a radiological investigation which involves ingestion and attempted swallowing of a radio-opaque dye. X-ray screening is performed which can follow the contrast in real time as it is swallowed. Pooling, hold ups and tracheal aspiration can all be detected using this method. Some modern imaging devices can screen at the bedside, but most patients will require a visit to the X-ray department to have this test performed.

Therapies

If dysphagia is diagnosed, it may be possible to instigate tailored interventions with the aim of improving the swallowing. These include:

- 'Training' the larynx with increasing trials of using a speaking valve in an attempt to normalise airflow through the larynx and restore normal physiology
- Swallowing exercises
- Reducing the size of the tracheostomy tube (if possible)
- Using certain types of diet (e.g. thickened liquids)
- Treat the underlying condition

Often the problems are multifactorial and linked to the underlying condition. Any general muscle weakness may manifest as swallowing difficulties. Attention to nutrition, mobilisation and improving the general condition of the patient will often improve swallowing with time. Repeated assessments are usually indicated, the timing of which will be individual (days to weeks).

Documentation

Outcomes of the assessment of swallowing secretions and oral intake must be clearly documented in the medical notes. Documentation must convey to other members of the MDT the findings of the assessment and the resulting recommendations. The entry should also ensure accurate reporting of any adverse reaction the patient experienced with the procedure and actions taken or still required. If referral on to a specialist dysphagia practitioner (eg Speech and Language Therapist) is required or has been made, this must be documented.

Summary

The table below summarises key actions related to swallowing assessment and their rationales (adapted from NPSA expert working group)

Action	**Rationale**
Explain and discuss the procedure with the patient	To ensure consent, understanding and reduce anxiety.
Have communication aids available e.g. alphabet chart, pen and paper, interpreters if necessary	To promote effective 2 way communication
Sit the patient upright (unless contra-indicated)	To promote chest expansion and help reduce aspiration risk
Suction the patient if necessary	To remove secretions prior to cuff deflation
Perform cuff deflation whilst suctioning and observe for signs of acute respiratory distress, de-saturation or patient discomfort. Inflate cuff if not tolerated and agree review date. This may be as frequently as daily.	To ensure the patient is able to tolerate their secretions prior to proceeding to oral intake.
If cuff deflation tolerated, attach the speaking valve if applicable to the patients individual weaning plan following local policy.	To optimise physiology of upper airway and provide additional clinical indicators of dysphagia.
Assess voice quality. Proceed to fluid challenge below if voice adequate	Detect signs of failure to manage oral secretions
Trial initially with sips of water, observing for signs of dysphagia. If signs of aspiration are observed, cease trials and refer to a specialist dysphagia practitioner, ideally a speech and language therapist. If trials successful progress cautiously to oral intake as each consistency is deemed safe.	To optimize progression to oral intake and to reduce risk of aspiration.
Remove speaking valve and re-inflate the cuff post-assessment/trial according to the patient's individual weaning plan.	To optimise weaning success and reduce patient risk.
Involve MDT throughout process including patient and their family	To optimise success and reduce patient risk.

Cuff management

It is usual that the initial tracheostomy tube to be inserted will be a cuffed tube. The cuff provides a sealed airway. A cuffed tube is usually a temporary measure until a patient is weaned from a ventilator and the patient can control their own secretions, but may be required long term if the underlying condition does not improve sufficiently. Examples include:

- Patient requires long term ventilation, either continually or intermittently (e.g. overnight).
- Patient has a reduced conscious level or neuromuscular or mechanical problems affecting the pharynx. The airway is at risk of aspiration of GI contents and a cuffed tube can provide a degree of protection against this.
- Patient has excessive oral secretions that cannot be managed by the patient's own efforts.

Management of the cuffed tracheostomy tube focuses on the appropriate management of the distal cuff. Tracheal capillary pressure lies between 20-30mmHg and an impairment of this blood flow will be caused by an obstruction between 22-37mm Hg. The complications from the continued use of an over inflated cuff include:

- Tracheal stenosis (scarring and narrowing of the trachea)
- Tracheomalacia (the cartilaginous structure of the trachea becomes weakened and the trachea is prone to collapse
- Tracheo-oesophageal fistula (an un-planned communication between the rear wall of the trachea and the oesophagus which lies behind. This can lead to GI contents contaminating the airway).
- Tracheo-inominate artery fistula – An artery near the trachea can get damaged due to prolonged pressure.

In addition a patient with an inflated cuff may experience de-sensitisation of the larynx, a reduced cough reflex and loss of voice or sound production.

Too low a cuff pressure will cause an air leak and lead to ineffective positive pressure ventilation. The cuff will develop longitudinal folds which permit micro-aspiration of secretions which have collected above the cuff. This subsequently increases the risk of nosocomial pneumonia . The accepted pressure is the minimum pressure required to prevent a leak but which must not exceed 35cmH_2O. Recommendations suggest that the cuff

pressure should be kept between 15-25cmH_2O (10-18mm Hg). Regular cuff pressure checks are carried out every 8 hour shift.

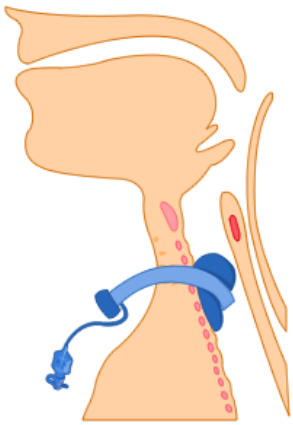
Cuff leaks

A cuff leak can vary in its significance from being irritating to staff and the patient owing to ventilator alarms, through to life threatening complications from aspiration or ventilation failure. The leak can come from a number of sources and importantly, may be associated with a partially displaced tube.

Sources of leaks include:

- Defective or damaged cuff (sometimes occur on insertion of the tube)
- Cuff not adequately inflated (see above)
- Patient is requiring high ventilator pressures and/or PEEP/CPAP which exceed the sealing capacity of the cuff
- Tube does not fit the airway
    - Simply too small
    - Positional changes cause a leak
    - Tracheomalacia or wound breakdown

Simply adding more air to a cuff or precariously positioning the tube or patient is not a solution to an intermittent cuff leak. Sometimes the weight of an attached ventilator circuit may contribute to partial displacement of a tube and when assessing the patient to locate the source of the cuff leak, remember to think about problems that may not be directly associated with the tube. A fibreoptic inspection of the tube, stoma or trachea may be indicated if clinical assessment cannot determine the source of the problem. A trial of a different or a larger tube may be indicated. If the patient is receiving high levels of respiratory support or oxygen, the decision to change a tube is balanced against the risks of leaving a potentially unsecured airway device in situ.



Patient assessment: cuff deflation

The decision to trial cuff deflation should be made by appropriate members of the multidisciplinary team and carried out and monitored by appropriately trained and skilled staff. Patients who may require cuff deflation include:

- Prior to tube removal
- Prior to assessment of patients ability to manage oral secretions

- Prior to eating or drink (where swallowing is assessed as safe)
- A patient using a speaking valve or occlusion (decannulation) cap
- As part of a structured weaning programme

Patients who have extremely limited respiratory reserve may not tolerate cuff deflation well, despite sometime having been free from ventilator support for some time. The patient will start to move gas through their mouth, nose and upper airways once the cuff is deflated. These are simply conduction airways and do not contribute to gas exchange. It takes an extra effort to shift the gas through this 'dead space' once the cuff is deflated. Also, inspired air via the mouth will dilute any oxygen given via the tracheostomy and may lead to a drop in the oxygen concentration reaching he lungs, contributing to hypoxia. Finally, the tube in the trachea offers resistance to airflow which requires respiratory effort to overcome when the patient breathes past this partial obstruction via the upper airways. The consequence is that cuff deflation is not always a benign process and patients must be adequately monitored.

Procedure: cuff deflation

It is recommended that two people are required for this procedure. Any secretions that may have collected above the cuff of the old tube need to be removed prior to cuff deflation. This reduces the risk of contamination of the airway. In the sedated patient, this will involve oral, pharyngeal and subglottic suction with a soft catheter. Awake patients will find this uncomfortable, but it is important to remove secretions from above the cuff if possible. Tubes with specific sub-glottic suction channels allow some of the secretions to be cleared more easily. Any remaining secretions can be removed by timing cuff deflation (prior to tube removal) with expiration. The patient is asked to take a breath in and exhale strongly or cough as the cuff is deflated. If the patient is ventilated, then deflation is timed with the expiratory phase.

The cuff is deflated with simultaneous suctioning, to remove any material that may have accumulated above the cuff and remains, despite the subglottic suctioning.

Documentation

Document cuff pressure checks at least once per shift, or in accordance with local guidelines. Ensure handover of all appropriate information reporting any problems in measuring cuff pressures.

Summary

The table below summarises key actions related to cuff management and their rationales (adapted from NPSA expert working group)

Action	Rationale
Explain and discuss procedure with the patient as appropriate. Explaining that they can expect to experience the movement of air and secretions within the upper airway and may be able to make audible sounds.	Allay patient anxieties where possible
Suction via tracheostomy and/or mouth (where necessary)	To remove secretions prior to cuff deflation
Deflate the cuff slowly using a clean syringe to aspirate air from the cuff via the pilot balloon	To deflate cuff
Perform tracheal suction as necessary whilst deflating cuff	To exclude the risk of aspiration of secretions
Assess patient comfort, respiratory rate and oxygen saturation throughout the procedure	To identify significant changes in respiratory pattern which may indicate cuff re-inflation.
Assess the need for re-inflation and re-inflate if required	To alleviate respiratory distress experienced with cuff deflation

Changing tracheostomy tubes

Changing the tracheostomy tube should be a multidisciplinary decision. The first change should always be performed or supervised by a suitably trained member of the medical staff. Videos of tube changes can be found here.

Knowledge and Understanding

In order to change a tracheostomy tube safely and appropriately, the practitioner must appreciate the specific clinical indications for the original formation of the individual patient's tracheostomy. In addition they will need to know when and how the tracheostomy was formed. It is considered that a newly formed tracheostomy will close more quickly than an established tracheostomy tract, and indeed within the first 48 hours of a surgical tracheostomy or 7-10 days for a percutaneous tracheostomy, extreme caution must be taken as a tube change may be difficult or even impossible.

Patient assessment

Indications to change a tracheostomy tube change include:

- The tube has been in-situ for maximum recommended duration: 30 days for tubes with a removable inner cannula (most manufacturer's recommendations) and 7-10 days for single lumen tubes
- Facilitating weaning by inserting a smaller, un-cuffed or fenestrated tube
- The patient needs ventilatory support or resuscitation and requires a change from an un-cuffed to a cuffed tube
- To improve fit or comfort of tube
- To replace a faulty tube
- To resolve a misplaced or displaced tube

A tube change may be contra-indicated if the patient:

- Is in an unstable clinical condition (balancing risks/benefits)
- Requires high levels of ventilatory support or oxygen
- The risk of loosing the airway is high
- The tracheostomy was performed within the last 7 days, especially if percutaneously formed.
- The patient is undergoing radiotherapy to the neck region (or has completed course in last 2 weeks)
- In palliative care patients where quality of life will not be improved by tube change
- Patient refuses

Each tracheostomy tube change and each patient should be assessed individually prior to each and every tube change, balancing the risks and benefits. The procedure will require two competent practitioners and more, especially if the patient becomes agitated during the procedure.

Particular caution needs to be taken in the following circumstances:

- First tube change
- Difficult previous tubes change
- Patient has a known obstructed or difficult upper airway (this is the 'back up' airway in case of difficulties with the stoma)
- Early changes (within 2-4 days of surgical tracheostomy and 7-10 days of percutaneous tracheostomy)
- Patients with a large neck
- Patients requiring high levels of ventilator support
- Patients requiring high concentration of inspired oxygen
- Patients with tumours surrounding the tracheostomy tract
- Patients with significant granulation tissue around the stoma site
- Agitated or combative patients

NB: If a difficult tube change is anticipated then a clinician experienced in upper airway management (including endotracheal intubation) and a clinician or practitioner proficient and experienced in managing tracheostomy tubes should be present. All relevant equipment and emergency anaesthetic drugs should be available. Plan for loss of airway and failure to cannulate the tracheostomy.

Most tube changes are uneventful, but those that don't go smoothly can go badly wrong. Thorough preparation is essential. Following a successful initial change of tube, subsequent tube changes can be performed by a competent and suitably trained person **but medical assistance and emergency equipment should be readily *available* at all times**. The *availability* depends on your risk assessment of the clinical situation. It is essential to record how you changed the tube and any complications that arose. This record should also document recommendations for subsequent tube changes, such as timing and whether any particular equipment or personnel are required. If the tube change was straightforward, this is useful information to pass on also. Record any important details on the bed-head sign.

The tubes may be changed like-for-like, changed for a different type of tracheostomy (e.g. fenestrated tube or a different brand), changed for a smaller tube (down-sizing) or removed completely (decannulation).

Equipment required for a tracheostomy tube change

- Two tracheostomy tubes of appropriate make
    - 1 same size, 1 size smaller
- Dressing pack
- Normal saline (0.9%) to clean
- 10 ml syringe and cuff pressure manometer if the tube has a cuff
- Suction equipment and suction catheters.
- Sterile gloves and protective eye wear

- Water soluble lubricating gel
- Tracheal dilators (local or individual preference)
- Pen torch
- Tracheostomy tube tapes, ties or dedicated holder
- Stoma dressing
- Stitch cutter if previous tube has been sutured

- New closed suction system (this is a good opportunity to change to clean ancillary equipment)
- Microbacterial swab of the stoma site may me indicated

- An exchange device such as an Aintree catheter or Bougie may be required

- Waveform capnography (essential if the patient is ventilator-dependent or a difficult procedure is expected)
- Resuscitation equipment
- Fibreoptic scope available
- Oxygen supply and appropriate masks to deliver oxygen to face or stoma
- Oxygen saturation monitoring
- Stethoscope

Patient preparation

Gaining the patient's trust and co-operation is essential. This is not always possible in the sedated, neurologically impaired or combative patient, but an explanation should always be attempted. The patient is likely to cough, feel a tugging and a pushing sensation in the neck, have blood stained secretions afterwards, but can be reassured that the procedure usually lasts less than 1 minute.

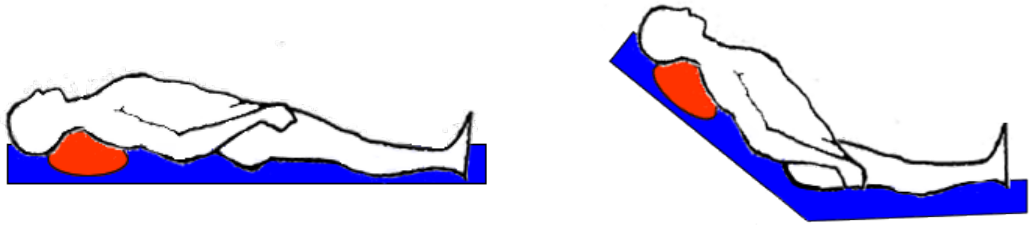
Some patients will benefit from a sedative or analgesic premedication. The risks of this should always be balanced against the benefits and sedation should be prescribed and administered by an appropriate person. Sedating patients who are not breathing fully independently or have a high requirement for oxygen should only be done in an appropriate environment. Full resuscitation equipment should be available. Using sedation may mean that future tube changes become more complex to arrange and facilitate.

Local anaesthetic gel can also be applied to the stoma for a few minutes prior to the procedure. Lubricating the new tube with local anaesthetic gel will improve any immediate post-procedural discomfort.

Pre-oxygenation is essential before a tube change of a patient with oxygen or ventilator dependency, or those in whom the difficulty of the change is unknown.

Due to the risk of vomiting and aspiration associated with tube changes and airway manoeuvres, patients should ideally be 'nil by mouth' for 6 hours for solids, and 2 hours for clear liquids before an elective tube change. If a patient has had many tube changes before without incident, then these guidelines could be reasonably relaxed. Patients fed via a tube feeding system should have this stopped and aspirated, and any gastric drainage tubes in situ should be aspirated also.

Positioning the patient with the neck extended brings the trachea anteriorly. This should be done for all patients unless contra-indicated (e.g. cervical spine injury). Tube changes can be performed with the patient supine or reclined in a suitable chair or bed, depending on the clinical condition. The role of any stay sutures should be identified if present as these may elevate and widen the stoma.



Any secretions that may have collected above the cuff of the old tube need to be removed prior to cuff deflation. This reduces the risk of contamination of the airway. In the sedated patient, this will involve oral, pharyngeal and subglottic suction with a soft catheter. Awake patients will find this uncomfortable, but it is important to remove secretions from above the cuff if possible. Tubes with specific sub-glottic suction channels allow some of the secretions to be cleared more easily. Any remaining secretions can be removed by timing cuff deflation (prior to tube removal) with expiration. The patient is asked to take a breath in and exhale strongly or cough as the cuff is deflated. If the patient is ventilated, then deflation is timed with the expiratory phase.

Changing the tube

An elective change of a tracheostomy tube can be performed using essentially 2 techniques: A 'blind' technique where the new tube is inserted directly into the old stoma, or a 'guided' technique using a wire or bougie to remove the old tube over and to 'railroad' the new tube over. There are slight variations in these techniques for different circumstances. Videos of tube changes can be found below and there is a section on the e-learning part of the website www.tracheostomy.org.uk.

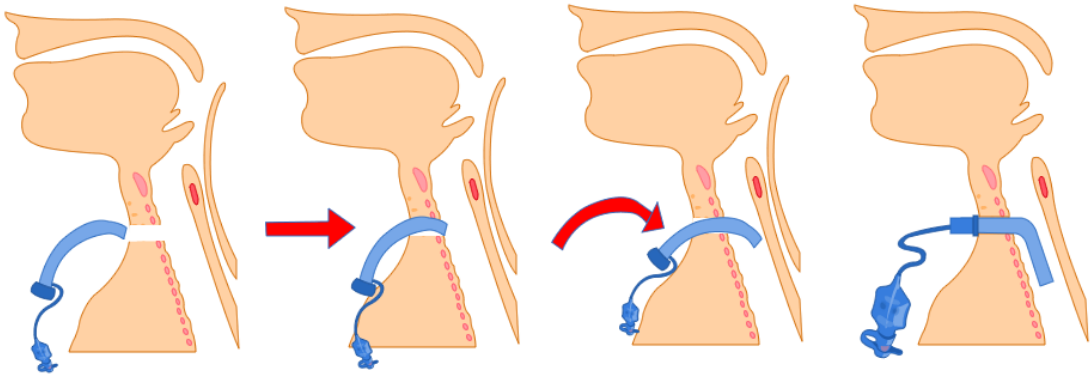
Tube changing videos may be found by clicking below:

- Removing a tracheostomy tube (narrated)
- Decannulation and application of oxygen to the stoma
- Tube changes over a bougie
- Fibreoptic inspection of a tracheostomy tube

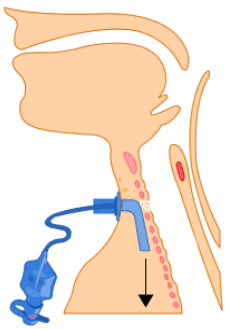
'Blind' insertion

For well-established stomas that had had uneventful tube changes documented previously, changing the tube by simply removing the existing tube and re-inserting the new tube into the stoma is an accepted technique. The new tube is prepared by leaving the 'obturator' in situ, as shown in the image to the right (purple piece in this image). This provides the tube with a smooth, tapered profile as it enters the neck.

The tube is initially introduced with the tracheal portion 'flat' to the stoma as shown in the sequences below. Once the trachea is entered, the tube is rotated through 90 degrees to enter the trachea. This rotation should not occur before the tube is within the trachea as this risks creating a 'false passage' in the anterior tissues of the neck.



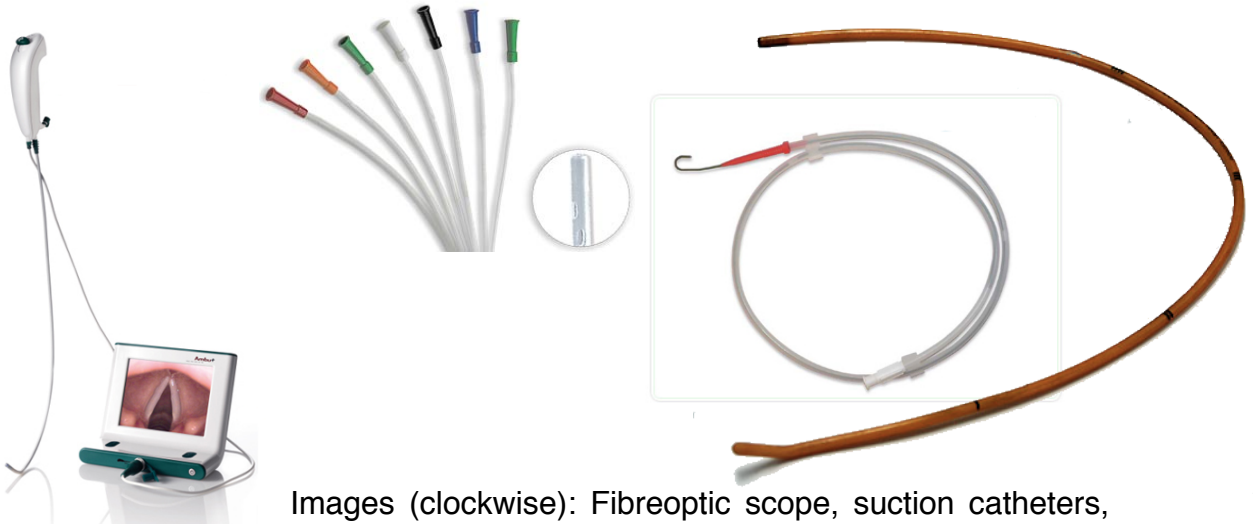
The image to the left and below demonstrates an tube which has been placed into a false passage. The tube lies in the anterior tissues of the neck. Attaching the tube to any sort of gas supply and attempting ventilation could rapidly result in airway obstruction, pneumothorax, pneumomediatinum or subcutaneous (surgical) emphysema which could rapidly become life threatening. This also means that the stoma is not effective as a means of oxygenation and the trachea itself could be compromised.



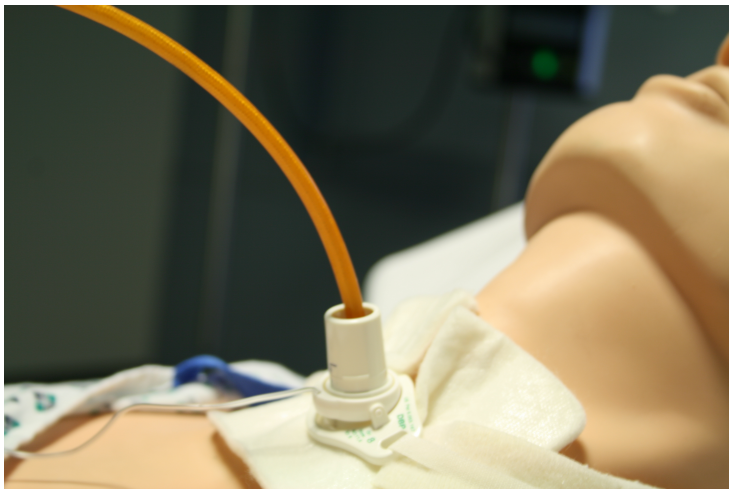
‘Guided’ tube changes

For the first tube change, or if there is either an unknown or predicted degree of difficulty in changing the tracheostomy tube, the exchange is usually performed over a guide. This can be a gum elastic bougie, an airway exchange catheter, a guide-wire or suction catheter. The principle is to insert the guide into the trachea via the old tube and leave it in situ when the old tube is removed. This ensures that the path from the skin, through the tissues of the neck to the trachea remains ‘marked’ and should make insertion of the new tube easier. This technique is especially useful if the patient has a relatively new tracheostomy stoma or the neck is large, making the stoma deep. The superficial and deeper layers in the neck may ‘spring’ back into their anatomical positions following removal of the existing tracheostomy tube as shown in the images below. Using a guide will help to reduce the impact of this.

A selection of guides suitable for this purpose are shown below. It should be remembered that this technique relies on the old tube being correctly placed within the tracheal lumen when the guide is inserted. If there is any doubt about this, a fibreoptic inspection is recommended. Some airway exchange catheters can be first loaded over a suitable fibreoptic endoscope so that the catheter’s position within the airway is confirmed visually. New tubes can be rail-roaded directly over a ‘scope, but ‘scopes are more easily damaged than a cheap, disposable bougie.



Images (clockwise): Fibreoptic scope, suction catheters, guidewire, gum-elastic bougie



The image to the left shows a bougie inserted into a tracheostomy tube. Because this is potentially unpleasant for the patient and risks trauma to the trachea, coughing or irritation of the carina (with associated vagal side effects), the bougie should be inserted for as short as possible. This means preparing the patient by first removing the dressings around the tube and the sutures or ties that hold the tube in place. The bougie should be held by a dedicated assistant, so that another 'pair of hands' concentrates on cuff management and tube exchange. It is useful to have a 'talk through' rehearsal between operators before undertaking the procedure.

Gum elastic bougies are not primarily designed for tracheostomy tube exchanges. Several specific airway exchange catheters are available. Some of these allow connection to standard anaesthetic circuits to allow oxygenation during the exchange procedure and some have a large enough internal diameter to allow a fibreoptic scope to be inserted as described above.

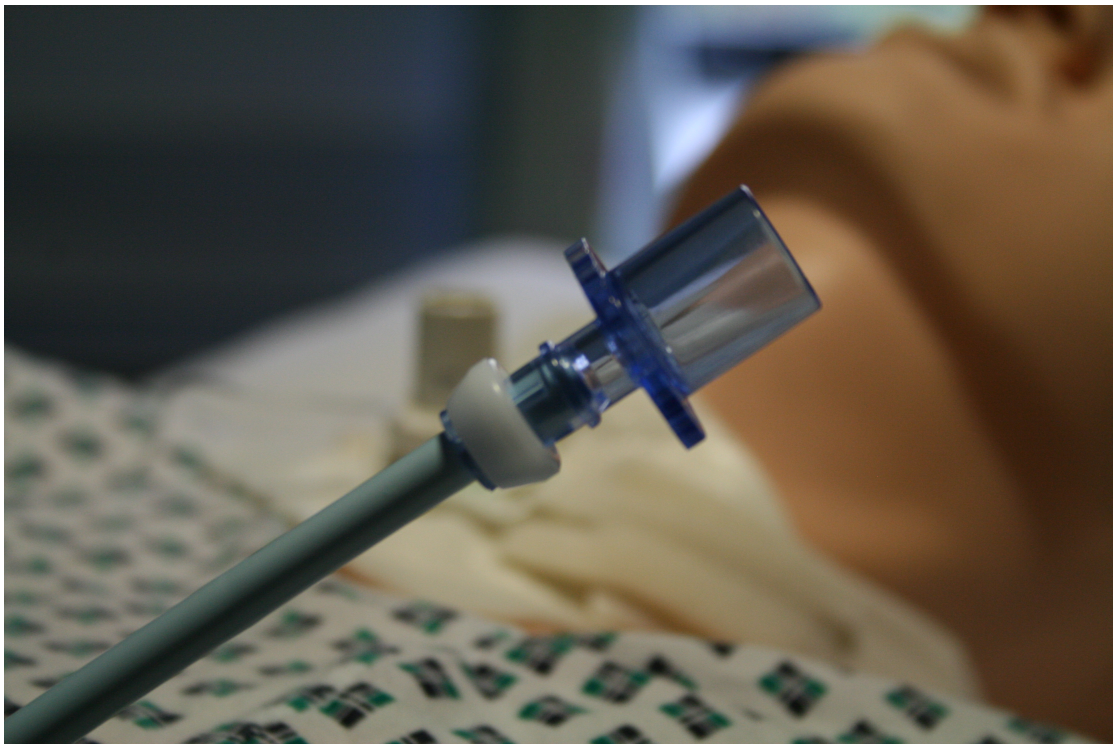


Image above shows a Cook Aintree Catheter connected to a 15mm port.

What to do if the new tube won't go in

Sometimes, new tubes won't insert easily. It is important not to force a new tube into a stoma. Similarly, blindly attempting to pass a bougie or introducer into a deep or fresh tracheostomy stoma may lead to the creation of a false passage, cause bleeding and delay attempts at more conventional airway management.

The key principle is to maintain oxygenation by whatever means necessary. In the elective situation, this may be as simple as reassuring the patient and awaiting a more experienced practitioner. In the oxygen or ventilator-dependant patient, this can be more arduous. All necessary equipment, drugs and personnel should be on hand to manage this situation if the patient and clinical area have ben adequately prepared.

The commonest solution to this problem is to insert a new tube that is a size smaller than the tube that has been removed. If necessary, the stoma can be formally dilated at a later time. If your experience and local guidelines allow, tracheal dilators (right) may be used to temporarily dilate the stoma whilst a new tube is inserted.

If the patient has a patent upper airway, oxygen should be applied to the face whilst more invasive attempts at intubating the stoma are made. The goal is a safely oxygenated patient, and a formal re-insertion of the tube may need to occur in a planned manner in an operating theatre environment. If the clinical condition of the patient means that tube exchange needs to be more urgent, options include:

- Identification of the tract and trachea using a fibreoptic 'scope
- A 'scope and airway exchange catheter
- Digital manipulation of a bougie into the trachea*
- Blind passage of a bougie or guide-wire into the stoma*
- Formal refashioning of the stoma surgically or percutaneously

*These options are more likely to result in incorrect placement of the tube tip and should only be considered in an emergency.

A video demonstrating cannulation of a stoma using an Aintree catheter and fibreoptic 'scope is available here. There is more detail on managing a deteriorating tracheostomy or laryngectomy patient whose airway is compromised in the emergency management section.

