

Tracheostomy on the intensive care unit for adult patients

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Samenvatting

Op de intensive care heeft de percutane tracheostomie de chirurgische tracheostomie verdrongen t.b.v. volwassen patienten. Het is lastig precieze aanbevelingen te geven aangaande de optimale timing van een (percutane) tracheostomie, aangezien dit afhangt van de klinische toestand en de prognose van de patiënt. Bovendien behoren vrijwel alle aanbevelingen tot “level D of E evidence”.

Indien de beademing langer lijkt te gaan duren dan twee weken, dan is een tracheostomie geïndiceerd (Level C).

De meeste contra-indicaties voor een percutane tracheostomie zijn relatief en hangen af van lokale richtlijnen en individuele ervaring (Level E).

Geen van de technieken van percutane tracheostomie heeft significante voordelen boven een andere en de keus hangt af van individuele ervaring en voorkeur (Level C).

Summary

Percutaneous tracheostomy has replaced surgical tracheostomy as the preferred technique for adult patients in the intensive care unit (ICU). It is difficult to give clear guidelines on the optimal timing of (percutaneous) tracheostomy, because this depends on the clinical situation and prognosis of the patient. Moreover, most recommendations are based on level D or E evidence.

When ventilation is expected to last longer than two weeks, early percutaneous tracheostomy, compared to prolonged translaryngeal intubation, is to be preferred (Level C).

Most contra-indications for percutaneous tracheostomy are relative and depend on individual experience (Level E).

None of the techniques of percutaneous tracheostomy has significant advantages or disadvantages over another and choice depends mainly on individual preference (Level C).

1) Outline

This guideline describes the indications for, and the procedure of percutaneous tracheostomy (PT) in adult patients in the intensive care unit (ICU). It is based on two published reviews in Dutch journals ^{1;2} and a recent international review ³. The procedures in an emergency situation are briefly described in paragraph 5 e.

In the literature, the terms tracheotomy and tracheostomy are inconsistently applied and most often used interchangeably ⁴. The committee prefers the term tracheostomy, reserving the term tracheotomy only for the act creating an opening in the trachea.

2) Indications

In general, for patients in the ICU, the majority of indications for surgical and PT are identical (Table 1) ^{5;6}. The percutaneous technique is preferred ^{7;8}, unless specific contra-indications exist (see below) (Level C).

3) Advantages of tracheostomy

Tracheostomy offers a number of practical advantages, both to the patient as to the medical and nursing staff, compared to endotracheal intubation (Table 2) ^{9;10} (Level D).

4) Contra-indications for tracheostomy

Most contra-indications are relative and depend on individual expertise (Table 3) ^{11;12}. Patient selection is important, in particular when sufficient expertise is not available (Level E).

5) Special subgroups with relative contra-indications

a. **Obesitas**

Several case reports and one series involving 13 patients were published describing successful accomplishment of PT in morbidly obese patients¹³. A recent study has presented experiences with PT in 73 morbidly obese patients (from a group of 474 patients). An almost five-fold increase of major complications in the obese patients group compared to the control group was seen¹⁴. Therefore, in obese patients, the risks and benefits of (percutaneous) tracheostomy should be carefully balanced, and an experienced team should perform the procedure. The routine use of an extended-length tracheostomy tubes should be considered¹⁵ (Level D).

b. **Poststernotomy**

Surgical tracheostomies are frequently colonized and infected and therefore constitute a risk factor for mediastinitis after cardiac surgery¹⁶. In 1973, cricothyrotomy was advocated to prevent median sternotomy infections¹⁷. More recently it was shown that PT is safe in this respect and the procedure can be advised in early poststernotomy patients who are expected to be ventilated for a prolonged period of time¹⁸ (Level E).

c. **Trauma with suspected neck injury**

PT can be safely performed without cervical spine clearance and neck extension in trauma patients who require long-term airway management^{19:20}. However, because the procedure is more difficult, physicians with limited PT experience should not perform it (Level D).

d. **Coagulation abnormalities**

Advantages of PT are the tight fit of the tract around the tracheostomy tube, which compresses any small bleeding vessels. Since it involves minimum tissue dissection, it is therefore suitable for patients with a high bleeding risk. Although coagulation abnormalities are no longer an absolute contra-indication, correction of haemostasis should be carefully performed²¹, aiming for levels comparable to those suggested in neuraxial blockade, i.e. INR<1.8, APTT<1.5*normal and avoiding combinations of antiplatelet therapy²². Some authors believe that the translaryngeal tracheostomy is superior to other percutaneous techniques in patients with coagulopathy²³ (Level E).

e. **Emergency situations**

A patient who has an upper airway obstruction that cannot be relieved by positive pressure mask ventilation or by endotracheal intubation (“cannot intubate, cannot ventilate”) must have an immediate surgical airway²⁴. Although there are several case reports describing successful PT in an emergency situation²⁵, cricothyrotomy is the method of choice. This is beyond the scope of this protocol.

