The tracheostomy tube change: a review of techniques

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Tracheostomy tube changing is a routine procedure. However, occasional problems can arise and result in fatalities. This article reviews the various measures and techniques used to optimize the safeguarding of the airway during a tracheostomy tube change, including the 'railroad' technique. The management of accidental decannulations is also reviewed.

Changing a tracheostomy tube can be problematic. In a patient who depends on the tracheostomy for ventilation, difficulty in tracheostomy tube replacement, either during routine tube change or after accidental decannulation, can be life threatening, and has caused a number of deaths (Price, 1983; Wright and Shearer, 1984; Black et al, 1988).

Tracheostomy tube changes within 72 hours of the tracheostomy procedure can be particularly problematic, as the tracheostomy tract is not established and on removal of the tracheostomy tube the stoma and soft tissues tend to close. Some authors advise that if a tube change is necessary during this period, it should be conducted in an operating theatre by qualified personnel with a complete tracheostomy tray (Quigley, 1988).

The tracheostomy tract matures over the course of 10–14 days (Young et al, 1995). Making the first tracheostomy tube change at this time is easier and should be done by the surgeon who performed the tracheostomy. For patients on a ventilator, an anaesthetist should be present to safeguard the airway and intubate should problems arise. The tube proper or outer lumen should be changed weekly or more frequently if in an environment of poor humidification or in the presence of viscous dry secretions, in order to prevent acute blockages (Quigley, 1988). Infrequent changes can lead to adhesions resulting in a more problematic tube change in an emergency.

Tracheostomy tubes with an inner tube, such as Shiley tracheostomy tubes (Mallinckrodt (UK) Ltd, Bicester, Oxfordshire), can usually have their blockages easily overcome by regular removal of the inner tube, its cleaning or replacement, followed by reinsertion. Placement of a tracheostomy tube after the tract is mature and established should pose fewer problems.

The main reasons for difficulties during this procedure are that the tube used is too large for the orifice in the tracheal wall, or the caudal turn during insertion is initiated prematurely, creating a false passage anterior to the trachea (*Figure 1*). Repeated efforts to insert the tube, inflate the cuff and attempt lung inflation cause enlargement of this false passage and tracheal compression. The situation may rapidly deteriorate as it becomes increasingly difficult to insert the tracheostomy tube and alternative measures to establish an airway are foiled by the tracheal compression (Wright and Shearer, 1984). Other factors that can complicate the tracheostomy change include:

- Obesity
- A short neck
- Anatomical abnormalities (e.g. secondary to a malignancy, surgical alterations or radiotherapy-related changes)
- Excessive granulation tissue
- Viscid respiratory tract secretions
- Lack of patient cooperation (because of pain or hypoxia)

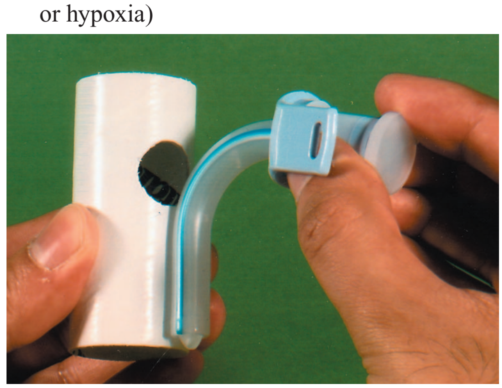

Figure 1. How not to do it. A model trachea demonstrating that if the caudal turn during insertion of the tracheostomy tube is initiated prematurely, a false passage anterior to the trachea is created.

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- Significant peritracheal oedema (Hannallah et al, 1995; Young et al, 1995).

Patients with short thick necks have excessive soft tissue between the trachea and the skin, thus preventing a standard tracheostomy tube from fitting snugly. The tube may not be advanced far enough into the trachea and may dislodge out of the trachea and into the pretracheal space on simply repositioning the patient's head (McQuarrie, 1975). These patients benefit from tubes with adjustable neck plates as shown in *Figure 2* (Myers and Carrau, 1991).

Complications that arise from tracheostomy tube changing include innominate artery rupture, haemorrhage and total tube displacement (Aronow and Bromley, 1988).

