Percutaneous Dilational Tracheostomy (PDT): Considerations in Placement and Management

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Disclosures

- None related to this topic.

Objectives

1. Understand the Indications and Contraindications of PDT.
2. Understand the rationale, timing, and placement procedure of PDT.
3. Be able to address pre and post-operative management concerns.

Tracheostomy Background

Indications
Adv/Disadv vs. Intubation
PDT Vs. ST
Contraindications
Advantages/Disadvantages
Timing

Indications

- Emergent
  - Acute upper airway obstruction/failed intubation
- Elective
  - Prolonged Mechanical Ventilation
  - Airway Protection/Secretion Management
  - OSA
  - Severe Subglottic Stenosis
  - Severe Vocal Cord Paralysis

Advantages/Disadvantages of Tracheostomy

	Intubation	Tracheostomy
Advantages	Rapid insertion No need for surgery/proc No stomal complications	Ease of replacement Improved Speech, mobility, swallowing Tx out of ICU Patient comfort Improved oral care/hygiene Airway stability Improves standard weaning parameters (RSI)
Disadvantages	Cuff complications Laryngeal complications Replacement skill Needs ICU Facial Injuries ?need for inc sedation	Cuff Complications Stomal complications Possible TIA Fistula Possible Mediastinitis Accidental decannulation

Mehta AB. Crit Care Med 2016.

Timing for Tracheostomy

- No optimal time for transition to tracheostomy
- Practice varies between 1-3 weeks following intubation.
- Early tracheostomy (ie, before 10 days) is of no proven benefit
  - May lead to unnecessary surgery and prolonged mechanical ventilation in patients who may otherwise be extubated.
- Consider circumstances and the patient/caregiver preference

Mehta AB et al. Crit Care Med 2016.
Esteban A et al. AJRCCM 2000.
Huang H, et al. *PLoS One*. 2014.
Hosokawa K, et al. *Crit Care*. 2015.

Surgical Trach (ST) vs. PDT

- Meta-analysis of 17 RCT with 1,212 patients
- PDT was equivalent to ST for bleeding
- PDT with reduced incidence of wound infection

Delaney A, et al. *Crit Care*. 2006;10(2):R55..

Risk of Aspiration or PNA with Trach

- Data are conflicting
- A prospective cohort study of >800 pts with increased (6X) rate of nosocomial pneumonia c/w ETT.
- A case control study of 354 pts (>7 days mech vent) - tracheostomy is associated with lower rate of nosocomial PNA.
  - Findings were supported by another retrospective cohort study.

Ibrahim EH et al. Chest 2001.
Nseir S et al. ERJ 2007.
Moller MG. Am J Surg. 2005.

Tracheostomy Effect on Mortality?

- Conflicting Data on whether mortality benefit to trach

- Tracheostomy-related deaths
  - More frequent during the weekend
  - More common among patients with cancer, chronic lung disease.

Frutos-Vivar F. Crit Care Med. 2005
Combes A et al. Crit Care Med 2007.
Clec'h C et al. Crit Care Med 2007
Pandian V et al. J Crit Care 2012.
Cramer JD et al. Laryngoscope 2019.

Contraindications To PDT

- Absolute
  - Anterior Neck Cellulitis
  - Uncorrectable Bleeding Diathesis
  - Absence of a cervical trachea (prior resection)

- Relative
  - Hemodynamic Instability
  - Severe Hypoxemia
    - PEEP>12
    - FiO2>0.6
  - Gross Neck Distortion
  - Obese/Short Neck
  - Difficulty with neck extension
  - Vascular – high-riding innominate or thyroid IMA

Advantages/Disadvantages of PDT

Advantages

- Performed at Bedside
- Requires less time
- Less expensive
- Typically performed sooner
- Reduced risk of wound infection

Disadvantages

- ?Increased risk:
  - Anterior tracheal injury
  - Posterior tracheal wall perforation
- Several Relative Contraindications

Types of Tracheostomies

Tracheostomy tube anatomy
Types of Tracheostomies
Trache Cuff
Trache Dimensions
Blue Rhino Kit
Trache Tube Selection

Types of Tracheostomy Tubes

Non-Metal (PVC, silicone, polyurethane)

- Cheaper
- More likely to conform to airway shape
- Has inflatable cuff
- Universal adapter
- Usually replaced every 6-8 wks

