Tracheostomy on the intensive care unit for adult patients

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Samenvatting

De percutane tracheostomie heeft de chirurgische tracheostomie verdrongen als techniek voor volwassen intensive care patiënten. 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 “evidence level D of E”. Indien de beademing langer lijkt te gaan duren dan twee weken, dan is een tracheostomie te overwegen (Level C). De meeste contra-indicaties voor een percutane tracheostomie zijn relatief en hangen af van lokale richtlijnen en individuele ervaring (Level E). De techniek met de conische dilatator lijkt de voorkeur te hebben (Level C).

Dit protocol vervangt het oude uit 2007.

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, may be considered (Level C). Most contra-indications for percutaneous tracheostomy are relative and depend on individual experience (Level E). The single step dilatational tracheostomy seems to be preferred (Level C).

This protocol replaces the previous one from 2007.

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 two recent reviews [3, 4]. 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 [5]. The committee prefers the term tracheostomy, reserving the term tracheotomy only for the act creating an opening in the trachea.

2) Indications

For patients in the ICU, the majority of indications for surgical and PT are identical (Table 1) [6-8]. The percutaneous technique is preferred [9-11], 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) [12, 13] (Level D).

4) Contra-indications for tracheostomy

As in all critical procedures, the benefits have to be weighed against the risks. This has to be discussed with the patient or relatives prior to the procedure and an informed consent should be obtained and noted in the medical record. Most contra-indications are relative and also depend on individual expertise (Table 3) [14, 15]. Patient selection is important, in particular when sufficient expertise is unavailable (Level E).

5) Special subgroups with relative contra-indications

a. Obesity

Several case reports and series were published describing successful accomplishment of PT in morbidly obese patients [16, 17]. One study has presented experiences with PT in morbidly obese patients. An almost five-fold increase of major complications, like loss of airway or a massive bleeding from a previously unidentified subcutaneous vessel, was seen in the obese patients group compared to the control group [18]. Another study did not show a difference in the incidence of perioperative complications, provided the procedure was performed by an experienced intensivist [19]. 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 cannula should be considered [20] (Level D).

b. Poststernotomy

Surgical tracheostomies are frequently colonized and infected and therefore constitute a risk factor for mediastinitis after cardiac surgery [21]. In 1973, cricothyrotomy was advocated to prevent median sternotomy infections [22]. Initially, PT was advised in early poststernotomy patients who are expected to be ventilated for a prolonged period of time [23]. However, the use of a tracheostomy post-sternotomy was discouraged more recently and therefore no final conclusion can be given [24] (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 [25, 26]. However, because the procedure is more difficult, physicians with limited PT experience should not perform it (Level D). Therefore, an unstable cervical spine is a relative contra-indication for PT.

d. Coagulation abnormalities

Advantages of PT are the tight fit of the tract around the tracheostomy cannula, 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 performed [27, 28], aiming for levels comparable to those suggested in neuraxial blockade, i.e. INR<1.8, APTT<1.5*normal [29, 30]. The platelet count should be 40.10^9/l at least. Mild coagulation disorders (PT <20 sec, platelets between $40\text{-}100.10^9$/l or use of aspirin and/or clopidogrel) are no longer an absolute contraindication for the procedure [31] (Level E). In those situations, extra care should be taken.

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 airway [32]. Although there are several case reports describing successful PT in an emergency situation [33], 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 controversial [34], although it is known that the number of complications increases after a prolonged duration of endotracheal intubation [35]. 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 days [9, 36] (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 ICU [37] (Level C). However, this conclusion was drawn from only five studies [38-42]. A recent prospective randomized study confirms these results [43]. Prospective randomized trials are difficult to organize; one promising study has been terminated prematurely because of inclusion problems due to the difficulty of clinicians to predict which patients required extended ventilator support [44].