This article describes techniques used during the tracheostomy procedure that can help prevent accidental decannulations and help in safe subsequent tracheostomy changes. The preparation before tube changing is outlined. The two main methods of tube changing are described. The classical method involves completely removing the old tube before inserting a replacement tube. The 'railroad' technique utilizes a 'guiding' obturator, which if hollow may also provide an airway. Different possible obturators are reviewed. Finally the management of the accidental decannulation is discussed.

TRACHEOSTOMY TECHNIQUES

The following section describes methods that can be performed at the time of tracheostomy to prevent future accidental decannulations and assist with tube changes.

Entrance into the trachea is gained by either removing a circular piece of cartilage the approximate size of the tracheostomy tube or by cutting a vertical slit. The latter is simpler, faster and may avoid subsequent tracheal stenosis. Silk stay sutures (2/0) inserted into but not through the cartilage on either side of the tracheal window can be taped to the chest wall so that if the tube accidentally comes out, or if a tube change is necessary, the stay sutures can be pulled to bring the tracheal 'hole' closer to the skin surface, thus making the reinsertion of a tube easier (*Figure 3*).

Bjork (1960) described fashioning a tracheostomy flap following the death of a patient who suffocated when the cannula slipped out and the inflated cuff compressed the trachea. He recommended an inverted U-shaped incision in the anterior tracheal wall, with the flap so formed reflected downwards and outwards, its upper border sutured to the skin with absorbable sutures to make a bridge of tracheal tissue to guide the tracheostomy tube safely into the trachea. However, the Bjork flap is said to be a causative factor in some cases of tracheal stenosis, and may cause difficulty in swallowing by tethering the larynx. It has also been reported that the flap has very occasionally dislocated inwards into the trachea during a tube change, thereby obstructing breathing (Price, 1983), and so it should be discouraged.

Hewlett and Ranger (1961) described an alternative method to prevent false passage formation anterior to the trachea. Their technique involved the excision of a circle of tracheal wall to give easy access for the tube, and then suturing the caudal edge of the tracheal hole to the skin.

During the tracheostomy procedure, the thyroid isthmus may be retracted superiorly, inferiorly or divided. Simply retracting and not dividing the thyroid isthmus can result in it slipping over the tracheal hole when the tube is removed for changing, so that when the new tube is introduced the isthmus obstructs entry to the trachea. If it is considered that the thyroid isthmus might pose problems, it should be divided and transfixed.

In addition to securing the tracheostomy tube with ties around the neck, it can be sutured from the upper flange close to the tube to the skin in order to further prevent accidental decannulations. Sutures placed too laterally on the flanges may allow excess movement and not effectively prevent decannulations. In a series of 88 paediatric patients, sutures reduced accidental decannulations from 31.8% to 4.5% (Black et al, 1988).

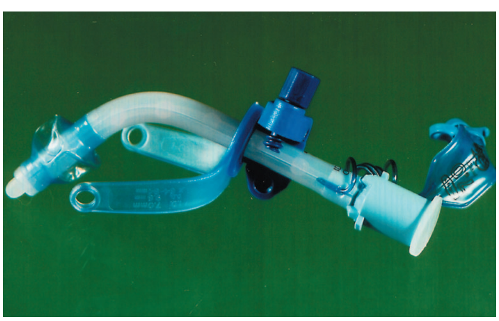

Figure 2. A tracheostomy tube with an adjustable neck flange for patients with thick necks.

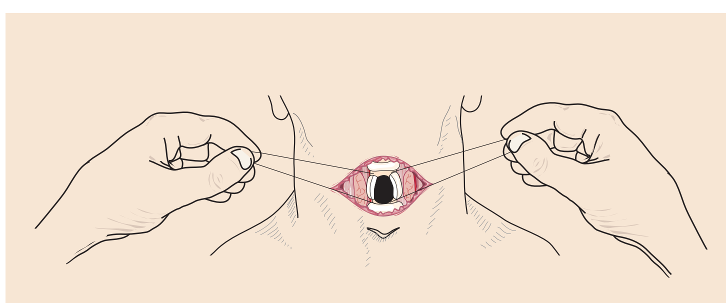

Figure 3. Stay sutures applied to either side of the tracheal window can be pulled to bring the tracheal 'hole' closer to the surface, making the insertion of a tracheostomy tube easier.