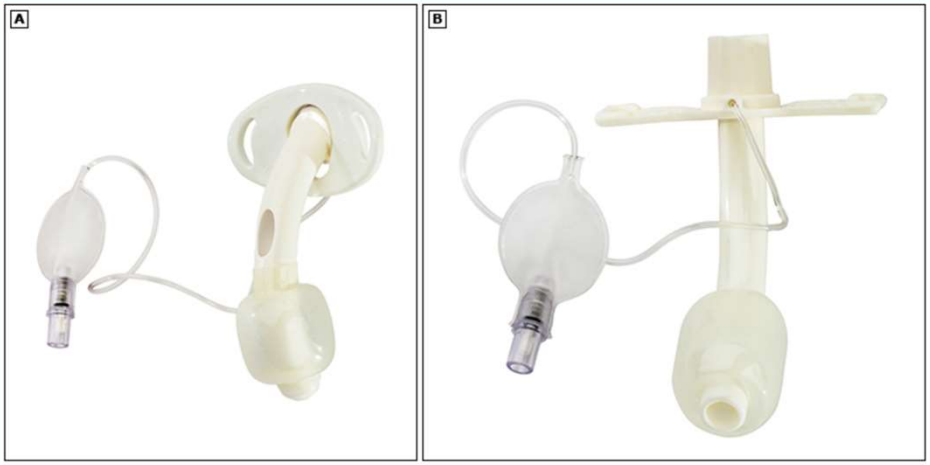
Metal

- Silver or Stainless Steel
- Rarely used (don't have cuffs or universal vent adapter)
- Expensive
- Rigid
- More resistant to infection
- Easier to clean
- May be good for life-long use
  - s/p laryngectomy
  - No need for vent

Tracheostomy Tube Selection

- Considerations
  - Patient age, weight, and height
  - Neck and tracheal size
  - Tracheal pathology (eg, tracheomalacia, distorted trachea)
  - The main purpose for tracheostomy (eg, airway secretion clearance, ventilation, weaning, phonation)
- Diameter
  - Maintain a good seal and minimize airway resistance and work of breathing
  - Avoid need for cuff overdistention
- Length
  - Standard
  - pXLT
    - Thick anterior neck wall
  - dXLT
    - Tall pt
  - Custom Length
  - Adjustable Flange

Tracheostomy Types



(A) Fenestrated tracheostomy.

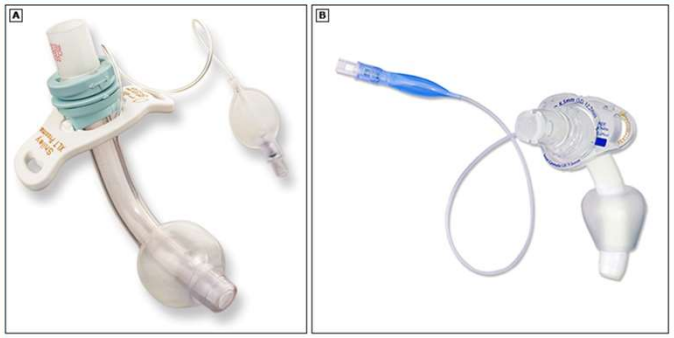
(B) Non-fenestrated tracheostomy.

*Fenestrated Trachs

- Not utilized very frequently
- Can help with phonation
- Can develop additional granulation tissue

Cuffed Tube  With disposable inner cannula  With reusable inner cannula	Used to obtain a closed circuit for ventilation.
Cuffless Tube  With disposable inner cannula  With reusable inner cannula	Used for patients with tracheal problems. Used for patients who are ready for decannulation (removal of tracheostomy).

Tracheostomy Types/Dimensions
One Size Doesn't Fit All



Differences between tracheostomy include inner and outer diameters and shape of cuffs. Both tracheostomies have the same internal diameter but differ in outer dimensions. On the right side of the image, note the tapered cuff that facilitates insertion, promotes more airflow around tube, and decreased pressure points on lateral tracheal walls.

(A) Shiley XLT-P (extended length proximal) 8.0:
Inner diameter – 8.0 mm
Outer diameter – 13.3 mm

(B) Shiley flexible cuffed 7CN80H
Inner diameter – 8.0 mm
Outer diameter – 11.4 mm

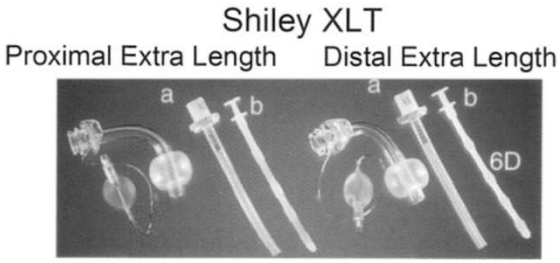


Fig. 8. Extra-length tracheostomy tubes. (Courtesy of Smiths Medical, Keene, New Hampshire and Tyco Healthcare, Pleasanton, California.)

Fig. 9. Flexible tracheostomy tubes with adjustable flange. Hv = high-volume. LP = low-pressure.

Fig. 5. Angled versus curved tracheostomy tubes. Note that the angled tube has a straight portion and a curved portion, whereas the curved tube has a uniform angle of curvature.

