

Danish Guidelines 2015 for Percutaneous Dilatational Tracheostomy in the Intensive Care Unit

Kristian Rørbæk Madsen, Henrik Guldager, Mikael Rewers, Sven-Olaf Weber, Kurt Købke-Jacobsen, Jonathan White

This 2015 revised edition of the 2011 edition has been approved by the Danish Society of Anesthesiology and Intensive Care Medicine (DASAIM) and the Danish Society of Intensive Care Medicine (DSIT) on January 22 2015

Correspondence: Kristian Rørbæk Madsen, Department of Anesthesiology and Intensive Care, Odense University Hospital, Soendre Boulevard 29, 5000 Odense C, Denmark

E-mail: Kristian.Roerbaek.Madsen@rsyd.dk

Summary:

Percutaneous dilatational tracheostomy is a common procedure in intensive care. This updated Danish national guideline describes indications, contraindications and complications, and gives recommendations for timing, anaesthesia, and technique, use of fibre bronchoscopy and ultrasound guidance, as well as decannulation strategy, training, and education.

Limitation: Applicable only for patients aged ≥ 15 years

Last literature review: November 2014

Next update: January 2019

List of abbreviations:

ICU = intensive care unit
 PDT = percutaneous dilatational tracheostomy
 ST = surgical tracheostomy
 RCT = randomized controlled trial
 PICO = population, intervention, comparator, outcome
 DASAIM = Danish Society of Anesthesiology and Intensive Care Medicine
 DSIT = Danish Society of Intensive Care Medicine
 OR = operating room

1. INTRODUCTION

Tracheostomy is a common procedure in the critically ill. In an international one-day prevalence-survey, twenty-four percent of all mechanically ventilated ICU patients were ventilated via a tracheostomy¹ Since 1985², PDT has gained popularity over surgical tracheostomy which, however, remains the back-up method in difficult cases.

2. CONTRIBUTORS, METHODS, SEARCH STRATEGY, AND LEVEL OF EVIDENCE

Contributors

Upon open call to the members of DASAIM, the authors of the 2011 version of this guideline were supplemented. Thus a group of Danish ICU doctors with special interest and expertise in PDT was constituted.

Research questions

Where possible formal research questions were formulated, all concerning tracheostomy in mechanically ventilated adult critically ill patients in the ICU:

Which indications, contraindications, and complications should be appreciated?

What is the optimal timing of tracheostomy?

Should PDT be preferred as standard method over ST?

Should fiberoptic guidance be used?

Should ultrasonic guidance be used?

Which form of anaesthesia is preferable?

How is training and education for PDT best organized?

PICO questions

Subtopics and PICO questions³ were formulated and delegated to individual authors within the group, who in turn handed in a draft for internal peer review.

Population:	adult critically ill patients in the ICU
Intervention:	percutaneous tracheostomy
Comparator:	any
Outcome:	mortality, morbidity, bleeding, pneumonia, length of mechanical ventilation, length of stay, and serious adverse events

Search strategy

PubMed and Cochrane Library were searched for literature. In addition, we hand-searched reference lists of relevant publications. No study designs were per se excluded but emphasis was put on RCTs and well performed recent meta-analyses.

Inclusion criteria

Adult critically ill patients in the ICU undergoing mechanical ventilation.

Exclusion criteria

Age less than 15 years. Studies conducted in a non-ICU setting.

Validation and grading of evidence

We evaluated trial data using the GRADE approach (www.gradeworkinggroup.org). The GRADE system does not grade the quality of single studies but sequentially assesses the quality of evidence from the best available data for the outcomes of interest followed by assessment of the balance between benefits versus risks, burden, and cost. Literature identified by the search strategy was considered to represent the best-quality evidence. The quality of the evidence was quantified (high, moderate, low or very low) and potentially downgraded in the domains 1) risk of bias, 2) inconsistency of results, 3) indirectness of the evidence, 4) imprecision of results, and 5) other considerations including suspicion of publication bias, and was downgraded based on the number of domains with concerns (Table 1).