PREPARATION FOR THE FIRST TUBE CHANGE

Conscious patients should be fully informed of what is about to take place and that coughing fits are common. The patient should be placed supine with the neck in hyperextension so that the tracheal orifice returns to the same relative position to the overlying soft tissue and closer to the skin surface as when the tracheostomy was performed. In some patients an upright position may be preferable to make the clearance of secretions more comfortable. Adequate lighting, suction and supplemental oxygen should be available, as well as a selection of tracheostomy tubes including the patient's present size and the next smaller sized tube. Tracheal dilators should always be to hand. A pulse oximeter and cardiac monitoring should be placed on the critically ill patient.

In difficult cases, before the tube change the patient should be ventilated with 100% oxygen for several minutes to maximize his/her oxygen reserve. If the patient is on a ventilator then an anaesthetist should be present to assist in safeguarding the airway should problems arise. However, certain medical conditions (head and neck malignancy) or sequelae of treatment (postoperative changes or radiotherapy-related scarring) may distort the anatomy to the extent that endotracheal intubation is not possible.

The tracheostomy tube change in the conscious patient may be made more comfortable by the application of a local anaesthetic, such as xylocaine spray, down the tracheostomy tube. Any sutures and ties are removed to 'free' the tracheostomy tube, but the tube is still held in place to prevent its premature decannulation. The cuff of the tube is deflated and tracheal suction is performed immediately before the tube change to clear the airway of secretions. Immediately before removing the old tube the patient is asked to hold their breath. Subsequent tube changes may not require so much preparation but if the tracheostomy tube is the patient's sole airway, maximum airway care is imperative.

TECHNIQUES OF TUBE CHANGE

Classical method

The classical method of changing tracheostomy tubes is to remove the old tube completely, and then to insert a new tube into the stoma. This technique is commonly used in established tracheostomy tracts. Adequate illumination is necessary. After removing the old tube, the new lubricated tube with introducer is initially applied rotated 90° from its correct position, to engage the tracheostomy 'hole' (*Figure 4*), and then turned 90° back to its correct position to be inserted into the trachea (*Figure 5*). This reduces the risk of creating a false anterior passage (*Figure 1*). To aid this process tracheal dilators may be used to locate and dilate the tracheal hole.

A correctly sized metal tracheostomy tube will sometimes enter the trachea when a plastic tube will not because the obturators for metal tubes are somewhat sharper, the thinner wall creates less of a 'ledge' around the obturator and there is no cuff to create additional resistance (Goodman, 1983).

Failure to insert a new tube in a patient who is dependent on one for ventilation can result in loss of the airway. Subsequent failure or excessive delay to intubate may be fatal.

The railroad technique

Levy (1982) described a failsafe method of changing tracheostomy tubes with continued maintenance of the airway without the loss of a single breath, thereby making it a useful technique in difficult cases. It is an extension of the Seldinger arterial cannulation technique (Seldinger, 1953), and is commonly known as the 'railroad' technique. It is described below and in *Figure 6*.

The patient is prepared as before. If there is an inner tracheal cannula it is removed. A hollow tube, which is at least three times the length of the

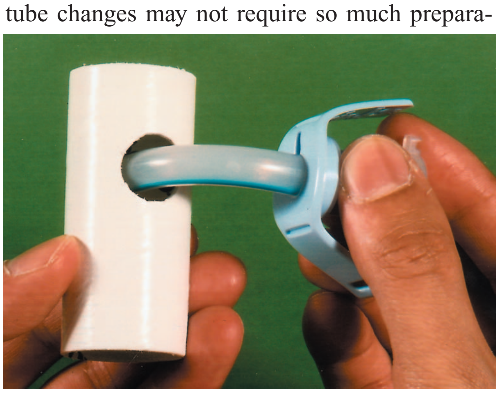

Figure 4. A model trachea demonstrating how the new tracheostomy tube with introducer is initially applied rotated 90° from its correct position, to engage the tracheostomy 'hole'.

