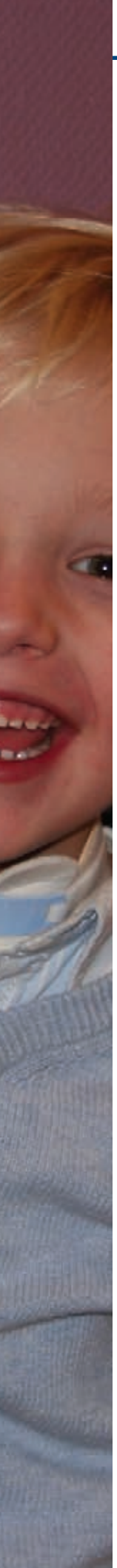

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Long-term tracheostomy care: How to do it

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Educational aims

- To provide an overview of long-term tracheostomy care.
- To increase the understanding of long-term tracheostomy care.
- To increase knowledge about tube selection.
- To improve understanding of how to avoid serious complications

Summary

The overall aim for long-term tracheostomy care is to help those with respiratory failure to achieve a high-quality active life. A long-term tracheostomy does not necessarily mean an increased need for hospital care. With an optimally fitted tracheostomy tube, patient and staff education and regular follow-ups, serious complications can be avoided. This article describes predictors of good long-term tracheostomy care, such as tube selection, indications of change and follow-up.

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A short history of tracheostomy

Long-term tracheostomy can currently be used in several diseases, for example upper airway obstruction, chronic hypoventilation due to neuromuscular disease, trauma including spinal cord injury, surgery in the face/neck region or post-stroke complications [1]. Tracheostomy is an age-old operation, during which the trachea is surgically opened in the anterior wall and a stoma is created to facilitate ventilation. It is one of the oldest surgical procedures described [2, 3]. The word tracheostomy comes from the Greek, meaning "I cut the trachea". The term tracheotomy commonly refers to the surgical incision into the trachea and tracheostomy to the creation of the stoma and the stoma itself [4]. The procedure was described in the Rig Veda, a sacred book of Hindu medicine, in 2000 BC, and was also depicted on two slabs dating back to ancient Egypt (2920–2770 BC) [2, 3, 5, 6]. As the development of intensive care units progressed, the need for intermittent positive-pressure ventilation grew and effective life-support was conducted [7]. Successful mechanical ventilation of poliomyelitis patients began in Copenhagen in 1952 and as there were insufficient mechanical ventilators, patients were hand-ventilated by nurses and medical students [8]. Gradually the ventilators improved and long-term support by ventilator and tracheostomy has helped thousands of patients [9].

Indications

Early indications for tracheostomy were upper airway obstruction due to infection, trauma, or a foreign body. In modern times, until the poliomyelitis epidemics in the 1950s, the

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major indication was diphtheria [2, 10]. The most common indications for tracheostomy today are to assist long-term ventilation in critically ill patients or in those requiring prolonged respiratory support, to relieve upper airway obstruction, to support bronchial toilet, to prevent aspiration of oral or gastric secretions, or as an adjunct to head, neck and thoracic surgery [1, 10–14]. A tracheostomy should normally permit speech and food intake, it eases suction, and it secures the patient's airways. Many patients, requiring prolonged respiratory support, receive home mechanical ventilation (HMV) [15]. Table 1 shows the diagnoses for patients with long-term tracheostomy.

Table 1 Diagnoses for patients with long-term tracheostomy at the National Respiratory Centre in Sweden, 1997 [16]

Diagnosis	%
Childhood conditions (*e.g.* congenital malformations and tracheal stenosis)	23
Post-polio/scoliosis	19
Tumours	14
Upper airway obstruction (*e.g.* tracheomalacia)	11
Neuromuscular diseases	10
Spinal cord injury	8
Tuberculosis, COPD and asthma	6
Other diseases (*e.g.* stroke)	6
Infections	3