Recommendations

The recommendations were agreed upon in the group, and if total agreement could not be obtained, the group voted; 4/6 of the votes were needed to issue a strong recommendation. Strong recommendations (marked 1) were given the wording ‘we recommend’ and weak recommendations (2) ‘we suggest’. The level of evidence was graded high (marked A), moderate (B), low (C) or very low (D) based on the number of domains that were downgraded in adherence to GRADE.

Table 1. Rating the quality of evidence according to GRADE.

Source: Balshem et al. ⁴

Study design	Quality of Evidence	Lower if	Higher if
Randomized trial →	High (A)	Risk of bias -1 Serious -2 Very serious	Large effect +1 Large +2 Very large
	Moderate (B)	Inconsistency -1 Serious -2 Very serious	Dose response +1 Evidence of a gradient
Observational study →	Low (C)	Indirectness -1 Serious -2 Very serious Imprecision -1 Serious -2 Very serious	All plausible confounding: +1 Would reduce a demonstrated effect or
	Very low (D)	Publication bias -1 Likely -2 Very likely	+1 Would suggest a spurious effect when results show no effect

Peer-review and approval

The guideline was presented and accepted with/ without revisions at the annual symposium of the DSIT at Hindsgavl,

Denmark, January 2015, and finally accepted for publication by DASAİM on 2015.

Table 2. Key recommendations

We suggest that optimal timing of tracheostomy be determined on an individual patient basis. There is insufficient or conflicting evidence to make a general recommendation of early versus late tracheostomy (2B)
We recommend bedside PDT as the standard method for tracheostomy in intensive care patients (1B)
We recommend that surgical tracheostomy in the operating room remains the back-up method in difficult cases (ungraded best clinical practice)
We suggest that anaesthesia for PDT should consist routinely of intravenous general anaesthesia and neuromuscular blockade (2D)
We suggest that PDT can also be safely carried out in local analgesia (2D)
We suggest the laryngeal mask airway as a safe alternative to retracting an endotracheal tube during PDT (2B)
We suggest bronchoscopic guidance for PDT (2D)
We suggest ultrasound as a possible adjunct to PDT (2C)
We recommend that the Surgical Safety Checklist, as developed by WHO, and with local modifications, should be routinely applied to the surgical procedure of PDT (1B)
We recommend capnometry /-graphy should be used in cases of suspected tracheal tube displacement (1D)
We suggest that all clinical staff who work in ICU should be trained in interpretation of capnometry/-graphy (2D)
We recommend the presence of a difficult airway trolley in close proximity to the unit (1D)
We suggest the establishment of an algorithm to be used in the clinical scenario where there is suspicion of a displaced tracheostomy (2D)
We suggest that all ICU doctors receive ongoing training in the use of supraglottic devices and are familiar in the techniques of advanced airway management (2D)
We suggest that an individual plan for tracheostomy management and decannulation should be presented at patient discharge from ICU to the general ward with a tracheal cannula in place (ungraded).
We recommend an active training and education strategy for PDT, with local modifications (ungraded).

2. PDT – INDICATIONS AND CONTRAINDICATIONS

Indications for PDT:

- Prolonged mechanical ventilation
- Airway protection against pulmonary aspiration (e.g. laryngeal incompetence due to critical illness, polyneuropathy, or bulbar dysfunction)
- Prolonged need for intratracheal suction
- Upper airway obstruction (e.g. tumor, bilateral recurrens paresis)
- Trauma or infection in oral cavity, pharynx or larynx.
- Minimisation of sedation

Contraindications against PDT:

- Unstable fractures of the cervical spine
- Severe local infection of the anterior neck
- Uncontrollable coagulopathy

Relative contraindications:

Controlled local infection
Coagulopathy
High PEEP or FiO2 requirements
Difficult anatomy (e.g. morbid obesity, short thick neck, reduced neck extension, excessive goiter, tracheal deviation)
Proximity to extensive burns or surgical wounds
Elevated intracranial pressure
Haemodynamic instability
Previous radiotherapy to the neck

No randomized, controlled trials concerning indications for PDT were found. In experienced hands, PDT seems to be a safe procedure. The risk/benefit and timing of PDT should be evaluated on an individual patient basis. Usually PDT is an elective procedure, and all reversible risk factors (e.g. severe coagulopathy or excessive PEEP/FiO2 requirements) should be corrected in advance.