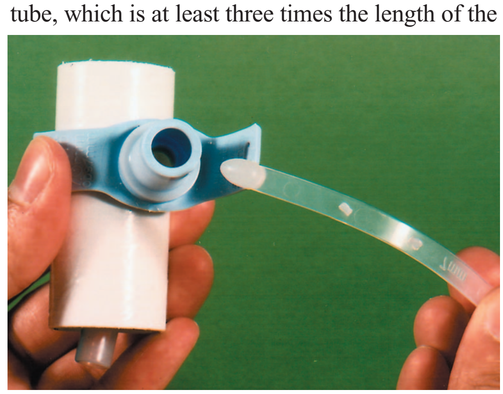

Figure 5. The tracheostomy tube is then turned 90° back to its correct position to be inserted into the trachea and the introducer is removed.

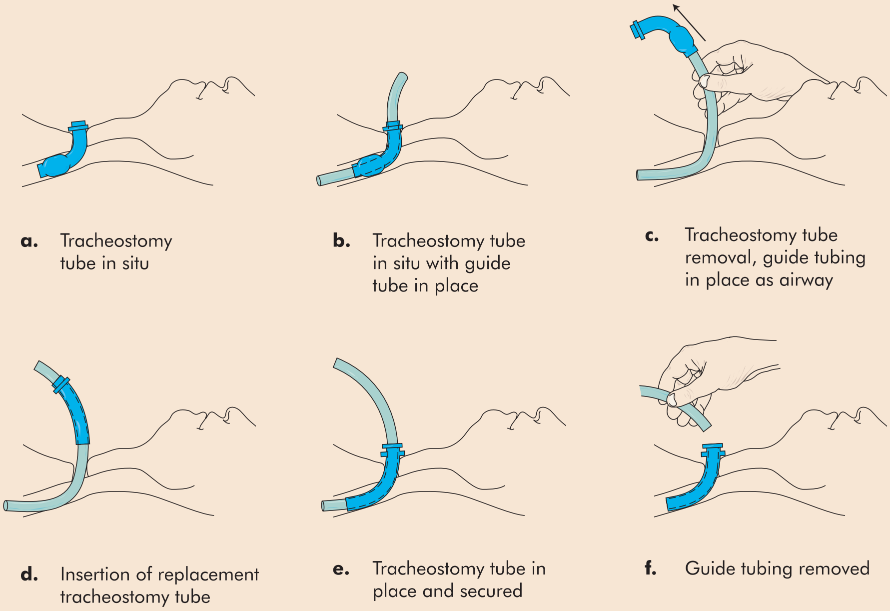

Figure 6. 'Railroad' technique for tracheostomy tube changing.

tracheostomy tube, is passed through the indwelling tracheostomy tube into the trachea (Cohen, 1983). This tube extends at least 2.5 cm below the lower end of the tracheostomy tube. The upper end of the tube is held by the thumb and index finger. If the patient is conscious they are told to hold their breath at this point. The tracheostomy tube is removed over the now indwelling tubing. Care is taken not to inadvertently remove the guide tube from the trachea during this manoeuvre. The guide tube functions as an airway through which the patient can breathe if necessary. The replacement, appropriately sized, lubricated tracheostomy tube is promptly slipped in by the reverse action. Once the new tube is in situ and secured, the guide tubing is removed and the patient may resume ventilation.

Removal of secretions by suctioning may be required at various steps during the tracheostomy tube change. After the tracheostomy tube is placed it is essential to demonstrate that a suction catheter can enter the trachea easily, without resistance. A conscious patient should be able to breathe without difficulty and air should be felt in front of the tube lumen on expiration. If problems arise when inserting the replacement tracheostomy tube, the next smaller sized tube is used.

With this technique tracheostomy cannula placement into an incorrect tissue plane is avoided. Severely ill patients are greatly benefited as the duration of separation from respiratory support is minimized (Gilsdorf, 1984).