COPD: chronic obstructive pulmonary disease

Tracheostomy techniques

The tracheostomy should be sited over the second and the third or over the third and fourth tracheal cartilages. There are several surgical techniques for performing a tracheostomy. The most common is currently percutaneous dilatational tracheotomy (PDT) which is performed at the bedside with commercially available sets in the intensive care unit by anaesthesiologists and intensivists, as well as ear, nose, and throat (ENT) specialists. It is considered safe for patients, with a rather low complication rate and as the stoma is made with dilation, a quick decannulation stomal closure can be expected [17, 18]. A PDT usually results in a small stoma that is not as stable as a stoma made with a standard surgical procedure. It can also be difficult to reinsert the tracheostomy tube as the stoma easily closes. Standard surgical tracheostomy (SST) techniques were previously the most frequently performed tracheostomy techniques. A surgical tracheostomy is preferably made in the operation theatre by ENT specialists. The SST allows for a larger tube size, which gives the patient a better airflow, an important factor in long-term mechanical ventilation. The stoma also becomes more firm as the edges are secured with sutures. The first tube changes have to be made carefully, especially when a flap technique has been used. Careful wound care is essential after a tracheostomy has been created, in order to avoid infections and future stoma leakage. When an elective tracheostomy is made, the patient's individual characteristics and needs must be taken into consideration, *i.e.* duration of the tracheostomy and need for long-term mechanical ventilation [19]. If the tracheostomy is planned to be permanent, an SST could be considered.

Table 2 Potential complications due to tracheostomy

Complications	Early	Late
Haemorrhage	X	
Subcutaneous emphysema	X	
Pneumothorax	X	
Pneumonia		X
Tube obstruction	X	X
Tube displacement	X	
Tube/cuff malfunction		X
Skin breakdown		X
Tracheal stenosis		X
Granulation tissue		X
Tracheomalacia		X
Fistula formation		X
Accidental decannulation	X	X
Cannula fracture		X

Early and late complications due to tracheostomy

Early and late complications include local infection, inflammation, and pain and tenderness, especially if there is stomal leakage, *e.g.* during mechanical ventilation. The early complications of tracheostomy are related to the insertion of the cannula and are associated with the operative procedure or soon after. The late complications may occur at any time after the procedure or even after decannulation (table 2) [20–22]. They may be prevented by a regular tube change and follow-up [10, 16, 23–25]. A properly fitted tube lowers the incidence of complications and infections in long-term tracheostomised patients [24]. It has also been shown that the presence of a tracheostomy tube does not influence swallowing. Nor does it cause aspiration, provided the

patient's ability to swallow was normal before tracheostomy [26]. But for patients with poor swallowing function, there is an increased risk of aspiration. With an inflated cuff, aspiration can occur, as the cuff may interfere with the normal function of the muscles used to swallow [27]. Therefore, it is important to evaluate the risk of aspiration when swallowing with a deflated cuff, *i.e.* to note any coughing or secretions afterwards. Blue food dye can be dropped on the patient's tongue in order to track aspirated secretions in the patient's airways. The decision to have the cuff deflated or inflated during swallowing has to be based on the condition of the patient.

Complications due to long-term tracheostomy can be decreased and kept low by the use of a customised tracheostomy tube [16, 23]. Patients with customised tubes have also reported a high quality of life [28].

Speech loss and speaking valves

Speech loss is a possible consequence of tracheostomy and can occur if the tracheostomy tube has no fenestration and an inflated cuff or if there is not enough space for exhalation between the tracheostomy tube and the inner wall of the trachea. It is absolutely vital for long-term tracheostomised patients to be able to talk and communicate in order to avoid isolation and discomfort [29]. Finding a tracheostomy tube that permits speech is thus important for the patient's well-being. To enable speech, a speaking valve can be used to force the exhalation to pass through the vocal cords. It is permanently closed on exhalation and opens on inhalation (figures 1 and 2). The speaking valve can either be combined with a fenestrated tracheostomy tube or with a tube with a smaller outer diameter [30]. It is important to check its function and to clean it daily in water with mild detergent. If there is a filter in the speaking valve, this should be changed as well.