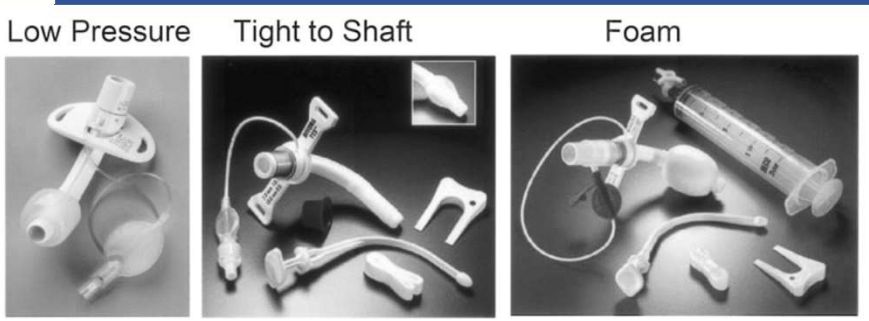


Fig. 12. Examples of low-pressure, tight-to-shaft, and foam-filled tracheostomy tube cuffs.

Hess D. Respir Care 2005.
Medtronic 2022.

Tracheostomy Types/Dimensions
One Type/Size Doesn't Fit All

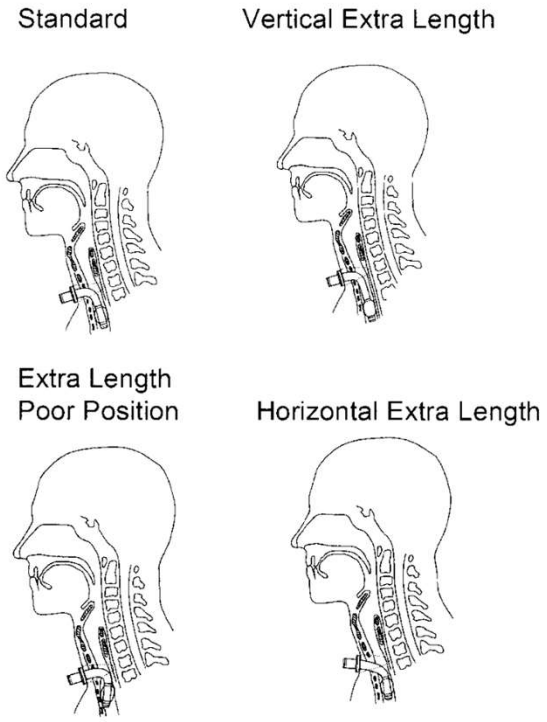


Fig. 7. Position of extra-length tracheostomy tubes in the trachea. Note that inappropriate use of an extra-length tube can cause distal tracheostomy-tube obstruction. (From Reference 5, with permission.)

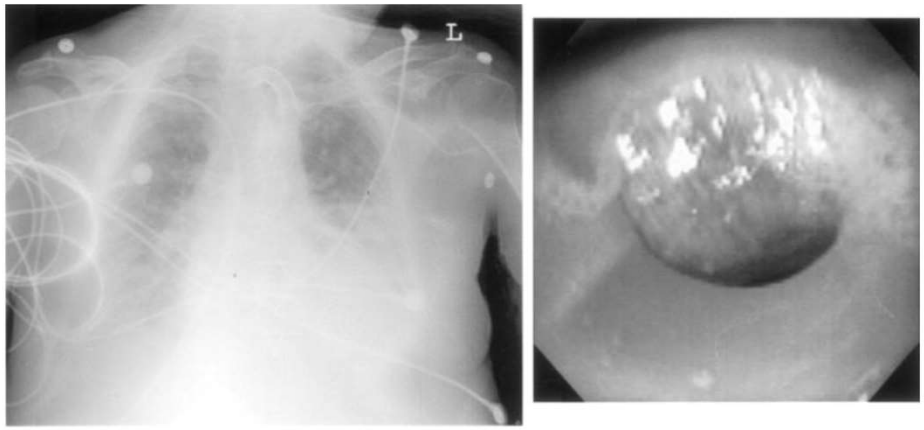
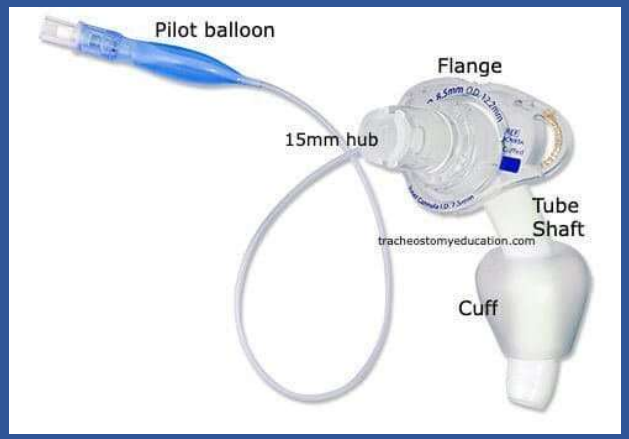
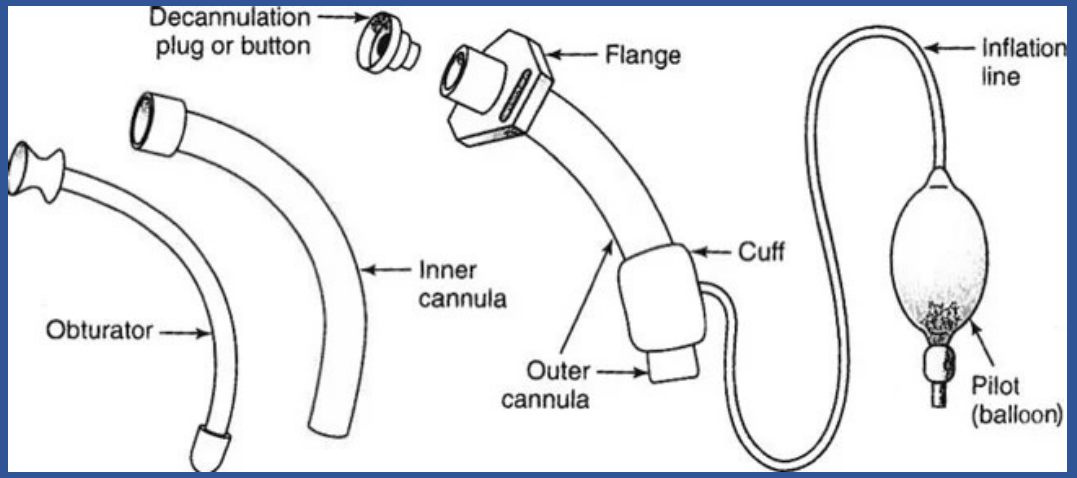