The number of relative contraindications to PDT declines with increasing operator experience. A case series with 207 patients showed that PDT can even be performed safely as an emergency procedure by experienced clinicians⁵. Also PDT has been performed with few complications in spite of coagulopathy⁶ or high PEEP/FiO2 requirements⁷. Some small studies and case reports have reported fewer laryngeal complications with tracheostomy as compared with prolonged translaryngeal intubation⁸.

Overweight patients (BMI > 27,5) have a 5 times higher risk of perioperative complications with PDT than normal-weight patients⁹.

Potential advantages with tracheostomy compared to prolonged translaryngeal intubation:

Less sedation needed for tube acceptance
Higher patient comfort (mobilisation, oral hygiene, phonation)
Reduced risk of laryngeal damage in long-term intubation
Reduced airway resistance and respiratory work
More efficient cough
Faster weaning from mechanical ventilation
Shorter ICU-stay

3. TIMING OF TRACHEOSTOMY IN THE CRITICALLY ILL - EARLY VERSUS LATE?

Population: Mechanically ventilated adult critically ill patients in the ICU
Intervention: early tracheostomy
Comparator: late or no tracheostomy
Outcome: mortality, pneumonia, duration of mechanical ventilation and ICU or hospital stay

Recommendation:

In prolonged mechanical ventilation, we suggest that optimal timing of tracheostomy be determined on an individual patient basis (2B). There is insufficient or conflicting evidence to make a general recommendation of early versus late tracheostomy.

Background:

Definitions of early tracheostomy vary from 2-10 days from start of mechanical ventilation. Thirteen RCTs with mortality data comparing early versus late tracheostomy were identified (table 2).

Table 2 : Early tracheostomy and ICU mortality in RCTs. Summary of findings.

Tracheostomy timing: Early Late or none Effect size

	Deaths/ total	Deaths/ total	Odds ratio (95% CI)
Young et al 2013 ¹⁰	133/448	132/445	1.00 (0.75-1.33)
Bosel et al 2013 ¹¹	3/30	14/30	0.13 (0.03-0.51) *
Zheng et al 2012 ¹²	19/58	32/61	0.44 (0.21-0.93) *
Koch et al 2012 ¹³	9/50	7/50	1.35(0.46-3.96)
Trouillet et al 2011 ¹⁴	24/109	26/107	0.88(0.47-1.66)
Terragni et al 2010 ¹⁵	108/209	128/210	0.69(0.46-1.01)
Blot et al 2008 ¹⁶	12/61	15/62	0.77 (0.33-1.81)
Barquist et al 2006 ¹⁷	2/29	5/31	0.39(0.07-2.16)
Rumbak et al 2004 ⁸	19/60	37/60	0.29(0.14-0.61) *
Bouderka et 2004 ¹⁸	12/31	7/31	2.17(0.71-6.57)
Saffle et al 2004 ¹⁹	4/21	6/23	0.67(0.16-2.79)
Sugerman et al 1997 ²⁰	13/53	11/59	1.42(0.57-3.51)
Rodrigues et al 1990 ²¹	9/51	13/55	0.69(0.27-1.79)

Source: Siempos et al 2014²² CI = Confidence interval * = Statistical significance (p < 0,05)