The air inspired by tracheostomised patients may not be humid enough to allow speech, as it does not pass through the upper respiratory tract, nose, larynx and pharynx. This could lead to changes in the function of the respiratory mucosa with moisture or heat loss. The simplest way to minimise this problem is to use a heat and moisture exchanger, often called an artificial nose. The principal function is that it collects the patient's expired heat and moisture and returns it during the following inspiration [26]. There are different kinds of heat and moisture exchangers. Most of them do not permit speech, but some are combined with a speaking valve (figure 1). Device

Never use a speaking valve on a tracheostomy tube with an inflated cuff, if there is no fenestration. There must be a passage for the exhalation.

Figure 1
Example of a combined speaking valve and heat and moisture exchanger.

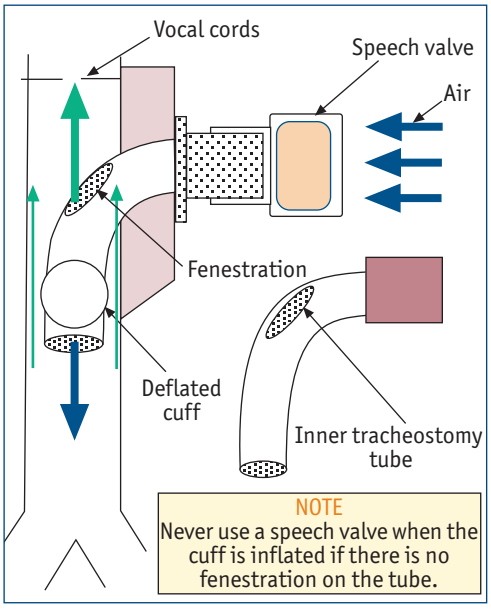

Figure 2
Sketch of the airflow through a fenestrated tracheostomy tube with a speaking valve/heat and moisture exchanger and a deflated cuff.

selection should be based on the individual needs of the patient. A heat and moisture exchanger should be cleaned or changed at least twice a day or more often, if occluded. There are also occlusion caps available that block the tracheostomy tube completely and allow for the re-establishment of a normal airway and weaning (figure 3).

Other consequences of tracheostomy

Some long-term tracheostomy patients have experienced fear of bathing, breathlessness, or pain when the tracheostomy tube is not properly fitted. However, most patients are relieved to be able to breathe and are content, providing their tracheostomy tubes are comfortable.

Tracheostomy tubes

A variety of tracheostomy tubes is available, designed for various needs. Some tubes consist of an inner and an outer cannula. The purpose of

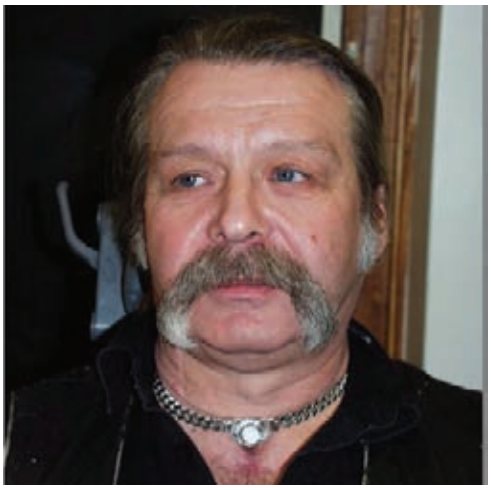

Figure 3
Example of an occlusion cap for daytime use.

the inner cannula is to ease the suction of the lower airways and to help remove secretions. The inner cannula also facilitates cleansing of the tube and removes the risk of tube occlusion. A double-lumen tube may have a decreased airflow compared with a single-lumen tube with the same outer diameter. Some tracheostomy tubes have cuffs, which form an effective seal with the tracheal mucosa. Different brands and types of tubes are available; most modern ones have low-pressure cuffs, with either high or low volume. A tracheostomy tube with a high-volume low-pressure cuff poses less risk for tracheal stenosis. Tracheostomy tubes with low-volume cuffs can be very useful for patients in long-term care, especially if the patient is on part-time ventilation. When deflated, the cuff is tighter to the shaft which makes it more comfortable for the patient.