Several studies in smaller groups have been performed to assess which patients may profit from an early tracheostomy. In patients with infratentorial lesions [45] or after neurotrauma with a GCS < 7-9 within the first week [46, 47], 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) [41]. However, there were several unclarified issues [48]. 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. Moreover, the decreased incidence of pneumonia and length of stay in the early tracheostomy group could not be confirmed in a prospective trial [49]. In order to see if physicians are able to differentiate between patients in need of tracheostomy and those who do not, it appeared that the closer the time to the actual intervention, the better the physicians are able to predict the decision to perform a tracheostomy [50].
Of the many variables during the first 24 hours on the ICU, shock was the only prognostic factor associated with prolonged ventilation (> three weeks) [51]. 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 cannula 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, in particular in neurological patients (Level C). Since this prediction is very difficult, tracheostomy generally should be delayed until at least 10 days after initiation [52].

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 ten procedures in order to be proficient to perform the procedure independently [53, 54] (Level E). In analogy to this, airway management in PT also requires training with the same amount of cases before the procedure may be performed independently. It is advisable that a limited number of physicians (or a tracheostomy team) should be designated to do these procedures [55, 56] (Level D). 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 cannula 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 technique [57]. In some other countries, there is more experience with the translaryngeal (Fantoni's) technique [58, 59]. The single step dilatational technique seems to have the least and the translaryngeal technique the most complications [60, 61].

The preparation of this bedside procedure carried out in the ICU is important and the use of a check list and a time out procedure are advisable. First of all, the patient should be checked for possible contra-indications (Table 3). Preoperative investigation with ultrasound is not deemed necessary on a routine basis, but may be indicated for patients with previous neck surgery, obesitas or if a vessel is visible or palpable in the operative field [62-64]. Patients should be stable, both circulatory and respiratory (for instance, MAP > 65 mmHg, PEEP<10 cm H_2O with PaO_2/FiO_2-ratio>25 kPa) (Level D), although the procedure may be safely done with higher PEEP-levels [65]. 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 an FiO_2 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 Anesthesiologists [66], including continuous oxygen saturation, rhythm, blood pressure and capnography. After the orotracheal tube has been retracted in between or just below the vocal cords, the trachea is punctured with a cannulated needle attached to a saline or air filled syringe for continuous suction (see 8 below: Airway control during PT). The goal is to aim 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 cases [67].

The puncture should be guided by fiberoptic view, as this reduces significantly the number of complications compared to PT without bronchoscopy (Level D) [55, 68]. 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, CO_2 retention, and elevated intracranial pressures), while true, are weak in comparison to the benefits [20]. 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 do the procedure and another who is responsible for airway control and for analgesia and sedation. An additional assistant may be useful to immobilize the withdrawn tube. After PT routine chest radiography is unnecessary [69] (Level D).

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 or with a videolaryngoscope 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. With this technique, airway loss is likely, so never do so when the intubation conditions are difficult.

b. Tube replacement.

It is also possible to replace the endotracheal tube by a laryngeal mask airway (LMA) [70-72]. 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. The advantages of better visualization and preventing damage to the bronchoscope have to be weighed against the possible disadvantages of aspiration and loss of the airway. [68] (Level C).

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%) [73-75]. Minor bleeding may result in a blood clot obstructing the airway. Therefore in the first two hours after the procedure the airway should be regularly checked for hemorrhage by suctioning. Major complications in PT occur in about 3% (0-14%) and intermediate complications in about 3% (0-26%) of cases [73]. It is advisable to have written procedural agreements with the surgical or ENT department, since their help may be needed in case of unforeseen circumstances. However, they don’t need to be physically present or stand by, since almost all

complications can be solved temporarily, awaiting expert help. Late complications (after decannulation), although rare, may vary from unaesthetic scarring to hoarseness and tracheal stenosis [60].

The procedure-related mortality, defined as mortality associated with the procedure, is less than 0.5% [76, 77].

10) Discharge from the ICU with a tracheostomy cannula.