Summary

The table below summarises key actions related to tube changes and their rationales (adapted from NPSA expert working group)

Action	Rationale
Identify need for tracheostomy tube change and clarify type of tube to be inserted	To ensure tube change is necessary and the correct tube type is selected for current and on-going patient care needs
Patient preparation may include ensuring 'nil by mouth' for 2-6 hours (liquid-solid) and/or aspirate gastric tube	To limit the risk of aspiration during tube change procedure
Decide on blind or guided technique and assemble appropriate equipment	Guided techniques more appropriate for first or (potentially) difficult exchanges
Explain the procedure to the patient and obtain verbal consent if appropriate	To ensure the patient understands the procedure & improve co-operation
Ensure appropriate staff and equipment are available	To deal appropriately with additional measures to secure an airway.
Set up bedside suction and oxygen equipment	To ensure oxygen and suction are available (when needed)
Prepare, check and lubricate new tube. Remove any inner cannulae from both old and new tubes	To ensure new tube has no faults and is prepared for insertion and application.
Remove any obstructing clothing or equipment	To ensure neck area is accessible for tube change
Position patient for procedure by placing a roll under the patient's shoulders, extending the stable neck. Patient may be placed lying down or sitting upright depending on individual patient assessment.	To bring the trachea closer to the skin and to stretch stoma opening in order to aide tube insertion
Identify the roles of any stay sutures	Elevate and open the stoma
If the tracheostomy tube is sutured in-situ, remove all sutures. Skin sutures may be considered for removal if appropriate.	To allow tube removal and to prevent sutures becoming embedded or an infection risk
Pharyngeal and sub-glottic suction orally or via dedicated port on tube	Reduces risk of aspirating collections above the cuff
Deflate cuff (if present) simultaneously suctioning	To enable existing tube to be removed and for secretions to be cleared.
Untie tapes and remove dressing whilst tube is held firmly in place	To remove old dressings and tapes
Insert guide via old tube (if used)	Maintains patency of stoma

Remove existing tube with a firm out and downwards movement as patient breathes out	To reduce patient coughing
Observe stoma site and tracheal opening	To identify signs of infection, granulation tissue and/or bleeding
Holding the introducer (obturator) in place, insert new directly tube into stoma OR using the guide, railroad the new tube	To pass tube along contour of tract
Remove introducer / guide	To allow patient to breathe and to allow confirmation of correct tube position
Check correct positioning: • Ask patient to breathe out, air should be felt through end of tracheostomy • Auscultate • Bilateral chest movement • Suction below the end of the tracheostomy to confirm placement within trachea • Capnography* • Fibreoptic endoscopy*	Evidence of airflow exiting the tube will confirm correct placement within the airway. *Capnography and endoscopy should be immediately available for difficult cases

Following successful exchange:

Re-attach any oxygen or ventilation needs Inflate cuff and check cuff pressure, (as per guidelines) Apply tapes and dressing (as per guidelines)	To recommence respiratory requirements and secure tube position
Re-position patient as to patient requirements and comfort	To maintain patient comfort

Weaning, down-sizing and planning for decannulation

Tracheostomies may be only a short term requirement for patients and should be removed as soon as they are no longer needed. Judging the timing of removal of the tube (decannulation) can be difficult, and the patient may need to spend several days or even weeks progressing towards this step. The best way to reduce complications from having a tracheostomy tube in situ is often to remove the tube as soon as it is safe to do so.

The term ‘weaning’ can mean either a reduction in support from mechanical ventilation (or assisted spontaneous breathing modes), a generic term for the period of time as the patient progresses towards decannulation, or the term is sometimes applied to a reduction in the size of the tracheostomy tubes. The latter term is referred to as ‘down-sizing’ in this manual.

Within the hospital setting, patients will be in with one of three different categories with their tracheostomy: permanent tracheostomy (non-weanable), long-term (weanable with difficult or under specialist supervision) or temporary (weanable). Tracheostomy tubes may cause permanent anatomical or physiological damage to the airway and related structures and therefore timely weaning, where indicated, is advantageous.

Prior to the removal of a temporary tracheostomy tube, there must be multidisciplinary team agreement that the indication for the tracheostomy has now been resolved sufficiently. The weaning process must be clearly led by individuals who as competent to do so, as the process is not without risk. This same team should remain the main point of contact for at least 48 hours post decannulation. If patient location prevents this being a viable option, care should be formally handed over to someone able to provide adequate advice and interventions.

A tracheostomy MDT will regularly include:

- Ward Nurse
- Physiotherapist
- Speech and language therapist
- Specialist Nurse (Tracheostomy, ENT or Critical Care e.g. Outreach)
- Respiratory physician
- Head & Neck surgeon
- Anaesthetist or Intensivist
- The patient and/or their carer may be valuable team members with considerable knowledge. The patient will be included in any relevant discussions if possible.

The team must have a thorough knowledge of the individual patient’s condition including indication for tracheostomy, established indicators for decannulation and plan of further any future assessments or interventions.

Practitioners caring for the patient through the decannulation process must have a sound understanding of the signs of deterioration during or post-decannulation and must be able to take necessary actions in the event of an emergency.

For some short-term conditions requiring a tracheostomy (e.g. facilitating a straight-forward wean from mechanical ventilation or covering extensive oral surgery) the original tracheostomy tube may suffice for the whole weaning process, prior to removal. In more complex situation, a smaller tube, a different type of tube (e.g. minitrach), a fenestrated tube or a variety of speaking valves or decannulation caps may be required.

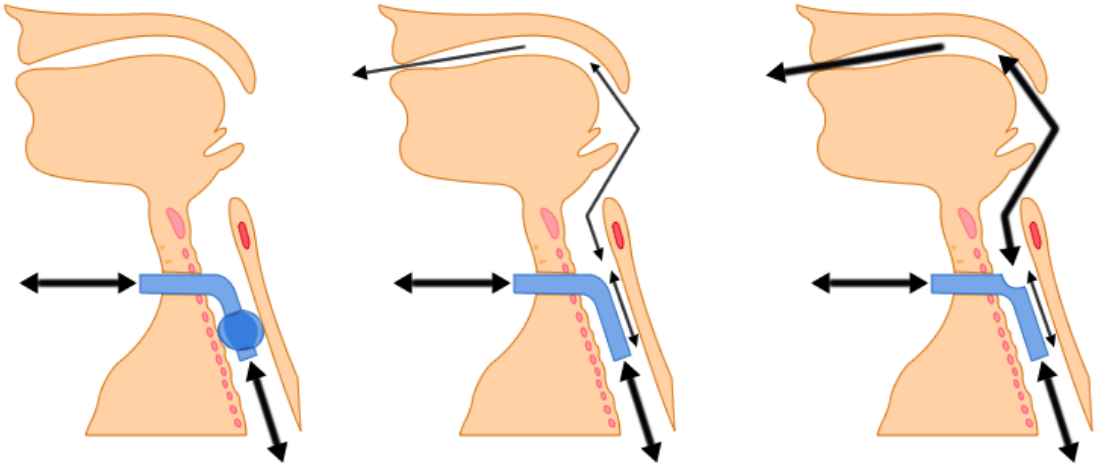


Image above demonstrates expected airflows with cuffed tube (left), un-cuffed tube (centre) and an un-cuffed, fenestrated tube (right).

Patient assessment

In assessing whether a patient is a suitable candidate to attempt weaning with an aim of decannulation, it must first be clarified whether the reason for the tracheostomy has now been resolved. This may require assessment by endoscopy to assess patency of upper airway and movement of vocal cords. This can be carried out by anyone competent to do so, but may involve head & neck surgical teams, anaesthetists, intensivists or SALT teams who are usually more experienced with endoscopy. A more general assessment of the patient is also required to ascertain whether the patient is well enough to endure the remove of the tracheostomy within the coming days.

A checklist to use prior to commencing weaning should ascertain:

- Is the upper airway patent? (may require endoscopic assessment)
- Can the patient maintain and protect their airway spontaneously?
- Are they free from ventilatory support?*
- Are they haemodynamically stable?
- Are they absent of fever or active infection?
- Is the patient consistently alert?

- Do they have a strong consistent cough (able to cough into mouth)?
- Do they have control of saliva + / - a competent swallow
- Are there any planned procedures requiring anaesthesia within next 7-10 days?
- Is this patient causing us concern?
- Can we safely support the weaning process in the patient's current clinical environment?

*Under specialist supervision, it is possible to decannulate some patients who will need on-going non-invasive respiratory support via a face or nasal mask.

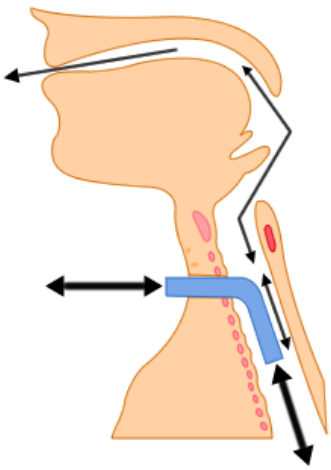
The principles of weaning involve gradually returning the airflow patterns in the upper airways back towards 'normal' thus restoring normal physiological functions. This process will only succeed if the tracheostomy tube in situ is of an appropriate size to allow sufficient airflow around and/or through the tube to the upper airways.

The process

There are many variations on decannulation protocols described in the literature. It is not clear which of these is 'the best' or whether some work better in certain situations. If your institution has a protocol which works for your patients, then you are probably just as well continuing to working with it. We have attempted to explain here the principles behind the various strategies that may be employed.

The first step after determining suitability is to deflate a tracheostomy tube cuff, if present. This is in order to ensure the patency of the upper airway and to ensure that the patient can manage their upper airway secretions. Deflation of a cuff is explained in detail elsewhere in this manual. In summary, it involves prior subglottic and pharyngeal suctioning (or suction of a dedicated subglottic suction port) prior to cuff deflation with simultaneous suctioning.

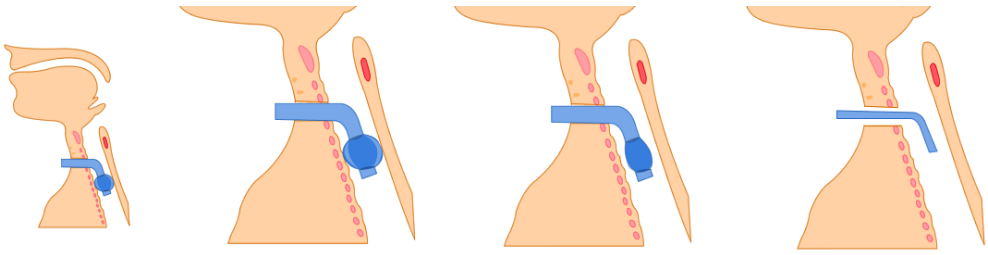
If a patient has had a cuffed tracheostomy tube in situ for some time, then deflation and the subsequent flow of air through the upper airways can cause some initial coughing or distress. The cuff may have to be deflated on a number of occasions for increasing time periods. If the patient is breathing significantly through the upper airways, then consideration should be given to the inspired oxygen concentration. Room air (21% oxygen) will be mixed with the concentration inspired via the tracheostomy and the oxygen concentration delivered to the lungs will be lower than that delivered. If the patient is oxygen dependant, this could lead to hypoxaemia. The oxygen concentration delivered to the tracheostomy can be increased, supplemental oxygen may need to be given by



facemask or the cuff may need to be re-inflated. Hypoxia usually indicates that the patient is not ready to proceed beyond short trials of cuff deflation.

If the patient can tolerate cuff deflation, we will have established that they have a patent upper airway and that they can manage their oral secretions. Cough effort and swallowing can also be assessed at this point. If a patient has had a tracheostomy tube in situ for a prolonged period of time, cuff deflation should normally be tolerated for around 24 hours prior to attempting further interventions and proceeding with the decannulation plan. Patients who are relatively well or who have had a short-term tube in situ may be able to progress rapidly if each step is well tolerated.

Occlusion of the end of the tracheostomy tube will mean that the patient has to breath solely through the upper airways and all airflow in the trachea will have to be *around* the tube and not *through* it. With the tracheostomy tube and deflated cuff siting in the airway, this offers a significant resistance to airflow, associated with an increase in the work of breathing. The image below shows the different amounts of space available to breathe around a tracheostomy tube sited in the trachea.



Digital occlusion with a gloved finger is a simple way to assess whether the patient is able to tolerate further attempts at weaning with the current tube in situ. If the patient can breathe adequately past the tube, in and out via the nose and mouth without any signs of respiratory distress, then weaning could reasonably progress with the same sized tube. If the patient cannot breathe adequately via the upper airways, then the tube may be too large and down-sizing to a smaller tube (as shown in the right-hand image above) may allow more gas to bypass the tube to the upper airways. This will offer less resistance to gas flow in the trachea. The largest tubes that will be tolerated for weaning in this way are usually 7.5mm ID for males and 6.5 mm ID for females. Failure to tolerate brief tube occlusion must raise the possibility of upper airway obstruction, which should warrant fibreoptic inspection.

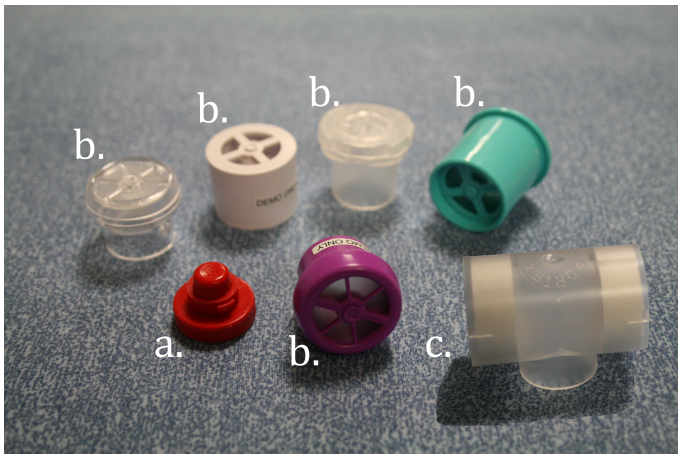
A fenestrated tube (with single or multiple holes on outer curvature of tube) may be useful for weaning, especially for patients who do not cope well with down-sizing or when down-sizing is not possible. They are used as appropriate and caution must be taken as the fenestrations may cause the formation of granulation tissue within the trachea and/or allow trauma to the posterior tracheal wall if suctioned through inadvertently.

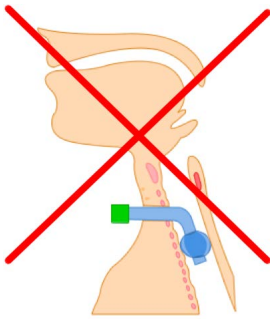
The choice of whether to leave a cuffed tube in situ or change to an un-cuffed tube will depend on the patient and the circumstances. If the patient is only tolerating short periods of cuff deflation or if intermittent or nocturnal ventilation may still be required, a cuffed tube will need to remain. Otherwise, an un-cuffed tube will offer less resistance to flow to the upper airways.

When a patient is known to have a complex airway (e.g. requiring an adjustable flange tracheostomy) or has a previously documented difficult intubation extra caution is taken throughout the whole process. In these cases, it is essential to liaise closely with the relevant parent team with responsibility for the tracheostomy.

Speaking valves and caps

Speaking valves and occlusion caps are advocated by many and can be used prior to tube removal. The speaking valves (labelled 'b' in the image) are one way valves, allowing gas to be inspired via the tracheostomy tube. The valve closes in expiration, forcing gas thought the upper airways. A decannulation cap (labelled 'a' in the image) blocks all airflow via the tracheostomy tube. Both of these systems cause an increase in the resistance to airflow through the trachea, as the tube is still present in the lumen of the trachea. Some patients will therefore tire even after a few minutes of this sort of intermittent or permanent occlusion and need the valve or cap removing. Monitor all of these trials carefully as if a brittle patient become fatigued, the weaning process may be delayed by several days while that patient recovers. They may not always be required if the patient has had a relatively short-term tracheostomy in situ.





One of the most important points to remember when using speaking valves or caps is that they must never be used with a cuffed tube with the cuff inflated. Outside of specialist areas, it is probably safer to stipulate that these devices should simply not be used with cuffed tubes at all, as even the potential to inflate the cuff with these devices attached can be fatal. The patient cannot exhale through the tracheostomy tube when a speaking valve is attached, and if the only alternative means of exhalation (via the upper airways) is blocked with an inflated cuff, the patient will suffocate. Both inhalation and exhalation via the tube are

impossible when a cap is used. Videos explaining the use of speaking valves can be found here, with a narrated Captivate presentation available here.

Speaking valves can be used in breathing circuits with ventilators in some circumstances. Normally, ventilator-dependant patients do not tolerate attempts at speech as this comes at the expense of oxygenation and appropriate ventilation. However, for some patients who are weaning from mechanical respiratory support slowly, or those who require long-term ventilatory support, attempts at speech may be appropriate. It is important to deflate any cuff that is used prior to inserting the speaking valve. The ventilator will usually have to be set to deliver larger tidal volumes. The subsequent loss of gas from the upper airways as it is exhaled via the larynx will cause most ventilators to assume that a significant circuit leak is occurring and the alarms but be set appropriately.

When the patient can tolerate a deflated cuff, manage their oral secretions, protect their airway and breathe adequately through their upper airways (usually following some sort of tube occlusion trial) then they are ready to have the tube removed.

Weaning documentation

The standardised weaning and subsequent decannulation practices must be locally agreed and supported by multi disciplinary guidelines and documentation.

Local guidelines and practice must ensure that:

- The team taking responsibility for a patients' tracheostomy wean review the patient regularly
- Their assessment, interventions and plan is clearly documented to guide the ward MDT
- Observation charts include tracheostomy and respiratory observations are accurately maintained
- The ward MDT have written guidance of how to access expert help in an emergency at any time (Bedhead signs)

Summary

The table below summarises key actions related to weaning and their rationales (adapted from NPSA expert working group)

Action	Rationale
Explain and discuss the procedure with the patient	To ensure consent, understanding and reduce anxiety
Have communication aids available e.g. alphabet chart, pen and paper, interpreters if necessary	To promote effective 2 way communication
Sit the patient upright (unless contra-indicated)	To promote chest expansion and help reduce aspiration risk
Suction the patient if necessary	To remove secretions prior to 1st cuff deflation
Perform the 1st trial cuff deflation (suctioning at the same time) and observe for signs of acute respiratory distress, de-saturation or patient discomfort. Re-inflate cuff if not tolerated and agree re-review date. This may be as frequently as daily	To ensure timely tracheostomy wean and reduce risk of tracheal damage
If cuff deflation tolerated, proceed with wean to point of decannulation according to local guidelines.	See next table
Involve MDT throughout process	See next table
Recognise signs of clinical deterioration or improvement and slow / stop / restart / speed up the weaning process as indicated	To optimise wean success and reduce patient risk

An example of a staged weaning approach	
Stage 1	Trial cuff deflation and speaking valve (up to 30 mins) Consider down-sizing or un-cuffed tube
Stage 2	Increase speaking valve use up to 12 – 24 hours (Cuff may still be inflated overnight if necessary)
Stage 3	Trial tube occlusion 'capping off' up to 12 - 24 hours
Stage 4	MDT assessment and confirm decision to decannulate
Stage 5	Decannulate and assess stoma
Stage 6	Remove tracheostomy equipment after non eventful 48 hours post decannulation

Decannulation

The removal of a tracheostomy should occur as soon as there is no further need for it to remain in-situ. The process of removing a tracheostomy tube is referred to as decannulation. It should be considered only when a patient has successfully progressed through a structured tracheostomy weaning programme. The use of standardised multidisciplinary processes will reduce the risk of complications following the removal of the tube. Prior to the removal of a tracheostomy tube, there must be multidisciplinary agreement. Occasionally a tube must be removed in an emergency (partially displaced tube in the image). There is more detail in the emergency management section, but remember to deflate the cuff and remove any sutures prior to attempted decannulation.

The tracheostomy MDT will regularly include:

- Ward Nurse
- Physiotherapist
- Speech and language therapist
- Specialist Nurse (Tracheostomy, ENT or Outreach)
- Anaesthetist or Intensivist
- Respiratory physician
- Head and neck surgeon

The timing of the decannulation procedure needs consideration, to minimise the risks to the patient. The clinical environment should have sufficient competent staff and equipment available. YouTube videos demonstrating safe decannulation are available here, with Captivate narrated presentations available here: Videos of decannulation.

The position of the patient within their clinical setting should allow staff to visualise the patient easily and the patient should have constant access to an appropriate call system. It may be necessary to transfer the patient undergoing decannulation to an area where 1:1 nursing care can be offered and ready access to specialist staff who could appropriately deal with a failed decannulation or other complications. Decannulation should not occur late in the working day or at weekends unless adequate staff and resources are constantly available to provide advice, assessment and perform advanced airway and tracheostomy management should the procedure not be successful.

Prior to Decannulation the Tracheostomy MDT will confirm:

- The patient can maintain and protect their airway spontaneously
- They are free from ventilatory support with adequate respiratory function
- They are haemodynamically stable
- They are absent of fever or active infection
- The patient is consistently alert
- They have a strong consistent cough (able to cough into mouth)
- They have control of saliva + / - a competent swallow
- They are not planned for procedures requiring anaesthesia within next 7-10 days
- They are considered clinically stable

Extra caution is essential if the patient is known to have a complex airway (e.g. requiring an adjustable flange tracheostomy) or has a previously documented difficult intubation.

Equipment

For all decannulation procedures, standard bedside equipment and:

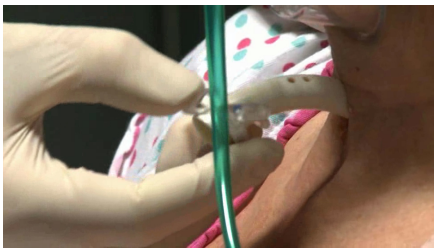
- Oxygen available
- Continuous oxygen saturation monitoring
- Microbiological swab for stoma
- New tracheostomy tubes (for possible re-insertion)
- Sterile dressing pack
- 0.9% Saline
- Semi-permeable occlusive dressing
- Suction equipment
- Relevant MDT documentation
- Resuscitation equipment must be locally available
- Access to advanced airway expert, with appropriate equipment

Additional equipment may include:

- Stitch cutter
- 10ml syringe
- Gum elastic bougie
- Bag valve mask circuit
- Rebreathe circuit
- Facial nebuliser circuit / adrenaline available for nebulisation

Procedure

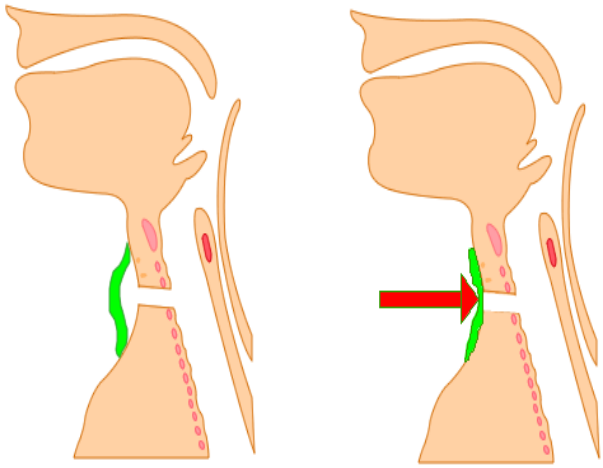
Decannulation is a 2-person procedure. After checking all relevant equipment, the patient is placed in a comfortable position with access to the neck. A full explanation is required as this is often a time of great anxiety for the patient.



Any tapes, ties or sutures are removed whilst the assistant holds the tube in position. The tube will usually have had the cuff deflated for some time prior to decannulation, or be of the un-cuffed type. Suction is performed and the tube is removed in expiration, to try and ensure any secretions are coughed out.

The stoma site can be inspected, swabbed and cleaned as necessary. Most stomas will heal well provided that the general condition and nutritional status of the patient is good, and the stoma is kept dry and infection free. The diameter of the stoma may be expected to shrink by around 50% in the first 12 hours following removal of the tube. Stomas may heal completely in as little as 3 to 4 days, but may take several weeks. A small number may require formal surgical closure. Initially the stoma is covered with sterile gauze and an appropriate semi-permeable dressing (such as tegaderm™ or opsite™).

On coughing and talking, it is common for the dressing to bulge outwards whilst the stoma remains patent. The patient can place a finger over the dressing to prevent this. The dressing is usually inspected and changed at least daily. The patient and their carers must be instructed to seek appropriate attention if there is a residual leak in expiration, redness, wetness or discharge from the stoma over the days following decannulation.



Documentation

Local policy and practice must ensure that:

- The team performing a decannulation document all associated events in patient notes immediately following the procedure
- The team performing a decannulation document if they plan to re-review routinely or have discharged from caseload.

- If the team performing the decannulation have discharged the patient from review, they must provide written criteria and contact details for urgent re-referral should the patients condition deteriorate
- The level of respiratory observation required is identified
- The ward MDT have written guidance of how to access expert help in an emergency at all times
- Tracheostomy emergency equipment should be left at the bedside for a further 48 hours following decannulation

Post –decannulation

Following the removal of the tracheostomy tube, the patient is left with an opening into their trachea. This needs protection form entry of water or foreign bodies and needs assistance to close. An airtight dressing is required to prevent the ongoing passage of air through the tract (tracheo-cutaneous fistula) which will delay wound healing. Where possible, the patient should be encouraged to apply gentle pressure to the dressing whilst coughing or speaking. This will reduce the air pressure through the fistula to the underside of the dressing, which will loosen the dressing's contact with the skin, necessitating frequent dressing changes. The wound should be airtight within two weeks and if not, then a referral to the Ear, Nose and Throat team should be considered. Tissue forming along the fistula may require specialist assessment and treatment.

The use of a standardised weaning procedure should reduce the risk of patients 'failing' a decannulation attempt. However, a patient's condition can alter which may necessitate consideration for re-insertion of the tracheostomy. The emergency tracheostomy equipment should be left at the patient's bedside for 48 hours following decannulation to enable access to tracheostomy equipment for this period post decannulation. This is particularly important to maintain for those patients transferred to other clinical settings within 48 hours post decannulation.

Summary

The table below summarises key actions related to decannulation and their rationales (adapted from NPSA expert working group)

Action	Rationale
Discuss the procedure with the patient. Have communication aids available e.g. interpreters.	To ensure consent, understanding and reduce anxiety.
Initiate continuous oxygen saturation monitoring for procedure	To identify and alert staff to de-saturation following procedure.
Ensure patient sitting in an upright position.	To promote chest expansion and reduce risk of aspiration.
Stop any naso-gastric feed or oral intake for 4 hours pre-procedure. Local policy may allow aspiration of NG tube.	To minimise the risk of aspiration and / or acute desaturation.
While holding onto the tracheostomy tube, undo ties and remove all dressings in preparation for removal. Ensure cuff is deflated if present.	To prepare tube for removal
Remove the tracheostomy on maximal inspiration or as per local policy.	To minimise the risk of alveolar collapse.
Prior to dressing application: check for signs of respiratory distress and confirm patient can voice/cough whilst stoma occluded	To monitor for complications to tube removal prior to dressing application
Using a sterile technique, clean the stoma site with saline and dress site with a semi-permeable occlusive dressing.	To reduce the risk of infection and optimise wound healing.
Ensure close observation of patients' respiratory status post-procedure as per local guidelines.	To reduce patient risk.
Update MDT post-procedure and clarify further monitoring requirements, dressing needs and alert to possible complications	To optimise team communication and safe patient rehabilitation
Redress site at least every 24 hours. Measurements of the closing fistula may assist with objective assessment of a slow healing wound.	To monitor for appropriate wound closure (estimated at 7-14 days)

Bedside equipment

Emergency equipment

Any clinical area caring for patients with a tracheostomy must have emergency equipment immediately available. Some of this will be at the patients bedside as it is required for routine care, whilst other equipment is provided in the ward or nursing area.

If a patient is transferred to a different location within a hospital then the accompanying staff must ensure that any equipment that may be required in an emergency is available at the destination, and also en route. There have been many incidents recorded in hospital lifts, corridors and remote departments where a blocked or displaced tube could not be managed due to a lack of immediately available equipment.

Equipment may be in the form of a dedicated case or box that accompanies the patient, or stocked on a difficult airway trolley in a critical care area. This equipment, including suction, should accompany the patient wherever they go during their hospital stay. An appropriately trained carer who is competent to use the equipment in an emergency must also accompany them.

Emergency equipment available in a ward or clinical area

- Basic airway equipment – oxygen masks, self inflating bags, oral and nasal airways
- Advanced airway equipment – Laryngeal Mask Airways and laryngoscopes with appropriate tubes (arrest trolley or similar)
- Capnography[1]
- A fibreoptic 'scope[2]
- Tracheal dilators[3]
- Bougies

[1,2] Waveform capnography and a fibreoptic 'scope (suitable for immediate use) should be *available* for all patients with a tracheostomy. In critical care, specialist ward areas and areas who look after a high volumes of tracheostomy patients these should be *immediately* available. For other ward areas, availability should be within minutes (e.g. on a cardiac arrest trolley). This should ideally be portable and able to be used quickly without a lightsource and separate 'stack' system. All staff caring for tracheostomy patients and those who respond to emergencies should know how to access and operate these devices around the clock.

[3] There is conflicting opinion on whether tracheal dilators are useful in an emergency. This should be agreed locally and influences include patient demographics, types of tracheostomy performed and clinician preference.

Equipment for routine care kept at the bedside

- Humidification equipment
- Suction with selection of appropriate suction catheters
- Spare tracheostomy tubes
    - One the same size
    - One tube one size smaller
- Clean pot for spare inner cannula
- Sterile water for cleaning the suction tube
- Scissors (and stitch cutter if tracheostomy tube is sutured)
- Water soluble lubricating jelly
- Sterile dressing pack
- Tracheostomy dressings
- Tracheostomy tapes
- Personal protective equipment (gloves, aprons, eye protection)
- Sterile gloves- for performing deep suction
- Nurse call bell: the patient may be unable to verbally call for help
- Communication aids: the patient may not be able to verbalise
- Bedside equipment checklist

It is important to check all equipment is available at the beginning of every shift. A suitable container or carrier box is useful to keep all of this equipment together. TRACHI-CASE™ is one of a number of commercially available kits for this purpose. These types of cases can then accompany the patient is they need to be transferred to a different location. Remember that you will need portable suction and a portable oxygen supply to accompany the patient.

The case should contain:

- Spare trachy tubes
- Suction catheters
- Scissors
- Stitch cutter
- Lubricating jelly
- Tapes
- Dilators (local choice)

Dedicated clinical areas

One of the recommendations to come from the work looking at patent safety incidents is to cohort patients together to concentrate staff, skills, equipment and expertise. This should make equipping and training locations that will be designated to care for tracheostomy patients easier.

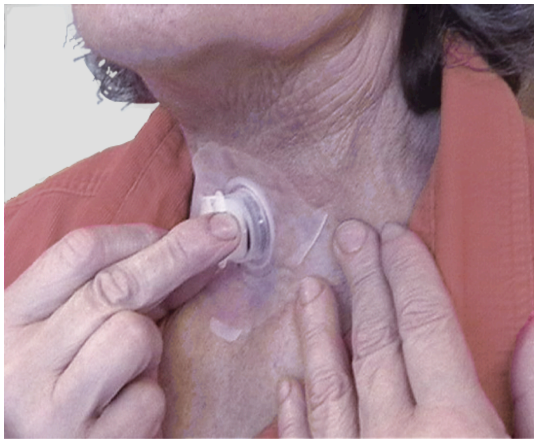
This approach does mean that the majority of clinical locations will loose expertise of looking after neck breathing patients which may restrict bed movements in an acute hospital. However, the risks of caring for this cohort in clinical areas without the necessary equipment, training and experience places the patient at an increased risk of airway complications, morbidity and mortality. One of the key recurring themes in the published critical incident reviews was a lack of equipment and training by staff meaning that routine care was not provided, warning signs and red flags were missed and that emergencies were not managed effectively. Concentrating training, equipment and expertise would be expected to reduce these incidents.