Alternative obturators for the railroad technique: The ideal obturator guide tube for the railroad technique should have a number of features. It should fit snugly inside the tracheostomy tube to avoid a large step at the leading end of the tracheostomy tube that may catch on the tracheal wall and prevent its entry. The tube should not be too thin, malleable or stiff and it should be possible to ventilate through this tube if difficulties arise. Possible obturators include the following:

Suction catheters: The standard suction catheter is easily available and cheap. The suction connection can be cut off the catheter and then inserted through the tracheostomy tube into the trachea. If the suction catheter fits neatly into the tracheostomy tube then suction should not be applied as this may cause lung collapse. With the catheter in the trachea, the old tracheostomy cannula is removed over it and the new cannula threaded directly into the trachea.

If difficulties are encountered, ventilation can be achieved through the suction catheter by attaching a Portex adapter (Sims Portex Ltd, Hythe, Kent) with endotracheal tubing to the end of the catheter. Alternatively a venous cannula with jet insufflation tubing could be used before emergency endotracheal intubation or a further attempt at tracheostomal cannulation is made (*Table 1*; *Figure 7*).

Uncuffed tracheal tube: The ideal uncuffed tracheal tube is the largest size that will pass easily through the tracheostomy tube. The correct sized uncuffed tracheal tube for the different sized tracheostomy tubes is shown in *Table 2*. During the railroad technique the ventilation adapter is removed from the endotracheal tube, but if problems arise the adapter can be reinserted to allow connection to ventilation equipment (*Figure 7*).

Jet stylets: The use of jet stylets for tracheostomy tube replacement facilitates tube exchange and allows jet ventilation if any difficulties are encountered (Hannallah et al, 1995). The Cook Aintree intubation catheter (Cook (UK) Ltd, Letchworth, Hertfordshire) has different Rapi-Fit™ adapters that enable connection to either standard ventilatory equipment or a jet stylet (*Figure 8*). A fibreoptic bronchoscope can also be used as a jet stylet (Hannallah et al, 1995).

Other obturators: Other obturators described include a stiff Salem sump, a Robnel catheter, a Levine tube, a 16 Fr Tiemann curved urology catheter with a balloon (Aronow and Bromley, 1988), a solid bougie, a nasogastric tube (Young et al, 1995), and an Intracath™ catheter (Smith and Smith, 1974).

MANAGEMENT OF TRACHEOSTOMY TUBE DISPLACEMENT

Tracheostomy tube displacement is a rare event that may occur at any time in the patient's course. One series of tracheostomy complications reported a 1.5% displacement rate, with seven fatalities owing to loss of adequate airway (Chew and Cantrell, 1972). Another series of 88 paediatric patients showed a 25% accidental decannulation rate with one mortality (Black et al, 1988).

TABLE 1. Portex endotracheal and cannula sizes for each suction catheter size

Suction catheter	Portex endotracheal connector	Cannula
CH8		16G (grey)
CH10		14G (brown)
CH12	2.5 mm	14G (brown)
CH14	2.5 or 3.0 mm	14G (brown)
CH16	3.0 or 3.5 or 4.0 mm	14G (brown)
CH18	3.5 or 4.0 mm	

TABLE 2. Best fit guides for tracheostomy tubes

Tracheostomy tube (m ID)	(FG)	Guide uncuffed tracheal tube (mm ID)	Suction catheter
6.0	24	2.5	Up to CH14
7.0	27	3.0	Up to CH16
7.5	30	3.5	Up to CH18
8.0	33	3.5	Up to CH18
9.0	36	4.0	Up to CH18
10.0	39	4.0	Up to CH18

Verified for tracheostomy tubes manufactured by Sims Portex Ltd, Hythe, Kent, uncuffed tracheal tubes manufactured by Mallinckrodt (UK) Ltd, Bicester, Oxfordshire and suction catheters manufactured by Maersk Medical, Redditch, Worcestershire

