Patent upper airway: the 'Green algorithm'

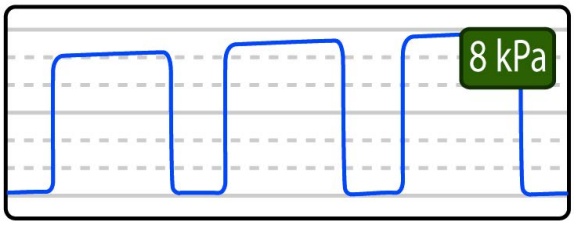
This algorithm is paired with the green bedhead sign and assumes a *potentially patent* upper airway, meaning that it is anatomically possible for the upper airway to connect to the trachea and thus theoretically allow ventilation by this route. This is in contrast to the situation with a laryngectomy. 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.

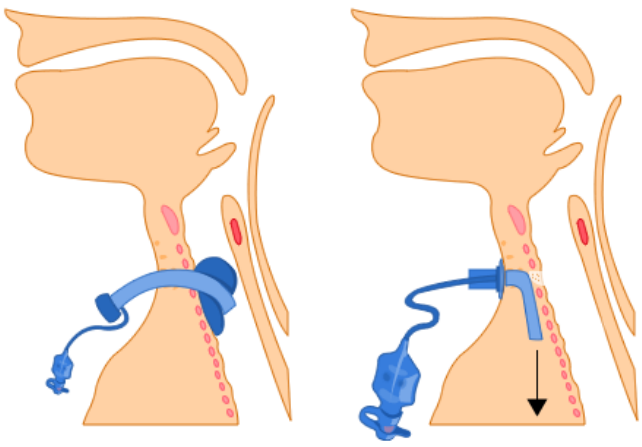
Inner tubes used with tracheostomies and can significantly reduce the risk of tube occlusion, provided they are cared for and used appropriately. If a tracheostomy tube becomes blocked, simply removing the inner tube may resolve the obstruction. However, it must be remembered that inner tubes vary significantly 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

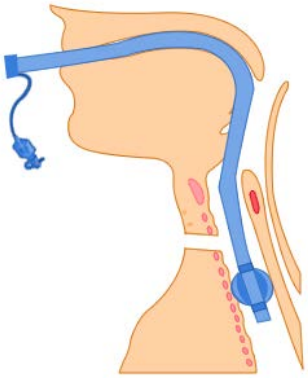
If the patient fails to improve after removing the tracheostomy tube, *primary emergency oxygenation* may be achieved by the oro-nasal route, the tracheostomy stoma or by both routes. The choice of route will depend on the responder's experience. If attempting to ventilate via the upper airways, remember 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.

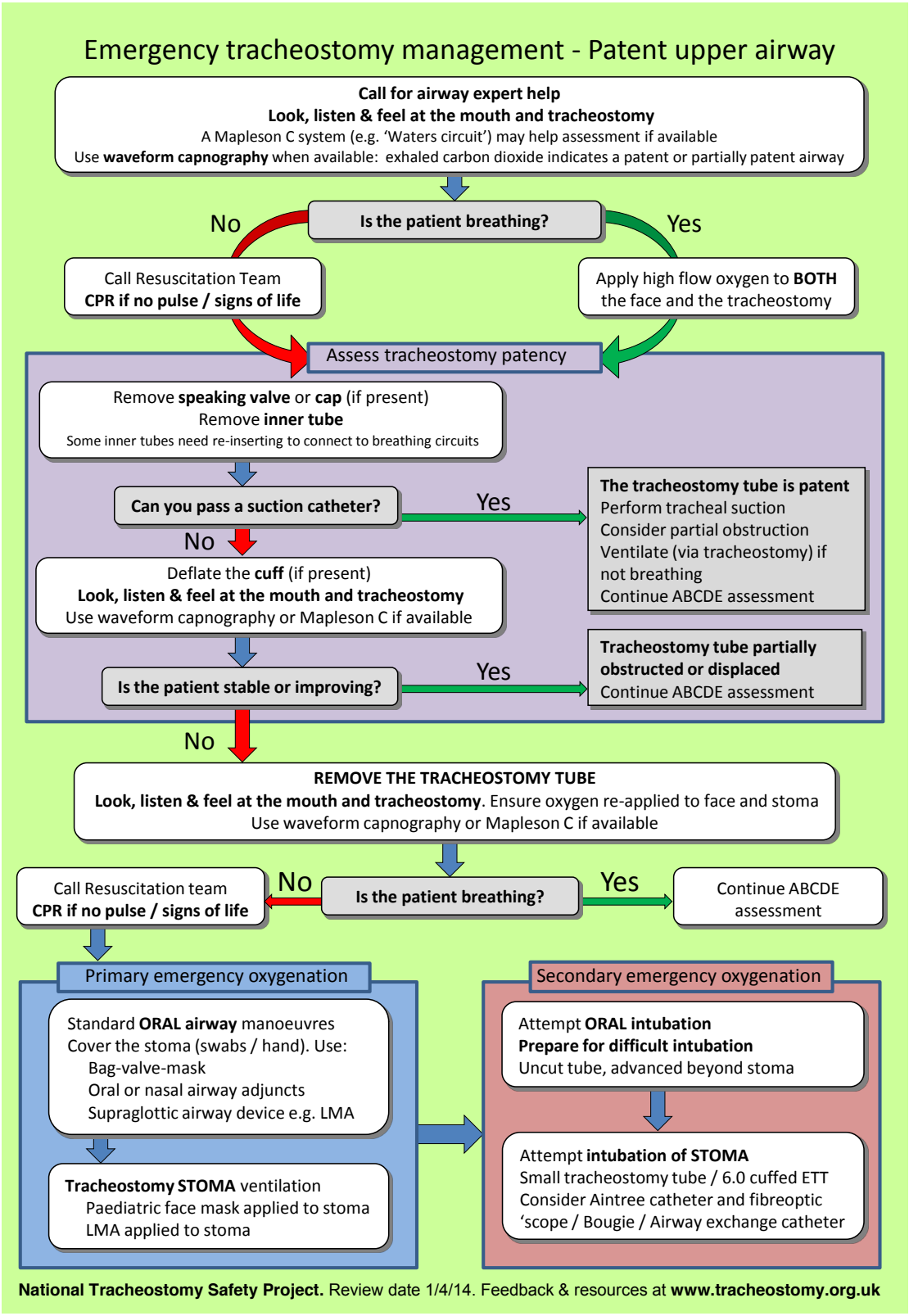
If effective oxygenation or ventilation cannot be achieved, *secondary emergency oxygenation* manoeuvres are required. These are advanced techniques and the choice will depend on the patient, the responders and the equipment available. These are likely to be dire clinical situations and separate airway 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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