A patient can only be discharged safely from the intensive care unit to a nursing floor if adequate care can be provided. In general, only patients with a cuffless cannula should be transferred to the nursing floor. When an inflated cuff is present, obstruction of the cannula may lead to a potentially lethal obstruction of the airway. When adequate exposure and adequate experience are both present (as for example on a neurology department), patients may be transferred with an inflated cuff. A removable inner cannula should always be used, to facilitate cleaning and to overcome acute cannula obstruction. Cannula displacement also 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. 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. It is advisable that patients with a tracheostomy should be followed up by a multidisciplinary tracheostomy team, since this will improve care and shorten the duration of cannulation[78] (Level D). In the absence of such a team, local protocols are important to describe the appropriate aftercare of patients with a tracheostomy cannula on the ward, like who is responsible and which specific measures are necessary (i.e. availability of a tracheal spreader, humidification, physiotherapy, suctioning, stoma care etc).

A speech valve can be used safely, provided the patency of the airway and swallowing are checked prior to transfer by a speech therapist. The indication of the tracheostomy cannula should be questioned daily. Although little evidence is available to guide the optimal timing of tracheostomy cannula removal, the best arguments for this are the presence of an adequate respiratory drive, good cough and the ability to protect the airway [79]. Ideally, there should be follow up of patients until the trachea has properly healed for several months after removal of the tracheostomy cannula. Unless the events are recorded as critical incidents or as part of an ongoing audit, underreporting of acute complications will occur.

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 reflex [45-47] (Level D).
        iv. Severely compromised pulmonary function before admission to the ICU [80] (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 problem [81] (Level D).

3. Indications for a primary surgical tracheostomy (Level E):
    a. Expertise for performing a PT not available.
    b. Anatomical landmarks impossible to localize
    (although with careful blunt dissection landmarks may become clear)
    c. Oral or nasal intubation impossible or contra-indicated.
    d. Ventilator settings whereby loss of airway is inacceptable, even for a short period of time.
    e. High risk of loss of airway and cannot re-intubate situation anticipated.

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 cannula for a fenestrated cannula after a minimum of five 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 [82] (Level E).
6. Better security of the airway, because in general a tracheostomy cannula 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.

Table 3: Contra-indications of PT [79]

Absolute:

1. No informed consent for the procedure.
2. Patients in whom anatomical landmarks are impossible to localize.
3. Large goiter.
4. Age < 12 years old.

Postpone the procedure in the underlying conditions:

1. Infections at the site of the procedure.
2. Uncorrectable coagulation abnormalities.
   (Mild coagulation disorders (PT <20 sec, platelets between 40-100.10^9/l) or use of aspirin and/or clopidogrel) are no longer absolute contraindication).
3. Elevated intracranial pressure.
4. Intensive respiratory support (e.g. FiO_2>50%, PEEP>10cmH_2O).
5. Mean blood pressure below 65mmHg despite maximum hemodynamic support.

Relative:

1. Emergency situation (“Cannot intubate, cannot ventilate situation”).
2. Age between 12 and 16 years or weight < 40 kg.
3. History of neck surgery and/or irradiation or burns to the neck as the anatomy may be altered.
4. Short neck with thyromental distance of less than 3 centimeters, even after optimal exposure.
5. Unstable cervical spine.

Table 4. Currently available techniques of percutaneous tracheostomy

Technique	Characteristics	References
PDT (Percutaneous dilational tracheostomy)	Antegrade, multi-step dilation with up to 7 dilators	83, 84
GWDF (Guide wire dilating forceps)	Antegrade, two-step dilation with modified Howard-Kelly forceps	60, 85
TLT (Translaryngeal tracheostomy)	Retrograde, single-step dilation with the cannula itself	58, 59
CDT (Conic dilational tracheostomy)	Antegrade, single-step dilation with a conically shaped, hydrophilically coated dilator	86, 87
PercuTwist™	Antegrade stoma formation with a self-cutting plastic screw	88, 89
Blue Dolphin™	Inflatable balloon dilation system	90

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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