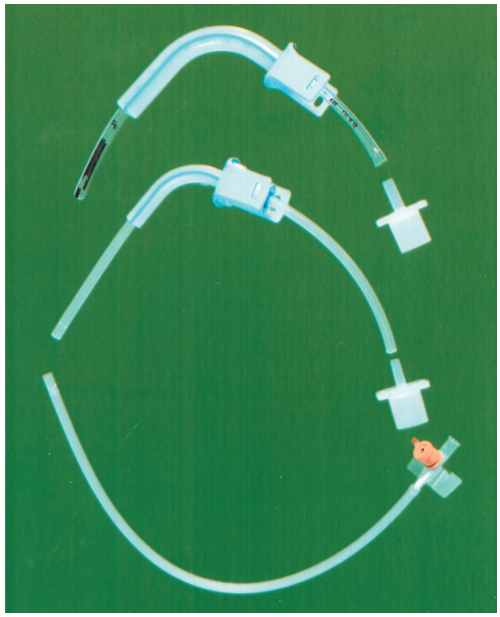

Figure 7. Uncuffed tracheal tube and suction catheter acting as obturators with adapters to be attached should ventilation be required. Venous cannula attached to lower suction catheter for jet insufflation.

The tube may be displaced completely out of the wound making the situation obvious, or the tube may come out of the trachea but remain within the wound, which may present more insidiously with respiratory failure.

An accidental decannulation within the first 72 hours of the tracheostomy procedure may have disastrous consequences. The stoma may close over making it difficult to reinsert the tracheostomy tube at the bedside. Unsuccessful recannulation attempts may result in tube misplacement into the pretracheal region, which in turn may result in tracheal compression and respiratory arrest. If recannulation appears potentially difficult, critically ill patients with respiratory failure can undergo stabilization by emergency endotracheal intubation in the absence of upper airway obstruction. The tracheostomy tube can

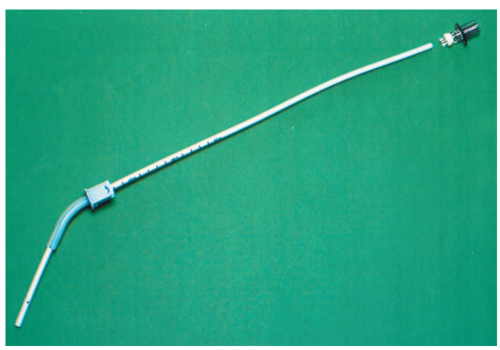

Figure 8. An Cook Aintree intubation catheter with Rapi-Fit™ adapter (Cook (UK) Ltd, Letchworth, Hertfordshire).

then be reinserted electively under more controlled conditions (Myers and Carrau, 1991). If endotracheal intubation is not possible because of upper airway obstruction, then re-establishment of a tracheostomy tube is a serious challenge.

The major difficulty encountered is often the inability to clearly define the tracheostomy tract from the adjacent tissue, resulting in forceful attempts at insertion of the replacement tube through the external orifice. Such attempts are painful and frightening to the patient. They also introduce the potential for significant haemorrhage and disruption of the pre-existing tract, further aggravating the situation (Young et al, 1995). If the tube is placed in the pretracheal space, an inflated cuff blocks the airway, and the mediastinum is insufflated with air from a respirator. Such an error compromises venous return and fails to maintain adequate oxygen exchange. Continuing forceful attempts to replace the tube compresses the trachea and blocks any air exchange (McQuarrie, 1975). Tracheostomy tracts mature over the course of 10–14 days. Reinsertion of a dislodged tube after that time can be difficult but is usually safer (Young et al, 1995).

When an accidental decannulation occurs, the patient should be quickly positioned with the neck extended, the tapes and skin sutures cut, and the tube removed. If traction stay sutures are present they should be pulled, exteriorizing the trachea against the skin to prevent insertion of the replacement tube between these two structures (*Figure 3*). If the opening is easily visualized, the tube can be inserted directly into the lumen with its introducer.

If the trachea is not readily visualized then the blade of a standard anaesthesia infant laryngoscope may be used as a lighted retractor to explore the tracheostomy wound. The tracheal hole can be easily located even in a fat neck. The blade of an infant laryngoscope is small enough to be placed in the trachea and the lower part of the trachea can be lifted upward. For a patient who is breathing this manoeuvre allows adequate air exchange. It is then relatively simple to insert the tracheostomy tube into the trachea under direct vision using the open side of the laryngoscope as a smooth guide (McQuarrie, 1975).