Thus only three of these individual trials showed a statistically significant survival benefit with early tracheostomy, on the other hand none showed statistically significant harm. Recently the largest RCT to date failed to show any mortality reduction with early tracheostomy¹⁰. However the study did not achieve its intended sample size. In fact all RCTs so far have been underpowered to detect a possible small yet clinically relevant benefit of early timing of this widespread procedure in the ICU. Correspondingly, meta-analyses^{23 24,25 26 27 28} have returned non-significant results on outcomes such as mortality, pneumonia, duration of mechanical ventilation, and length of intensive care or hospital stay, however with the most recent meta-analysis being in favour of early tracheostomy²². On this background, we find insufficient evidence to support a firm recommendation of early versus late tracheostomy in routine clinical practice. Optimal timing of tracheostomy should be determined individually with daily clinical assessment.

4. PDT VERSUS SURGICAL TRACHEOSTOMY

Population: Mechanically ventilated adult critically ill patients in the ICU
Intervention: PDT
Comparator: ST
Outcome: mortality, bleeding, infection, pneumothorax, other major complications, accidental decannulation, tracheal stenosis, indication to procedure time, financial cost.

Recommendation:

We recommend bedside PDT as the standard method for tracheostomy in intensive care patients (1B), since

- bedside PDT is logistically simpler and has fewer or equally few complications compared to ST (B)
- bedside PDT is less expensive than ST in the operating room (C)

We recommend that surgical tracheostomy in the operating room remains the back-up method in difficult cases (ungraded best clinical practise).

Background:

In controlled studies, clinically important complications are infrequent following both PDT or ST. Most serious or fatal complications such as uncontrollable bleeding or irreversible loss of airway have only been published in case reports. Table 3 shows reported complications of both PDT and surgical tracheostomy.

Table 3. Complications of tracheostomy (both PDT and surgical tracheostomy)

Immediate/early	Late
Bleeding	Stomal infection
Hypoxia / loss of airway	Displaced tracheal tube / via falsa
Tracheal lesion; posterior wall perforation or tracheal ring fracture.	Bleeding from erosion into blood vessels (including innominate artery)
Oesophageal lesion	Subglottic or tracheal stenosis
Displaced tracheal tube / via falsa	Delayed healing after decannulation
Obstruction of tracheal tube by blood clot	Tracheo-oesophageal fistula
Hypercapnia	Permanent voice changes
Raised intracranial pressure	Scarring of the neck
Simple or tension pneumothorax	Dysphagia
Pneumomediastinum	
Surgical emphysema	
Atelectasis	
Needle damage to fibre bronchoscope (PDT)	

A meta-analysis from 2006²⁹ of 17 RCTs including 1212 patients found a significantly reduced wound infection rate of 2,3 % after bedside PDT versus 10,7 % following surgical tracheostomy either bedside or in the OR. A possible cause is the minimally invasive surgical technique with PDT. Bleeding requiring transfusion or subsequent surgical haemostasis was seen in 5-6 % in both groups. A subgroup analysis of bedside PDT versus surgical tracheostomy in the OR revealed a significantly lower risk of bleeding and lower mortality with bedside PDT. This finding could reflect the risk of intrahospital transport of a critically ill patient. Also the financial cost of bedside PDT is lower than that of surgical tracheostomy in the OR³⁰.

The most significant study³¹ in the above-mentioned meta-analysis randomized 200 ICU patients to either bedside surgical or percutaneous tracheostomy. No significant difference was found in the combined primary endpoint (bleeding, infection, pneumothorax, accidental decannulation, other major operative complication, or death). The total complication rate was low: 3,5 %. However, there were fewer stomal infections in the PDT group at day 7. Also time from randomization to tracheostomy was shorter in the PDT group. The latter could reflect the logistical advantage of the intensivists themselves performing the procedure.

Presumably, clinically relevant long-term complications following tracheostomy in the critically ill are infrequent. Tracheal stenosis is common, but mostly subclinical. The paucity of long-term follow-up studies impedes conclusions about PDT versus surgical tracheostomy.