6) Timing of tracheostomy

The decision when to perform a tracheostomy is controversial²⁶, although it is known that the number of complications increases after a prolonged duration of endotracheal intubation²⁷. A frequently cited consensus conference on artificial airways in 1989 recommended endotracheal intubation as the method of choice for an artificial airway needed for up to ten days, whereas tracheostomy is preferred when the need for an artificial airway exceeds 21 days²⁸ (Level E). A systematic review concluded that performing a tracheostomy at an earlier stage than currently practiced may shorten the duration of artificial ventilation and length of stay in the ICU²⁹ (Level C). However, this conclusion was drawn from only five studies³⁰⁻³⁴. Future trials are eagerly awaited. One such study has recently been started in the United Kingdom (www.tracman.org.uk).

Several studies in smaller groups have been performed to assess which patients may profit from an early tracheostomy. In patients with infratentorial lesions³⁵ or after neurotrauma with a GCS < 7-9 within the first week^{36;37}, an aggressive policy towards early tracheostomy is justified (Level D). A study prospectively comparing the benefits of early to delayed tracheostomy showed that the benefits of early tracheostomy outweigh the risks of prolonged endotracheal intubation, even in terms of mortality (Level C)³³. Although this is a very interesting study, there were several unclarified issues³⁸. For example, the *prediction* as to whether a patient will need more than two weeks of mechanical ventilation is notoriously difficult and often lacks specific objective criteria. Of the many variables during the first 24 hours on the ICU, shock was the only prognostic factor associated with prolonged ventilation (> three weeks)³⁹. Despite this, 42% of patients with shock on admission were extubated earlier than three weeks. This suggests that including all patients with shock on admission for tracheostomy would be inadvisable.

In conclusion, the decision to convert an endotracheal tube to a tracheostomy canula in the ICU has to be individualized, since firm evidence to support an aggressive approach is lacking. The potential benefits (Table 2) and risks (see 9. Complications) of the procedure compared with prolonging endotracheal intubation need to be considered. Based on the available information, one could consider a tracheostomy as soon as it is apparent that weaning from artificial ventilation is unlikely to happen within two weeks after endotracheal intubation (Level D). The duration of artificial ventilation is shortened when a tracheostomy is placed in an early stage of weaning (Level C). For certain patient categories, in particular neurological patients, the decision to perform a tracheostomy can be made within the first week of admission (Level E).

7) Technique

Like with many other procedures, there is a learning curve with the performance of PT. However, in small ICUs sufficient experience is hard to obtain. It is difficult to define a minimum number of PTs that one needs to perform in order to obtain an acceptable skill level, as this depends on the dexterity of the operator. A reasonable minimum number in the learning phase would be about 15 procedures in order to be proficient to perform the procedure independently^{40;41} (Level E). It is advisable that a limited number of physicians should be designated to do the procedure⁴² (Level E). Local circumstances could thus lead to a preference for surgical tracheostomy if training in PT is lacking or caseload is below a certain amount of procedures.

All modern methods for PT rely on the Seldinger technique. Subsequently, dilation up to the degree required for the positioning of the tracheal canula is necessary, either with a single or multiple dilator technique (Table 4)¹. In The Netherlands, almost all ICUs performing PTs use the guide wire dilating forceps or the conic dilation technique⁴³. In some other countries, there is more experience with the translaryngeal (Fantoni's) technique^{44;45}. None of the techniques has significant advantages or disadvantages over another and choice depends mainly on individual preference (Level C), although the translaryngeal technique is by far the most complicated.