In the absence of a laryngoscope, digital exploration of the tracheostomy wound will allow palpation of the tracheostoma and a suction catheter or other such 'guidewire' can be guided into the trachea. A tracheostomy tube can then be 'railroaded' over the catheter and inserted into the trachea (McQuarrie, 1975).

Alternatively, rather than a suction catheter a fibreoptic endoscope can provide an excellent guiding obturator (Myers and Carrau, 1991; McNamara and Chisholm, 1996), with the tracheostomy tube around the scope ready to be railroaded into position. The fibreoptic laryngoscope has several advantages. Its flexible tip allows greater directional control to find a passage to the trachea. Correct tube placement can rapidly be confirmed by direct vision of the tracheal rings and therefore the risk of false passage formation is substantially reduced (McNamara and Chisholm, 1996). Its use, however, requires some expertise and experience (Young et al, 1995). **HM**

Conflict of interest: none

Aronow J, Bromley HR (1988) Tracheostomy tube replacement using a modified Seldinger technique. *Crit Care Med* **16:** 818–19

Bjork VO (1960) Partial resection of the only remaining lung with the aid of respirator treatment. *J Thorac Cardiovasc Surg* **39**: 179–88

Black TL, Fernandes ET, Carr MG (1988) Preventing accidental decannulations following tracheostomy. *J Ped Surg* **23**: 143

Chew JY, Cantrell RW (1972) Tracheostomy: complications and their management. *Arch Otolaryngol* **96:** 538–45

Cohen RS (1983) Tracheostomy tube replacement. *Arch Otolaryngol* **109:** 62

Goodman RS (1983) Tracheostomy tube replacement. *Arch Otolaryngol* **109**: 277

Gilsdorf JR (1984) Facilitated endotracheal and tracheostomy tube replacement surgery. *Gynaecol Obstet* **159:** 589–90

Hannallah M, Brager R, Ved S, Troost T (1995) Jet stylets as an aid for replacement of tracheostomy tubes. *Ann Otol Rhinol Laryngol* **104**: 695–7

Hewlett AB, Ranger D (1961) Tracheostomy. *Postgrad Med J* **37**: 18–21

Levy RB (1982) Increased safety in tracheostomy tube replacement. *Arch Otolaryngol* **108**: 327

McNamara J, Chisholm DG (1996) Use of fibreoptic intubating laryngoscope to replace a misplaced tracheostomy tube. *Anaesthesia* **51:** 894

McQuarrie DG (1975) Safe replacement of tracheostomy tubes. *Surg Gynaecol Obstet* **140:** 169–70

Myers EN, Carrau MRL (1991) Early complications of tracheotomy: incidence and management. *Clin Chest Med* **12:** 589–95

Price DG (1983) Techniques of tracheostomy for intensive care unit patients. *Anaesthesia* **38:** 902–4

Quigley RL (1988) Tracheostomy-an overview. Management and complications. *Br J Clin Prac* **42:** 430–4

Seldinger SI (1953) Catheter replacement of needle in percutaneous arteriography. *Acta Radiol* **39:** 368–76

Smith RB, Smith JD (1974) A technic for tracheostomy-tube change. *Anaesth Analg* **53:** 627–8

Wright MM, Shearer AJ (1984) Tracheostomy tube insertion and replacement. *Anaesthesia* **39:** 717–18

Young JS, Brady WJ, Kesser B, Mullins D (1995) A novel method for replacement of the dislodged tracheostomy tube: the nasogastric tube 'guidewire' technique. *J Emerg Med* **14:** 205–8

KEY POINTS

- In a patient who is dependent on tracheostomy for ventilation, difficulty in replacement can be life threatening.
- Tracheostomy tube changes within 72 hours of the tracheostomy procedure can be particularly problematic.
- Tracheal dilators and smaller sized tracheostomy tubes should always be at hand.
- The 'railroad' technique is a useful method of changing tracheostomy tubes with a continued maintenance of the airway.