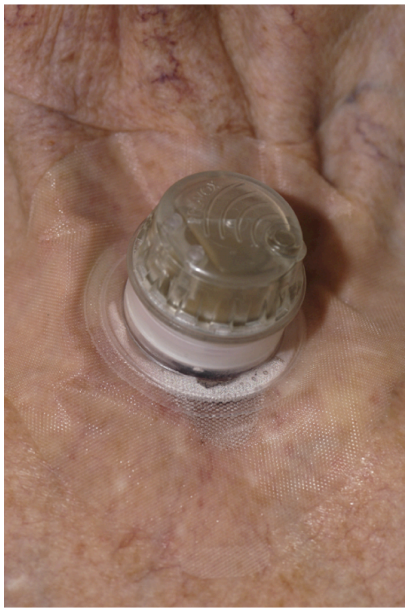
Dedicated tracheostomy teams and tracheostomy ward rounds is another well published approach to reducing tracheostomy-related critical incidents. The choice of approach adopted will be determined locally.

Laryngectomy humidification

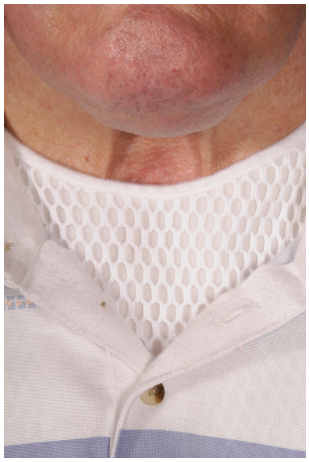
Following total laryngectomy, the normal warming and humidification that is provided by the native upper airways is lost as inspired and expired air flows directly through the laryngectomy stoma on the front of the neck, bypassing the nose and mouth.

Patients will therefore need an alternative method of ensuring that the gas inhaled into the lungs is humidified. This can be provided by applying specific covers to the stoma that contain hygroscopic material (like in HME filters), which can capture moisture, and to some degree, heat. Most patients will be self-caring shortly after their initial procedure and will be able to apply, remove and care for any bespoke stoma covers themselves. The covers do add a degree of resistance to respiration which may become clinically relevant if the patient develops an acute infection or the covers become blocked with purulent secretions. Any stoma covers should be removed in an emergency for this reason.





A Buchannon bib or similar device is another way of humidifying inhaled gases and is preferred by some patients. These can be used by tracheostomy or laryngectomy patients and come in a variety of styles and designs. Some can disguise the stoma completely and the patient just appears to be wearing a scarf or cravat (see images below)



Speech after total laryngectomy

Surgical removal of the vocal cords results in an inability to phonate. This can be a source of immense frustration for patients. There are a variety of options available to total laryngectomees which will be considered in turn.

Electrolarynx

These devices vibrate the external skin of the neck. They are used in combination with altering the shape of the mouth to create artificial speech. A degree of training is usually required.

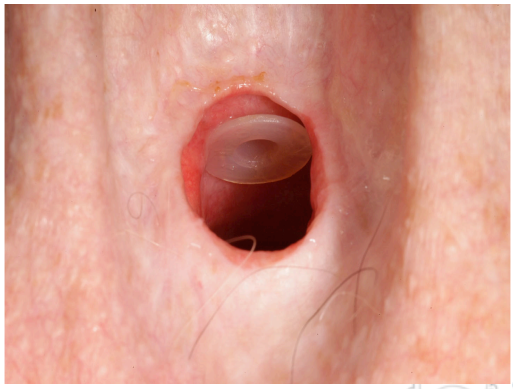
Oesophageal speech

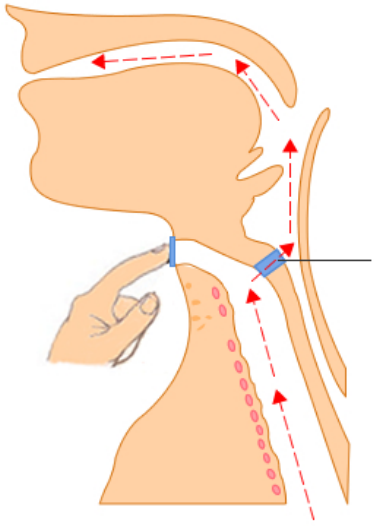
This type of speech involves swallowing air into the gullet via the mouth/nose and then 'burping' it back into the pharynx. This can be coupled with mouth shaping to generate speech. Some patients are very good at this, but again, this technique requires practice.

Tracheo-Oesophageal Punctures

These devices are often known as TEP (from the US spelling of 'esophagus'). They can be created at the time of primary surgery, or later. A puncture is made into the posterior portion of the trachea into the oesophagus behind. Exhaled air can be forced through this connection by the patient by covering their stoma in expiration. Air passes through the pharynx as above and oesophageal speech is possible. A one-way valve is usually placed into the puncture site to reduce the risk of contamination of the airways with GI contents. Some stoma covers incorporate an additional valve to direct air through the TEP valve without manual occlusion of the stoma, which makess hands-free speech. possible. TEP valves *should not be removed* in an emergency as they should not occlude the airway and removing them will not improve acute respiratory problems.

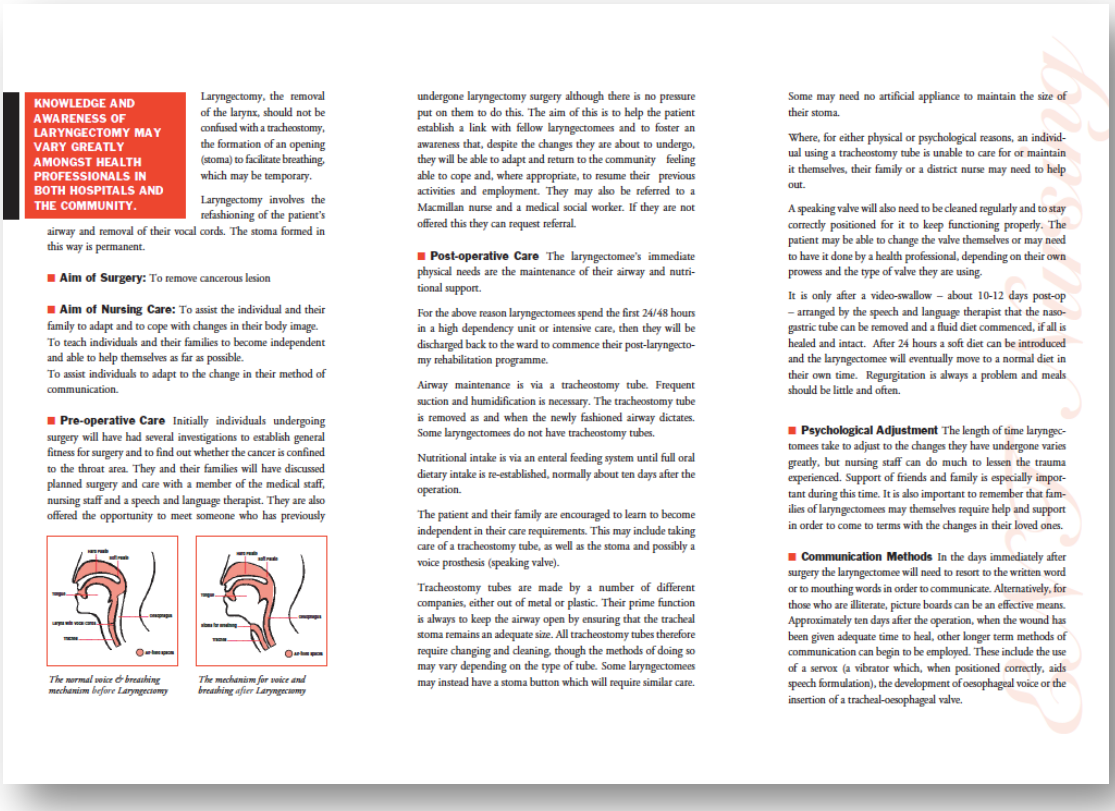
Image: TEP valve visible through the laryngectomy stoma, between the posterior wall of the trachea and the oesophagus behind.





Patient information sheets

There are a selection of information sheets for patients, carers and staff developed by the National Association of Laryngectomee Clubs in the UK. Their resources can be found at www.laryngectomy.org.uk



KNOWLEDGE AND AWARENESS OF LARYNGECTOMY MAY VARY GREATLY AMONGST HEALTH PROFESSIONALS IN BOTH HOSPITALS AND THE COMMUNITY.

Laryngectomy, the removal of the larynx, should not be confused with a tracheostomy, the formation of an opening (stoma) to facilitate breathing, which may be temporary.

Laryngectomy involves the refashioning of the patient's airway and removal of their vocal cords. The stoma formed in this way is permanent.

■ **Aim of Surgery:** To remove cancerous lesion

■ **Aim of Nursing Care:** To assist the individual and their family to adapt and to cope with changes in their body image.
To teach individuals and their families to become independent and able to help themselves as far as possible.
To assist individuals to adapt to the change in their method of communication.

■ **Pre-operative Care** Initially individuals undergoing surgery will have had several investigations to establish general fitness for surgery and to find out whether the cancer is confined to the throat area. They and their families will have discussed planned surgery and care with a member of the medical staff, nursing staff and a speech and language therapist. They are also offered the opportunity to meet someone who has previously undergone laryngectomy surgery although there is no pressure put on them to do this. The aim of this is to help the patient establish a link with fellow laryngectomees and to foster an awareness that, despite the changes they are about to undergo, they will be able to adapt and return to the community feeling able to cope and, where appropriate, to resume their previous activities and employment. They may also be referred to a Macmillan nurse and a medical social worker. If they are not offered this they can request referral.

The normal voice & breathing mechanism before Laryngectomy

The mechanism for voice and breathing after Laryngectomy

■ **Post-operative Care** The laryngectomee's immediate physical needs are the maintenance of their airway and nutritional support.

For the above reason laryngectomees spend the first 24/48 hours in a high dependency unit or intensive care, then they will be discharged back to the ward to commence their post-laryngectomy rehabilitation programme.

Airway maintenance is via a tracheostomy tube. Frequent suction and humidification is necessary. The tracheostomy tube is removed as and when the newly fashioned airway dictates. Some laryngectomees do not have tracheostomy tubes.

Nutritional intake is via an enteral feeding system until full oral dietary intake is re-established, normally about ten days after the operation.

The patient and their family are encouraged to learn to become independent in their care requirements. This may include taking care of a tracheostomy tube, as well as the stoma and possibly a voice prosthesis (speaking valve).

Tracheostomy tubes are made by a number of different companies, either out of metal or plastic. Their prime function is always to keep the airway open by ensuring that the tracheal stoma remains an adequate size. All tracheostomy tubes therefore require changing and cleaning, though the methods of doing so may vary depending on the type of tube. Some laryngectomees may instead have a stoma button which will require similar care. Some may need no artificial appliance to maintain the size of their stoma.

Where, for either physical or psychological reasons, an individual using a tracheostomy tube is unable to care for or maintain it themselves, their family or a district nurse may need to help out.

A speaking valve will also need to be cleaned regularly and to stay correctly positioned for it to keep functioning properly. The patient may be able to change the valve themselves or may need to have it done by a health professional, depending on their own prowess and the type of valve they are using.

It is only after a video-swallow – about 10-12 days post-op – arranged by the speech and language therapist that the nasogastric tube can be removed and a fluid diet commenced, if all is healed and intact. After 24 hours a soft diet can be introduced and the laryngectomee will eventually move to a normal diet in their own time. Regurgitation is always a problem and meals should be little and often.

■ **Psychological Adjustment** The length of time laryngectomees take to adjust to the changes they have undergone varies greatly, but nursing staff can do much to lessen the trauma experienced. Support of friends and family is especially important during this time. It is also important to remember that families of laryngectomees may themselves require help and support in order to come to terms with the changes in their loved ones.

■ **Communication Methods** In the days immediately after surgery the laryngectomee will need to resort to the written word or to mouthing words in order to communicate. Alternatively, for those who are illiterate, picture boards can be an effective means. Approximately ten days after the operation, when the wound has been given adequate time to heal, other longer term methods of communication can begin to be employed. These include the use of a servox (a vibrator which, when positioned correctly, aids speech formulation), the development of oesophageal voice or the insertion of a tracheal-oesophageal valve.

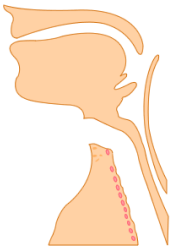
NTSP
www.tracheostomy.org.uk

THE NATIONAL ASSOCIATION OF LARYNGECTOMEE CLUBS

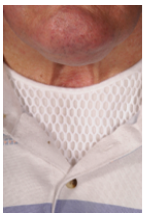
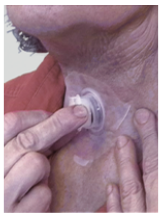
Laryngectomy information sheet
(for healthcare providers)

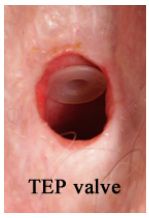
This information sheet has been produced to help healthcare professionals who may not be familiar with laryngectomies. More information can be found on the NALC (www.laryngectomy.org.uk) or NTSP websites (www.tracheostomy.org.uk).

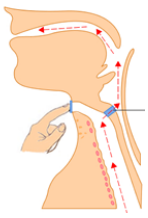
What is a laryngectomy?
A laryngectomy involves surgical removal of the larynx (voice box), usually as treatment for cancer of the larynx. The remaining trachea (wind pipe) is brought to the front of the neck as an end stoma. The mouth, nose and upper airways are no longer connected to the lungs. All breathing, ventilation and oxygen delivery can only occur via the stoma in the neck. Bed-head signs are available to display this information.



Humidification & suction
The humidification normally provided by the upper airways is lost. Laryngectomees need continuous artificial humidification of air or oxygen inspired via the neck stoma. This can be achieved using various stoma covers or bibs. Any oxygen administered *must* be humidified. Cough effort can also be reduced or less effective. Regular suction is required and should *always* be available.





Communication
Laryngectomees have lost their 'voice box'. Artificial speech is possible via an 'electolarynx' which vibrates the neck externally, oesophageal speech ('burping' swallowed air) or via a Tracheo-oEsophageal Puncture (TEP) valve. The TEP valve allows expired gas to be forced into the oesophagus, facilitating speech.

Anaesthesia
There are no contra-indications to anaesthesia with a laryngectomy. For general anaesthesia, the laryngectomy stoma can be intubated with a tracheostomy tube, specialist laryngectomy tube (eg. Montadon tube shown here) or an endotracheal tube. Supplemental humidified oxygen via an open stoma can be delivered via a 'trachy-mask.' The TEP valve should be left in situ. Emergency management algorithms and further resources are available from NALC and NTSP.

Complications associated with tracheostomies & laryngectomies.

Complications associated with a tracheostomy

Complications can be divided into those associated with insertion of the tracheostomy (surgical or percutaneous), those which arise following the procedure (usually blocked or displaced tracheostomy tubes) or later complications. These can be serious and sometimes fatal. These complications are usually grouped as follows:

1. Immediate Complications (peri-operative period)

- Haemorrhage (usually minor, can be severe if thyroid or blood vessels damaged).
- Misplacement of tube - within tissues around trachea or to main bronchus.
- Pneumothorax.
- Tube occlusion.
- Surgical emphysema.
- Loss of the upper airway.

2. Delayed Complications (post-operative period < 7 days)

- Tube blockage with secretions or blood. May be sudden or gradual.
- Partial or complete tube displacement.
- Infection of the stoma site.
- Infection of the bronchial tree (pneumonia).
- Ulceration, and/or necrosis of trachea.
- Mucosal ulceration by tube migration (due to loose tapes or patient intervention).
- Risk of occlusion of the tracheostomy tube in obese or fatigued patients who have difficulty extending their neck.
- Tracheo-oesophageal fistula formation.
- Haemorrhage (local tissue trauma or erosion through blood vessels)

3. Late Complications (late post-operative period >7 days)

- Granulomata of the trachea may cause respiratory difficulty when the tracheostomy tube is removed.
- Tracheal dilation, stenosis, persistent sinus or collapse (tracheomalacia)
- Scar formation-requiring revision.
- Blocked tubes may occur at any time, especially if secretions become thick, the secretions are not managed appropriately (suction) and humidification is not used.
- Haemorrhage

Potential problems post placement

Blocked Tracheostomy

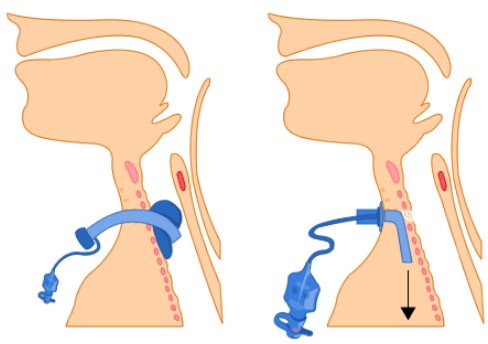
One role of the upper airway is to moisten and warm inhaled air before it reaches the lungs. Cilia are small hair like protrusions that line the respiratory tract; the function of the cilia is to prevent infection within the respiratory tract by moving mucus and other particles away from the lungs. Inserting a tracheostomy tube bypasses these natural mechanisms, which mean the lungs will receive cool, dry air. Dry air entering the lungs may reduce the motility of the secretions within the lungs and may reduce the function of the cilia. In addition the patient may not be able to cough and/or clear the secretions from their airways through the tracheostomy. This may cause the tracheostomy to become blocked by these thick or dry secretions. Blocked tracheostomy tubes can be minimised by careful humidification, tracheal suction and inner tube care. However it is necessary to keep emergency equipment at hand at all times as a blocked tube may lead to respiratory arrest.

Pneumonia

A build up of secretions may lead to consolidation and even collapse of some areas of the lung, and thus contribute to pneumonia. The presence of a foreign body in the airway will hamper normal physiological defence mechanisms and particulate matter, oral secretions, gastric contents and bacteria can be aspirated past any cuff into the airway. These risks can be minimised by careful humidification, tracheal suction and inner tube care, and may be helped by suctioning above the cuff with specific subglottic suction tubes. Aspiration of gastric contents may also lead to pneumonia. This can occur with patients who are unable to swallow safely. Any patient who you suspect may have aspirated will need to have a formal swallowing assessment.

Displaced Tracheostomy Tube

The tracheostomy tube can become partially or completely displaced. The tube may migrate out of the stoma or into the soft tissue of the neck. The tube may become displaced by coughing, because of its weight or the weight of attached breathing circuits, or by patient interference. Partial tube displacement is more dangerous as it is not always visibly obvious that there is a problem with the tube. In order to keep tracheostomy tubes in position they must be secured carefully



and monitored. Any concerns raised by the patient or nursing staff must be promptly investigated.

Haemorrhage

It is common for some bleeding to occur after a tracheostomy has been performed. This usually settles with a few days. Bleeding can occasionally be significant or even catastrophic. Bleeding can be from the trachea, stoma or surrounding tissues and can be due to direct trauma of the tissues, puncture or injury to adjacent blood vessels or the tube or cuff eroding into surrounding tissues or vessels over time. Bleeding can also come from the lungs themselves and become evident through tracheal suction. These problems are compounded in a patient with a coagulopathy.

A trachea-innominate fistula can occur if the tube erodes into the innominate artery. This is a rare complication but is associated with lower placement of the tube in the trachea. The hallmark is a warning or 'sentinel' bleed. Any haemorrhage should prompt a fibreoptic inspection of the trachea. If an arterial bleed is suspected, this should occur immediately with an experienced surgeon and resuscitation measures available. Arterial haemorrhage can become rapidly fatal. Hyperinflation of the tracheostomy tube cuff or an endotracheal tube cuff may hep to tamponade the bleeding point, prior to definitive surgical management.

Tracheostomy Red Flags

Most healthcare workers will be familiar with the descriptions of critical incidents that developed where warning signs were often present and sometimes recorded, without their significance being recognised. Tracheostomy red flags may be clues that a problem has, or is about to occur and need to be acted upon. Prompt assessment by someone competent to do so is required and a fibreoptic inspect of the position of the tracheostomy tube to confirm correct placement within the trachea is usually indicated. All staff caring for patients with a tracheostomy should be familiar with these warning signs. Red flags and emergency management is discussed later in this chapter.

Red flags include:

1. Airway
    a. The patient with a cuffed tracheostomy tube suddenly being able to talk (implying gas escaping proximally and the cuff no longer 'sealing' the trachea)
    b. Frequent requirement for (excessive) inflation of the cuff to prevent air leak

c. Pain at the tracheostomy site
d. A suction catheter not passing easily into the trachea
e. A changing, inadequate or absent capnograph trace

2. Breathing
    a. Increasing ventilator support or increasing oxygen requirements
    b. Respiratory distress
    c. Surgical (subcutaneous) emphysema (gas in the soft tissues)
    d. The patient complaining that they cannot breathe or have difficulties in breathing
    e. Suspicion of aspiration (feed aspirated on tracheal toilet – suggests that the cuff is not functioning adequately)

3. Circulation or any other general clinical deterioration
    a. As with all assessments of the acutely unwell patient, an ABCDE assessment includes ensuring that the airway is patent. In this case, this includes assessment of the tracheostomy tube.

Local Infection

The stoma is an open surgical wound and there is always a risk of site infection, with the ever-present threat of introducing organisms from the sputum. A stoma should be treated as a surgical wound and cared for appropriately. Careful observation, keeping the wound clean and dry with regular dressings changes will help to reduce the incidence of infection. Prompt swabbing and appropriate topical and systemic antimicrobial treatment will help to minimise the impact of local infection. As the stoma is an open wound opening directly into the respiratory tract there is potential for the lower respiratory tract to become infected. Poor suction technique may also increase the incidence of infection.

Tracheal Damage/ Ischaemia

Damage to the trachea may be caused by the pressure of the inflated cuff pressing on the mucosa of the trachea. The capillary pressure in the tracheal mucosa is around 20 cm H_2O and consistent cuff pressure above this limit will risk ischaemic damage to the trachea. This situation may be made worse by critical illness and hypotension, which will reduce the capillary perfusion pressure. Direct mucosal damage can also occur by poor tracheal suctioning techniques, ill-fitting tubes, or excessive movement of the tube within the trachea. Modern tracheostomy tubes have low-pressure cuffs which extend over a greater surface are, however over-inflation should still be avoided. The pressure in the cuff should be just adequate to prevent air leakage and seal the airway against aspiration.

Altered Body Image

This is an important factor as it can have a major psychological impact. If possible the patient should have careful pre-operative explanation. If this is not possible the patient must receive explanation and support post-operatively. The patient should know that scarring would usually be minimal when the tracheostomy is removed and the stoma has healed. One of the most frustrating aspects for patients, especially those waking from an induced coma, is that they are unable to speak when the tracheostomy tube cuff is inflated. As soon as possible, the patient should be reassured that speech will return. Most stomas will heal well provided that the general condition and nutritional status of the patient is good, and the stoma is kept dry and infection free. The diameter of the stoma may be expected to shrink by around 50% in the first 12 hours following removal of the tube. Stomas may heal completely in as little as 3 to 4 days, but may take several weeks. On average the stoma will close and heal within 4-6 weeks.

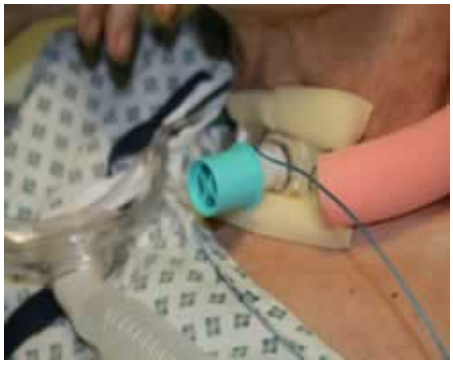
Communication

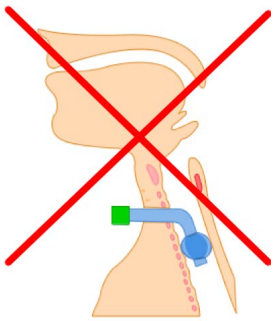
Patients with a cuffed tracheostomy will be unable to speak; loss of speech whilst the tracheostomy is in place could cause great distress to the patient, even if warned beforehand. This can cause fear because of inability to attract attention or anxiety due to inability to communicate (even with the cuff down). Generally patients who have an un-cuffed tube or the cuff deflated will be able to speak with a speaking valve in place. Communication aids such as pen / paper or picture cards are vital to prevent the patient feeling frightened and isolated. In addition ensure the patient has a nurse call bell at all times.

Speaking valves

These are one-way valves that fit over the end of the tracheostomy tube. They allow the patient to breathe in through the tracheostomy, but not out. The airflow has to go up through the larynx and out of the mouth. This can allow the patient to talk, but can be tiring for the patient due to increased resistance to airflow. Click here for an animated presentation showing airflow when speaking valves are used. Because air cannot flow out through the tracheostomy, these valves can be extremely dangerous. Speaking valves should ideally only be used with an un-cuffed and fenestrated tube and only when the fenestrated inner cannula is in place. It is possible to use with a non-fenestrated or even cuffed tube, providing that the cuff is deflated. If a speaking valve is used with a standard tube with the cuff deflated, this is

potentially hazardous and should only be used by staff with the experience and the necessary infrastructure to recognize and immediately manage any resulting complications.





A speaking valve in situ with a cuffed tube. The cuff must *always* be deflated otherwise the patient cannot exhale and will asphyxiate.

Red flags

Like most critical incidents, warning signs often precedes tracheostomy-related clinical problems. Because these signs are sometimes only apparent with hindsight, it is essential that you know what to look out for, so that you can trouble shoot at an early stage and stop minor problems escalating. Tracheostomy-related clinical problems are called 'tracheostomy red flags', although some are applicable to laryngectomy patients too.

It is easy to develop a false sense of security when a patient has a tracheostomy tube in situ. Remember though that this is an artificial airway, just like an endotracheal tube. Problems that arise are therefore airway problems and can develop quickly and dramatically into life threatening situations, especially if the patient is ventilator-dependent or critically ill. Think about a patient on ICU or in the operating theatre with a large air leak from an endotracheal tube - everyone would agree that this needs to be attended to as a matter of urgency. This is the same for a tracheostomy tube.

What should you do if you detect a red flag?

A prompt assessment of the tracheostomy and the patient should be made by someone who is competent to do so. Who this is depends on how the patient is, your role and where you work, but the person making the assessment must to be able to work out what the problem is and address it. Interventions could range from a simple reassuring assessment, a fibreoptic inspection of the tube or airways, or replacement of the tracheostomy tube.

Like any assessment of the unwell patient, this should always start with ‘A for airway’. In the case of a patient with a tracheostomy, there *may* be two airways to consider, or with a laryngectomy, only one (in the front of the neck, not the face). Any airway problem can cause the patient to become unwell and show signs of distress. Conversely, patients with tracheostomies can become unwell with all the problems that other patients get too. It is easy to become fixated with the tracheostomy.

The ‘flags’ can be divided up into different categories:

- Airway flags
- Breathing flags
- Specific tracheostomy flags
- General flags

Airway flags

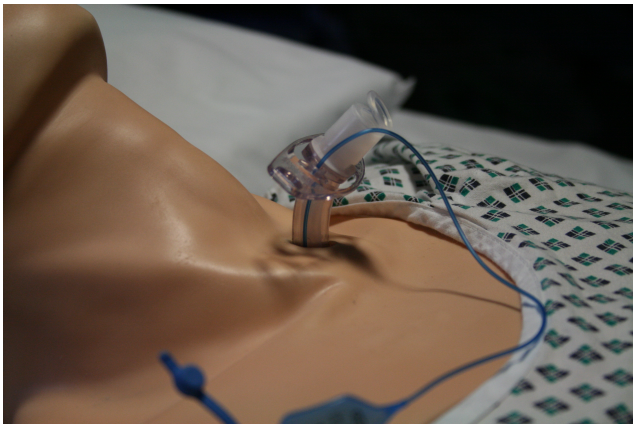
If the patient has a cuffed tracheostomy correctly sited in the trachea, no gas should escape through the mouth. If the patient is talking to you, or audible air leaks or bubbles of saliva are seen or heard at the mouth or nose, then gas is escaping past the cuff. This may imply that the cuff is damaged or the tube tip is not correctly sited. Grunting, snoring or stridor are also signs that there is an airway problem.

Breathing flags

Listening to the patient, or observation of the patient or instrumentation, may show that the patient:

- Is not breathing (apnoea), which is detected by capnography or clinically
- Has difficulty in breathing (or with ventilation), which may be reported by the patient or observed clinically:
    - Accessory muscle use
    - Increased respiratory rate
    - Higher airway pressures
    - Lower tidal volumes
- Has hypoxia
- Is making whistling noises or has noisy breathing

Specific tracheostomy flags



Careful observation may show that the patient:

- Has a visibly displaced tracheostomy tube. If this is an adjustable flange tube, check to see where it was last positioned
- Has blood or blood-stained secretions around the tube - a recently performed or changed tracheostomy bleeds a little, but if in doubt, it should be assessed
- Reports increased discomfort or pain
- Requires a lot of air to keep the cuff inflated, which may be because:
    - The cuff is damaged or has an air leak (in which case, it needs to be replaced)
    - The tube may be displaced and the cuff needs hyper-inflation to keep it 'sealed'

General flags

Any physiological changes can be due to an airway problem. Specifically, changes in:

- Respiratory rate
- Heart rate
- Blood pressure
- Level of consciousness

Anxiety, restlessness, agitation and confusion may also be due to an airway problem.

Emergency management of the patient with a tracheostomy or laryngectomy.

The management of tracheostomy-related emergencies has developed somewhat piecemeal, in a similar way to that of general airway emergencies before publication of the difficult airway algorithms. Before such guidance, emergencies were commonly managed by relying on individually acquired skills and experience or lessons learned from previous errors. The NTSP were involved in analysing critical incidents reported to the UK National Patient Safety Agency and recurrent themes were identified, evident in similar analyses. It was clear that simple, clear and authoritative guidelines were urgently required, similar in structure to previous difficult airway algorithms and Resuscitation Council (UK) ALS guidelines. Our tracheostomy and laryngectomy emergency guidelines were developed following wide consultation with key national bodies involved in tracheostomy care, incorporating feedback from their members and utilising case reports in the literature. This chapter presents the guidelines and discusses their rationale. A similar, detailed explanation has been published in the journal *Anaesthesia* in 2012, upon which this section is based. The full text of this article is freely available from this link: McGrath B, Bates L, Atkinson D & Moore J. Multidisciplinary guidelines for the management of tracheostomy and laryngectomy airway emergencies. *Anaesthesia* 2012 Sep;67(9):1025-41.

Guideline development

Draft guidelines were developed and then tested and refined locally before being re-submitted to the UK stakeholder organisations. Extensive use was made of real-life critical incidents that were recreated using high fidelity simulation and different management strategies were attempted with different staff members and local airway experts. Near-final guidelines were subject to open peer review for a period of 6 months via the NTSP website and that of the UK stakeholder organisations. During this period, the resources were accessed >28,000 times and the emergency algorithms downloaded nearly 9,000 times, with worldwide feedback received. Generally, feedback was positive and supportive of the project aims, with many comments adapted to be included in the final version of the guidelines with the contributors' permission.

First, it was clear from initial analyses that distinct bedside information and algorithms were required for patients with a potentially patent upper airway and those with a laryngectomy. This led to the development of the bed-head signs, allowing essential information to be clearly displayed and immediately available to responders in an emergency. This allows the responder to know immediately whether the patient has any special considerations for managing the upper airway or the tracheostomy stoma. Bedside information can also summarise key details regarding the nature and date of the tracheostomy, method of forming the stoma and the function of any 'stay sutures.'