5. ANAESTHESIA FOR PDT**Recommendation:**

We suggest that anaesthesia for PDT should consist routinely of intravenous general anaesthesia and neuromuscular blockade (2D)

We suggest that PDT can also be safely carried out in local anaesthesia (2D).

We suggest the laryngeal mask airway as a safe alternative to retracting an endotracheal tube (2B).

Usual fasting rules are applicable. Prepare for a difficult airway (ungraded)

Background:

Randomised clinical studies of anesthesia for PDT were not identified, so this recommendation relies primarily on expert opinion and case reports. Sedation to tube tolerance is not sufficient for surgical anesthesia. Thus, real doses of anaesthetics are used³². Neuromuscular blockade optimises surgical conditions and eases controlled ventilation. Inhalational anaesthesia is avoided, since the procedure implies gas leakage. In this procedure, managing the airway is the anaesthesiologist's greatest challenge³³. To facilitate the surgical procedure, the upper part of the back is elevated and the neck hyperextended which makes direct laryngoscopy more difficult. Prior prolonged intubation constitutes a risk for airway oedema³⁴. The oro-tracheal tube can be retracted under direct laryngoscopy until the cuff is just distal to the vocal cords, before the trachea is punctured³⁵. Still there is a risk that the introducing needle hits the tracheal tube if the tip of the tube is not proximal to the puncture site. An alternative is to extubate the patient and insert a laryngeal mask, where the risks are pulmonary aspiration, air leakage and compromised ventilation. However one randomized clinical trial concludes that the laryngeal mask airway has significant advantages over withdrawing an endotracheal tube³⁶. The exact choice of method depends on clinical evaluation and personal preference. Equipment for managing the difficult airway should be available.

6. PDT: TECHNIQUE AND PROCEDURE

Several commercial kits are available for PDT. The basic contents, however, remain similar: an introducing needle, one or more dilators and possibly a forceps for the initial penetration of the tracheal wall. To minimize complications, we recommend that each institution chooses one kit and gains familiarity with this specific kit to appreciate its advantages and drawbacks. No firm evidence supports one specific kit or technique, though single step dilatation is gaining popularity due to fewer minor complications and ease of insertion compared to forceps dilatation, multiple dilatation, screw like dilatation, ballon dilatation or translaryngeal techniques.^{37,38} The following suggestions for PDT technique and procedure are based on expert opinions and rules of thumb.

Suggested PDT procedure: (ungraded)

The procedure differs slightly with choice of kit, but some basic steps remain common³⁹ [21]

Staff:

In most cases two doctors should participate to allow bronchoscopic guidance, safe management of any complications, and clinical teaching. However, we appreciate than in very experienced hands, PDT can be performed safely by one doctor, if assisted by an experienced intensive care nurse. Physician assistance and bronchoscopic guidance should be readily available.

Preparation:

- If the patient is competent: informed consent must be obtained directly from the patient.
- If the patient is temporarily incompetent: The patient's next of kin are informed if possible.
- If the patient is permanently incompetent: informed consent must be obtained from the patient's guardian.
- Nil per os: Common rules for NPO apply. Vomitus can be provoked by direct tracheal or indirect pharyngeal or esophageal stimuli.
- Anti-coagulation should be paused according to institutional practice.
- Intubation and anaesthesia: see *section 5: Anaesthesia for PDT*.

Instruments:

- PDT-kit.
- Laryngoscope, intubation tray and equipment for difficult airway management should be immediately available.
- Fibre bronchoscope.
- Optional ultrasound machine.