To adjust the cuff pressure, let the patient speak while inflating the cuff until the patient cannot talk. Control the cuff pressure with a cuff pressure manometer. The recommended pressure to minimise damage to the trachea is 15–25 cmH_2O (10–18 mmHg) [29, 30]. Over-inflation of the cuff may cause complications, such as tracheal mucosa ischaemia, ulceration or tracheal stenosis [30]. Deflate the cuff at least twice a day to minimise pressure on the tracheal wall.

Figure 4
Examples of plastic tracheostomy tubes. From left: silicone, PVC and polyurethane tubes.

Pre-fenestrated tracheostomy tubes have either several small holes or one large hole over the mid-tube area. It is essential that the fenestration is positioned in the right place for an optimal airflow (figure 2). A pre-fenestrated tracheostomy tube that is not well positioned, may cause complications, as the position of the fenestration is rarely right. It is likely that granulation tissue will develop in relation to the fenestration, which in turn will increase pain, discomfort and secretions.

Tracheostomy tube materials

Tracheostomy tubes exist in several different materials (figure 4). The majority of tracheostomy tubes on the market are made of plastic (polymeric materials). The most commonly used materials are polyvinyl chloride (PVC) or silicone. Polyurethane is still quite unusual in respiratory products but is frequently used in central venous catheters. The tube materials have different long-term properties, which are affected by the biofilm covering the tube surface and by the complex bacteriological environment in the patient's trachea [31–33]. If the tracheostomy tube changes colour, there are probably remains of bacterial colonisation on the tube surface and degradation of the material has started. This could also act as a source of infection. Due to material wear, the tube ought to be replaced with a new one within 3 months [31].

Silver tracheostomy tubes used to be the only option before plastic tubes became available. They are still used for long-term treatment. Silver is durable and therefore can last longer than polymeric tracheostomy tubes, which makes more cost-effective in the long-term. Moreover, silver tubes are not affected by the tracheal environment as quickly as the polymeric alternatives, although they have to be cared for with careful cleansing and extra polishing. A fenestrated silver tracheostomy tube is shown in figure 5. If the silver tube is not fitted properly, it may easily cause ulcers or granulations in the trachea, as the material is rigid; therefore the fit is very important. Tracheostomy tubes made of silver combined with heat-sensitive plastic (inside the trachea) are available.

There have been reports of fractures, some with a fatal outcome, of tracheostomy tubes made of either polymeric materials or metals [34–36]. As pointed out in an official statement by the American Thoracic Society, there is a great

Figure 5
Fenestrated silver tracheostomy tube.

need for knowledge when it comes to the mechanisms involved in the ageing of the different polymeric materials used in tracheostomy tubes [20].

Tube selection

The selection of a tracheostomy tube should be based on the individual needs of the patient. The tube should fit the patient's anatomy and match the clinical needs, such as mechanical ventilation or need for suctioning. If the patient has need of frequent airway clearance, a tracheostomy tube with an inner cannula may be useful, but the fit of the tube is essential. A tracheostomy tube should allow for sufficient airflow without causing complications [37]. The curvature information of the tube is vital when making a selection. Figure 6 shows examples of tracheostomy tubes with different curvatures. A tracheostomy tube should be comfortable and not cause pain when the neck is moved. If possible, it should permit speech and be aesthetically pleasing. Providing a patient with an unadjusted tube may cause or increase complications such as secretions, cough, granulation tissue, discomfort, pain, bleeding, etc. If the tube fits the patient properly, complications can be minimised [16, 23].

Customised tubes are available for patients with special needs. They can be ordered directly from the manufacturer but can also be made by special clinical units with authorisation to modify tracheostomy tubes [16]. An example of a customised adjusted silver tracheostomy tube from the National Respiratory Centre, Stockholm, Sweden, can be seen in figure 7.