Fig. 6. A curved tracheostomy tube in which the distal end abuts the posterior tracheal wall. There is a hint of this on the anterior-posterior chest radiograph (left), and this was confirmed by bronchoscopy (right). Approaches to this problem include replacing the tube with one that is larger, angled, or of extra length.

Hess D. Respir Care 2005.

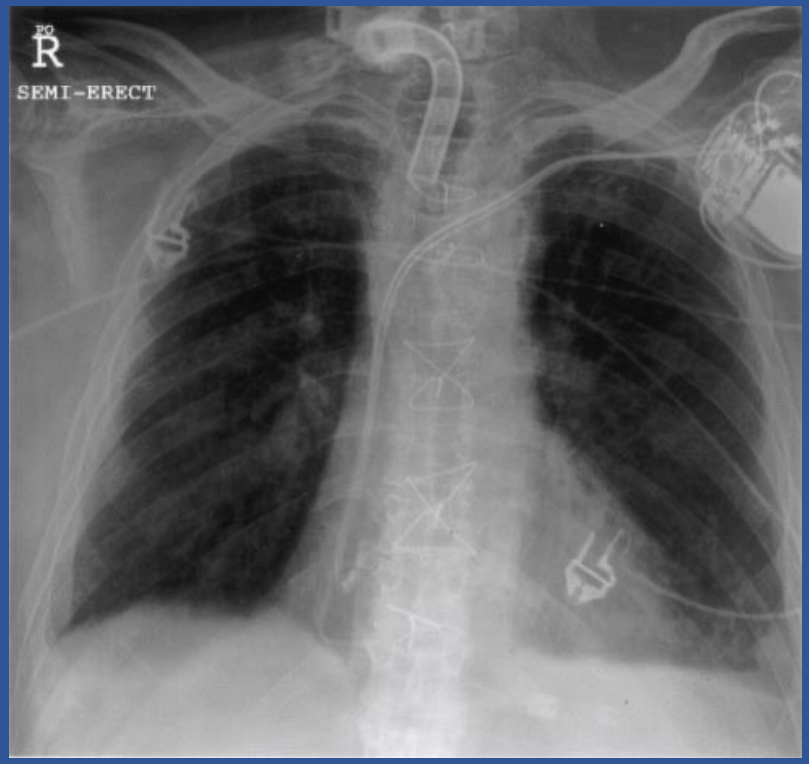
Components of a Tracheostomy Tube





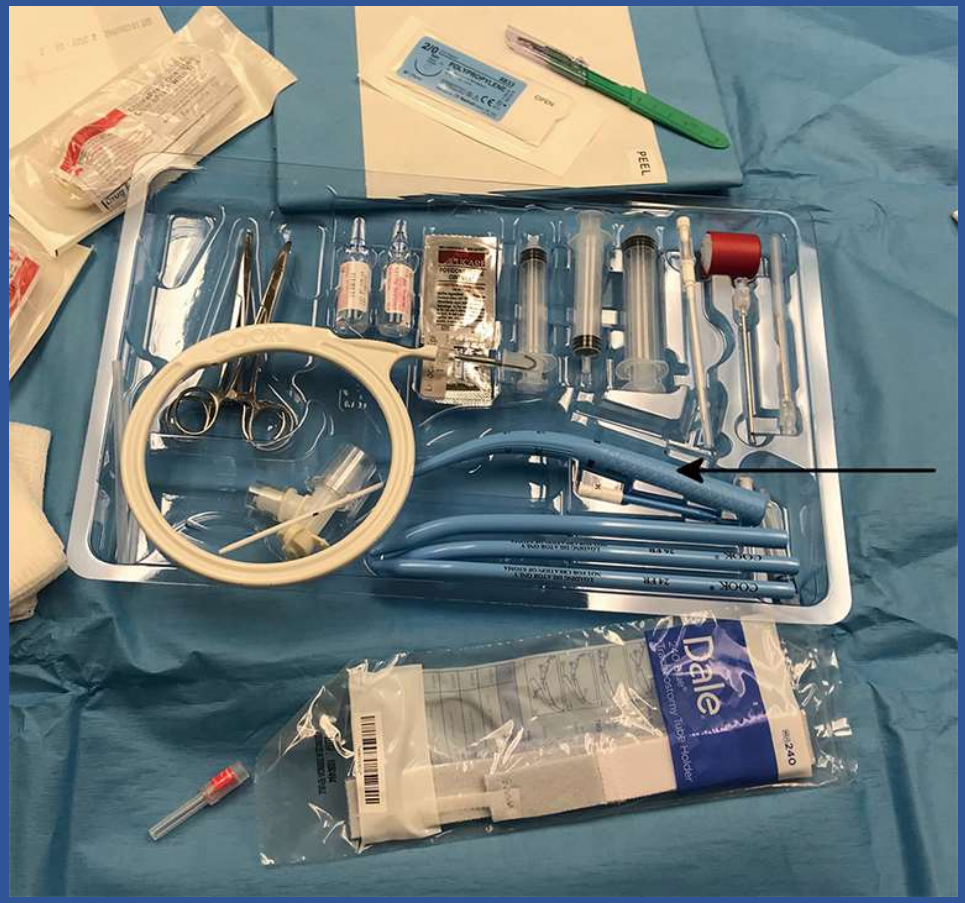
Tracheostomy Cuffs

- Tracheal capillary perfusion pressure =25–35 mm Hg.
- High tracheal-wall pressures = tracheal mucosal injury
- If cuff pressure is too low, silent aspiration is more likely.
- Recommend cuff pressure 20–25 mmHg (25–35 cmH2O) to minimize the risks for both tracheal-wall injury and aspiration.



Hess D. Respir Care 2005.

Cook® Ciaglia Blue Rhino Tracheostomy Kit



PDT Preprocedural Concerns and Special Populations/Scenarios

Obesity

Coagulopathy

Positioning

Repeat Procedures

Ventilator Settingsnts

Hemodynamics

Neuro Patients

Obesity

- Controversy in studies
- PDT - BMI > 27.5 to 30; overall complications rate was higher in obese group vs control group
- ST – BMI > 40 (89 pts); associated with an increased risk (odds ratio 4.4) of tracheostomy-related complications
- A Retrospective study of 143 pts - PDT or ST – BMI > 35; no significant difference in complication rates including mal-positioning of tracheostomy tube, loss of airway, or bleeding

** Bottom Line: PDT can be done safely in obese population with skilled operators

Byhahn C, et al. *Anaesthesia*. 2005;60(1):12-15.
El A, et al. *Crit Care R3* 2007;11.
Heyrosa MG, et al. J Am Coll Surg 2006;202:618-22.

Coagulopathy, Antiplatelet, and Anticoagulation

- Retrospective study of 42 patients, mean platelet of 26, PTT > 40, and INR > 1.5