Second, it was recognised that separate algorithms were needed for patients with a potentially patent upper airway and those with a laryngectomy. However, it was also apparent that there would be similarities between the algorithms, with the management of laryngectomy patients following the same steps as for tracheostomy patients, but without the upper airway elements.

It was clear to us that a number of principles should underpin the guidelines that we developed. The two key priorities were supported by our critical incident reviews: oxygenation of the patient takes priority (not necessarily securing the airway immediately and definitively, unless required for oxygenation) and the best assistance should be sought early. Ideally, this assistance would include other members of the multi-disciplinary team who are trained and competent to deal with tracheostomy emergencies. Emergencies should be managed in adequately equipped clinical environments.

Rather than taking a problem-specific approach, we developed a generic algorithm that would cover the vast majority of common and easily reversible clinical situations that arise whilst accepting that a number of special circumstances do exist (e.g. the critically ill ventilated patient on ICU or the patient who has undergone a complex tracheal reconstruction). Even in these complicated scenarios, key airway management principles can still be followed. This approach also allows training to be standardised.

We have divided the competencies and training required between those of the primary and secondary responder. The primary responder (typically a nurse, junior doctor or allied health professional) needs to be guided to detect airway problems, to assess tracheostomy and airway patency and to provide basic emergency oxygenation. The secondary responder (typically an anaesthetist, intensivist, head and neck surgeon or specialist practitioner) will have skills in conventional airway management and will also be guided to use skills in managing the tracheostomy or stoma. These skills would typically include oro-nasal intubation techniques (including difficult intubations), ability to use a fibreoptic ‘scope to assess or replace tracheostomy tubes and the ability to perform and manage an emergency surgical airway or tracheostomy. Our emergency algorithms are thus divided into sections to reflect the differing skills of the responders.

The algorithms are applicable for any urgent or emergency situation that develops in a patient with a tracheostomy or laryngectomy.

Interactive algorithms with video links to each of the key steps are available from the website www.tracheostomy.org.uk. There are details of each of the key steps in the algorithm explained in the e-learning resources associated with this manual.

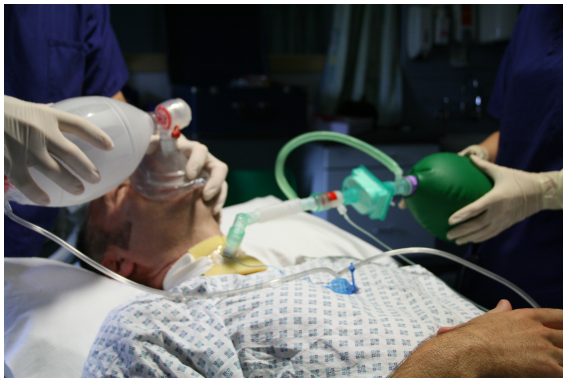
Patent upper airway: the 'Green algorithm'

This algorithm is paired with the green bedhead sign and assumes a *potentially patent* upper airway, meaning that it is anatomically possible for the upper airway to connect to the trachea and thus theoretically allow ventilation by this route. This is in contrast to the situation with a laryngectomy. The following section should be viewed in conjunction with the green algorithm. It is important to remember that the original reason for the tracheostomy may have been a difficult or even impossible upper airway.

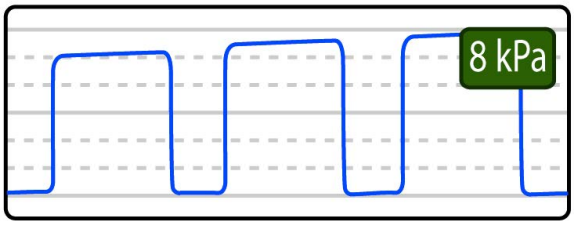
Help and equipment.
The first step is to call for help. Who is called will depend on the patient, the responder and the location. The bedhead sign should display local details specific to this patient of who to call and how to avoid delays. The details of the bedhead signs should be agreed and completed when the patient is first admitted or transferred to the clinical area, not when an emergency occurs. If out of hours specialist or clinical cover is not immediately available, appropriate arrangements must be in place to ensure that assessments and emergency responses can be delivered. Clinical areas caring for patients with tracheostomies should be staffed and equipped to do so. This includes the provision of routine and emergency airway equipment. Most equipment should be at the bedside. Additional equipment and fibreoptic 'scopes should be available at all sites (including wards) where patients with a tracheostomy are cared for. Fibreoptic 'scopes are used either to enable inspection of the tube position, to assist in the replacement of the tube or to enable management the upper airway. Specialist areas such as critical care will need a difficult intubation trolley, waveform capnography and a fibreoptic 'scope immediately available.

Assessment of breathing
Following the principles of basic life support the first clinical steps attempt to open the airway and look for evidence of breathing. Tracheostomy patients will *usually* have two airways (the native upper airway and the tracheostomy) and clinical assessment takes place by looking, listening and feeling at the face *and* tracheostomy tube or stoma for 10 seconds, following basic upper airway opening manoeuvres. Videos of this can be seen here.

A Mapleson C anaesthetic breathing system (commonly referred to as a 'Waters circuit') can be used attached to a facemask placed over the face or tracheostomy stoma, or directly to the tracheostomy tube. The collapsible bag can offer visual clues to confirmation to the presence of respiration if the bag is seen to move. This circuit also enables ventilation, but must be used only by those who are



competent to do so, as harm may occur if the expiratory valve is left closed. Videos detailing this assessment may be viewed here.



Waveform capnography (left) is invaluable when managing airways and should be used at the beginning of the assessment. If the patient is breathing spontaneously, apply high-flow oxygen to the face *and* tracheostomy. This will require two oxygen supplies, which may necessitate the use of the oxygen cylinder on the resuscitation trolley. Pulse oximetry can add valuable information as to the success of interventions and to the urgency of subsequent interventions.

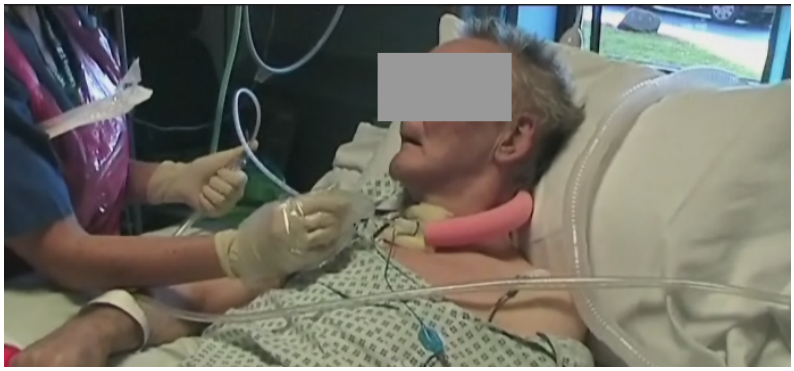
If the patient is not breathing (apnoea or occasional gasps) or there are no signs of life, then a pulse check must occur and cardiopulmonary resuscitation commenced as per international guidelines. The rest of the detail of these algorithms deals with managing the airway – a critical component of any advanced life support teaching. A primary tracheostomy problem (e.g. tracheostomy tube blockage) may have led to the cardio-respiratory arrest in the first instance.

Assessment of tracheostomy patency

Simple, easily reversible problems have caused significant morbidity and mortality to tracheostomy patients. This has included inappropriate use of obstructing (decannulation) caps or obturators attached to the tracheostomy tubes, incorrectly used speaking valves (with an inflated, cuffed tube) and humidifying devices (e.g. Swedish noses) blocked with secretions. Because of this, any device attached to a tracheostomy tube must be removed in an emergency.

Inner tubes used with tracheostomies and can significantly reduce the risk of tube occlusion, provided they are cared for and used appropriately. If a tracheostomy tube becomes blocked, simply removing the inner tube may resolve the obstruction. However, it must be remembered that inner tubes vary significantly in their design, with some requiring replacing after cleaning, to allow connection to breathing circuits. It is essential to know what equipment is used in your clinical areas as unfamiliarity with equipment may lead to morbidity and mortality.

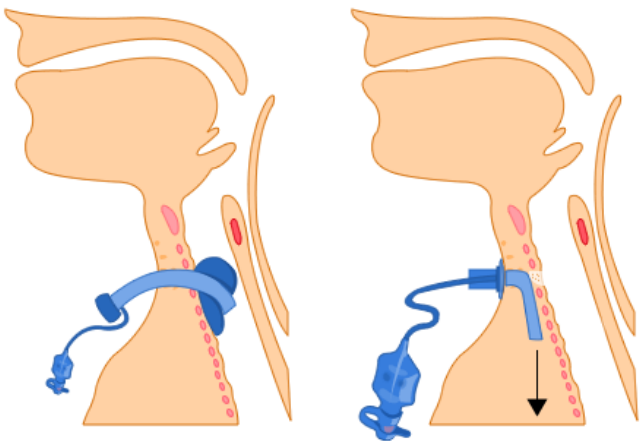
Passing a suction catheter via the tracheostomy will establish whether or not the tube is patent and also allow therapeutic suction to be performed. The suction catheter needs to pass easily beyond the tracheostomy tube tip and into the trachea. The depth of insertion will depend on the length of the tube in situ. Gum elastic bougies or similar introducers should be avoided at this stage because these stiffer devices are more likely to create a false passage if the tracheal tube tip is partially displaced. The soft suction catheters will not advance sufficiently into the pre-tracheal tissues and are less likely to cause further problems is used to assess patency.



A distinction is made between using hand ventilation (by attaching an anaesthetic breathing circuit to the tracheostomy tube) for *resuscitation* versus its use for *diagnosing* airway patency. There have been several incidents, including deaths, where vigorous attempts at ventilation via a displaced tracheostomy tube have caused significant surgical emphysema, making access to the neck increasingly difficult. This can be made worse if a fenestrated tube becomes partially displaced. Therefore, this guidance only recommends the use of gentle hand ventilation if required, and only *after* the tracheostomy has been confirmed to be patent using a suction catheter.

If the suction catheter passes easily into the trachea, then the tracheostomy tube can be regarded as at least partially patent. The 'ABCDE' assessment can continue as per standard guidelines. If the patient is not breathing, effective ventilation via the tracheostomy will require an inflated cuff (with un-fenestrated inner tube if necessary) to seal the trachea and allow positive pressure to be delivered to the lungs.

If the suction catheter will not pass, it is reasonable to conclude that the tube is blocked or displaced. At this stage we are moving to salvage the situation and deflating the distal cuff, if present, may allow airflow past a partially displaced tracheostomy tube to the upper airways. In the special circumstance of early post



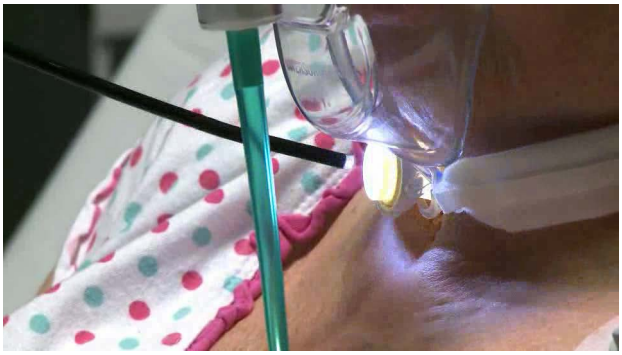
procedural haemorrhage (complicating up to 5% of new tracheostomies) leaving the cuff inflated may cause a tamponading effect as discussed in the complications section. Reassessment of both the tracheostomy and the upper airways will determine if the airway(s) are now patent. If cuff deflation improves the clinical condition then the responder can continue the 'ABCDE' assessment and await experienced assistance. The goal is adequate oxygenation and although the tracheostomy tube may still be (partially) occluded or displaced there may be sufficient air entry to ensure some clinical stability whilst awaiting expert assistance.

Removal of the tracheostomy tube

If a suction catheter cannot be passed and deflating the cuff fails to improve the clinical condition, the tracheostomy tube may be completely blocked or displaced, and the patient cannot breathe around the tube adequately. Continued attempts at 'rescue' ventilation via the upper airways or the tracheostomy tube will not be effective as the airway is obstructed. The tracheostomy tube should be removed at this point. There may be concerns about the consequences of removing a tracheostomy tube from a patient with a difficult or obstructed upper airway, or one who's tracheostomy is known to be difficult. However, when faced with a deteriorating patient with an obstructed airway, a non-functioning tracheostomy offers no benefit, with considerable potential for harm. Following tracheostomy tube removal, reassessment at both airways (mouth and trachea) is required, ensuring oxygen is reapplied to face and stoma, to maximise the chances of oxygenation. This may resolve the immediate airway problem and if the patient is breathing and improving, ABCDE assessment continues.

It is important to note that definitive management of the airway (re-insertion of a tracheostomy or oral tube) is not necessarily required immediately if the patient is not hypoxic. Insertion of a new tracheostomy tube or endotracheal tube is likely to require expertise and equipment, and harm has resulted from inappropriate attempts to manipulate the stoma blindly when this is not immediately required.

The special circumstance of a known difficult or obstructed upper airway, or previously difficult-to-insert tracheostomy, may necessitate a fibreoptic inspection of the tube whilst it remains in situ, in preference to its prompt removal. This is only relevant where appropriate equipment and expertise is *immediately available* and the patient is clinically stable enough to tolerate the procedure. Waiting for equipment or performing unsuccessful fibreoptic examination should not delay the removal of blocked or displaced tube when faced with a deteriorating patient.

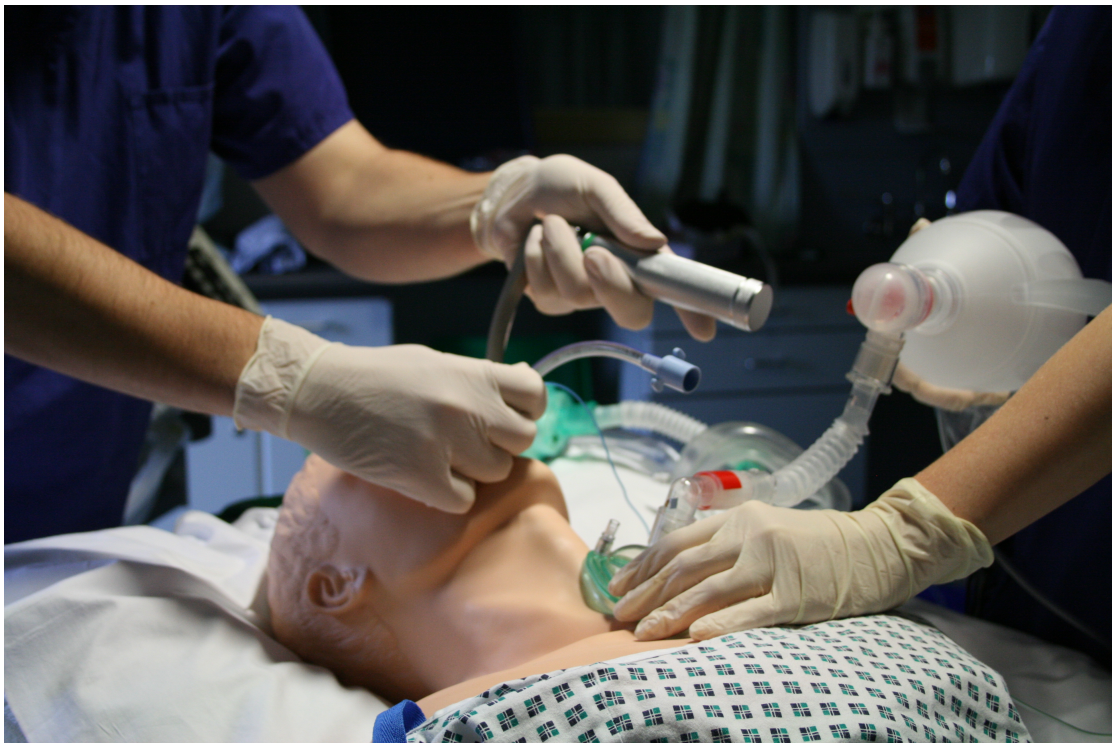


Emergency oxygenation

If the patient fails to improve after removing the tracheostomy tube, *primary emergency oxygenation* may be achieved by the oro-nasal route, the tracheostomy stoma or by both routes. The choice of route will depend on the responder's experience. If attempting to ventilate via the upper airways, remember to occlude the tracheal stoma to maximise the possibility of effective ventilation. Ventilation can also be achieved directly via the tracheostomy stoma. A small, paediatric facemask or a laryngeal mask can be

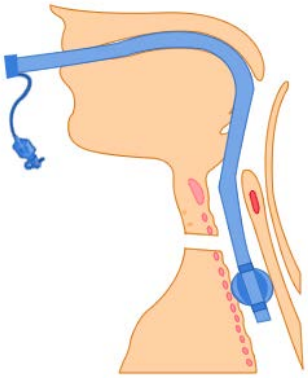
applied to the skin of the anterior neck. In order to achieve effective ventilation, occlusion of the upper airway by closing the nose and mouth may be required, especially if there is a large leak. Two airway teams may attempt to oxygenate the patient simultaneously if ventilation proves difficult. The goal remains oxygenation, and formal insertion of an airway device may not be required - a situation analogous to prioritising oxygenation and not intubation in every cardiac arrest patient.

If effective oxygenation or ventilation cannot be achieved, *secondary emergency oxygenation* manoeuvres are required. These are advanced techniques and the choice will depend on the patient, the responders and the equipment available. These are likely to be dire clinical situations and separate airway teams may be appropriate – one working at the head/face and one working on the neck. Oral intubation may be possible, and if so, a long (i.e. uncut) tube can be used. This tube may be advanced beyond the stoma, distal to the hole in the anterior tracheal wall.

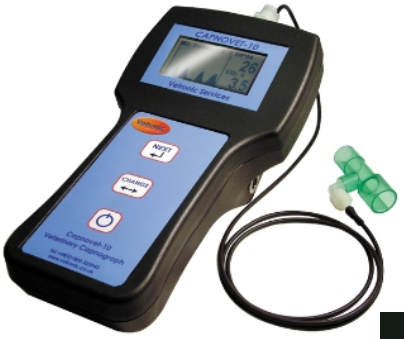


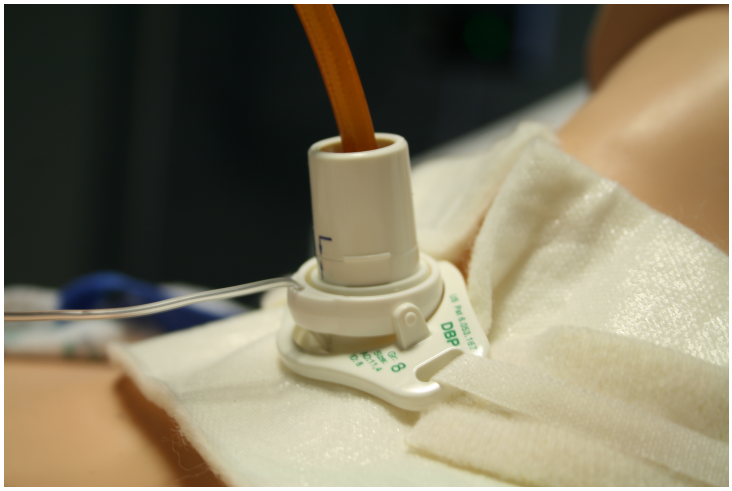
If the patient has an established tracheostomy or if the upper airway is known to be difficult, then it may be more appropriate to attempt intubation of the tracheostomy stoma at this point. Simple re-insertion of a smaller

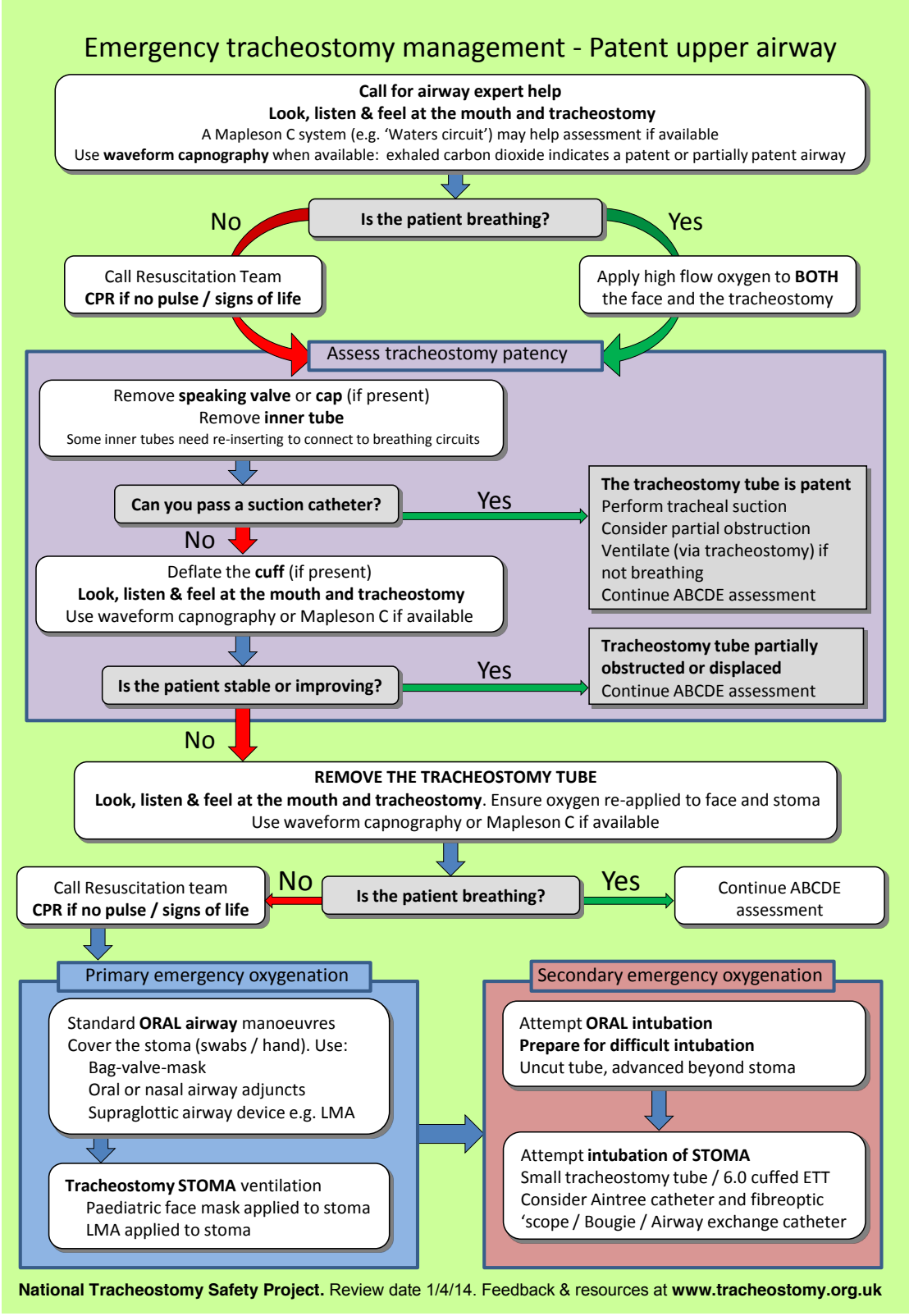
tracheostomy tube or endotracheal tube may establish a patent airway, although a 'deeper' stoma may require more advanced or endoscopic techniques. Where possible, a fibreoptic 'scope should be used to facilitate placement of an airway catheter (e.g. Aintree catheter) or bougie. A fibreoptic scope can be used to allow an endotracheal or tracheostomy tube to be 'rail-roaded' into the trachea and help to ensure correct placement. Small, delicate endoscopes may not offer enough support to a new tracheostomy tube when used as a guide in this way, especially if the neck or trachea is deep. Other advantages of a fibreoptically guided bougie is that they may be able to be connected to a system providing oxygen delivery. Care should be taken when using a high-pressure oxygen supply. If the tip of an airway exchange catheter lies beyond the carina in a smaller bronchus, delivering high-pressure gas flows may cause barotrauma and lead to a pneumothorax. In an emergency situation without availability of a fibreoptic 'scope, blind or digitally assisted placement of a bougie may be helpful, but the risks of malposition are increased.



The use of waveform capnography in establishing effective ventilation via a patent airway has been reinforced by recent guidelines and capnography should be available for hospitalised patients in a resuscitation attempt regardless of location. Capnography should be *immediately* available in 'high risk' locations such as critical care units or wherever patients are ventilated. It should be *available* in all other areas and the introduction of ward-based defibrillators which can display waveform capnography, or other bedside devices which detect CO_2 should be encouraged.







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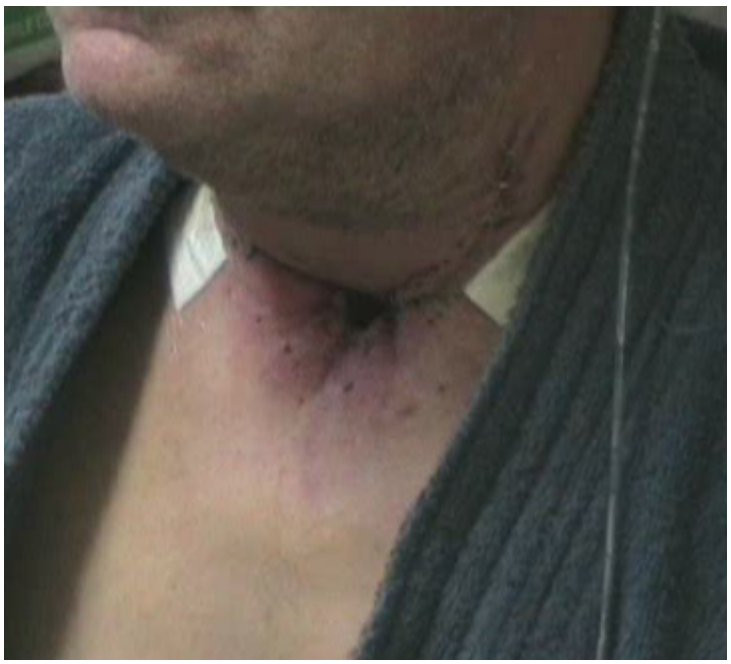
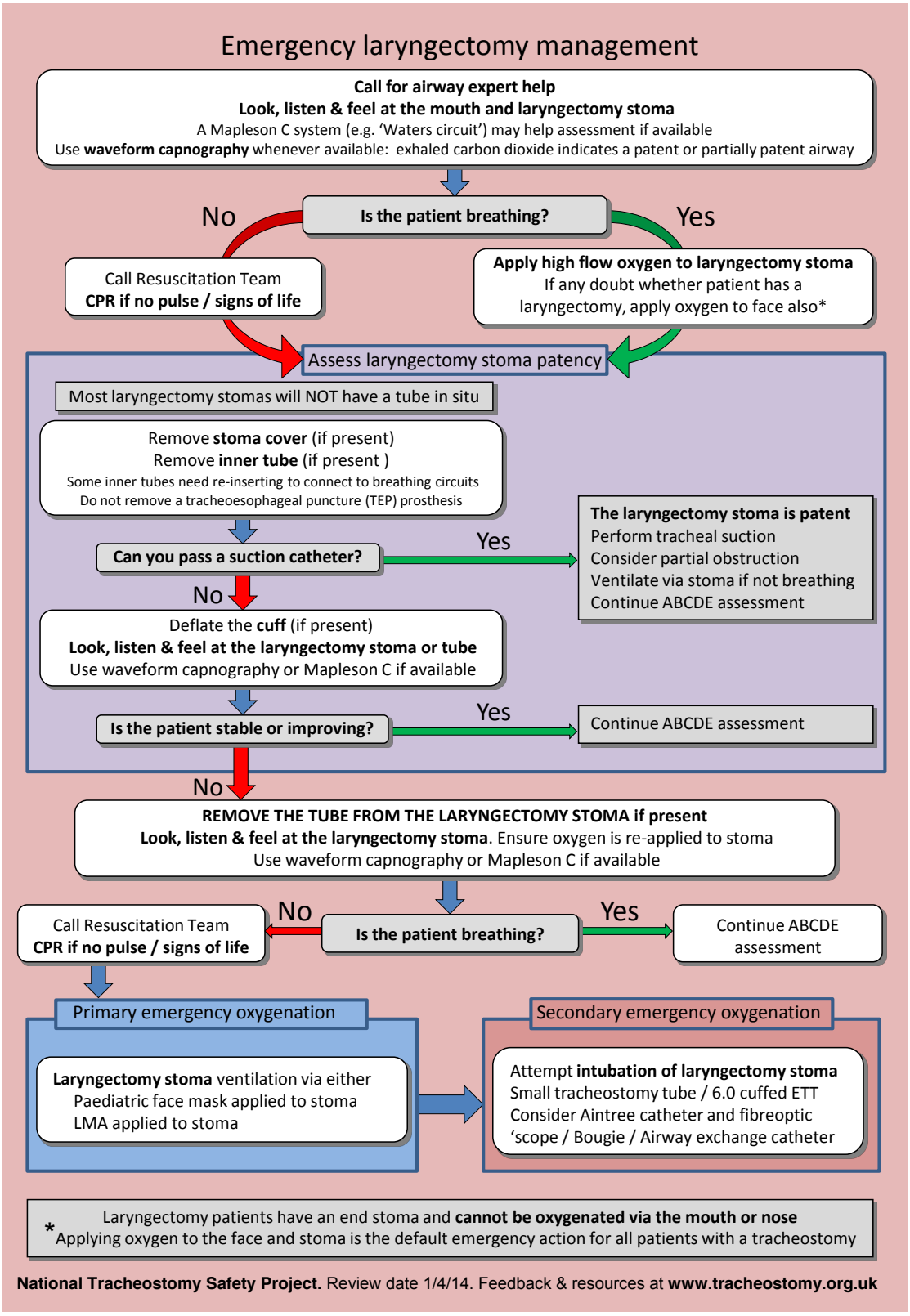
Laryngectomy: the ‘Red algorithm’

This algorithm is paired with the red bedhead sign and indicates that the patient does not have an upper airway which is connected the lungs. The principles of the algorithm are the same, without the conventional upper airway management steps described above. Patients with laryngectomies usually do not have a tracheostomy tube in situ, but may have other devices inserted into their airways, such as humidifiers or tracheo-oesophageal puncture ‘TEP’ valves. These devices should not be removed (see relevant section) The exclusion of the upper airway means laryngectomy patients will not obstruct their airway when laying flat on their back and aspiration of gastric contents is not a concern. In the context of cardio-pulmonary resuscitation, chest compressions will generate more significant tidal volumes owing to a reduction in dead space. Oxygen insufflation alone without ventilation may be effective if ventilation proves difficult.

A patient with a tracheostomy is more likely to come to harm by not having oxygen applied to the face if confusion surrounds the nature of the stoma. The default emergency action is to apply oxygen to the face and the stoma for all neck breathers when there is any doubt as to the nature of a stoma. Any oxygen applied to the upper airway can be removed in the case of a laryngectomy once this has been confirmed to be the case. Ventilation via laryngectomy stomas can be achieved directly using paediatric face masks or laryngeal masks applied to the anterior neck.