The preparation of this bedside procedure carried out in the ICU is important. First of all, the patient should be checked for possible contra-indications (Table 3). Patients should be stable, both circulatory and respiratory (for instance, PEEP < 10 cm H₂O with PaO₂/FiO₂-ratio > 25 kPa) (Level D), although the procedure may be safely done with higher PEEP-levels⁴⁶. Nasogastric feeding is stopped, the stomach contents are emptied and the hypopharynx suctioned just before the actual procedure to prevent aspiration of stomach contents into the airway. It is advisable to start ventilating the patients with controlled ventilation with a FiO₂ of 1.0 about 5-10 minutes before the start of the procedure. Care should be taken to compensate for the volume loss due to air leakage during the procedure. Adequate analgesia, sedation and if preferred muscle relaxation should be ensured, according to a local protocol. Local infiltration with lidocaine with epinephrine further reduces the need for analgesia and minimizes bleeding around the incision. Minimal monitoring should be according to the guidelines of the Netherlands Society of Anesthesiologists⁴⁷, including capnography. The trachea is punctured with a cannulated needle attached to a saline or air filled syringe for continuous suction, aiming for the interspace between the first and second or second and third tracheal rings, although one must realize that accurate placement is achieved in less than half of the cases⁴⁸.

The puncture may be guided by fiberoptic view, as this reduces significantly the number of complications compared to PT without bronchoscopy (Level D)^{15;49}. It helps to confirm the correct position of the puncture, i.e. in the midline of the anterior trachea, and ensures that the posterior wall is not injured. Therefore, arguments that bronchoscopy adds time, cost, and an unnecessary complexity to the procedure and may incur risks to the patient (such as difficulty in maintaining ventilation, CO₂ retention, and elevated intracranial pressures), while true, are weak in comparison to the benefits¹⁵. An exception can be made for a patient with normal anatomy and an experienced team, but even then a bronchoscope should be readily available in case of unforeseen problems. At least two experienced physicians are required to perform the

procedure safely: one to perform the tracheostomy and one for airway control. An additional assistant may be useful to immobilize the withdrawn tube.

After PT routine chest radiography is unnecessary ⁵⁰ (Level D). The patient with a tracheostomy may be transferred to the general ward, see table 2.7. A removable inner canula should always be used, to facilitate cleaning and to overcome acute canula obstruction. Canula displacement represents a potentially catastrophic complication, in particular in patients who are unable to protect their upper airways (for example EMV<9 or vocal cord paresis) and in particular within the first week of the procedure. Local protocols are important to describe the appropriate aftercare of patients with a tracheostomy canula on the ward, like presence of specific instrumentation (i.e. a tracheal spreader), humidification, physiotherapy, suctioning, stoma care etc. The recent introduction of a consultative intensive care nurse, available 24 hours a day, has also contributed to the care of these patients on the general wards.

8) Airway control during PT

Airway control during PT has several pitfalls, such as the risk of accidental extubation, endotracheal tube cuff rupture, or transfixion of the endotracheal tube. There are several ways to secure the airway, although only the two most relevant methods are discussed here.

a. Tube withdrawal.

One method is to withdraw the endotracheal tube under direct laryngoscopic view prior to puncturing the trachea, so that the cuff is placed in between or just below the vocal cords. It is also possible to withdraw the tube into the pharynx and, following cuff inflation, leaving only the tip into the laryngeal opening, so the tracheal tube cuff acts as a laryngeal inlet obturator.

b. Tube replacement.

It is also possible to replace the endotracheal tube by a laryngeal mask airway (LMA) ⁵¹. However, this method relies on a second technique of airway control, with inherent complications, most importantly aspiration of gastric contents. Intensive care patients often require high inflation pressures, have impaired gastric emptying and have oropharyngeal and perilaryngeal edema secondary to prolonged endotracheal intubation, making emergency re-intubation hazardous. Moreover, bronchoscopy through a LMA is more cumbersome. This method is not advisable ⁵² (Level C).

The best way to deal with any complications during the procedure is to always have at least two physicians available: one to do the procedure and another with experience in airway management for airway control (Level E).

9) Complications of PT

Complications may vary from minor, intermediate to major complications. Minor complications are for example minor perioperative bleeding, mild stomal infection or ugly scarring, while major complications may comprise esophageal perforation, pneumothorax with drainage or tracheal stenosis. Minor complications occur in about 20% of cases, but there is a considerable study-to-study variability in reported complication incidence (1-58%)⁵³. Major complications in PT occur in about 3% (0-14%) and intermediate complications in about 3% (0-26%) of cases⁵³. Late complications (after decanulation), although rare, may vary from unesthetic scarring to hoarseness and tracheal stenosis.

Ideally, there should be follow up of patients until the trachea has properly healed for several months after removal of the tracheostomy tube. Unless the events are recorded as critical incidents or as part of an ongoing audit, underreporting of acute complications will occur.

The procedure-related mortality should be defined as mortality associated with the procedure. This mortality rate is less than 0.5%⁵⁴.