  - 40 patients received platelet transfusion.
  - Only 2 developed major bleeding, required suturing
- Case control study of 20 patients, actively on Clopidogrel
  - Only 1 patient (5%) had minor bleeding
- Retrospective cohort study of 34 patients receiving DAPT and AC reported that PDT was not associated with severe or potentially life-threatening procedure-related bleeding.

**Bottom Line:

- Stop Clopidogrel at least 5 days if able
- Recommend INR < 1.5, platelet > 50, or platelet transfusion prior to procedure

Kluge S, et, al. Chest 2004;126:547-51 Patel, D, et al. Chest 2009;136:50S-f-S.
Abouzgheib W. er al. *J Bronchology Interv Pulmonol*. 2013;20(4):322-325.
Lusebrink E et al. Crit Care Explor 2019; 1:e0050.

Un-Extended Neck

- PDT - 88 trauma patients, C-spine cleared vs non-cleared group; no statistical difference in terms of complications and spinal cord injury from trache.
  - Success rate was 100% for the cleared group compared with 96% for the non-cleared group.

** Bottom Line: Possible to perform for pts with un-extended neck if favorable anatomy

Mayberry JC et al. Crit Care Med. 2000.

Repeat Tracheostomy

- History of previous tracheostomy and no significant peri-procedural complications

**Bottom Line: Go through the previous scar tissue or at the site of the old stroma

Meyer M, et al. *Crit Care Med*. 2002;30(5):986-988.

High Ventilator Setting

- Study of PEEP 16.6 v. 7.6 – no significant decrease oxygenation in either group.
- Retrospective study of 14 patients with PEEP > 10, FiO2 > 70% - no differences in hypoxemia, and airway loss

**Bottom Line: Retract ETT when blunt dissection and identification of tracheal ring are completed, minimized loss of PEEP

Beiderlinden M et al. *Intensive Care Med*. 2003;29(6):944-948.