For optimal fit of a tracheostomy tube, the tip should be centred in the trachea; thus, the correct curvature and the length of the tube are very important features. A bronchoscopy will facilitate the control of the tube position. If the tube diameter is too narrow, there will be leakage of air at the stoma. Principles to consider when selecting a tracheostomy tube are as follows.

- position and shape of the tip of the tube
- tube curvature
- tube length
- outer diameter
- fenestration position
- tube material
- healing of the stoma by regular wound care and perhaps plastic surgery

Practical issues regarding tracheostomy care

Caring for tracheostomised patients requires experienced staff, who participate in mandatory education along with patients [30, 38]. The patient must always be informed of planned actions and documentation of the care is important. Routine tracheostomy care includes suction, inner cannula and stoma site care, which includes changing of the dressing and tie [10, 21, 29, 30, 38–43]. Routine care varies and there are few evidence-based studies on this topic; thus, local routines dominate [29, 44–47]. One of the most important aspects of tracheostomy care is prevention and management of complications, especially among those patients who are ventilator treated, as they have an increased risk of contracting pneumonia [42]. Two staff members are needed for stoma care and tube change: one

Figure 6
Tracheostomy tubes with different curvatures.

Figure 7
Fenestrated silver tracheostomy tube.

cleaning the stoma and changing the dressing and one keeping the tracheostomy tube in place.

Stoma care

A clean technique is recommended for stoma care and tracheostomy tube cleaning. Clean the skin around the stoma with gauze soaked in water, and keep dry in order to avoid skin infection. Change the dressing daily, or more often if needed. If the patient is infected, bacteriological sampling should be taken from the stoma and from the secretion in the trachea below the tip of the tracheostomy tube. Noninfected small granulation tissue in the stoma can be minimised by the application of silver nitrate. Removal of larger granulation tissue and stoma revision should always be carried out by a physician using local analgaesics to avoid pain. Regular tube changes and stoma care help to prevent the formulation of granulation tissue [10]. Figure 8 and 9 show examples of granulation tissue and a well-healed stoma. There are different kinds of dressings. If the patient's stoma is irritated an antibacterial dressing can be used for a period of time, likewise an occlusive dressing is preferable for the patient with secretion problems.

Tube change

Indications for tube change vary [10, 21, 48] and unfortunately there are few evidence-based studies for reference [29, 44, 47]. The tube should not be changed earlier than 2–3 days post-operatively, ensuring the stoma well established. The first change is often carried out by the surgeon [48]. To avoid the formation of granulation tissue and other complications, when the stoma has been established, the tracheostomy tube should be cleaned or changed frequently [10, 25, 30, 41, 48, 49]. Clinical observations have found that daily tube cleaning (including the outer tube) prevents infections. The maximum time according to the manufacturers and European standards, for a tracheostomy tube to remain in place is 30 days [50]. The tube can be reinserted after cleaning and inspection, if it is found to be in an acceptable condition. If the tracheostomy tube has colour changes, this may be a sign of material wear, and metabolites in the biofilm could have coloured the tube surface. Material studies in the research group have shown that a polymeric tracheostomy tube should be changed after no more than 3 months [31].

It is recommended that two staff members change the tracheostomy tube. A tube change may cause anxiety among inexperienced healthcare professionals and patients. The use of analgaesic cream facilitates insertion of the tube. The following equipment should be at hand:

- a pair of scissors
- curved forceps
- hooks
- forceps
- 10-mL injection cuff syringe
- a spare tracheostomy tube
- an extra small tube or an introducer
- analgaesics (cream)
- dressing and tie for the patient

Figure 8
Granulation tissue in the stoma.

Figure 9
Example of a well-healed stoma.

Occluded tracheostomy tube

If the tracheostomy tube is occluded, the following steps should be taken:

- Take out the inner tracheostomy tube. Sometimes the occlusion is only in the inner tube and cleansing of the tube is enough.
- Deflate the cuff, if there is one.
- Take out the entire tracheostomy tube and keep the stoma open by inserting a spare tube or hooks. Call for help.
- Clear the airway secretions.