An interactive laryngectomy algorithm with videos highlighting key steps can be viewed at our website www.tracheostomy.org.uk.





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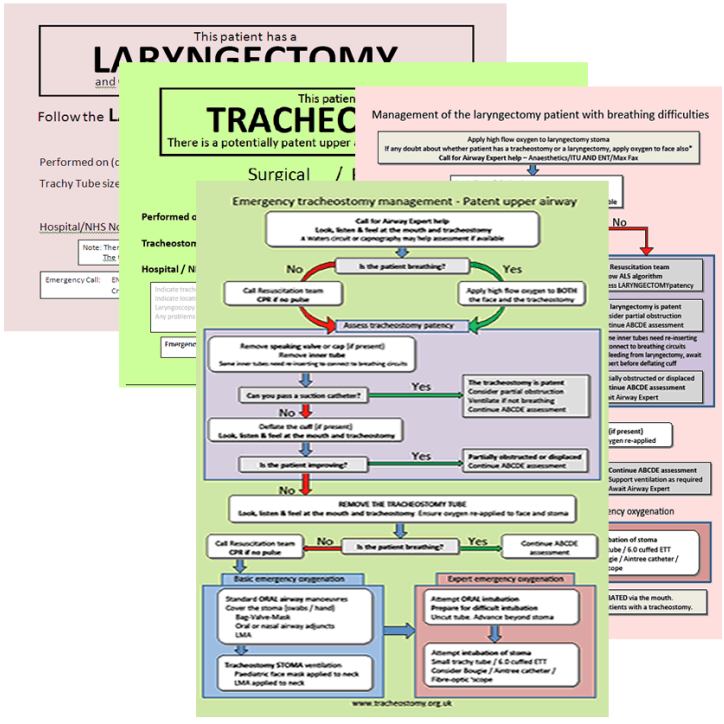
Comparison with previously published guidelines

The way in which the NTSP guidelines have been developed is unique. As a result, specific differences with other previous guidelines are evident. In the NTSP algorithms:

1. Waveform capnography has a prominent role at an early stage in emergency management.
2. Oxygenation of the patient is prioritised.
3. Trials of ventilation via a potentially displaced tracheostomy tube to assess patency are avoided.
4. Suction is only attempted after removing a potentially blocked inner tube.
5. Oxygen is applied to both potential airways.
6. Simple methods to oxygenate and ventilate via the stoma are described.
7. A blocked or displaced tracheostomy tube is removed as soon as this is established, not as a ‘last resort’.

In addition, previous guidance for tracheostomy emergencies has generally not been published as an algorithm, making them difficult to follow in emergency situation. Where algorithms have been used, they are often complex and not easily followed when tested in simulated emergencies. No other algorithms are colour coded and none are presented paired with bedhead signs. No emergency guidance was applicable to all situations (critical care, ventilated patients, surgical vs percutaneous tracheostomy, community patients) and many offered no ‘Plan B’ if the initial measures failed to resolve the situation.



Great Ormond Street Hospital for Children NHS Foundation Trust

This section details some of the specific guidance available for medical and nursing staff, allied health professionals, parents, carers and patients who are involved in the care of a child with a tracheostomy. This section has been adapted from the Great Ormond Street Hospital, London (GOSH) paediatric tracheostomy guidelines.

These guidelines were originally written by

- Sr Joanne Cooke TD MSc RGN RSCN, Advanced nurse practitioner, GOSH
- Miss Michelle Wyatt MA (Cantab), FRCS (ORL-HNS), Consultant Paediatric ENT Surgeon, GOSH

Background

More children with chronic medical conditions are surviving, largely due to advances in tracheostomy care and technology support. The vast majority of these children are now being cared for in their own homes and at school.

Tracheostomy is one of the oldest surgical procedures and was first successfully performed on children in the late 19th century. Today it is a common procedure and is life saving for many infants and children requiring airway and respiratory support. However, despite providing a safe and protective airway paediatric tracheostomy is often associated with significant morbidity and mortality

A tracheostomy is an artificial opening in the trachea, usually between the 3rd and 4th tracheal rings (see Figure 1) into which a tube is inserted and through which tube the child breathes. A tracheostomy is initially a life *saving* operation but is also a life *threatening* one unless the airway is kept clear from secretions and blockages 24 hours a day.

Children with tracheostomies require constant supervision from those trained fully in its care.

Indications for tracheostomy in a child

The most common indications for tracheostomy in children include:

1. **Cystic Hygroma.** An anomaly of the lymphatic system. It is a soft, smooth, non-tender mass of almost fat like consistency. It is grey and oedematous in appearance. It can involve the neck, mucosal surfaces of the mouth, tongue, larynx and pharynx causing a potential airway obstruction.

2. **Haemangioma.** A swelling containing abnormal blood vessels that can form at all levels of the respiratory system. As the child grows the haemangioma growth slows with or without treatment but it can initially obstruct the airway, which requires support.

3. **Laryngomalacia.** The structures of the larynx are particularly soft and collapse inwards as the child breathes. This can cause varying degrees of obstruction. As the child grows older the larynx becomes more rigid and the condition may resolve allowing for decannulation.

4. **Papillomatosis.** Benign wart-like lesions that are caused by Human Papilloma Virus. Their growth and the extent of disease varies considerably in children, but essentially the lesions can occupy and obstruct any part of the child's airway from the mouth and nose right through to lower airway structures.

5. **Sub-glottic stenosis.** A narrowing of the upper part of the trachea just below the larynx/ voice box. This may be congenital or acquired usually from prolonged intubation periods and or trauma at the time of tube insertion. Depending on the extent a child may recover from this or will require reconstructive surgery later in life.

6. **Tracheal stenosis.** Narrowing of the tracheal diameter, which may be congenital or acquired, possibly through trauma or previous surgery. If the stenosis is high enough the trachea may be stented by the tracheostomy tube, if not separate tracheal stents may have to be inserted to support the affected areas.

7. **Tracheomalacia.** An area of softening in the trachea, which may collapse inwards as the child breathes and may obstruct respiration. This condition usually resolves with time as the trachea enlarges and becomes more rigid. The tracheostomy tube may be useful in stenting the area of the collapse. Some children may require positive pressure ventilatory support if the lower tracheal area is collapsing.

8. **Bronchomalacia.** An area of softening in one or both of the bronchus, which may collapse inwards as the child breathes. As with all malacia this condition usually resolves as the child becomes older.

Until this time the child may require positive pressure ventilatory support.

9. **Trauma.** Direct trauma (for example burns) to the upper airway or surrounding structures can cause a potential airway obstruction and or narrowing.

10. **Vocal cord immobility.** Immobile vocal cords may be caused by injury during intubation/ and or surgery, or due to an underlying neurological condition. Dependent on whether the cords are fixed open or closed the airway may be compromised.

11. **Tumour.** Tumours of any part of the respiratory passage may cause an airway obstruction due to the potential nature, growth and shape.

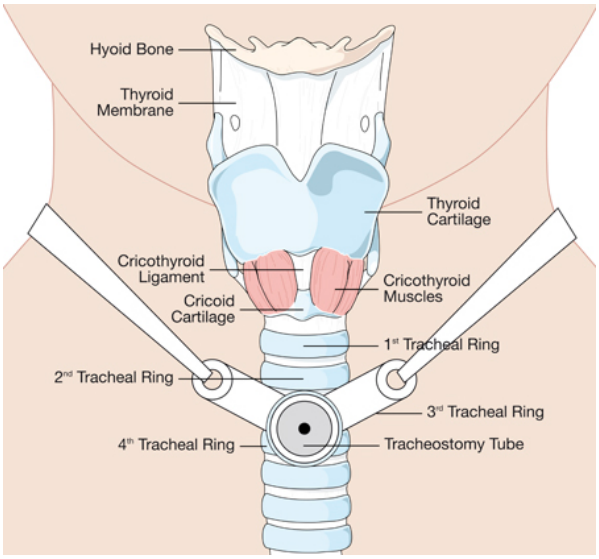
12. **Long-term respiratory support.** A tracheostomy may be required to facilitate long-term respiratory support, which would otherwise have to be managed with an endo-tracheal tube. The latter would lead to a variety of problems: including security of the tube, stimulation and development of the child, it would also mean hospitalisation. A tracheostomy is the preferred long-term option.

13. **Lung disorders.** Chronic lung disease can result from prolonged ventilation, aspiration, infection or congenital defects.

14. **Neuromuscular conditions.** A variety of congenital or acquired conditions can lead to the need for a tracheostomy either to 'protect' the airway from aspiration

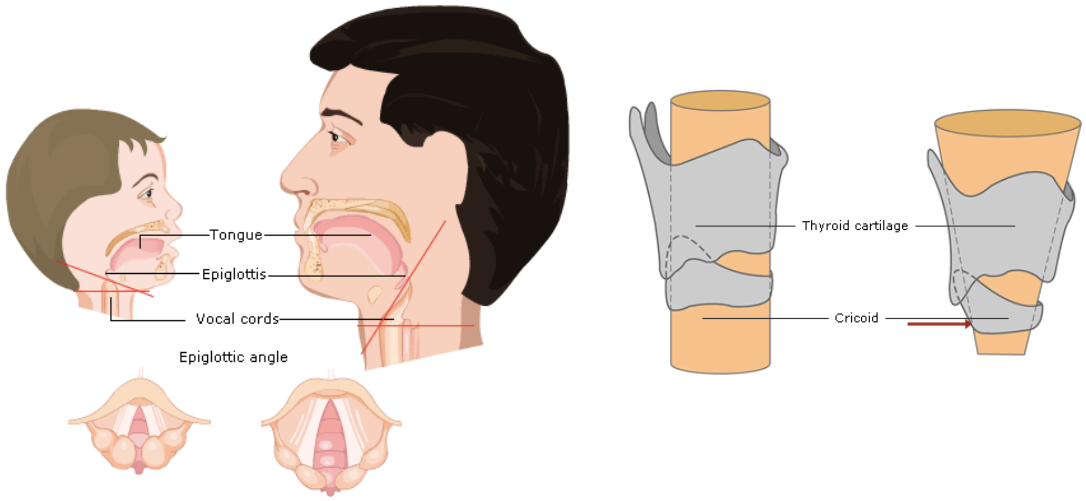
Differences between adult and paediatric airways

There are a number of important anatomical and physiological differences between the adult and paediatric airway. Clearly there are emotional, psychological and practical differences to also address, including the additional relationships that must be forged between the tracheostomy teams and the child and their parents.



The child's cervical spine is more flexed than an adult and this combined with the relatively larger head and tongue, predisposes to airway obstruction. The larynx itself is situated higher in the neck

than in the adult and the epiglottis is longer and less flexible. Intubation is performed in a slightly modified way in the child, often using a straight blade to elevate the epiglottis from 'behind'. A more conventional (adult) blade can usually be employed from 12-18 months of age depending on the child and operator preferences. By the age of 8, most children can be considered to have an adult larynx, although of much smaller calibre.



The narrowest part of a child's airway is at the level of the cricoid (see image above). This can be as small as 4mm in the neonate. A minor degree of swelling or airway obstruction will cause a significant increase in resistance to airflow.

Nursing and general care of the paediatric tracheostomy patient

Preparation of essential equipment and environment

The child's bed area must always be made easily accessible from both sides without obstruction, as the child's airway is at risk and may need immediate attention. All bedside equipment must be checked whenever a practitioner takes over the care of a tracheostomised child, including breaks and transfers to another ward/department. The child **MUST NEVER** be left alone.

The accompanying carer (including parents where applicable), as a minimum, must be able to:

- Recognise signs of airway obstruction
- Initiate suctioning of tracheostomy tube

The child should have a dedicated tracheostomy trolley by the bedside containing:

- Oxygen saturation monitoring - if oxygen therapy is required
- Suction catheters - correct size to safely suction tracheostomy tube
- Clean gloves to minimise the risk of cross-contamination
- Clean gauze to clean stoma/secretions
- Clean receiver with tap water to flush through suction tubing after use
- 2 ml syringe
- Ampoules of 0.9% sodium chloride for irrigation
- Yellow waste bag "for incineration"
- Goggles/protective eye wear should be available

- An 'emergency trachi box' with the following contents:
  - A spare tracheostomy tube (same size and make)
  - A tracheostomy tube (one size smaller)
  - A water based lubricant such as Aqua lube® or KY jelly®
  - Round ended scissors (safer cutting of tapes)
  - Spare tracheostomy tapes
  - A suction catheter (same ID as the suction catheter) to 'railroad' a new tube into the stoma (Seldinger technique)

Appropriate resuscitation and suction equipment with correct tracheostomy fittings (15mm swivel connector and a male adaptor for GOS, Silver & Montgomery tubes) checked and in full working order. A tube with a 15mm termination requires a Smiths Medical (Portex©) swivel connector which can be added to the resuscitator and must be available at the child's bedside. A flat-ended tube

requires an appropriately sized tracheal tube adapter and a Smiths Medical (Portex©) swivel connector that will 'slip into' the tube as required to create a 15mm termination that will be compatible with resuscitation equipment.

As with adult patients, tracheal dilators are not automatically recommended as essential bedside equipment. They should be *available* in the immediate area but not necessarily at the bedside unless specifically required. They should only be used by staff who are competent to do so.

Initial care following tracheostomy

Nursing actions during the first seven days following formation of the tracheostomy centre on maintaining the correct positioning and patency of the new tube, stoma maintenance and parental teaching (if appropriate) As with newly formed adult tracheostomies, replacing a paediatric tracheostomy tube within the first week can be problematic and so the focus of care is ensuring the existing tube remains patent. Communication between the hospital and community health carers must be commenced following surgery to ensure effective and timely discharge planning.

The initial nursing care of a child with a tracheostomy is very different from that for an established stoma. At GOSH the first tube change occurs after one week which allows sufficient time for the stoma tract to mature. Other units have advocated changing the tube after as little as 3 days. The Tracheostomy Nurse Practitioner (TNP) or an appropriate head & neck surgeon will perform the first tube change.

To ensure the safety of the airway, the trachea is sometimes sutured onto the child's skin with tiny interrupted disposable sutures - these are called 'maturation sutures'. These 'maturation sutures' will help to form a more permanent and safer stoma, especially if the tube requires changing in the first week. In addition, two long looped 'stay' sutures extend from inside the stoma and are taped to the child's chest. These sutures are attached to the tracheal wall on either side of the stoma. These 'stay sutures' will assist with the opening of the stoma during the first week, by raising the trachea to the skins surface and pulling the stoma apart so that a tube can be inserted. Tape on the child's chest will be labelled **'DO NOT REMOVE'** (for the first 7 days following the procedure) and will be removed after the first tube change.

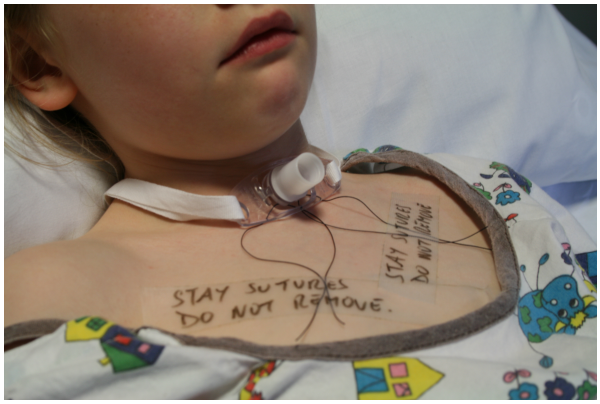


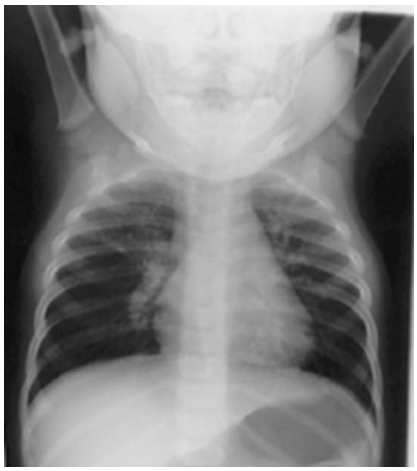
Image shows the position of stay sutures taped to the child's chest.

Observations

The child's vital signs should be recorded in accordance with local policy, with the frequency reducing as the child's condition dictates. Practitioners should also carry out routine non-invasive observations to rule out the following potential initial complications:

- Check that the tape tension is correct and able to support the tracheostomy tube
- Observe any neck swelling (surgical emphysema - see below)
- Check for air entry through tube - place finger above tube opening & feel for the flow of air against your finger
- Inspect the chest for bilateral chest movement
- Auscultate the chest for equal air entry (pneumothorax/ tube position)

A flexible endoscopy may be performed post operatively if the child is distressed and or coughing.



Post-procedural tube check

For the majority of children a chest X-ray is performed in theatre, if this has not happened then a portable post-operative chest X-ray must be performed within one hour or soon after the child has returned to the ward to confirm tube position and to rule out a pnuemothorax and surgical emphysema.

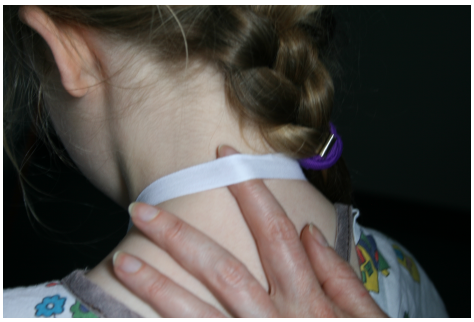
Other Initial Complications

Initial complications are largely avoidable if the procedure is carefully performed together with careful and effective post-operative management.

Other initial complications include:

- **Haemorrhage.** May be primary, reactionary or secondary. A large haemorrhage may be fatal. Secretions may initially be blood stained but will settle within a few hours, if it continues then practitioners should contact the appropriate specialist tracheostomy or surgical team.

- **Tube Blockage.** Although children should only be suctioned when required, it is imperative that a new tracheostomy tube is kept patent at all times. Children must be nursed in continuous humidity for the first week (may come off for short periods only). To reduce the incidence of tube occlusions, suction should be performed:
  - At least ½ - hourly suction for the first 12 – 24 hours
  - As required until first tube change



- **Accidental decannulation / tube displacement.** This is always a risk with a new tracheostomy. Common causes include: chubby infant neck, incorrectly chosen tube, loose tapes or the child pulling at the tube. Risks can be minimized by appropriate choice of tube size and type, careful insertion technique and careful nursing. Check correct tension of the tapes securing the tube, ensuring that only one finger between the neck and tapes. Close observation is required: respiratory rate, effort, chest movements and air entry on return to the ward, coupled with direct observation of the tube itself. The tube may visibly come out of the stoma or can be pulled out of the trachea and sit in the pre-tracheal tissues. In this situation, the tube can be reinserted by an appropriately trained person, but must not be forced. On reinsertion, air entry must be checked and confirmed and the appropriate clinical team must be contacted immediately to review tube position.

- **Infection** (chest/stoma site) The stoma site must be cleaned daily or when soiled. Using a clean technique and sterile gauze/saline. The wound must be inspected for signs of inflammation/ and or infection. Observe colour and nature of secretions.

- **Surgical emphysema** - Air may leak around the tube into the surrounding tissue - this is particularly problematic if the child has had neck sutures inserted. Checking tape tension not only confirms that the tube is secured correctly but also if they appear tighter may indicate swelling. Contact the appropriate clinical team for review.

The child, where possible, should not leave the ward during the first week unless medically indicated, as their airway is at risk and they must remain in an environment that can manage any complications.

Feeding

If there have been no previous feeding concerns, the child may recommence their normal feeds after a specified time of being 'nil orally'. This is normally 3 hours post-operation, but practitioners must confirm this with the anaesthetic chart or team. The vocal cords are often sprayed during the procedure, making them less responsive/effective in protecting the airway from aspiration. Other (sometimes pre-existing) physical complications accompanied with post surgical oedema, restricted laryngeal elevation preventing complete and safe closure of the lower respiratory tract may cause aspiration and/or regurgitation of food.

For a child that has had feeding difficulties or has never orally fed, consultation with the Speech and Language Therapist (SALT) should be sought before the commencement of oral feeding. Begin with water. If the child shows signs of aspiration, for example, if there is coughing after/ during drinking, or visible drink coming out of the tracheostomy, then maintain nil orally and contact ENT team and the SALT.

Humidification

- GOSH do not use a Heat and Moisture Exchanger (HME) during the first week following a new tracheostomy. The HME does not provide enough humidity in the initial phase to prevent tube occlusion in the first week.

- Administer humidity via sterile water and elephant tubing continuously for 1 week as far as is practicable. The child may come off for short periods, i.e. to feed, play, bathe, mobilise, etc.

- Small and vulnerable infants under one year must have continuous warmed humidity.

- Change humidity apparatus when the bottled water needs changing (usually 24hrs) or earlier if contaminated with secretions or if the mask comes into contact with the floor. When not in use, the mask should be covered.

Other care needs

- Change the tapes at least **daily** or when soiled or wet.

- A suitable dressing, such as Trachi-dress®, should be inserted behind the flanges to protect the skin (shiny

side to skin). Avoid using bulky substitutes as these may pull the tube away from the neck precipitating accidental decannulation.

- Never use cotton wool or cut gauze dressings (keyhole) as flecks of displaced cotton may enter the respiratory tract.

- At GOSH the first tube change occurs after one week, which allows sufficient time for the stoma tract to mature. The Tracheostomy Nurse Practitioner (TNP) or an appropriate head & neck surgeon will perform the first tube change. The 'stay sutures' will be removed at this time.

Once the stability of the tracheostomy stoma and tract has been verified the child may be allowed off the ward with a person appropriately trained in routine and emergency tracheostomy skills.

Routine management of the paediatric tracheostomy patient

Suctioning

Airway suctioning is a common practice in the care of a child with a tracheostomy, and is undertaken to remove secretions from the child's respiratory tract. A child with a tracheostomy may find it difficult to clear their secretions effectively therefore suction is an essential aspect of their care. Suctioning is associated with many potential complications and is now only recommended when there are clear indications that the patency or ventilation of the children could be compromised. Suctioning a paediatric tracheostomy is very different from suctioning an adult tube, so adult practitioners will need to adapt their practice.

Potential complications of suctioning include:

- Hypoxia
- Formation of distal granulation tissue/ ulceration
- Cardiovascular changes
- Pnuemothorax
- Atelectasis
- Bacterial infection
- Intracranial changes

Practitioners trained in the skill should perform tracheostomy suctioning to minimise complications and maximise treatment. The child and family must be informed of the reasons for suctioning, positioning, risks and outcomes as appropriate. A 'clean' technique must be used and the catheter should be discarded if the tip is contaminated with hands, cot sides, etc. Suction equipment must accompany the child at all times, regardless of the nature of the journey or the distance to be travelled.

Suctioning equipment

The following equipment should be prepared:

- Suction catheters of the correct size
- Suction unit with variable vacuum control
- Gloves
- Apron (don if there is time - a child should never wait for suctioning)
- Tap water (in clean container)
- 2ml syringe with 0.9% sodium chloride for irrigation (not for routine suctioning)
- Yellow waste bag "for incineration"

Practitioners must be aware that some pre-term, vulnerable infants and especially those who are requiring > 40% inspired oxygen, may require pre-

oxygenation prior to suctioning to minimise the potential for hypoxia following suction. Distal tracheal damage and hypoxia are very real potential complications in the vulnerable paediatric airway. These complications may be reduced by having:

- The correct size catheter, as a guide, practitioners should double the size of the tracheostomy tube to obtain the appropriate catheter size (e.g. 4.0 ID tracheostomy tube = size 8F catheter). A suction catheter diameter should be less than half of the size of the tracheostomy tube to reduce potential for hypoxia and allow the child to breathe throughout the procedure.

- 1 distal and 2 lateral ports with rounded ends allows secretions to be collected both distally and from the sides of the tube to minimise tube occlusion. Catheters with more than three lateral holes may render the wall too weak.

- The lateral port should be smaller than the distal port so that mucosal adhesion and biopsy does not occur.

- An integrated valve for vacuum control, as suction should only be applied on removal. Catheters should not be kinked prior to insertion in an effort to control the vacuum.

- It is preferable to use suction catheters with graduations, so that practitioners can measure the exact depth to be suctioned. Suctioning should not occur distal to the tube tip. Catheters should only be inserted so that the distal hole sits at the end of the tube. This allows collection of secretions but not trauma to the distal tracheal mucosa.

- Suction pressures should be kept to a minimum as excessive pressures can cause trauma, hypoxaemia and atelectasis. As a general guide pressures should not exceed:

    - 60-80mmHg (8-10kPa) for neonates/ small infants
    - Up to 120mmHg < 16kPa for older children

The table below offers a more specific guide (Adapted from GOSH guidelines, Dean 1997; McElery 1996; Mowery, 2002; Simpson, 2001; Billau, 2004; Young, 1984)

Age of child	Approx tube size	Suction pressures
Pre - term - 1 month	3.0	8 - 10 kPa 60 - 75 mmHg
0 - 3 yrs	3.5 - 5.0	10 - 12 kPa 75 - 90 mmHg
3 - 10 yrs	5.0 - 6.0	12 - 15 kPa 90 - 112 mmHg
10 - 16 yrs	6.0 - 7.0	15 - 20 kPa 112 - 150 mmHg

Suctioning is not a painful or distressing procedure; in fact most infants will remain asleep throughout. If the child becomes distressed during suctioning then practitioners should review their technique. Constant observation of the child during suctioning is essential; practitioners should observe for an improvement or deterioration in respiratory rate and quality, child's colour, and oxygen saturations (if monitored).

Paediatric suctioning technique

- Perform a clinical hand wash (if there is time) and put on a minimum of gloves.

- Turn suction unit on and check the vacuum pressure and set to the appropriate level, according to the child's age.

- The carer must know the length of the tracheostomy tube. If the tube is fenestrated then an un-fenestrated inner tube should be inserted. This will prevent the catheter going through the fenestration and causing trauma, although practically, trying to suction through a fenestrated inner tube is more likely to ‘catch’ the suction catheter on insertion and lead to inappropriate concerns that the tube is blocked.

- Do not apply suction on insertion as this may cause mucosal irritation, damage and lead to hypoxia.

- Insert catheter gently into the tracheostomy tube, enough to ensure that the lateral and distal holes just pass through the tip of the tube, use the graduations on the catheter as a guide. Adult literature suggests

longer distances, however the distance between the tube tip and a child's carina could only be a matter of millimetres.

- Handle only the proximal end of the catheter. Catheters should be discarded if the end has been touched before insertion.

- Apply suction by placing thumb over the valve, found either on catheter or suction tubing. Kinking the catheter (to stop suction and then apply it) can result in unpredictable negative pressures and is not recommended. An intermittent suction technique does not reduce trauma and is less effective.

- Slowly withdraw the catheter straight out of the tube maintaining the vacuum.

- There is absolutely no need to rotate the suction catheter on withdrawal, as both the distal and lateral holes on the newer-style of catheter allows for circumferential suctioning.

- Suctioning should be quick but effective and should not exceed 5-10 seconds. In paediatrics, maximum durations should be based on the child's underlying medical condition and current clinical condition. Practitioners should adjust timings accordingly, for example 10 seconds is a long time for a neonate with underlying lung disease.

- The catheter may be re-used if immediate suction is required, as long as secretions have not occluded the suction ports. If the distal end of the catheter has not been contaminated prior to the suctioning episode then there is no evidence to suggest that by using the same catheter up to three times at the same suctioning episode increases the risk of infection. In fact with effective re-training on technique, some institutions have repeatedly used the same catheter on the same patient for a 24-hour period and have reported no increase in infection.

- Wrap the catheter around the gloved hand, remove the glove by inserting it over the used catheter and discard in yellow waste bag according to Waste Policy.

- Flush suction tubing with tap water to clear secretions from the suction tubing and connect a new catheter to the tubing.

- Wash hands.

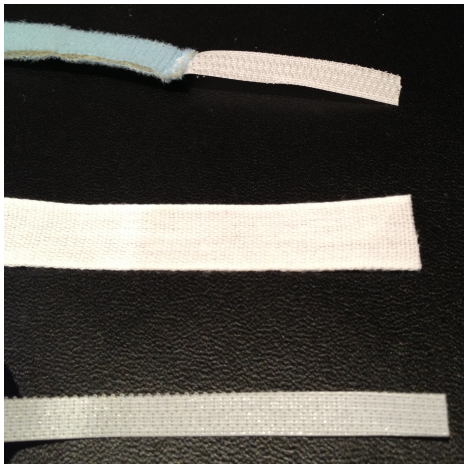
Record if the secretions are bloody, purulent, foul smelling or unusually thick in the child's health care records. Take samples as required.

Deep suctioning may be required in certain circumstances - for example during broncho-alveolar lavage - but this should not be routine practice. Saline should not be used routinely.

Tape changes (cotton)

A tracheostomy tube is held in place with cotton tapes around the neck. It is essential that the ties are secure and the tension of the ties is correct. The tapes are secured with knots tied either side of the tracheostomy tube.

Velcro ties are not routinely used at GOSH. This is due to fatal incidents involving Velcro becoming stuck to bedding and contributing to accidental decannulation. If children arrive with velcro ties, these will usually be replaced by cotton tapes for the duration of their stay, following an appropriate explanation to parents and carers. Velcro ties may be used in certain situations and institutions if local risk assessment allows.



Tracheostomy tape changes are normally performed daily. Only Personnel trained and competent in the techniques involved must change tracheostomy tapes and two people are required. All staff/parents should be taught to tie the tapes in the same way to ensure continuity of care. Parents may prefer to adopt another method of securing the tapes once they have established a routine at home. This method may be continued when the child is re-admitted to hospital but will need individual assessment.

Equipment

The following equipment should be prepared and be readily available:

- Appropriate emergency equipment readily available in case of accidental decannulation.
- Gauze swabs and saline sachets
- Two lengths of ¼ inch cotton tape with short plastic backing. The backing can be made from appropriately sized available tubing e.g. 24hr urine or O_2 tubing.
- Cut the ends of the tapes to a point to allow easier insertion through the flanges of the tube.
- Round ended scissors
- A rolled up towel to place under the child's shoulders will hyperextend the neck, making observation and cleaning of the stoma easier.
- A blanket to swaddle a baby or uncooperative toddler. If a child is moving during the procedure there is potential of accidental decannulation. Involve the play specialist where possible. Most children will settle once they get used to the procedure and especially when parents begin to carry it out.

- Suction equipment available (see suction guidelines).
- Non-sterile gloves and an apron with goggles/protective eye wear.
- Child's own comforter, e.g. dummy, as appropriate.
- An older child may not require swaddling. Some children may assist with the procedure by holding the tracheostomy tube in place and some may even prefer to sit during a change. These options must be discussed with the child and parents/carers as swaddling the child may cause increased distress.

Technique to change the tracheostomy tapes

- Perform a clinical hand wash, put on gloves, apron and protective eye wear (parents do not need to wear the protective clothing).
- The warmed water should be poured onto the gauze swabs.
- Assistant to swaddle baby, exposing shoulders and above. Place baby/child in supine position, with a rolled up towel under shoulders.
- Place clean tapes behind the baby/child's neck.
- Assistant should hold tube in position using either their thumb and index finger, or index and middle finger to support the tube and minimize the risks of accidental decannulation (see figure below). Minimal pressure should be applied.