Hypotension

- Avoid PDT in patients with multiple pressors or high dose of single pressor.
  - Relative contraindication

Meyer M, et al. *Crit Care Med*. 2002;30(5):986-988.
Beiderlinden M et al. *Intensive Care Med*. 2003;29(6):944-948.

Neurocritical Care Population

- Hypoventilation, hypercarbia, increased ICP, and decreased CPP can lead to secondary brain injury.

- Techniques to help mitigate these risks:
  - Appropriate ventilator setting changes
  - Use of a smaller diameter bronchoscope
  - Minimizing suctioning during bronchoscopy
  - Shortening the time the bronchoscope is in the ETT.
  - Close ICP and ETCO2 monitoring.

Ghattas C et al. JTD 2020.

Trach Timing for Stroke Patients

- There is no major advantage to performing early tracheostomy (≤5 days).

- Recent randomized trial of 382 patients with stroke
  - Early Trach did not experience improved functional outcome.
  - Early Trach may lead to unnecessary surgery.

Bosel J et al. NEJM. 2022.

PDT and COVID-19

Use of Tracheostomy During the COVID-19 Pandemic

Check for updates

American College of Chest Physicians/American Association for Bronchology and Interventional Pulmonology/Association of Interventional Pulmonology Program Directors Expert Panel Report

Carla R. Lamb, MD, FCCP; Neeraj R. Desai, MD, FCCP; Luis Angel, MD, FCCP; Udit Chaddha, MD; Ashutosh Sachdeva, MBBS, FCCP; Sonali Sethi, MD, FCCP; Hassan Bencheqroun, MD, FCCP; Hiren Mehta, MD, FCCP; Jason Akulian, MD, MPH, FCCP; A. Christine Argento, MD, FCCP; Javier Diaz-Mendoza, MD, FCCP; Ali Musani, MD, FCCP; and Septimiu Murgu, MD, FCCP

TABLE 3] General Risk Reduction Best Practices

General Risk Reduction Best Practices
1. Equipment and medications should be preplanned with checklist and procedure kits prior to entering the room.
2. Avoid using carts in the room to reduce the need to undergo decontamination. Consider a disposable bronchoscope.
3. Universal protocol and time out may be performed outside the room with procedure team followed by appropriate donning of enhanced PPE per institutional protocol.
4. Use of ultrasound to assess anatomy and point of entry (use standard decontamination protocol of durable equipment).
5. Deep sedation and neuromuscular blockers should be used for the procedure to minimize cough and agitation.
6. Before start, perform a trial of apnea to mimic apnea.
a. Withhold ventilation (apnea).
b. Discontinue positive end-expiratory pressure.
c. Increase the F_{IO_2} to prevent desaturation, for a duration of 30 s to 1 min.
If apnea is not tolerated, reduce the ventilatory pressures and respiratory frequency to minimize the risk of aerosolization. Otherwise, consider deferring the procedure until ventilatory requirements are optimized.
7. Key intervals where apnea must be performed during a traditional bronchoscopic-guided percutaneous dilational tracheostomy are as follows:
• When the bronchoscope adaptor is added to the circuit.
• Prior to inserting the bronchoscope into the ETT.
• During the pullback of the ETT with cuff deflation.
• Time of insertion of the introducer needle, angiocatheter, dilation, and insertion of the tracheostomy tube, bronchoscopic confirmation of placement, until connected to closed circuit connection with ventilator.
• Removal of the ETT from oropharynx.
8. The oropharynx and the hypopharynx may be packed. A suction tip may be placed in the mouth to lessen the risk of aerosolization of oral secretions during the ETT pullback.
9. During the procedure, place a moist gauze or sponge around the guidewire, during dilation, and neck stoma as needed.
10. Ultrasound can be incorporated into PDT to avoid the need for bronchoscopic guidance. Sonography equipment will need to be decontaminated at the end of the procedure. Additionally, a modified PDT technique with placement of bronchoscope alongside the ETT while advancing the ETT below the intended stomal point of entry might reduce aerosolization.
11. During an open tracheostomy, in addition to the aforementioned steps using apnea during ETT manipulation and prior to incision into the anterior wall of the trachea, avoid or minimize the use of diathermy and suction because it carries a risk of aerosolizing particles.
12. Place a petrolatum gauze dressing at the site of the fresh stoma until it heals to prevent aerosolization or air leak.

See Table 1 and 2 legends for expansion of abbreviations.