The procedure itself:

- Operator position, two possibilities:
 - operator at patient's side. Advantage: direct access to surgical field without moving patient or bed.
 - Operator at head end of patient's bed. Advantage: Easier management of airway complications such as accidental extubation.
- Patient positioning for optimal presentation of anterior neck anatomy, usually with a pillow under the shoulders and maximal cervical spine extension.
- Direct laryngoscopy with retraction of the tracheal tube until the cuff is placed just under the vocal cords. At the same time the laryngoscopy difficulty grade is evaluated in case of need of oro-tracheal re-intubation.
- Marking: The cricoid and tracheal rings are palpated. The optimal site for tracheostomy is determined and marked, always under the cricoid cartilage and ideally between the second and third tracheal ring. More proximal placement increases the risk of tracheal stenosis, whereas a more distal placement increases the risk of erosion of the great vessels in the mediastinum. The choice of tracheostomy site can be guided with fibre bronchoscopy (light through the anterior tracheal wall) and/or ultrasound.
- Antiseptic and sterile preparation according to institutional guidelines.
- Infiltrational analgesia with a local analgetic containing adrenaline (to reduce bleeding) from skin to trachea.
- Skin incision: 8-12 mm horizontal incision at the chosen level. The incision must be as short as possible to reduce risk of bleeding and infection and to provide a tight-fitting stoma.
- Introduction of guidewire: The cuff of the tracheal tube is deflated, the trachea is punctured in the midline, and the guidewire is introduced. Clinical confirmation of intra-tracheal placement: Ventilation-synchronous oscillation through introducer needle/catheter, unhindered passage of guide wire until bronchial stop at expected anatomical depth. Preferably, fibreoptic guidance through the orotracheal tube.
- Stomal dilatation with one or more dilators, possibly with the use of a dilating forceps.
- Control of intra-tracheal placement:
 - Ventilation-synchronous air escape (through open stoma with guidewire in situ or through dilator with removed guidewire).
 - and fiberbronchoscopically confirmation through oral tube.

- Choice of tracheal cannula: according to clinical judgement. A few rules of thumb:
 - use tube with adjustable flange for patients with deeply-located trachea.
 - use wire tube in patients with risk of kinking of tube (short neck, obesity, caudally placed stoma).
- Perioperative bleeding:
 - Minor bleeding (no transfusion requirement):
 - manual compression.
 - subcutaneous infiltration with adrenaline containing local analgesic circumferentially to the tracheal stoma.
 - compress soaked with adrenalin-solution (1 mg adrenalin, 4 ml sterile water) wrapped around the tube between the flange and the skin.
 - Major bleeding (transfusion requirement or continued bleeding in spite of the above measures)
 - consult an ENT specialist (exploration, suture, cautery)

7. BRONCHOSCOPIC GUIDANCE

Recommendation:

We suggest bronchoscopic guidance for PDT (2D)

- Background:** No RCTs of PDT with bronchoscopic guidance versus no bronchoscopic guidance were identified. However, a systematic review of all published deaths related to PDT identified lack of bronchoscopic guidance as a serious risk factor⁴⁰. With the bronchoscope the following can be ascertained:
- correct tracheostomy site (midline placement, level at tracheal rings, light at the anterior tracheal wall).
 - intra-tracheal guidewire placement.
 - intratracheal dilator placement without tracheal damage.
 - position of tracheal cannula postprocedurally.

8. ULTRASOUND GUIDANCE

Recommendation:

We suggest to use ultrasound as a possible adjunct to PDT (2C).

Background:

- Prior to the procedure, ultrasound allows evaluation of³⁹
- the anatomy of major vessels and the thyroid gland in relation to tracheostomy site.
 - any small vessels anterior to the tracheostomy site
 - the position of the tracheal rings and the midline.
- even in obese patients⁴¹.
- In skilled hands real time ultrasound is associated with even fewer complications⁴². Thus ultrasound guidance may even obviate the need for bronchoscopy. In one minor study with 16 patients⁴³ the use of ultrasound was associated with less hypoxia and shorter procedure time than the use of bronchoscopy, but the majority of studies with ultrasound has used both adjuncts.