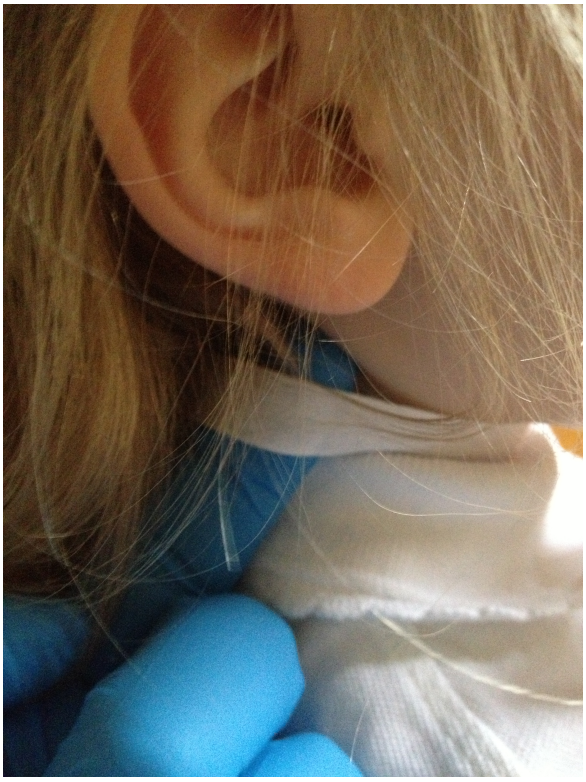
Positioning for a tape/tube change.

The person designated to change tapes should cut the tapes between the knot and the flange and remove dirty ties.

The stoma site (above, below and under each flange) and back of the neck should be cleaned and thoroughly dried with the water and gauze using a clean technique.

- Thread the new tape through the flange on the side furthest away from the tape changer.
- Tie the tapes using three knots ensuring the tape is flat to the child's skin.
- Thread tape through near side flange, tie once and make a bow.

- Check tape tension by:
    - Raising baby/child to a sitting position whilst assistant continues to hold tube in position.
    - With the baby/child's head bent forward it should be possible to slip one finger comfortably between the ties and the baby/child's neck (see image).



One finger should slip comfortably between the tapes and the child's neck.

Tape Tension for Tracheostomy

- If the ties are too tight or loose lay the baby/child back down, undo the bow and readjust.
- If the tension is correct, lie the baby/child down and change the bow into three knots by pulling the loops of the bow through to create a second knot.
- Tie one further knot to secure the ties.
- Cut off excess tape to leave ½ inch remaining.
- Assistant may release tube only when instructed to do so.
- Record the tape change in the baby/child's health care records.
- Check all equipment is replaced and restocked as necessary.

Planned (elective) tube changes

Tracheostomy tubes can be changed weekly to monthly depending on the type of tube, the maturity of the stoma and the patient. Ask the TNP or child's doctor if unsure. Only personnel trained and competent in the techniques involved must perform a tracheostomy tube change and two people are required.

An older child should not require swaddling. Some children may assist with the procedure, such as cleaning the stoma site, holding the tracheostomy tube, etc. Some children may need to be swaddled to maintain their safety during the change; assess each child individually.

Equipment

The following equipment should be prepared:

- Emergency equipment, oxygen and suction
- A tracheostomy tube of the same size
- A tracheostomy tube a size smaller
- A water based lubricant such as Aqualube® or KY jelly®
- Gauze swabs
- Saline sachets
- Two lengths of ¼ inch cotton tape
- Round ended scissors
- A rolled up towel
- Gloves and an apron
- Goggles/protective eye wear
- Two syringes may be required if the child has a cuffed tube

To change a tracheostomy tube:

- Perform a clinical hand wash.
- Put on gloves, apron and protective eye wear.
- Lubricate new tube with a “dot” of water-based lubricant on the outside bend of the tube. Insert obturator into the tube.
- Position the rolled up towel under the child’s shoulders, as per tape changes.
- Assistant to swaddle baby, exposing shoulders and above (baby in supine position) if appropriate.
- Place clean tapes behind the baby/child’s neck.
- Assistant should hold the tube in position using either their thumb and index finger, or index and middle finger.
- Tube changer should cut the ties between knot and flange.
- Remove the dirty ties.
- Remove the tube from the stoma with a curved action.
- Quickly insert new tube with a curved action.
- Remove obturator.
- The assistant should take over and hold the tube in position.
- The stomal area and back of the neck should be cleaned and dried with the water and gauze using a clean technique.
- The ties are then tied using the method previously described

Remember to document any difficulties encountered and how you managed them, along with recommendations for personnel, equipment, environment and procedures for any subsequent tube changes.

Staff and Carer Competency Guides

Most paediatric patients will be cared for by a combination of nursing staff and the child's parents or carers. If the child is going to leave hospital with a tracheostomy tube in situ, then preparation and training of the carers should commence as soon as possible. GOSH have developed the competency documents below to assist with defining which competencies are required for both carers and staff and therefore to guide training.

The following documents are available by clicking on the hyperlinks. This ensures that the latest versions are available. The versions from 2012 are available in the Appendix to this document.

Staff and carers should be trained and assessed in the following competencies:

- Staff competency - home preparation
- Staff competency - ventilated child

- Carer competency - home preparation
- Carer competency - ventilated child

Emergency management of the child with a tracheostomy

The basics of cardio-pulmonary resuscitation (CPR) and Basic Life Support (BLS) are universal to all protocols for emergency care:

- Airway management
- Rescue breathing
- Circulatory support

As with adult tracheostomy-related emergencies, there are often 2 airways to consider. However, although you are extremely unlikely to encounter a child with a laryngectomy, tracheostomies may have been performed because of a difficult or impossible to manage upper airway. This is essential information that must be communicated between medical and nursing staff at hand-overs as it will influence management in an emergency.

As with adult patients, the nature and age of the stoma are important, although most stomas will be formed with an open surgical technique. Extreme care must be taken when manipulating or changing a tube that sits in a stoma that is less than 1 week old. The risks of misplacement into the soft tissues of the anterior neck are high.

The airway element of BLS will require modification in children with tracheostomies, it is therefore essential that practitioners have received training in both routine and tracheostomy BLS. The following section describes BLS for children with a tracheostomy in the community setting. Hospitalised patients will have extra equipment, infrastructure and expertise immediately available and are considered separately. BLS is similar in the sequence of skills to be performed for those with a tracheostomy:

1. **Safety**
2. **Stimulate**
3. **Shout**
4. **Airway**
5. **Suction**
6. **Breathing**
7. **Circulation**

Safety

If you think there is a problem with a baby or child with a tracheostomy, you must act confidently and quickly. However, make sure you are not putting yourself at risk and potentially causing two casualties. The first thing to do is to rapidly assess that it is safe for both you as the rescuer, and the child as the victim, for you to approach and touch the baby or child.

Quickly look around the area in which the baby or child is lying to make sure there are no environmental hazards – for instance, road traffic, chemical spills, electrical currents. If necessary, you must make the area safe first before you approach. Before you touch the baby or child, have a look for any clues as to what may have caused the problem – for instance, have they fallen or choked? If you have any suspicion the child's head, neck or spine could be injured, then they should be moved only if absolutely necessary. However, remember that even if a person has a severe head or neck injury and is not breathing, they will die without BLS.

Stimulate

Try to establish whether or not the baby or child is responsive – use gentle stimulation such as tugging the hair or pinching the child, as well as loudly calling their name if you know it, or asking them to wake up.

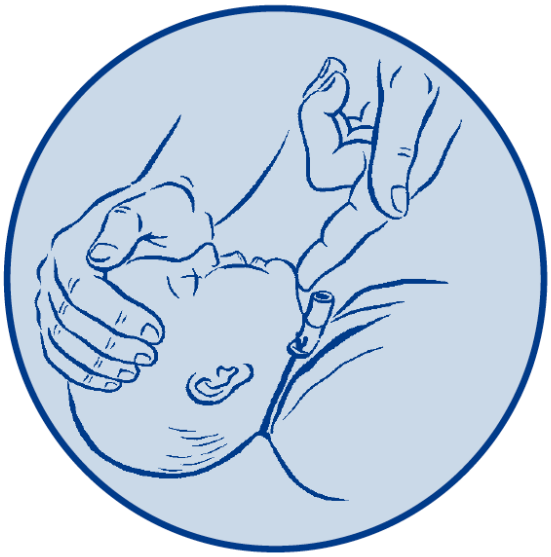
Shout

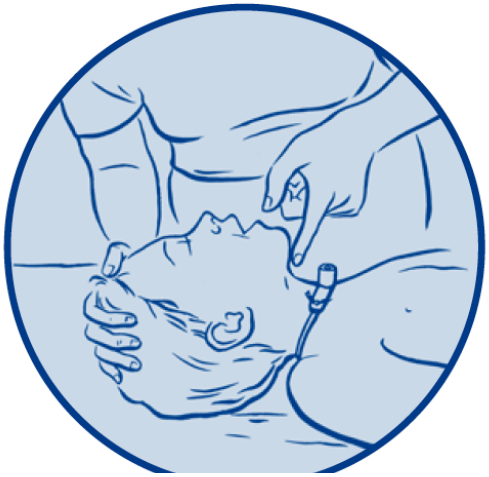
Do not leave the baby or child but call out for assistance from another person. As you continue to deal with the child, identify a person to go to call for the emergency services. You should ask them to phone for an ambulance, and tell the operator that a child with a tracheostomy is being resuscitated, stating the exact location. Ask them to come back to tell you they have done this.

If you are on your own, still call out for help but do not leave the baby or child at this stage, as it is essential you start to provide BLS.

Check and open the airway

If the baby or child is unresponsive, you must make sure their airway is not blocked and that air can pass to their lungs. Lie the baby or child on their back on a flat, firm surface and place one of your hands around the top of their head to support it. With the fingers of your other hand, gently lift the tip of the baby or child's chin backward. This exposes the tracheostomy tube.

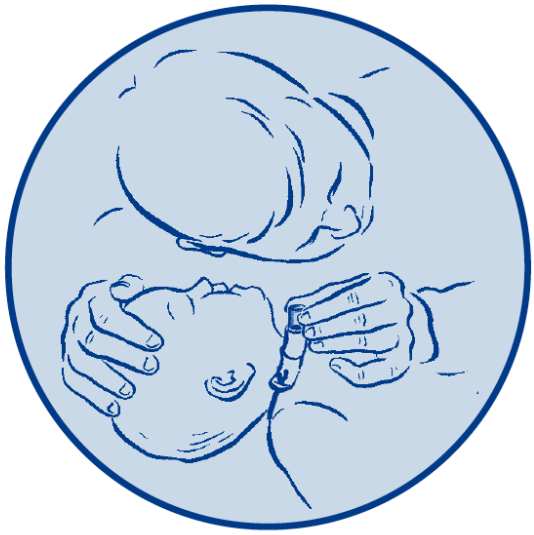




Take care not to press on the soft tissues underneath though, as this may block the upper airway.

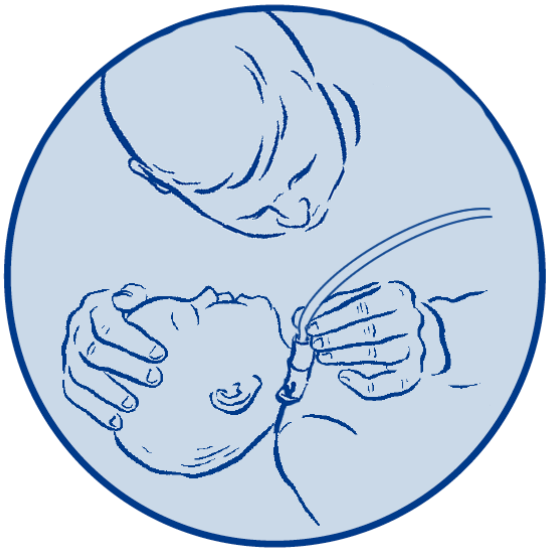
Any humidification devices, HME filters or speaking valves should be removed in an emergency as they may have become blocked with blood or secretions.

Older children may have tracheostomy tubes in situ which are large enough to accommodate a removable inner cannula. Inner tubes used with tracheostomies and can significantly reduce the risk of tube occlusion, provided they are cared for and used appropriately. If a tracheostomy tube becomes blocked, simply removing the inner tube may resolve the obstruction. However, it must be remembered that inner tubes vary significantly in their design, with some requiring replacing after cleaning, to allow connection to breathing circuits. It is essential to know what equipment is used in your clinical areas as unfamiliarity with equipment may lead to morbidity and mortality. If an inner tube is present, this should be removed at this stage.



Suction

The next step is to suction the tracheostomy tube. Suctioning will clear any obstruction in the majority of cases. However, if any resistance is felt or the suction catheter is unable to pass down the tube, then the tube may be partially displaced or completely blocked. The tracheostomy tube should be change the tracheostomy tube immediately.

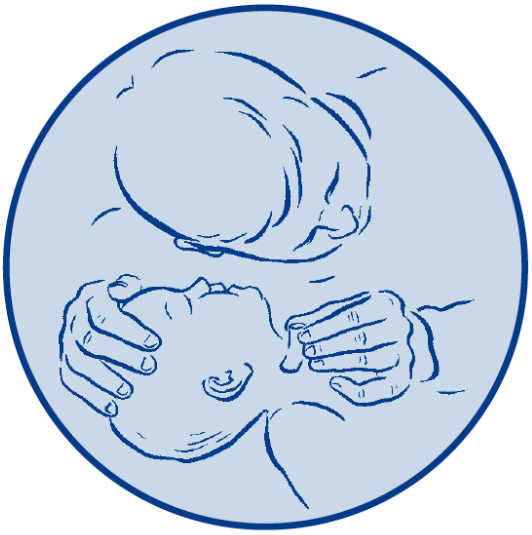


If the stoma closes on removal of the tube and the new tube cannot be replaced, attempt to pass a smaller tube. If this is unsuccessful, thread a suction catheter through the tracheostomy tube and insert the tip into the stoma. Then attempt to guide the tracheostomy tube along the catheter and through the stoma. If this is also unsuccessful, ventilation can be attempted either via the catheter or by the nose/mouth method (see below).

These options may not be suitable for all infants or children. The exact requirements and sequence of events will be discussed during individual training with parents or carers.

Assess breathing

Following attempt to clear the tracheostomy tube or changing it for a new tube, the next step is to assess for breathing through the airway(s). Supporting the (new) tube, place the side of your face over the tracheostomy tube to listen and feel for any breath. At the same time, look at the baby or child's chest to observe any breathing movement. Take up to a maximum of ten seconds to check for breathing.



If the baby or child is breathing normally – that is, more than a few occasional gasps – keep their airway open by suctioning the tube and regularly reassess the breathing as you wait for the ambulance to arrive. If you are on your own you must secure the tracheostomy tube with your emergency strapping.

Then, either carry the baby or child with you to summon more help, or if they are too large to carry, turn the child onto their side into a position where their airway is kept open and they cannot roll over. Return to them as soon as you have summoned more help and reassess them as above. The person who demonstrates the procedure for BLS to you will discuss this in more detail appropriate to your baby or child.

If the baby or child is not breathing, or there are only occasional infrequent gasps, you will have to provide rescue breaths for them.

Rescue breathing

With the baby or child lying on their back and the tracheostomy tube exposed, gently blow into the tracheostomy. The easiest way to do this is to put a catheter mount (from your emergency kit) on the end of the tracheostomy tube. Adapters are available from the hospital where the tracheostomy was initially performed or from the

Community Nurses. Cover the mount with your mouth and blow until you see their chest rising (this tells you that their lungs are inflating).

Remove your mouth from the tracheostomy tube to let the breath escape from their lungs (you will see their chest fall again). Repeat this five times, at a rate of about one breath every two seconds. Breathing is adequate if you can see their chest rise and fall with each breath. After five rescue breaths, you must check to see whether or not oxygen is still circulating around the baby or child's body. To do this you must see if there are any 'signs of life'.

Check for 'signs of life'

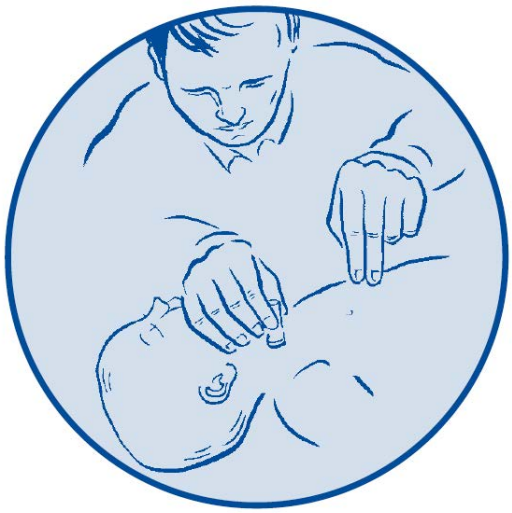
To check for signs of life, look at the baby or child for any breathing, swallowing or body movement. Take up to a maximum of ten seconds to check. If there are none, or you are in any doubt, you must proceed to chest compressions. Assessing for 'signs of life' has replaced a pulse check for non-medically trained responders as accurately detecting a pulse can be notoriously difficult, even to an experienced clinician.

Chest compressions

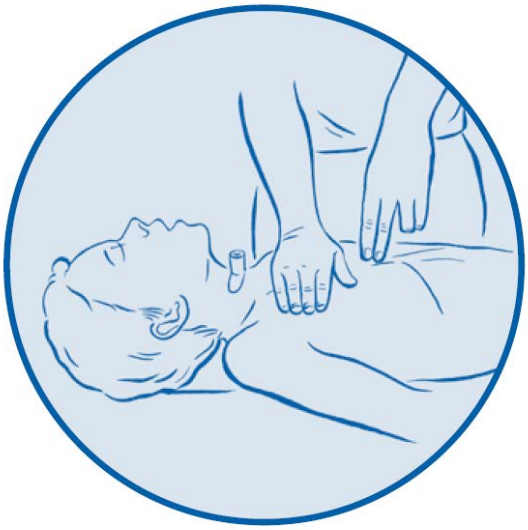
External chest compressions are required when the baby or child's own circulation is not adequate enough to circulate blood and oxygen around the body. The heart may have stopped beating or may beating too slowly to provide an effective circulation. This will result in none of the 'signs of life' referred to above and requires chest compressions to start an artificial circulation. To deliver chest compressions effectively and as safely as possible, the fingers or hand(s) need to be placed over the lower part of the sternum (breastbone).

In babies (under one year): place two fingers approximately a finger's breadth up from the point where the ribs join the sternum. Check to see that you are not over the very end of the sternum – if you are, move your fingers further up the chest.

In children above 1 year: place the heel of one hand approximately a finger's breadth up from the point where the ribs join onto the sternum. Again, check to see that you are not over the very end of the sternum – if you are move the heel of your hand further up the chest. Use your body weight to depress the sternum by one-third of the chest diameter. If it is difficult to achieve this depth, both hands (one on top of the other) may be needed.



In all cases, the chest should be depressed fifteen times. Each depression (compression) should be a smooth, non-jerky manoeuver that spends equal time in the depression (compression) and the relaxation phase. The fingers or hand(s) should not be removed from the chest wall until the cycle of fifteen is complete. Chest compressions should be delivered at a rate of approximately 100 times per minute.



Combining rescue breaths and chest compressions

Once you have started chest compressions, they need to be interspersed with rescue breaths. It is recommended that in babies and children, two breaths should be delivered between each cycle of fifteen compressions. This sequence of fifteen to two should be continued for approximately one full minute before you reassess the situation.

Ongoing resuscitation

After one minute of BLS, you should stop and reassess the baby or child for any spontaneous breathing and signs of life in the same manner as before. If there are none, then you must continue you attempts at resuscitation.

Additionally, at this time you must check whether help is on the way. If someone has already been asked to summon more help, you must confirm that this is coming. If there is any doubt that more help has been summoned then you must now do this yourself. You may have to make a decision as to whether or not you can safely carry the baby or child with you to summon more help. If it is not possible to do this safely, then you must leave the child and summon more assistance. Return as quickly as possible, and resume BLS as before.

Once started BLS should be continued until

- There are any 'signs of life' from the baby or child (which means you need to reassess them and decide if BLS is still needed).
- Trained healthcare personnel take over from you.
- You are too exhausted to continue.

Further training for carers

You never know when these vital life-saving skills may be necessary. It might not even be for your own child, but that of a friend, neighbour or complete stranger who could be dependent on someone like yourself having learned and practiced these techniques. Unfortunately, however, there are some tragic occasions when despite the best efforts of yourself, ambulance and hospital personnel, some babies and children will not respond to resuscitation attempts. However, by learning these essential skills and revising them regularly, you will give babies and children the best possible chance of survival.

These instructions are available in a printable guide via the Great Ormond Street Hospital website (www.GOSH.nhs.uk tracheostomy pages) or directly from the link below. Carers should read these instructions regularly to refresh their memory. Try to imagine an emergency before it arises so that you can

anticipate what you would do in that situation. It is also worth ensuring other family members and friends know how to summon emergency help and encourage them to formally learn BLS skills also.

Emergency care and BLS can be learned and practiced by enrolling on a St John Ambulance or other recognised First Aid course.

Link to Tracheostomy BLS guide in PDF format

Useful numbers

At Great Ormond Street Hospital:
Resuscitation service
020 7813 8197
020 7829 7854
Tracheostomy Nurse Specialist
020 7405 9200 bleep 0712

St John Ambulance National HQ:
27, St John's Lane
London EC1M 4BU
08700 10 49 50

www.sja.org.uk

Advanced Life Support (ALS) for the baby or child with a tracheostomy

The principles of basic life support (BLS) as described in the previous section can be applied in the hospital setting. There are differences in the patient case mix, infrastructure, equipment and personnel available to manage an emergency when comparing similar situations that may occur in the community setting. Hospitalised patients are more likely to have acute medical or surgical problems and therefore be more prone to rapid deterioration. The tracheostomy itself may be relatively new, which may have implications for emergency management. However, there is also access to advanced resuscitation equipment, oxygen, capnography and trained airway experts in hospitals to assist with managing these emergencies.

When applied to a patient with a tracheostomy, CPR may be more difficult to teach and to learn because additional processes are required to determine and correct the cause of the collapse. The airway element of BLS will require modification in children with tracheostomies, it is therefore essential that practitioners have received training in both routine and tracheostomy BLS. The following section describes ALS for children with a tracheostomy in the hospital setting and should be read in conjunction with the previous section which is aimed primarily at non-medically trained carers. BLS is similar in the sequence of skills to be performed for those with a tracheostomy:

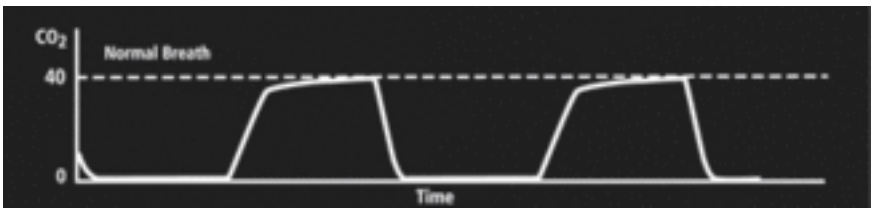
1. **Safety**
2. **Stimulate**
3. **Shout**
4. **Airway**
5. **Suction**
6. **Breathing**
7. **Circulation**

Initial response

Ensure safety of yourself and the child. Stimulate the child and call their name, taking care to support their head and body.

Calling for for assistance is essential in the hospital environment. If there is any doubt about the clinical condition of the child, summon the hospital's paediatric emergency or cardiac arrest team. You will also need a senior clinician with expertise in tracheostomy management. Who this is will depend on your hospital and the infrastructure within it. Senior nursing staff, Tracheostomy Specialist Nurses, Head and Neck Surgical team members, Anaesthetists or Intensivists may all be suitable to be called in an emergency. There should be systems in your hospital to do this quickly, with contingency plans if an individual or team is unavailable (usually a cascade bleep system or similar mechanism).

In addition to personnel, emergency equipment is required. Most of this should be checked and ready at the bedside, but additional oxygen supplies, capnography and anaesthetic breathing circuits may need to be brought from the ward or unit's resuscitation (crash) trolley, along with additional monitoring such as pulse oximetry, ECG and Blood Pressure monitoring. If a tracheostomy tube has become displaced or the stoma or airway is known to be difficult to manage, an appropriate fibre-optic endoscope should be summoned. This should be immediately available in clinical areas where tracheostomies are routinely managed (ENT wards or PICUs) and other areas should know where to find a 'scope in an emergency.



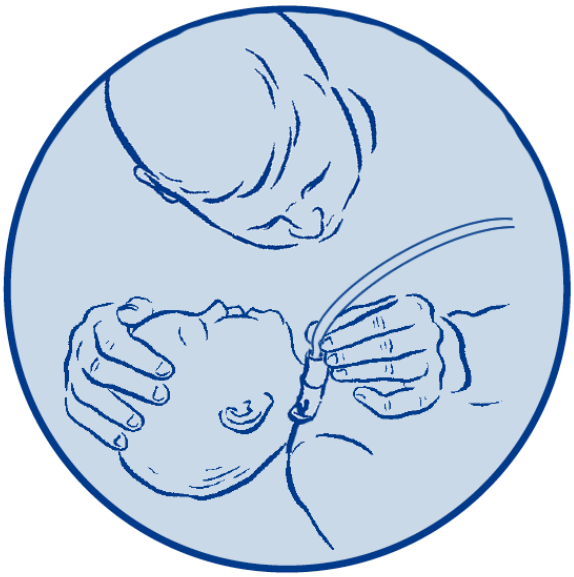
If you are by yourself do not leave the patient at this stage. Open and check the child's airway by placing supine on a flat firm surface. It may be helpful to put a folded towel under the shoulders, only if this is immediately available. Do not waste time by collecting towels. Gently tilt the tip of the chin upward, taking care not to press on soft tissue underneath.

Any humidification devices, HME filters or speaking valves should be removed in an emergency as they may have become blocked with blood or secretions. Inspect tube for obvious problems or signs of blockage: crusts, kinks or dislodgement.

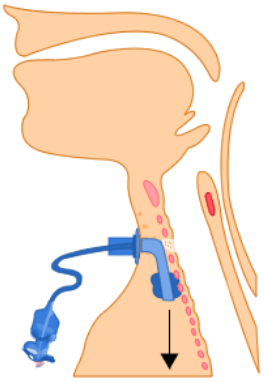
Older children may have tracheostomy tubes in situ which are large enough to accommodate a removable inner cannula. Inner tubes used with tracheostomies and can significantly reduce the risk of tube occlusion, provided they are cared for and used appropriately. If a tracheostomy tube becomes blocked, simply removing the inner tube may resolve the obstruction. However, it must be remembered that inner tubes vary significantly in their design, with some requiring replacing after cleaning, to allow connection to breathing circuits. It is essential to know what equipment is used in your clinical areas as unfamiliarity with equipment may lead to morbidity and mortality. If an inner tube is present, this should be removed at this stage.

Assessing tracheostomy patency

The next step is to suction the tracheostomy tube. Suctioning will clear any obstruction in the majority of cases. However, if any resistance is felt or the suction catheter is unable to pass down the tube, then the tube may be partially displaced or completely blocked. The tracheostomy tube should be change the tracheostomy tube immediately. If the stoma is less than 1 week old, then the risks of inserting a new tube into a false passage in the soft tissues of the neck are increased. Along with trauma and bleeding, misplacement of a tube into a false passage does not secure the airway.



When changing a tube, the same size tube should be inserted. If you are unable to insert the same size tube try to insert the one that is a size smaller. If the stoma closes on removal of the tube and the new tube cannot be replaced, attempt to pass a smaller tube. If this is unsuccessful, thread a suction catheter through the tracheostomy tube and insert the tip into the stoma. Then attempt to guide the tracheostomy tube along the catheter and through the stoma. The Seldinger technique should be practiced as a first line attempt at reinserting a tracheostomy tube. Tracheal dilators should only be used by practitioners experienced in their use. If tube reinsertion is unsuccessful, ventilation can be attempted either via the catheter or by conventional rescue breaths (e.g. mouth-to-mouth or bag and mask over the mouth & nose). Supplemental oxygen should be applied as soon as it is available.

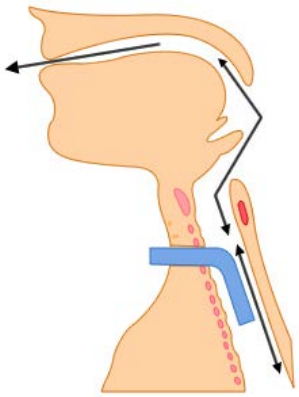


It is important not to attempt high-pressure ventilation via a tracheostomy tube that appears blocked or displaced (suction catheter won't pass, absent capnography trace). If the tube has become displaced into the soft tissues of the neck, rapid surgical emphysema can develop and even a small amount of gas in the tissues can make managing a paediatric stoma or airway difficult or impossible.

All options may not be suitable for all infants or children, especially those with abnormal upper airway anatomy. The exact requirements and sequence of events will be discussed and agreed when the patient first presents. Airway alert or tracheostomy bedhead signs can be

extremely useful in these circumstances to inform emergency responders of underlying disease or anatomy.

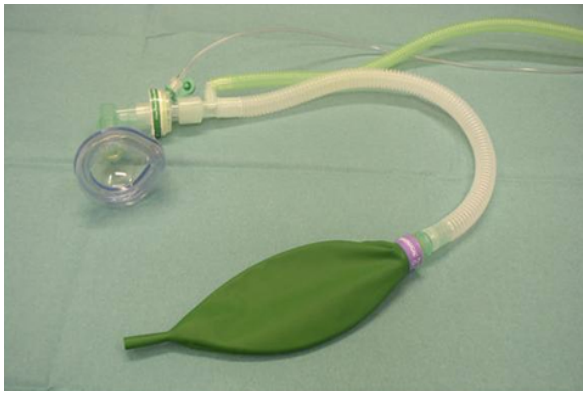
If the patient has a patent upper airway, they may be able to breathe around the tracheostomy tube, even if it is blocked or displaced. If there is any evidence of breathing via the upper airways, then oxygen should be applied via a conventional facemask.



Primary emergency oxygenation

Following airway opening maneuvers (native upper airway and attempting to suction or change the tracheostomy tube) the next step is to reassess whether the interventions have improved the situation. This assessment is primarily a clinical one, but is supported by appropriate monitoring such as pulse oximetry and capnography.

Look, listen and feel for any breathing at both the upper airway (nose & mouth) and the tracheostomy tube, or open stoma if a new tube could not be re-inserted. At the same time look at the child's chest to observe any breathing movement. Take up to a maximum of ten seconds to do this.



If the child is breathing adequately, give oxygen and keep their airway open by regular suction and wait for the clinical emergency team.

If the child is not breathing (or only making agonal gasps), then emergency oxygenation is required. The priority is to oxygenate the child, not necessarily to reinsert a new tracheostomy tube or oral/nasal endotracheal tube, although these more invasive methods may be required if simpler measures are unsuccessful.