Tube cleansing

Tracheostomy inner tube cleaning should be carried out with clean technique at least twice a day. In a recent randomised study, the present author compared two cleaning methods for tracheostomy tubes: clean technique and clean technique followed by disinfection. The results showed that disinfection of the tube is not necessary after mechanical cleaning. Using the clean

technique is ecologically friendly, cheap, and practical for both patients and staff [51]. The inner tube should be cleaned thoroughly inside and outside with gauze pads soaked in warm water and mild detergent and rinsed with warm water at least twice a day or more often, if necessary (figure 10).

Airway secretion clearance

A tracheostomy may cause increased airway secretion. Clearance of the deeper airways should only be carried out by educated staff and patients. It should not been performed routinely, but only when necessary. Closed suction systems are common in intensive care but are rarely used in long-term care of the tracheostomised patient. To clean the deep airways a suitable suction catheter should be chosen: 50% the size of the tracheostomy tube's inner lumen. If the tracheostomy tube has a fenestration, a curved suction catheter is preferable, as it does not get stuck in the fenestration. The inner tube must then be removed and suction should be applied on the way up for a maximum of 10 s each time. The patient must then be given time to recover his/her breath. The process is repeated until the airway is sufficiently cleared, using new suction catheters each time to avoid contamination of the deeper airways [30]. A cough-assist machine can also be very useful in airway secretion clearance.

Follow-up: patient and care-giver support

A limitation to the long-term care of the tracheostomised patient may be the lack of patient and care-giver support. Once the patient is discharged, there is always a risk of insufficient support. The present author showed in a retrospective study that being long-term tracheostomised does not necessarily lead to an increased risk of hospitalisation. Nor did it influence the patient's life expectancy in comparison with an age-matched and sex adjusted control cohort [16]. A regular follow-up (at least monthly) with an inspection of the tracheostomy tube and stoma, a properly fitted tracheostomy tube and special education of care-givers and patients, will lower the incidence of complications.

It is important that the care provided to the tracheostomised patient is of a high standard to ensure patient safety [20, 29, 38, 42, 52–54]. A multi-professional team, comprising physicians, nurses, respiratory therapists, assistant nurses and medical technicians should preferably be involved in the regular follow-up care. Patients with tracheostomy, especially those on HMV, have special needs associated with their care to guarantee their safety and well-being. Studies have shown that tracheostomised patients on HMV may have a poor outcome [55]. It is therefore very important to educate patients, care-givers and families in tracheostomy and HMV management [14, 29, 39, 48, 56]. The ethical burden and the amount of support needed by the family should always be considered. Care-givers should be provided with an emergency contact number to call.

Figure 10
Tracheostomy tube cleaning.

Patients with tracheostomy living at home have reported high quality of life [28] and have fewer complications [57], which supports clinical data from the present author. There are also special tracheostomy units and weaning centers with skilled staff (*i.e.* tracheostomy specialist nurses) providing care and education; however, there is a great need for more centres and staff education.

Conclusions

Successful treatment with long-term tracheostomy requires monthly follow-up of the tracheostomy equipment and health of the patient. The right choice of tracheostomy tube, a regular tube change, and stoma care with the removal of granulation tissue, are also essential for the patient's well-being and for minimising complications. Good education for patients, care-givers and staff, as well as documentation of the care, will improve the success rate of treatment with long-term tracheostomy.

Educational questions

1. List three essential points for a successful long-term tracheostomy.
2. What are the limitations to long-term tracheostomy in home-care? Give three examples.
3. What should you consider when selecting a tracheostomy tube for a patient? Give at least three examples.
4. How often should a tracheostomy tube be cleaned and when should it be exchanged for a new tube?

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Suggested answers

1) An optimally fitted tracheostomy tube; regular tube change; regular follow-up service with prevention and management of complications.

2) Inexperienced caregivers; lack of education to patients and caregivers; cost.

3) The patient's individual needs; position of the tip of the tube in the trachea; tube curvature; tube length; tube material.

4) It should preferably be cleaned daily and exchanged within 3 months.