9. PATIENT SAFETY

Recommendation: In intensive care units caring for tracheostomized patients:

- **We recommend that the Surgical Safety Checklist, as developed by WHO, and with local modifications, be routinely applied to the surgical procedure of PDT (1B)⁴⁴**

- **We recommend capnometry /-graphy should be used in cases of suspected tracheal tube displacement (1D)**
- **We suggest that all clinical staff who work in ICU should be trained in interpretation of capnometry/-graphy (2D)**
- **We recommend the presence of a difficult airway trolley in close proximity to the unit (1D)**
- **We suggest the establishment of an algorithm to be used in the clinical scenario where there is suspicion of a displaced tracheostomy (2D)**
- **We suggest that all ICU doctors receive ongoing training in the use of supraglottic devices and are familiar in the techniques of advanced airway management (2D)**

Background: Considering the results of the national audit project (NAP4) from the United Kingdom it seems prudent to implement the above measures⁴⁵.

10. DECANNULATION

Recommendations: (all ungraded best clinical practise)

The patient should be decannulated as soon as possible when

- cough is sufficient
- inspiratory fraction of oxygen is reasonably low
- suctioning is rarely needed
- mechanical ventilation has not been needed for more than 24 hours
- the airway is spontaneously patent

At discharge from ICU to the general ward with a tracheal cannula in place:

- the tracheal cannula should be without cuff (to avoid risk of total airway occlusion) unless the ward is specialized in care of patients with cuffed tracheal cannulas. An individual plan for tracheostomy management and decannulation should be presented.

Background: Recommendations about decannulation suffer from lack of solid evidence and are largely based on expert opinions. An international survey demonstrated considerable variability in the decannulation practices of intensive care doctors⁴⁶. A prospective observational study showed that discharge from ICU to the ward with a tracheal cannula in place was an independent risk factor for mortality – especially in case of a high BMI⁴⁷. A recent survey in Denmark revealed inadequate post-ICU follow-up in non-decannulated patients on the ward⁴⁸. An intensivist-led, post-ICU tracheostomy follow-up team has been associated with earlier discharge from hospital⁴⁹.

11. TRAINING AND EDUCATION

To minimise complications, PDT should be performed by doctors able to maintain their routine in this procedure, typically at a specialist level in intensive care medicine.

Training a procedure, in this case PDT, involves both knowledge (indications, contraindications, complications), practical management (preparation, dexterity, technique) as well as communication and teamwork (consent, modesty, knowing when to call for senior assistance)⁵⁰.

When a colleague is training a procedure, the following steps are suggested⁵¹:

- 1) **Demonstration:** The supervisor demonstrates the procedure at a normal pace, but without comments.
- 2) **Deconstruction:** The supervisor demonstrates and simultaneously describes the steps of the procedure.
- 3) **Understanding:** The supervisor demonstrates the steps of the procedure, but this time with the trainee talking the supervisor through the steps.
- 4) **Management:** The trainee demonstrates and describes the steps of the procedure.

In this way the procedure is split into manageable steps, and the trainee is asked to describe each step. The repetition reinforces the learning process, and possible mistakes are corrected. Also, different learning styles are possible, because the trainee sees, hears, describes and performs the procedure, whereby the learning outcome is optimised.

We recommend that the supervisor and the trainee meet two times as a minimum to ensure that all 4 steps are carried out. Step 1 is demonstrated on a clinical patient, or a teaching video. It is important that the trainee has the possibility to identify fully through a thorough demonstration. Step 2-4 can be trained theoretically, but preferably on a mannequin. These steps are repeated until the supervisor finds the trainee ready to perform the procedure on a clinical patient under supervision (step 4). It is individually decided when the colleague is ready to perform PDT without supervision.

We recommend the following structure for every learning session⁵²:

- **Introduction:** The trainee's basic knowledge of PDT? Consider the placement of the trainee: Next to you or opposite? Left- or right-handed?
- **Dialogue:** Have you broken down the PDT procedure into clearly defined steps? Do you give positive feedback to the trainee? ("What went well?", "What would you do differently next time?") Avoid too much talk. Often too many details are given.
- **Conclusion:** Can the colleague safely perform PDT? How will he or she continue the learning process? Take home messages.

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