If the tracheostomy tube is patent, commence artificial respiration with a bag-valve system directly connected to the tracheostomy tube and administer 5 breaths. This is best achieved with a 15mm swivel connector attached to a self-inflating bag (eg Ambu© bag) or paediatric anaesthetic breathing circuit (image above shows a Mapleson F circuit). Remember to attach oxygen and capnography as soon as they are available. Oxygen should be set at a minimum of 10 litres/minute for a paediatric system (usually weight under 20kg) and 15 litres/minute for the adult system (appropriate for weights over 20kg). Ensure that the breaths are effective by observing chest movement and an appropriate waveform on the capnography display.

Standard oral airway manoeuvres include the use of oral or nasal adjuncts (Guedel airways, naso-pharyngeal airways) or supraglottic airway devices such as the Laryngeal Mask Airway (LMA). If the tracheostomy stoma is open (without a tube) and the patient is being ventilated via the upper airways, the stoma may need to be covered to allow effective delivery of the gas to the lungs.

Ventilation can also be achieved by delivering oxygen via the open stoma. Suitable techniques include a small, paediatric facemask, or an LMA applied to the skin.

Secondary emergency oxygenation

If the less invasive methods of oxygenation fail, then insertion of an airway device is required. This can either be via the upper airways (oral or nasal intubation) or via the tracheostomy stoma. The choice of route depends on several factors:

- The age of the tracheostomy stoma. A stoma that is less than 1 week old will be more difficult to cannulate with increased risks of misplacement. The stoma may also close on removal of a tube.

- The presence of stay sutures. These may assist reinsertion of a tube into the stoma, making this the easier airway to manage.

- If the patient has a known difficult (or sometimes impossible) to manage upper airway. The stoma becomes the easier airway in this circumstance. It may still be possible to oxygenate to some degree via the upper airway.

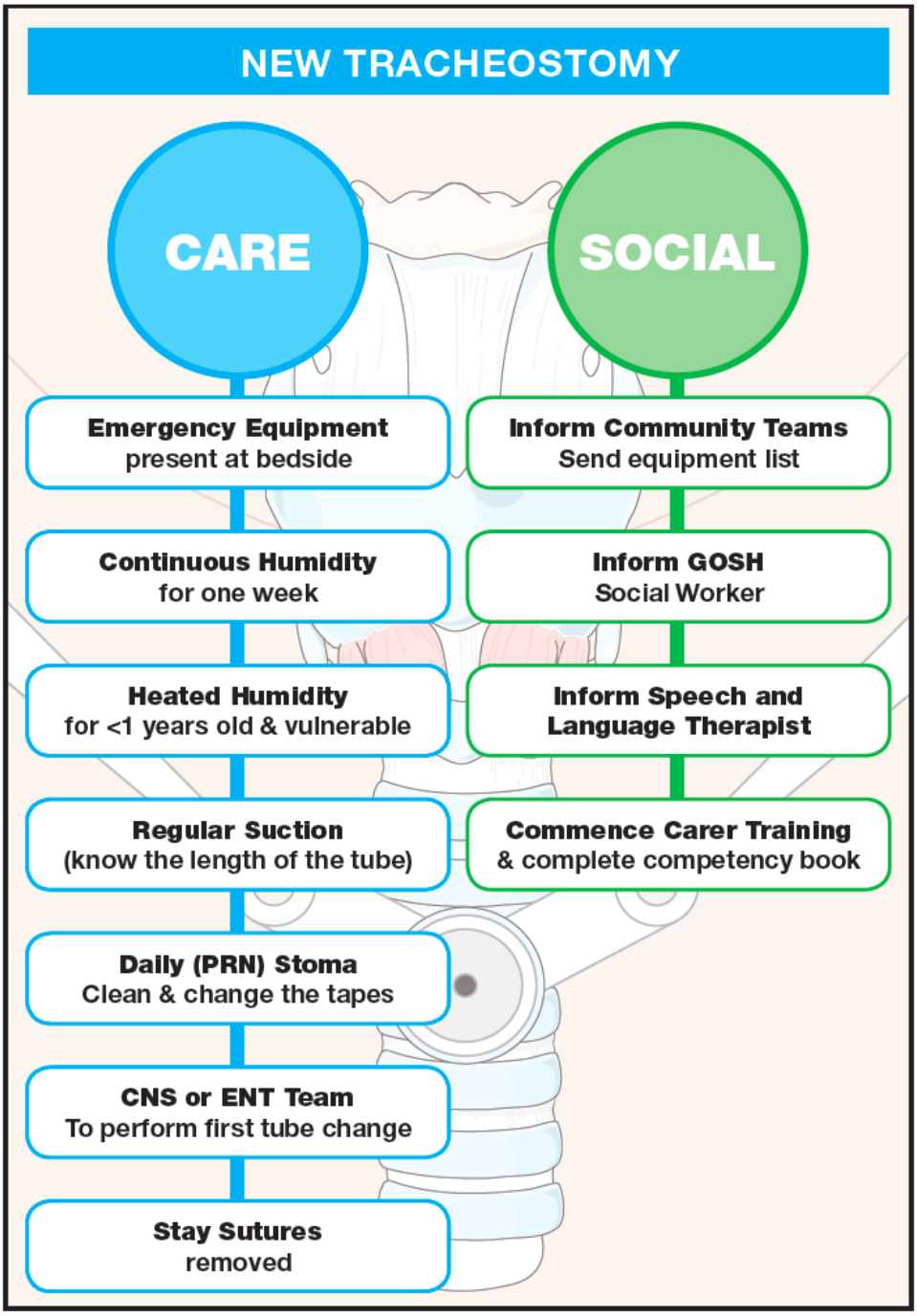
- The expertise and experience of the attending emergency team. If your expertise is managing upper airways (usually anaesthetic backgrounds) then don't change what you do normally in an emergency. Likewise if you are more comfortable manipulating tracheostomy tubes and managing stomas (usually head and neck surgical backgrounds).

- The equipment that is immediately available. All difficult airway equipment including a range of laryngoscopes, bougies, introducers and a suitable fibre-optic endoscope should be available for tracheostomy emergencies. Emergency anaesthetic and resuscitation drugs may also be rapidly required.

- The location. Sometimes it is better to wait until the patient is in a safe location for airway management before attempting invasive airway manoeuvres. The risks of transferring a patient will need to be balanced by the attending clinical teams. If a patients oxygenation can be adequately maintained, it is often safer to assemble the personnel, equipment and any required drugs in a critical care or theatre area to optimize the chances of successful difficult airway management.

Discharge from hospital with a paediatric tracheostomy

Consideration of discharge planning should start as soon as the decision to perform a tracheostomy is taken. Consideration needs to be given to who will provide care, where and how the child with a tracheostomy will be managed following discharge. This can be straightforward in the case of a well-supported child but the complex interactions between primary and secondary care mean that planning and communication are essential to facilitate the smooth transfer of safe care.



The community team should be contacted after one week to confirm tube style/ size, which may have had to be changed during the first week.The progress of supply orders should also be checked. Discussion of respite and carer support should be broached with community team. Most children will be discharged back via their local hospital, which will allow local services and support to be activated. Negotiations to do this should begin as soon as the tracheostomy is formed.

The formation of a tracheostomy must be confirmed (usually by telephone) with the child's:

- Health Visitor (HV)
- General Practitioner (GP)
- Paediatric Community Nurse (PCN)
- School (including school Nurse if applicable)
- Local Hospital

This should occur as soon as practical following the insertion of the tracheostomy is inserted. An equipment list and introductory letter should be sent so that equipment can be ordered, minimizing potential delays on discharge from hospital.

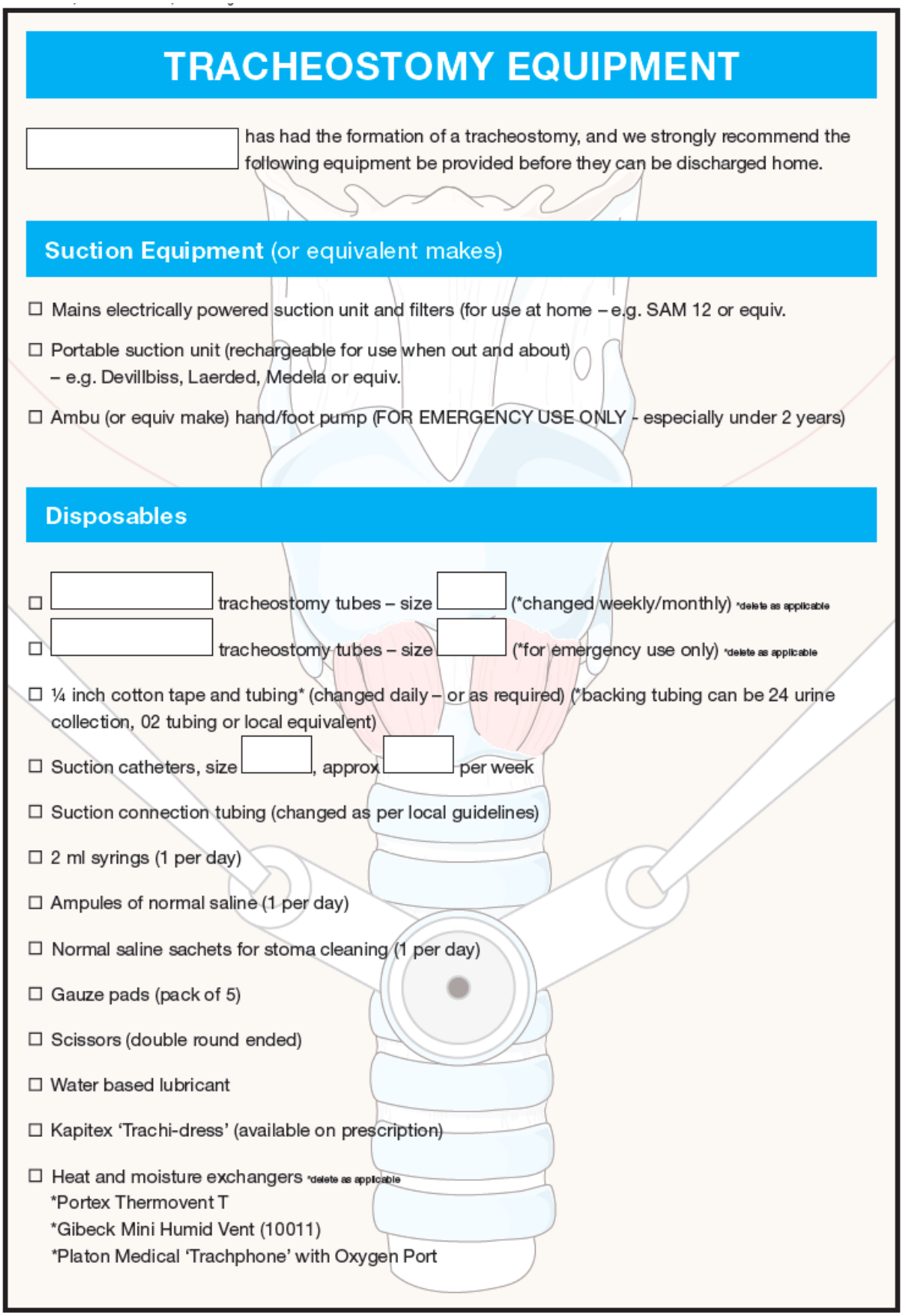
However some children, such as those who have had a planned tracheostomy or who have been in hospital for a long time may be discharged home straight from a tertiary hospital. Some equipment may have to be provided to facilitate this, which should be discussed individually with the communities involved. Ensure that the portable suction unit has been collected from the community team before the day of discharge and bought to the hospital for the transfer home and parents are aware of how it works.

The child's parents, or two main carers, must be taught and be deemed as competent in the following:

- Tracheostomy tube changes (minimum of two)
- Tracheostomy tape changes
- Stoma care
- Suctioning
- Resuscitation skills/ emergency care
- Carer must stay and do an overnight stay with their child and carry out all care overnight
- Feel confident in themselves taking the child out of the hospital

Sometimes it is not possible to complete all the training at the primary hospital and local teams may have to complete some elements of the training. This should be explicitly communicated. Tracheostomy care and resuscitation booklets are available to support carer training. The GOSH booklets are available from the GOSH website, with the links available at the end of this

chapter. All training received must be recorded on the child's discharge planner and kept in their health record for future reference.



TRACHEOSTOMY EQUIPMENT

[ ] has had the formation of a tracheostomy, and we strongly recommend the following equipment be provided before they can be discharged home.

Suction Equipment (or equivalent makes)

- ☐ Mains electrically powered suction unit and filters (for use at home – e.g. SAM 12 or equiv.
- ☐ Portable suction unit (rechargeable for use when out and about) – e.g. Devillbiss, Laerded, Medela or equiv.
- ☐ Ambu (or equiv make) hand/foot pump (FOR EMERGENCY USE ONLY - especially under 2 years)

Disposables

- ☐ [ ] tracheostomy tubes – size [ ] (*changed weekly/monthly) *delete as applicable
- ☐ [ ] tracheostomy tubes – size [ ] (*for emergency use only) *delete as applicable
- ☐ ¼ inch cotton tape and tubing* (changed daily – or as required) (*backing tubing can be 24 urine collection, 02 tubing or local equivalent)
- ☐ Suction catheters, size [ ], approx [ ] per week
- ☐ Suction connection tubing (changed as per local guidelines)
- ☐ 2 ml syrings (1 per day)
- ☐ Ampules of normal saline (1 per day)
- ☐ Normal saline sachets for stoma cleaning (1 per day)
- ☐ Gauze pads (pack of 5)
- ☐ Scissors (double round ended)
- ☐ Water based lubricant
- ☐ Kapitex 'Trachi-dress' (available on prescription)
- ☐ Heat and moisture exchangers *delete as applicable
  *Portex Thermovent T
  *Gibeck Mini Humid Vent (10011)
  *Platon Medical 'Trachphone' with Oxygen Port

Parents and carers will need to be taught tracheostomy BLS and ‘mouth to trachy’ resuscitation for going home. In addition to the other equipment required they must be given a catheter mount 15mm female, and two emergency Velcro tapes. Community teams will usually supply the equipment for the child's discharge home. Depending on the type of tube inserted, other relevant emergency equipment may include:

- Two pairs of velcro tapes
- Two disconnection wedges
- Two tracheostomy extensions +/- male to female adapters

Parents require both theoretical and practical teaching / practice of both emergency algorithms, namely action to take on a blocked tube and action to take if the tracheostomy tube cannot be replaced (Seldinger technique).

Follow up

Follow up is very important for children with tracheostomies. Practices do vary however and there are often local influences on the decision. Commonly, an eight-week ENT outpatient appointment will be arranged prior to discharge (unless indicated otherwise by the medical team). Although community teams will usually supply the equipment for the child's discharge home, it is important that parents and carers have the correct emergency equipment (and knowledge of how to use it) for as soon as the patient leaves hospital. This starts as soon as the child leaves the ward and includes the journey home.

Further information

General Information:

- GOSH general information guide
- Covering indications, tubes and humidification

GOSH pdf guides & leaflets:

- Staff competency - home preparation
- Staff competency - ventilated child

- Carer competency - home preparation
- Carer competency - ventilated child

- GOSH BLS guide for parents and carers: BLS guide

- New tracheostomy discharge algorithm
- New tracheostomy equipment form

Information for parents of a child with new tracheostomy:

- Living with a tracheostomy – GOSH webpage
- Living with a tracheostomy - pdf leaflet

T

Tapes - Keep tube secure

Ensure the tension of the tapes is tight enough to support the tube One finger should fit comfortably between the child's neck and the tapes.

R

Resus - Know the resuscitation process

- Safety, Stimulate, Shout for help
- SUCTION airway- if the tube is difficult to suction or is blocked, change the tube, suction again,
- Check for breathing. If required, use the self-inflating bag ventilation device with the Portex swivel connector to give rescue breaths, then follow BLS algorithm for circulation.

A

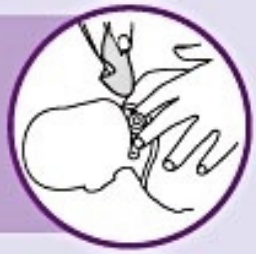
Airway clear - Use correct suction technique

Use correct catheter size and length of suctioning. Know the length of the child's tube and only suction just beyond it, i.e. To allow the lateral and distal holes beyond the tube tip. The catheter size should be 'double the size of the tube'. For example 8 FG catheter for a 4.0 ID tube.

C

Care of the site - Stoma and neck

Trache site should be cleaned at least daily and any breakdown noted and treated. Don't forget the back of the neck!



H

Humidity - Essential to keep tube clear

Must use either the water system or an HME. If it is the water system no more than 6 sections of tubing and check that water droplets are present throughout the tubing. Use warmed humidity systems for small babies who are at risk of heat loss. Use the Correct size Heat and Moisture Exchanger (HME- Swedish Nose).

E

Emergency box - Have the box present

Emergency box should only contain the correct equipment. Equipment list is inside the lid of the box. No other items should be present.

Infrastructure considerations

Introduction

In order to safely care for patients with tracheostomies in our hospitals, we need to address the organisation and infrastructure of the clinical areas where patients with tracheostomies and laryngectomies will be managed. This is important outside the hospital in community organisations and the homes of patients.

As part of this project, we have been able to look at many Trust's policies and documentation. We have also been able to view detailed reports from coronial inquests and serious untoward incident reviews, which have helped to inform the following pages.

This section includes guidance in the following areas:

- Infrastructure and resources for hospital inpatient areas.
    - Example care pathway
    - Example policy
    - Risk assessment
- Competencies for tracheostomy care and management.

Hospital in-patient management

Any clinical area can potentially look after neck-breathing patients, but these areas must be:

- Adequately staffed
- Adequately trained
- Adequately equipped
- Adequately supported

In order to do this effectively, most Trusts will have to cohort patients with tracheostomies together into designated wards. This allows training and equipment to be targeted and concentrates expertise and experience. Nominated areas would typically include:

- Critical care areas
- Head and neck wards
- Designated respiratory / medical / surgical wards

Patients with tracheostomies or laryngectomies should not be cared for outside these areas. This has implications for the flow of patients into, out of and around a hospital, and the bed managers will need to be adequately involved in planning patient movement. Patients can also come directly from the community or through the emergency department.

The key areas to consider for those designated wards are:

1. Competency and training
    a. Staff must have received documented training appropriate to their duties
    b. Knowledge of where to find additional resources (some of the resources presented as part of this project could be considered 'just-in-time' training)
    c. Staff must know who to call and what to do in an emergency
2. Equipment provision
    a. Wards must be stocked with airway and tracheostomy specific equipment
    b. Only suitable tubes should be used (uncuffed, inner cannula)
    c. Immediate access to a fibre-optic endoscope
    d. Bedside emergency equipment must be available at all times and accompany the patient if they move around the hospital
    e. Equipment must be checked and a means of documenting this must be in place
3. Staffing numbers
    a. Extra staff may be required if the dependency of a tracheostomy patient requires it.
    b. Consideration of one-to-one nursing / nursing auxiliary on initial step-down from a higher level of care for 24-48 hrs
4. Discharge planning
    a. Multi-disciplinary
    b. Documented
5. Follow up
    a. Patients who have had a tracheostomy should be followed up by a clinical team able to
        i. Assess for long term complications
        ii. Diagnose and either treat such complications, or have access to appropriate services

b. Follow up should be offered to patients who have been decannulated and those in whom a tracheostomy tube remains in situ
c. Patients with long-term tracheostomies should also undergo periodic review by a team able to assess and manage potential long term complications, and able to assess the on going need for the tracheostomy to remain
d. Medical and multi-disciplinary follow up arrangement must be clear and documented

6. Documentation

With regard to inter-hospital transfer between acute hospital sites, it is the responsibility of the transferring/discharging hospitals/units to ensure that the patient transfer is communicated to the relevant team(s) within the receiving Trust. Adult patients with tracheostomies should only be transferred to hospital sites where there is appropriate arrangement in place to adequately care for the patient's needs.

Draft tracheostomy policy outline

The policy detailed below is an example based on amalgamated policies from several hospitals in the North West Region of England. Clearly, hospital policies will vary, but this is included to give the reader a framework if you were considering writing your on tracheostomy policy. It may be useful to designate specialist areas (ICU, HDU or a head and neck unit), non-specialist areas which will be nominated, trained, adequately staffed and equipped to care for patients with tracheostomies and then all other clinical areas.

Duties within the organisation

Chief Executive

The Chief Executive is responsible for ensuring the requirements within this policy are fulfilled and operational responsibilities are in place when patients who are 'neck breathers' are nursed on general wards.

Chief Nurse

The Chief Nurse is responsible for ensuring requirements within this policy are fulfilled and that this policy is disseminated to all Heads of Nursing for appropriate action.

Executive Medical Director

The Medical Director is responsible for ensuring that this policy is disseminated to Consultants who supervise medical staff in training and that education and training facilities are available to ensure medical staff can maintain level of clinical standards to appropriately manage patients who trigger on the MEWS.

General Managers

The General Managers will ensure that adequate resources are available within their divisions to make provisions within this policy feasible.

Consultant (or lead clinician)

The Consultant is the professional with the overall clinical responsibility for their patients, therefore will ensure patients cared for in a designated area other than their allocated ward will receive a daily visit from a member of their team. The Consultant will ensure that clinical standards are maintained and that any necessary deviation from this policy is documented and explained in the medical notes.

Heads of Nursing

Heads of Nursing have a responsibility to ensure that this policy is disseminated to Matrons and Ward Managers to inform clinical staff of their responsibilities in the safe care of patients who are neck breathers. In collaboration with Matrons and Ward Managers, Heads of Nursing must ensure that adverse clinical incidents in relation to the care of patients who

are neck breathers in their clinical areas are reported and investigated and action plans produced to prevent future occurrence.

Matrons and Ward managers
Matrons and Ward Managers have a responsibility to ensure that any staff responsible for caring for patients who are neck breathers receive training on their care and management and recognise when to escalate care when needed to the appropriate people. Matrons and Ward Managers have a responsibility to ensure that all clinical staff have access to equipment and documents for providing safe care for patients who are neck breathers.

Bed Managers
Bed Managers must ensure that patients with a tracheostomy/laryngectomy admitted to a general ward from a critical care area, specialised ward or from any community setting must be cared for in the designated areas. These areas will be identified following a Trust-wide consultation process.

Critical Care/Specialist Ward Clinical Staff
Most patients with a tracheostomy discharged from a specialist ward should have an un-cuffed tracheostomy tube with an inner cannula sited. Exceptions to this must be clearly justified (reduced conscious level, excessive secretions, inability to protect he airway). Standardising or limiting the different types of tube available may make teaching easier and reduce potential confusion with tubes. At least 24hour notice should be given to the receiving ward when a patient is being discharged from a specialist area. This will ensure the receiving ward can make all necessary preparations to safely accept responsibility for the patient with a tracheostomy.

A tracheostomy Care Plan will be completed by discharging team, and be communicated to the receiving ward nurse and agreed before the patient is discharged from Critical Care/Specialist Ward. This will ensure a full handover of care is given and the receiving ward can maintain a safe environment for the patient with a tracheostomy. A risk assessment should be completed and agreed with the receiving ward. Any problems with the tracheostomy should be clearly communicated (see draft risk assessment).

Receiving Ward Clinical Staff
The receiving ward should ensure that the patient with a tracheostomy/laryngectomy is nursed in a bed that is observable from the nursing station and wherever possible not in a side room. As a general rule the patient should be nursed in an open observation area, rather than a side room (unless continuous 1:1 staffing is provided). Discussion with infection control teams should take place as close observation for airway compromise is likely to take priority over use of a side room for infection control purposes. The receiving ward should ensure that the patient with a tracheostomy/laryngectomy must have access to a nurse call bell and other communication aids, if they are able to use them.

If a patient does not have adequate means of communication due to their clinical state, then adequate provision for one-to-one care must be adopted. The receiving ward should ensure that the patient with a tracheostomy or laryngectomy requiring oxygen must have an oxygen supply and suction equipment at the bedside, and that the oxygen is prescribed on the patients prescription chart. Any patient with a tracheostomy/laryngectomy who is oxygen dependant should have their oxygen warmed and humidified. The receiving ward should ensure that the patient with a tracheostomy has the emergency airway box at the patient's bedside at all times. The appropriate 'Bed-Head' sign should be completed describing the details of the tracheostomy. This form will be completed by the person performing the tracheostomy or by a competent member of staff if a patient is admitted to the Trust with an existing tracheostomy.

Patients with a tracheostomy/laryngectomy must have regular checks carried out as per the tracheostomy/laryngectomy care plan and patient bedside checklist. The receiving ward should ensure that the patient with a tracheostomy/laryngectomy has been referred to the Physiotherapy and Speech & Language teams if appropriate.

Critical Care Outreach Team
Some hospitals have 'Outreach Teams' who are well placed to support and assist ward staff with caring for neck-breathing patients and often play a vital educational role. Systems need to be in place to notify Outreach teams if a neck-breathing patient is admitted or transferred.

Emergency teams
Any patients with a tracheostomy or laryngectomy who develop breathing difficulties or display any of the 'Tracheostomy Red Flags' need prompt assessment by someone trained to do so. For tracheostomy/laryngectomy problems (or where clinical deterioration may be related to the airway) the patient must be seen by the ENT or MaxFax team (for ENT or MaxFax patients) or by the relevant Medical team within 30 minutes. Contact details are displayed on the appropriate 'Bed Head' signs. For an emergency related to the airway, decide in advance who should be called (depending on your hospital setup)

Hospital Incident Reporting System (HIRS)

Most hospitals have a system for recording adverse events and facilitating subsequent investigation. If a patient's care is affected by a failure to provide appropriate infrastructure or not following a local policy, then the HIRS system is a useful way of recording this and improving the systems.

Standards and key performance indicators and process for monitoring compliance

The following standards and key performance indicators could be used for monitoring compliance to a tracheostomy policy, monitored via audit:

- The Critical Care Outreach Team (or similar) have been informed of any patient nursed on a general ward within the Trust with a tracheostomy or laryngectomy
- A Tracheostomy/laryngectomy Discharge Plan has been completed for patients discharged from a specialist area.
- The patient is cared for in a designated area.
- The designated area has been given 24 hours notice before the patient has been admitted from a specialist area
- Any patient with a tracheostomy tube will have an uncuffed double cannulae tube sited (if appropriate)
- Time of discharge from a specialist area is not between 22.00 and 07.00
- A tracheostomy/laryngectomy care plan is in use and completed correctly
- An emergency airway box is always at the patients bedside
- Emergency Algorithms are displayed above the patients bed where appropriate
- Suction equipment is connected correctly and working
- An oxygen supply is available at the bedside
- Other emergency equipment is available on the ward
- The patient is nursed in a bed which is easily observable to nursing staff
- If administering oxygen via a stoma it is humidified
- A referral is made to physiotherapy for a daily and weekend visit
- An adequate supply of all necessary equipment is available on the receiving ward

Dissemination, Implementation and Access to this Document

All staff working on a receiving ward will receive documented training and education on the care of the patient with a tracheostomy or laryngectomy on a regular basis.

RISK ASSESSMENT

The following risk factors must be taken into consideration when determining an appropriate clinical environment for a patient with a tracheostomy. Any of these factors place the patient at a greater risk of airway obstruction requiring more frequent observation by trained and competent staff and greater visibility at all times. These should form the principles for the risk assessment for the patient that should be determined by the lead clinician.

- Patient discharged from critical care within last 48 hours
- Tracheostomy less than 7 days old
- Patients requiring a single lumen tracheostomy tube for clinical reasons
- Patient known to have a complex airway and/or difficult endotracheal intubation or tube insertion (bed head sign)
- Patients unable to call for help (including unable to use call system)
- Patients at risk of self decannulation
    1. Delirious
    2. Agitated
- Patients with an obstructed upper airway (dependent on their tracheostomy for breathing) or dependent on ventilatory support

Care plans

The tracheostomy care pathway will vary from Trust to Trust. We have again viewed many excellent local examples and provided a summary that you may wish to consider for reference if updating your own pathways. Any care pathway should be used in conjunction with the bedhead sign, detailing essential details about the tracheostomy, including any major incidents, such as decannulation, tube obstruction etc.