Lamb CR et al. Chest. 2020

The PDT Procedure

Setup

Site Selection

Ciaglia Blue Rhino Procedure

Tracheostomy Procedure Setup

Table 1 Pre-procedural preparation and recommended equipment for PDT

Patient review
Medical history
Vital signs, coagulation profile, kidney function
Medication list, including vasopressors and sedatives
Therapeutic anticoagulation was appropriately held
Indications and contraindications to PDT
Prior endotracheal intubation procedural details, ETT size, ventilator settings, and suctioning needs
CT neck or CT chest, if available
Perform US exam of the neck
Informed consent was obtained
Functional intravenous access
Medications to be readily available
Sedation
Analgesia
Neuromuscular blocker
Vasopressor
Intravenous fluid (IVF)
Recommended equipment
Ultrasound
Bronchoscope and cart
Tracheostomy kit
Variety of tracheostomy sizes
Sterile procedure equipment—gowns, gloves, drapes, chlorhexidine
Marking pen
Airway cart/box, including BVM
Electrocautery or Bovie
Shoulder roll
Sterile water
Tracheostomy sign
Adjustment of mechanical ventilation
Increase FiO_2 to 100%
Ensure adequate minute ventilation
Monitoring
Continuous pulse oximetry, capnography and ECG
Frequent blood pressure monitoring every 2–3 minutes

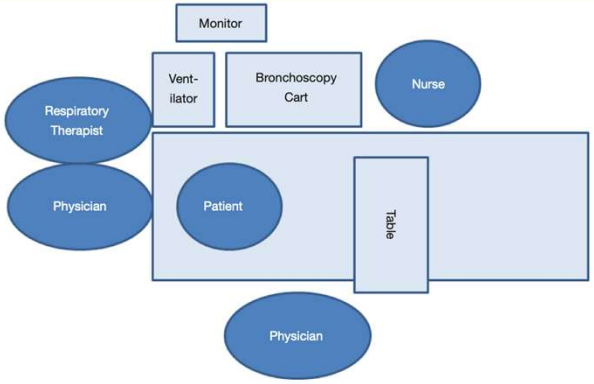


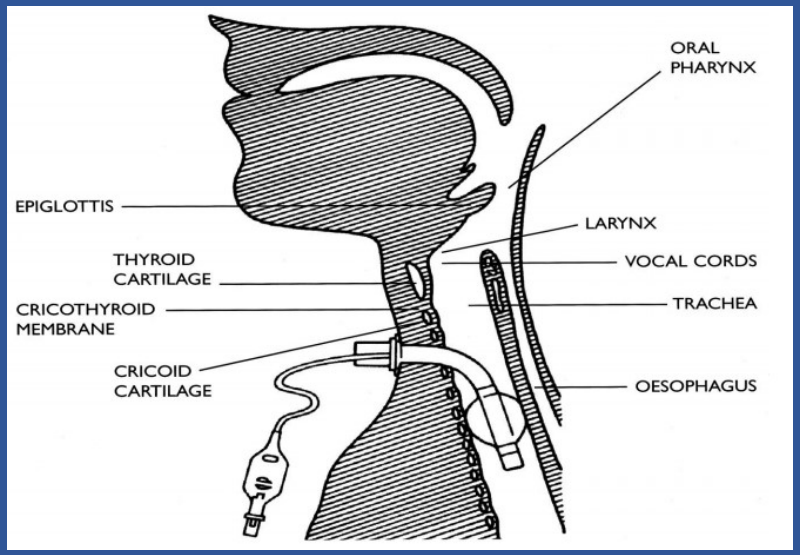
Figure 3 Optimal configuration of tracheostomy team members for bedside PDT. PDT, percutaneous dilatational tracheostomy.

Figure 1 Neck with anatomical landmarks identified.

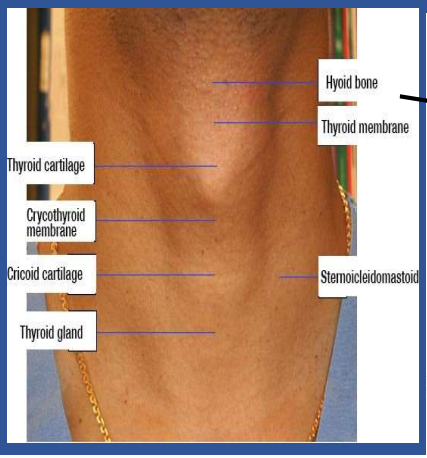
Figure 2 Neck ultrasound image performed with a linear array probe. The 1st-3rd tracheal rings are labeled. C, cricoid cartilage.

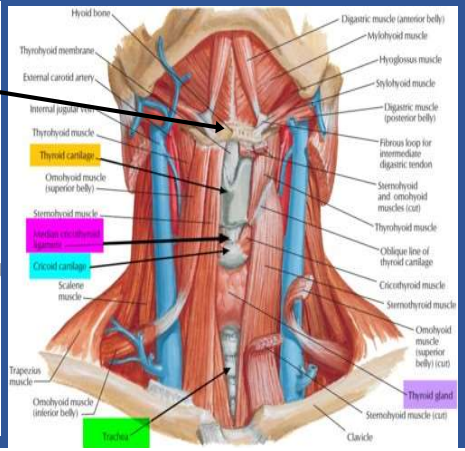
Ghattas C et al. JTD 2020.