Table 1: Indications for tracheostomy

1. Indications for *PT*:
 - a. Any patient who is expected to require mechanical ventilation for at least two weeks with for example:
 - i. Severe (critical illness) polyneuropathy (Level E).
 - ii. Post-multi organ failure, with profound muscle weakness (Level E).
 - iii. Neurological patients with a Glasgow Coma Score < 7-9 and/or an impaired swallow- and cough reflex³⁵⁻³⁷ (Level D).
 - iv. Severely compromised pulmonary function before admission to the ICU⁵⁵ (Level D).
 - v. Need for reintubation due to sputum retention. This may also be an indication for a minitracheotomy (see below) (Level E).
 - b. Severe upper airway obstruction (Level E).
2. Indication for minitracheotomy. This is limited to:
 - a. Patients where retention of sputum is the only problem⁵⁶ (Level D).
3. Indications for a primary *surgical* tracheostomy (Level E):
 - a. Expertise for performing a PT not available.
 - b. Patients in need of home ventilation, who require a wide stoma for easy canula changes.
 - c. Patients in whom anatomical landmarks are impossible to localize (although with careful blunt dissection the landmarks may become more clear).
 - d. Oral or nasal intubation impossible or contra-indicated (Level E).

Table 2: Advantages of tracheostomy

1. Eating and drinking is possible to some degree (provided the patient is able to swallow) (Level D).
2. Speech is possible, whether by deflation of the cuff, or by change of the canula for a fenestrated canula after a minimum of 5 days, in order to let the tracheostomy wound heal sufficiently (Level D).
3. Oral hygiene is easier and respiratory secretions are easier removed. The patient is able to cough (Level C).
4. Absence of laryngeal and vocal cord injuries. The patient is able to move his or her head more freely and less sedation is needed (Level D).
5. Decrease in airway resistance, anatomical dead space and work of breathing, therefore facilitating weaning from mechanical ventilation in patients with marginal respiratory mechanics, although this benefit may be marginal ⁵⁷ (Level E).
6. Better security of the airway, because in general a tracheostomy tube can be changed more easily than an endotracheal tube (Level E).
7. Depending on local protocols, the patient with a tracheostomy may be transferred to the general ward, provided he/she is able to breathe independently and is able to cough adequately. Tracheal suctioning by nurses should be necessary only once or twice per shift. In the first 48 hours after transfer, close contact with the referring intensive care unit is advisable, for example with the aid of a consulting intensive care nurse.

Table 3: Contra-indications of PT

Absolute:

1. Infections at the site of the procedure.
2. Uncorrectable coagulation abnormalities.
3. Patients in whom anatomical landmarks are impossible to localize.
4. Short neck with thyromental distance of less than 3 centimeters, even after optimal exposure.
5. Large struma.

Relative:

1. Elevated intracranial pressure. Postpone the procedure.
2. Emergency situation (“Cannot intubate, cannot ventilate situation”).
3. Age < 16 years or weight < 40 kg.
4. Patients in need of home ventilation, who require a wide stoma for easy canula changes.
5. A history of neck surgery and/or irradiation to the neck as the anatomy may be altered.

Table 4. Currently available techniques of percutaneous tracheostomy

Technique	Characteristics	References
PDT (Percutaneous dilational tracheostomy)	Antegrade, multi-step dilation with up to 7 dilators	58;59
GWDF (Guide wire dilating forceps)	Antegrade, two-step dilation with modified Howard-Kelly forceps	60;61
TLT (Translaryngeal tracheostomy)	Retrograde, single-step dilation with the canula itself	44;45
CDT (Conic dilational tracheostomy)	Antegrade, single-step dilation with a conically shaped, hydrophilically coated dilator	62;63
PercuTwist TM	Antegrade stoma formation with a self-cutting plastic screw	64;65

Level aanbevelingen

- A. Ondersteund door tenminste twee grote prospectief gerandomiseerde gecontroleerde klinische onderzoeken of een meta-analyse met een kleine kans op een vals positief of een vals negatief resultaat
- B. Ondersteund door één groot prospectief gerandomiseerd gecontroleerd klinisch onderzoek met een kleine kans op een vals positief of een vals negatief resultaat
- C. Ondersteund door één of meerdere kleine prospectief gerandomiseerde gecontroleerde klinische onderzoeken of een meta-analyse met een matige tot grote kans op een vals positief of een vals negatief resultaat
- D. Ondersteund door alleen een niet-gerandomiseerd maar wel gecontroleerd klinisch onderzoek, een cohort studie of een patiëntcontrole onderzoek
- E. Ondersteund door alleen niet-vergelijkend onderzoek, historische controles, case reports of de mening van deskundigen

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