The pathway should include the following:

- Record of tracheostomy tube insertion and changes (and how easy/hard these were)
- Tracheostomy equipment checklist
- Tracheostomy weaning plan
- Daily care record

We have reviewed several coronial inquests and serious untoward incident investigations regarding tracheostomy or laryngectomy care. It is useful to consider any documentation from the point of view of an external agency trying to establish facts after an event such as:

- When was the tracheostomy suctioned
- Was the inner tube changed today

Your documentation should make this easy to record and establish. Daily care record should therefore include the following:

- Type of tube inserted
- Cuff up/down? Speaking valves?
- Inner tube cleaning
- Suction performed
- Humidification
- Oxygen
- Stoma care / dressing
- Securing the tube
- Nutrition / hydration

It should also be easy to locate tracheostomy specific documentation and instructions relating to:

- SALT / swallowing assessment / instruction
- Plans for cuff deflation / down-sizing / decannulation
- Physiotherapy plans
- Risk assessments (which may alter during the course of the inpatient stay)

Draft Care Plan (from UK Intensive Care Society 2008)

TRACHEOSTOMY CARE

Appendix 3

TRACHEOSTOMY CARE

Patient addressograph

WARD BASED APPRAISAL OF NEED

DATE OF TRACHEOSTOMY:

TUBE TYPE: **SIZE:** **FENESTRATED: Y/N**

(Y = YES, N = NO, √ = satisfactory, CFC = cause for concern)

DATE:					
PREVIOUS TUBE CHANGE ?Problems-Y/N					
GCS					
CPAP DEPENDENT Y/N					
O_2 DEPENDENT % FiO2					
BREATHING RATE/PATTERN					
Speaking Valve Y/N how long?					
Occlusion Cap Y/N how long?					
AIRWAY VOICE Strong/Weak?					
SWALLOW assessment?					
COUGH strong/weak/into mouth?					
SECRETIONS ?sticky/infected					
SUCTION No./24 HRS					
EXCESS DEMAND?e.g. Anaemic/pyrexial/ LV Function					
? Abdominal Distension					
FAILED Decannulation?					
WEANABLE ?Cuff Deflated					
Formal SALT assessment?					
DOCTOR /PHYSIOTHERAPIST:					

Competencies for staff caring for patients with tracheostomies or laryngectomies

TRACHEOSTOMY CARE: COMPETENCY ASSESSMENT CRITERIA

COMPETENCY STATEMENT
Demonstrates safe practice for patient requiring a tracheostomy and dealing with tracheostomy emergencies

Key Skills	Assessment Criteria
1. Demonstrates an understanding of the anatomy and physiology of the respiratory system	Identify the main structures of the respiratory system Discuss the position of these structures in relation to their function Discuss the mechanics of respiration Discuss the process of oxygen delivery
2. Describes indications for tracheostomy	Identify reasons for the insertion of a tracheostomy tube Discuss the benefits to the patient Discuss the different techniques used for tracheostomy insertion Describe the investigations that are required prior to insertion
3. Demonstrates and discuss choice of tube	Identify the different tubes available and the reason for the choice of tube Discuss the principles of cuff safety
4. Demonstrates the ability to assist with insertion and can discuss potential complications	Preparation and explanation to the patient as required Discuss issue of consent Assemble the correct equipment and perform safety checks prior to procedure Assist medical as indicated Ensure chest x- ray is ordered and reviewed post insertion (if required) Discuss possible complications following this procedure e.g pneumothorax, bleeding, tube inserted incorrectly

Key Skills	Assessment Criteria
5. Demonstrates the ability to assist with decannulation and can discuss potential complications	Can state the standards for decannulation Assemble the correct equipment for decannulation Identifies personnel required to assist/support during the procedure Demonstrates the procedure safely and correctly Discuss possible complications following this procedure e.g ineffective cough, aspiration, exhaustion
6. Demonstrates the ability to perform tracheal suctioning	Identify the need for suction Assemble the correct equipment - including correct size catheters Demonstrate and understand the need for aseptic technique through out Explain the procedure to the patient Discuss complications and interventions to reduce risk Demonstrate good suction technique Evaluate effectiveness of suctioning Demonstrate correct documentation and reporting as necessary
7. Demonstrates and discuss the nursing care for a patient with a tracheostomy tube	Discuss the importance of humidification Demonstrate the ability to care for tracheostomy tube, including cleaning of inner tube Discuss the care of the stoma, including appropriate selection of dressings and tapes Patient positioning and comfort Discuss issues with communication Discuss the role of speech therapy in assessing the swallow reflex
8. Demonstrates the ability to perform an accurate respiratory assessment with reference to specific tracheostomy checks	Describe the routine respiratory observations and their significance in patient assessment Discuss how these observations alter in respiratory failure Discuss normal blood gas values and how they alter in respiratory failure Assess the effectiveness of respiratory support Demonstrates and understands the measurement of cuff pressures Demonstrates and understands the use of end tidal CO2 monitoring

Key Skills	Assessment Criteria
9. Discuss the 'RED FLAG' indicators that represent tracheostomy problems	Discuss red flag indicators that represent tracheostomy problems e.g inability to pass suction catheter, vocalising with cuff up, added sounds, Increasing respiratory distress
10. Discuss and demonstrate the use of the emergency equipment needed for a tracheostomy emergency	Assemble the equipment required at the bed side and describe the use Discuss where the emergency equipment and fibre-optic scope are located Discuss their role in an emergency situation Demonstrates understanding of the use of all equipment
11. Demonstrate the emergency algorithm for tracheostomy patients	Able to discuss the algorithm Understands the importance of each step Demonstrates the need to get help immediately Demonstrate the algorithm in a scenario
12. Demonstrate the emergency algorithm for laryngectomy patients	Able to discuss the algorithm Understands the importance of each step Demonstrates the need to get help immediately Demonstrate the algorithm in a scenario
13. Demonstrates correct documentation and reporting as necessary	Refer to local policy or guidelines Use of observation charts Use of nursing documentation Use of bed head signs Clear legible timely documentation

Adapted from Central Manchester NHS FT guidelines.
Available as PDF from www.tracheostomy.org.uk

Implementation of these resources in UK hospitals

We have asked 2 colleagues who work in large NHS Trusts in the North West of England to describe how they have implemented these resources into their Trusts. Their accounts describe some of the barriers to implementation and how these were overcome.

Lancashire Teaching Hospitals NHS
NHS Foundation Trust

The National Tracheostomy Safety Project: Reducing harm in Lancashire Teaching Hospitals Trust.

Dr Irfan Chaudry, Consultant in Anaesthesia & Critical Care

Over the last year we have been implementing the National Tracheostomy Safety Project (NTSP) at Lancashire Teaching Hospitals (LTHTR), this article will explore how the project has led to a change in practice and culture within the trust.

On the Critical Care Unit at LTHTR we felt that much could be done to improve the management of tracheostomy emergencies particularly in the initial phase. Looking at previous incidents it became apparent that a well coordinated team response was urgently required, particularly by those who were initially present at incidents. The NTSP had initially been started as a North West project, which was being coordinated through the Association of North West Intensive Care Units (ANWICU). A full day course had already started and was being well received by candidates who were mainly medical trainees. At LTHTR we felt that most of the first responders would be nursing staff on the critical care unit and we felt that we needed to teach this staff group as a priority. At LTHTR we have access to a simulation centres, which can provide excellent support for real time scenario based teaching.

A core team was assembled consisting of; Critical Care Consultant, Outreach Nurse Consultant, Outreach Senior Sister, Simulation Instructors and Practice Educator for Critical Care. It was decided to aim the teaching initially at Critical Care nursing staff. The course content was to be centred on the algorithms, which form the core of the NTSP. In practice we decided that the teaching could be done in an afternoon session, which equates to approximately four hours. The simulation centre is fully equipped with two simulation mannequins with real time physiological monitoring and a debriefing room with audio-visual playback for candidates. The afternoon teaching sessions started with a presentation of slides on the content of the algorithms and basic management and equipment for first responders. After a theory presentation candidates are then introduced to the mannequins and instructed to play out scenarios adapted from clinical incidents which have occurred in the candidate's clinical areas. Debriefing and feedback occurs before the close of each session.

We were able to train all relevant staff within a 12 month period. Anaesthesia and Critical Care consultants and senior nursing staff volunteered to lead individual sessions with the support of the simulation centre and faculty.

LTHTR has been offering similar training courses to staff from across the NW region since 2011 and have ran a number of successful courses using the NTSP resources. Staff from all disciplines consistently report increased knowledge and confidence when dealing with neck-breathing patients following participation in our half day courses.

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Tracheostomy safety at Salford Royal Hospital FT

Dr Anna Perks, Consultant Anaesthetist

Salford Royal Hospital is a 850 bedded tertiary neurosciences centre, with 17 ICU beds, 26 HDU beds and a total of 10 cohort wards which accept patients with tracheostomies.

In 2008, the North West Regional tracheostomy group was established in our region. With the goal of introducing their emergency algorithms, I made enquiries as to what training and policies were already in place. There was a huge response and enthusiasm from colleagues in ENT and neurosciences, which lead to the formation of our 'Tracheostomy Steering Group' to address all aspects of tracheostomy care including equipment standardization and coherence of training throughout the trust.

Having a steering group with representation from neurosciences, ENT, speech and language, resuscitation training, rehab and critical care, we were in a strong position to overhaul tracheostomy care, whilst implementing the now National Tracheostomy Safety Project's work.

There were several issues to address to make progress. The emergency algorithms are free to access from the www.tracheostomy.org.uk website, but their implementation required training, access to resources and use of the bedhead signs.

Taking simplified versions of the case scenarios and two lectures on tracheostomy basics and an introduction to the algorithms from the NW regional course, we set up a 2-hour teaching session for medical and nursing staff to attend. Early involvement of Alan Jervis on the resuscitation team meant ready access to tracheostomy manikins and use of their facilities in the Mayo building. The resus team have also taken our scenarios onto the wards for their daily teaching with the junior doctors on the crash team, to ensure that there are ongoing refresher sessions throughout the year on the wards. Our anaesthetic registrars have also been encouraged by the deanery to attend the advanced tracheostomy management course run by the NW regional group, to ensure that when expert help is requested that it is more likely to arrive!

There are various items of equipment, which are not standard to the resus trolley, but are required for the emergency algorithms. Safe tracheostomy care also requires that the patient has a spare inner cannula at the bedside for when it needs changing or cleaning. The tracheostomy care bundle was already in the process of implementation, ensuring various items are present and checked regularly. In order to simplify tracheostomy equipment, we decided on an additional box, which contains a Water's circuit, paediatric face mask and other vital items, to sit on top of the current resus trolleys on each cohort ward. These boxes also contain copies of the algorithms.

The final hurdle was the use of the bed head sign. There was initial reluctance from the Information Governance lead here due to the risk of breaching patient confidentiality. The idea of publishing a patient's tracheostomy details was likened to having an HIV status sign above their heads! Using the argument that the sign merely colour coded a medical device, which could be seen by anyone looking at the patient softened the blow and approval was given provided that only unit number and not patient name was shown.

To cover all nursing and medical staff on cohort wards, plus the hospital at night team and matrons, we estimate there are over 600 staff to train. There will be a lag period before we can realistically make this training mandatory, but approximately 150 staff have already completed the training and we have provision for all to be trained within a 12 month period. We have strong support from post-graduate education and ward managers and together, we are working towards making the wards safer for this group of patients.

Anna Perks

Courses

The National Tracheostomy Safety Project (NTSP) has been running courses teaching basic, intermediate and advanced management of tracheostomy emergencies since 2008. Resources have been developed for the first responder and also for those who will attend as airway experts. 'Train the Trainer' days have allowed other Trusts, Regions and Community organisations to develop their own local training, supported by the NTSP resources.

NTSP courses now run in partnership with the Advanced Life Support Group ALSG (www.alsg.org). This is due to an overwhelming increase in demand for primary and secondary training around the UK. ALSG is a UK-based charity providing training in over 37 countries around the world for courses such as Advanced Paediatric Life Support (APLS), Advanced Trauma Life Support (ATLS), MedicALS and Safe Transfer and Retrieval (STaR). The ALSG courses provide standardised, international, professional courses, resources and instructors.

One of the advantages of multidisciplinary courses, especially if held in your own organisation, is that it brings together key personnel who will be involved in managing routine and emergency care. Staff from different backgrounds provide different approaches to care and are a resource for each other. Future working practices are usually a lot easier when you know your colleagues, especially in a large organisation.

Involving local industry representatives is another advantage and the NTSP has strongly encouraged links with industry where possible. Being able to handle and discuss the variety of devices and ancillary equipment available is extremely useful: the worst time to encounter a new or unfamiliar device is

in an emergency. Industry representatives will often have new or updated products to demonstrate and usually are aware of what equipment local institutions are using. The NTSP courses have usually involved industry representatives in demonstrating relevant equipment on courses, which can help to facilitate a 'hands-on' station with appropriate demonstration equipment with minimal infrastructure required by local organisers.

As the NTSP courses have developed, we have found local relationships with company representatives to be mutually beneficial and would encourage any organisations hosting courses (ALSG courses or bespoke local courses) to consider contacting and engaging with your local representatives.

{Chapter No}Chapter 13

{Chapter Title}Human Factors

{Header 1Introduction

> **Error *is inevitable, but harm is not (****Sarah Corcoran, Associate Director of Clinical Effectiveness, Central Manchester Foundation Trust, 2009)*

This manual provides information and resources for the safe management of tracheostomy and laryngectomy care, but also is focused on the assessment and management of the acutely ill patient. Responders are frequently required to utilise their knowledge and skills to care for a collapsed, or deteriorating, patient who is only one of several concurrent responsibilities.

Although the ideal of each patient being managed by a dedicated, focused, mentally and physically fit, smoothly functioning team, without interruptions or distractions, cannot be achieved, ways of working can be adopted that optimise the quality of patient care and minimise the risk of error even under the most difficult of circumstances.

The performance of individuals and teams working in complex, high pressure environments is influenced by a wide range of intrinsic (personal) and extrinsic (environmental) factors. Some 20 years ago, the aviation industry began to take account of these factors, how they impact on human performance, and their significance for flight safety. Today, all airline staff are required to undergo a rigorous *human factors* training programme that equips them with the skills to recognise risky situations and behaviours and the tools to lead their team towards the safest methods of operation. More recently, this has started to be adopted within healthcare as a means of improving safety and quality. The Department of Health recommends human factors training as a way of improving safety (CMO Report 2008, Safer Medical Practice).

This chapter provides a brief overview of the human factors that can affect the performance of individuals and teams in the healthcare environment. The reader is encouraged to consider these factors in their everyday practice. Those attending the courses associated with this manual may receive direct feedback on their performance in this area. By the end of this chapter, the reader should understand the concept of human error in individuals and in teams and appreciate how situation awareness and good communication can help to minimise the effects of error.

{Header 1}Human Error

Humans make mistakes. No amount of checks and procedures will obviate this fact. Consequently, it is vital to work in a way that, as well as decreasing the occurrence of mistakes, ensures that when they do occur the resulting threat to patient safety is minimised.

{Header 1 Error Chains

Patient safety is only rarely compromised by a single mistake. Almost always a mistake or error A leads to harm B because of a series of factors that set up the conditions such that error A resulted in event B and without which event B would not have occurred. This is known as the error chain. This is the basis of the 'Swiss cheese' model.

{Figure 13.1 near here}

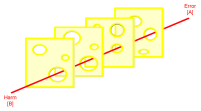


Figure 13.1 'Swiss cheese' model. *ALSG*

Each of the slices of cheese represents barriers that should prevent A leading to B. However, such checks and balances can fail. This is represented by the holes in the slices. For A to lead to B, the holes of all the intervening slices need to line up Simplistically viewed, the more checks that are put in place, the less likely an error is to occur. However, increasing complexity can be counterproductive, as humans will avoid or modify multiple steps to make life easier.

Consider the following critical incident:

The wrong dose of a drug has been administered to a patient by a clinician.

Why?

We know that the clinician should have checked the details of the prescription and the calculations and ensured that this all matched up with the formulation and strength of the medications they administered. People do not usually deliberately give the wrong dose and therefore it is not unreasonable to conclude that the clinician thought they had checked and matched everything as described.

So why did the error occur?

Further investigation revealed that the two drugs had been replaced in one another's normal positions in the ward trolley. The packaging of the two drugs was very similar.

{Figure 13.2 near here}
Figure 13.2 Similar package designs of two different medications. *ALSG*

The clinician picked the medication from its usual place, thought they recognised the box, and therefore didn't actively check the name and concentration of the drug. Habit can blind us to what we are doing. The problems of uniform packaging have been recognised and highlighted through a national adverse incident reporting system and recommendations made that packages for different strength medications should now look completely different. This change in practice is an example of how human factors theory is used to reduce the risk of error.

In the working environment, we may be present at the right time to observe the breaching of a barrier that would normally prevent errors occurring. It is critical that we are vigilant for these breaches and draw the attention of our colleagues to them in order to prevent the completion of an error chain. Events or conditions that are suspected of representing potential breaches in barriers preventing harm are referred to as red flags. The more red flags that arise, the greater the risk of an adverse incident occurring and therefore the greater the need to alert those involved to stop and review the situation.

{Header 1} Communication

Problems with communication underpin a significant proportion of critical events.

When the speaker and listener do not share the same language, the obvious solution is to use an interpreter. However there are limitations to discussions carried out through a third party. What about the issues that arise if one of the parties is communicating using their second language? Even when all parties are utilising their native tongue, non-verbal signals carry as much, if not more, information and meaning, than the words themselves. Non-verbal communication, outside the actual words we use, has been shown to contribute up to 93% of what we understand (A. Barbour 1976). Barbour's study identified that 38% of communication relates to how words are said (volume, pitch, rhythm, etc.) and 55% body language (facial expressions, posture, etc.). When those trying to communicate come from different cultural backgrounds, both verbal and non-verbal elements can be completely misinterpreted by both parties.

Box 13.1

S Situation: a concise statement of the problem

B Background: pertinent information related to the situation

A Assessment: analysis and considerations of options — what you found/think

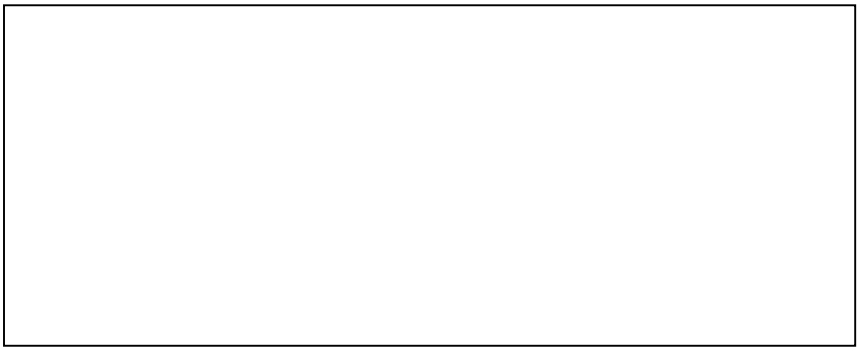
R Recommendation: action requested/recommended — what you want to do

St verbal and >50% of written
c , misinterpreted or simply
m sy clinical environment, when
m lectronic or telephonic, rather
than face to face, miscommunication occurs so frequently. The process of communication can be described as three separate phases:

1. *The Sender.* This is the process within which the originator articulates their message in their mind, in what they perceive to be a meaningful and contextual manner.
2. *The Channel.* This is the medium of communication chosen: verbal, non-verbal or written.
3. *The Receiver.* This is the process within which the intended recipient makes sense of the information. This is easily distorted by the use of euphemisms or localised terminology.

The resulting outcome in a noisy highly pressured clinical arena is unsurprisingly one of poor information exchange. A technique to improve communication is the feedback loop. This is a process by which the receiver repeats the message back to the sender to acknowledge receipt and confirm that it has been correctly deciphered. It is quick and simple to use, easy to teach and has been shown to produce immediate benefit in busy clinical areas where requests and instructions are being passed on at break neck speed.

To aid with communication when handing over care from one team/person to another, the SBAR tool is recommended (Box 13.1).



This formalises and structures the information transfer helping avoid assumptions of knowledge and highlighting the plan for ongoing care (recommendation). In summary, the discussion above only begins to touch on the complexity of human communication. Beyond this there are many layers of subtlety in our interactions. To try and mitigate the risk of miscommunication, it is vital that both talkers and listeners actively engage in the process.

Stage **Level of concern**

P *– Probe I think you need to know what is happening*

A *– Alert I think something bad might happen*

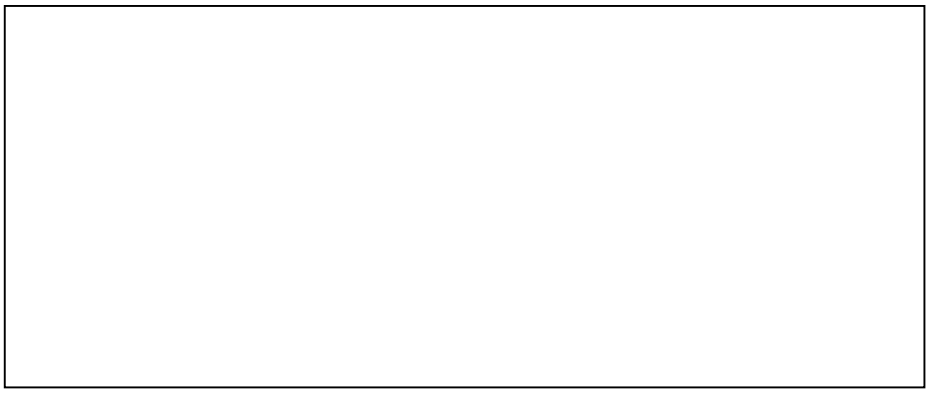
C *– Challenge I know something bad will happen*

E *– Emergency I will not let it happen*

{Header 2} Body language and Hierarchy

All individuals should always be aware of their non-verbal signals. Messages that say 'I'm bored', 'I'm tired' or 'I don't value you' can inhibit another person from passing on a key piece of information. The presence of a steep hierarchy can be particularly dangerous as it promotes an attitude of indifference to the input of those further down the pyramid. A culture where junior staff do not feel empowered to speak directly to senior staff, or senior staff are dismissive about concerns raised by junior staff, is inherently unsafe. If the clinical assistant walks into theatre and sees an expanding pool of blood under the operating table, they should feel able to voice their concerns. Whether or not it proves to be clinically important, their input should be positively acknowledged, as next time they might be the first to identify a critical issue.

{Header 2}Speaking up



A useful communication tool, utilised by the airline industry, is shown in Box 13.2. This structure can be used by any person who is concerned that they have information that might be important to others on the team. The levels *Probe, Alert, Challenge and Emergency* are utilised sequentially to express increasing concern. If a disaster is imminent, it is entirely appropriate to use the *Challenge* or even *Emergency* stages without recourse to the initial stages. Both the speaker and the listener should recognise the level of the communication and react appropriately. In the aviation industry, reaching the level of *Challenge* on the flight deck prompts a serious review, whether or not an incident occurs.

These stages are described with examples below:

Probe: When the observer points out something they think might be a problem. "Doctor I think this woman is cyanosed, should we give some oxygen?"

Alert is used if there is no response to the first prompt and the situation continues. The observer strengthens their statement and suggests a course of action. "Doctor, I am concerned the woman is deeply cyanosed; we must intervene to support her oxygenation before she deteriorates further?

Challenge: The situation requires urgent attention. One of the key protagonists needs to be directly engaged. If possible the speaker places themselves into the eye line of the person they wish to communicate with. "Dr Adams - this patient is cyanosed, by not intervening you are placing her at significant risk of cardiorespiratory collapse and brain damage. You must stop what you are doing and intervene to support her ventilation now."

Emergency is used where all else has failed and/or the observer perceives a critical event is about to occur. If possible physical action should accompany clear verbalisation. "Dr Adams, your inaction is placing this lady in danger, please move out of the way I am going to take over and bag-valve-mask ventilate this lady now."

Organisations that use this, or similar, systems sometimes make use of a code word or phrase to flag the level of concern. These may then be used to gain both the team's and a key individual's attention. For example "Code Orange, Code Orange, please stop and listen."

{Header 1}Situation awareness

People do not come to work to harm patients. When errors occur, they do so because the person making the mistake does not realise that their action will cause harm to the patient. If we have insufficient or incomplete information, we can draw the wrong conclusions about what is going on. For example, we can make a misdiagnosis. If we then intervene on the basis of that flawed diagnosis, it is not difficult to see that harm may ensue.

Good situation awareness is achieved when we have sufficient and correct information, have interpreted it correctly and correctly project the outcome of an intervention into the future, based on our current knowledge.

{Figure 13.3 near here}
Figure 13.3 Illustration of situation awareness. *ALSG*

Consider the picture in figure 13.3. What do you see? Around half of readers will see a young woman looking back/right and the other half will see an old woman looking forward/right (a few may see both). This is a simple example of how two people can look at the same thing yet make different interpretations.

The way we perceive a particular situation is affected by the information conveyed via our own sensorium, our past experience (an experienced clinician might recognise a compromised patient more rapidly than a junior), our level of alertness, our current workload and the influence of intercurrent distractions.

In psychological terms, our perception of the current situation is fitted into a model in our minds, based on our knowledge and previous experiences. We use this model to plan our next actions and anticipate the outcome of those actions. A simple example of this is a woman presenting with epigastric pain, with a previous history of severe pre-eclampsia in the last pregnancy. The clinician assessing the woman might conclude that she is suffering from gastroenteritis because of inexperience, or insufficient information (the history of previous pre-eclampsia) secondary to tiredness or distractions.

The loss of situation awareness is often triggered by the undertaking of a specific psychomotor task; an example would be the team leader who had maintained objectivity and an overall assessment of events, until he undertakes a specific task that greatly reduces his ability to receive and process information. Clinical staff have reported a complete loss of situation awareness, while undertaking complex tasks, in that they did not hear alarms or other team members alerting them to specific dangers. If it is the team leader undertaking the task and the team are also involved in busy practice, then it is not unusual for the entire team to miss critical elements of information that, if recognised, would have directly contributed to the correct diagnosis and care of the patient.

A common trap that people fall into is only seeing or registering the information that fits in with their current mental model. This is known as a *confirmation bias*. When this occurs, people favour information that confirms their preconceptions or hypotheses regardless of whether the information is true.

For example, a clinician receives a phone call requesting them to review an acutely deteriorating patient who is known to be asthmatic. Before seeing the patient, the clinician builds up a series of preconceived expectations of what they will find. They may even formulate a management plan based upon these expectations. Once this mindset is established it can be difficult to change. The clinician proceeds to examine only the systems affected by the presumed diagnosis. They seek to confirm their expectation by focusing on

auscultation of the chest at the expense of a thorough airway assessment. Upon hearing bilateral wheeze their preconceived ideas are confirmed and the remainder of the assessment is completed without due attention and more as a rehearsed exercise than an open minded exploration. They fail to notice that the patient also has a soft stridor and is hypotensive.

Alternatively, the clinician knows they have several other patients they need to get to and for this reason does not undertake a thorough assessment. The junior staff in attendance point out hypotension and signs of upper airway obstruction, but the clinician fails to recognise the significance of these signs. This occurs because psychologically they hold onto their preconceived diagnosis. In this situation they may dismiss these conflicting findings, or may even manipulate the findings to fit their preconceived mental model.

In both cases, the eventual diagnosis of anaphylaxis becomes a late consideration, or a situation that requires an objective newcomer to the team to point out the obvious.

Other examples of this loss of situation awareness relating to technical skills include the obstetrician who persists at operative vaginal delivery with all their attention focused on successful completion of the procedure, rather than on critically assessing progress during traction; or the anaesthetist who doesn't recognise oesophageal intubation because, "It felt right," or they are sure they saw the chest move.

It is vital that each individual understands the concept of situation awareness and continually questions their own thought processes and those of others around them. Remembering the possibility of the worst-case scenario helps to review things critically, to recognise warning signs early and avoid catastrophe. The whole team should also share their impressions of the current situation. There is good evidence that the situation awareness of a well functioning team is actually greater than the sum of its individual parts. This may be in part due to the elimination of bad data. Information or comments by colleagues that are out with one's current mental picture should be treated as a trigger to consider whether anyone's situation awareness is lacking. A discussion of the disparity should uncover the true picture. Problems occur when individuals either ignore or rationalise the errant data to fit into their current picture of the world, rather than treat it as a challenge.

{Header 1}Fatigue

When we are tired, we find it more difficult to absorb and process information, we react more slowly and mood can be affected. We may become impatient, uninterested and irritable. The negative impact on the ability to function individually and as part of a team is obvious.

Clinicians work in a highly pressured environment with the expectation that even when we know we are not functioning at 100% capacity, we will cope with a crisis. In a safe culture, staff need to feel able to say, "I'm not fit to do this," and know they will have the support of their colleagues. While it seems obvious that we need to ensure that fatigued people are not working at the sharp end of health care delivery, this is not currently part of the mindset. This is a culture change we all need to embrace.

Even when prolonged or arduous shifts are avoided, circadian rhythms can produce adverse psychological and physiological changes. This is relevant as clinicians routinely work shifts, including nights and have quick turnaround between patterns of rest/work activity. It is perhaps unsurprising to note that all of the recent major disasters attributed to human error (Exxon Valdez oil spill, Three Mile Island, Bophal chemical plant explosion, Chernobyl) occurred on the night shift, when alertness is at its lowest point.

It is suggested that the following are caused by circadian rhythm disturbance:

- lack of concentration
- periods of inattention
- reduced vigilance
- reduction in alertness level
- slow actions
- alteration in short term memory
- loss of critical analysis and advocacy
- interpretation errors

Recognition of the impact of fatigue on our ability to perform carries with it important personal responsibilities. If circumstances arise which result in us being unfit for work in any way, we have the responsibility for flagging it up to colleagues and managers. They, in turn, should ensure that anyone reporting such concerns is supported and, where necessary, allowed to step down from front line duties, until fit. If this feels over-idealistic, consider the following – would you be comfortable boarding an aircraft when you knew the pilot had been up all night with his child who is critically unwell in hospital?

The discussions above are primarily focused on tiredness or fatigue due to lack of sleep. Physical or mental illness, use of medications, alcohol and personal stress can all manifest in a similar manner and require appropriate, sensitive management.

{Header 1}Decision Making

In order to understand what factors can compromise the process of decision making, it is important to understand the factors that affect the reliability of any decision made. To reach a good decision, all aspects of a problem should be considered, all possible responses assessed and the consequences of those responses identified. The advantages and disadvantages of each course of action must be weighed up in order to draw a conclusion and make the decision. This must then be communicated to the team.

Good situation awareness is a prerequisite of this process. To achieve this, the decision maker must have all the key information. This is gathered through acquisition of data first hand (e.g. examining the patient yourself), and communication with their team. Decision makers should be on the alert to ambiguities or conflicting information. Any inconsistent fact should be treated as a potential marker for faulty situation awareness and not dismissed as unimportant anomalies in the absence of evidence to support such a decision.

No decision-making process should be concluded until the team are satisfied they have all the information and have considered all the options. Where time is a pressure, a certain amount of pragmatism must be employed. There is plenty of evidence to confirm that experience can mitigate some of the negative effects of abbreviating the decision making process. Those making decisions under such circumstances need to remain consciously aware of the short cuts they have taken. They should be ready to receive feedback from their team, particularly if any member of the team has significant concerns about the proposed course of action. Practical limitations accepted, there are few situations where a delay of 1-2 minutes to share the rationale for the decision is not possible.

As discussed above, it is vital that team members feel able to raise their concerns and that the decision maker values and considers them appropriately. One only has to examine some of the high profile medical incidents, such as the Elaine Bromley case (see Box 13.3), to see that junior clinicians were trying to voice their (correct) concerns from a time when, if they had been heard, it may have altered the outcome.

Box 13.3 Elaine Bromley died during a minor operation in 2005, after anaesthetists were unable to place an endotracheal tube. The doctors struggled for 20 minutes to insert the ET tube. They did not follow the standard, 'Can't intubate, can't ventilate,' protocol despite the appropriate kit being made available by theatre staff. During this episode Elaine Bromley suffered irreversible brain damage and subsequently died.

When decision makers inappropriately or repeatedly disregard the opinions of others this should be flagged up before an incident occurs.

{Header 1}Leadership: people, behaviours

The inevitable mix of personalities in a team will have implications for the smooth functioning of that team. In the pressured environment in which we work, latent personality traits, or even new ones, can be brought out. In extreme cases, this can manifest as aggressive or submissive affect. Depending on the individual and the team dynamics, this can be highly detrimental to the process of communication, situation awareness and decision-making.

Wherever possible, the adoption of a facilitative role can serve to draw the best from all members of the team. Every opportunity should be taken to debrief teams after an episode of working together. This can be enhanced where there is opportunity for the team to practise and reflect on their interactions in a simulated environment.

{Figure 13.4 near here}
Figure 13.4 Critical incident rehearsals and simulation experience can improve the performance of individuals and teams when responding to emeregencies.

{Header 1}Summary

We all work in a complex, pressured clinical environment. We are all responsible for patient safety and should be alert to red flags and voice concerns promptly. To do this we need to recognise and respect both our own limitations and those of the people we work with. This safety surveillance is facilitated by an understanding of the human factors at play around us.

{Header 1}Acknowledgement

The NTSP are grateful to the Advanced Life Support Group and Dr Peter-Marc Fortune for permission to include this adapted chapter in this manual.

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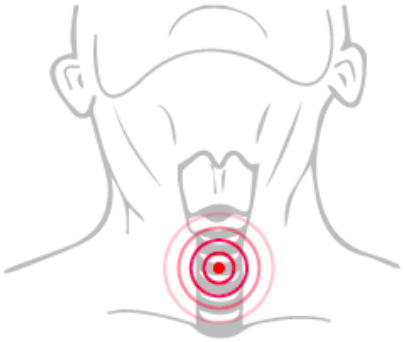

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