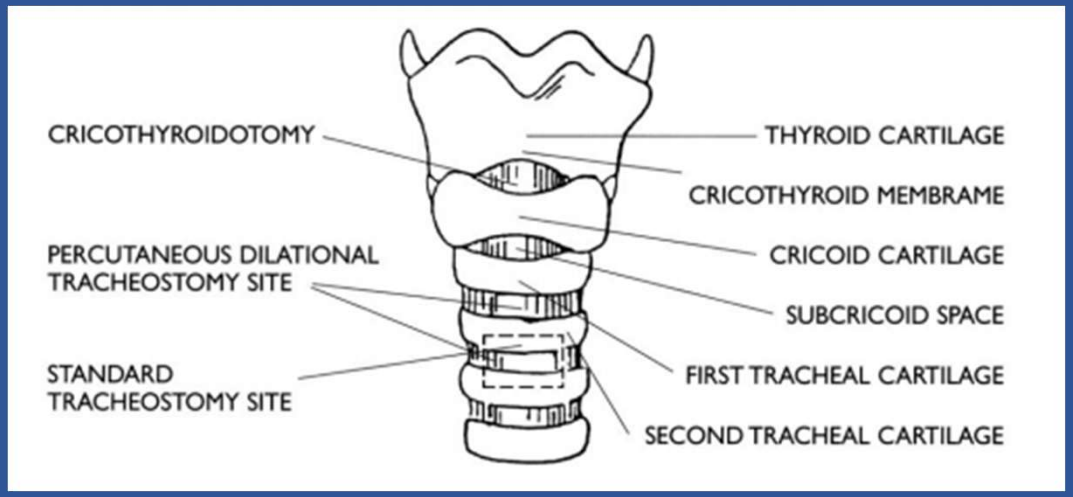
Tracheostomy Site



- Should be placed between the 2nd and 3rd tracheal rings if feasible.
- Below this level increases the risk of innominate artery bleeding.
- Placement above the 1st ring increases the risk of subglottic stenosis.







Percutaneous Tracheostomy Procedure

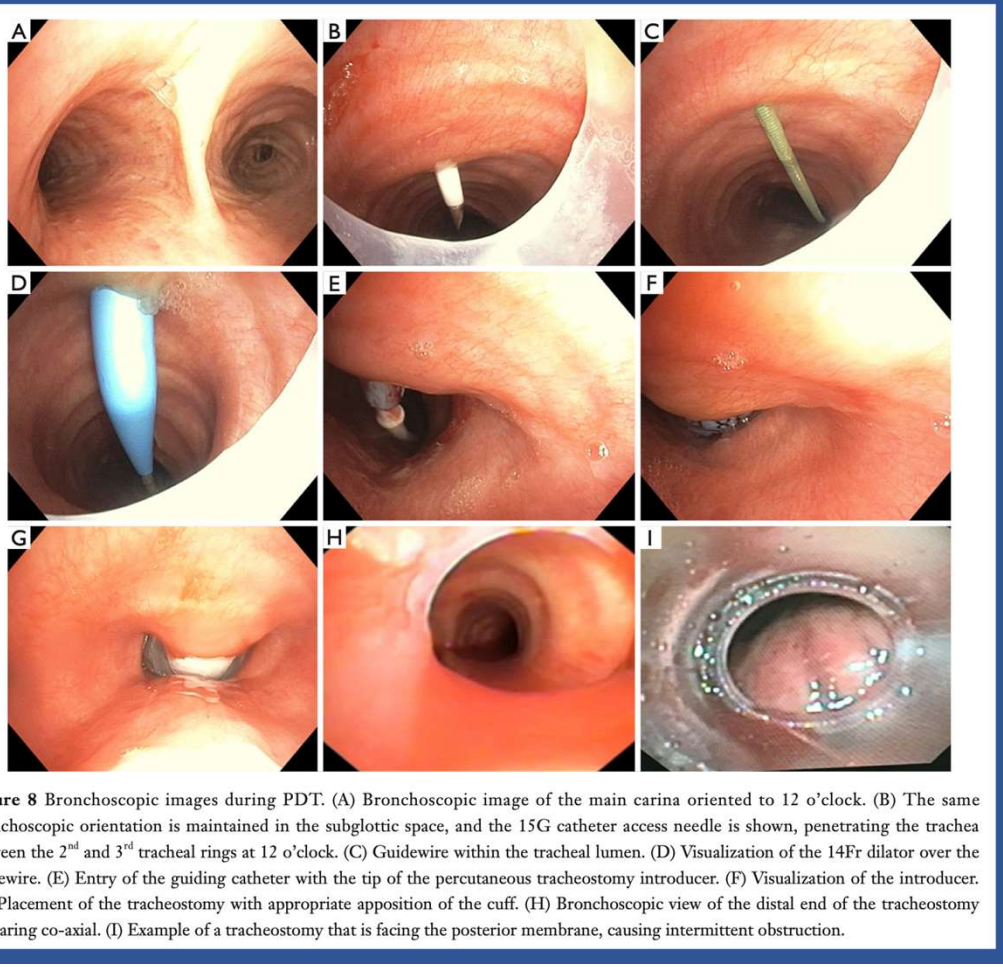
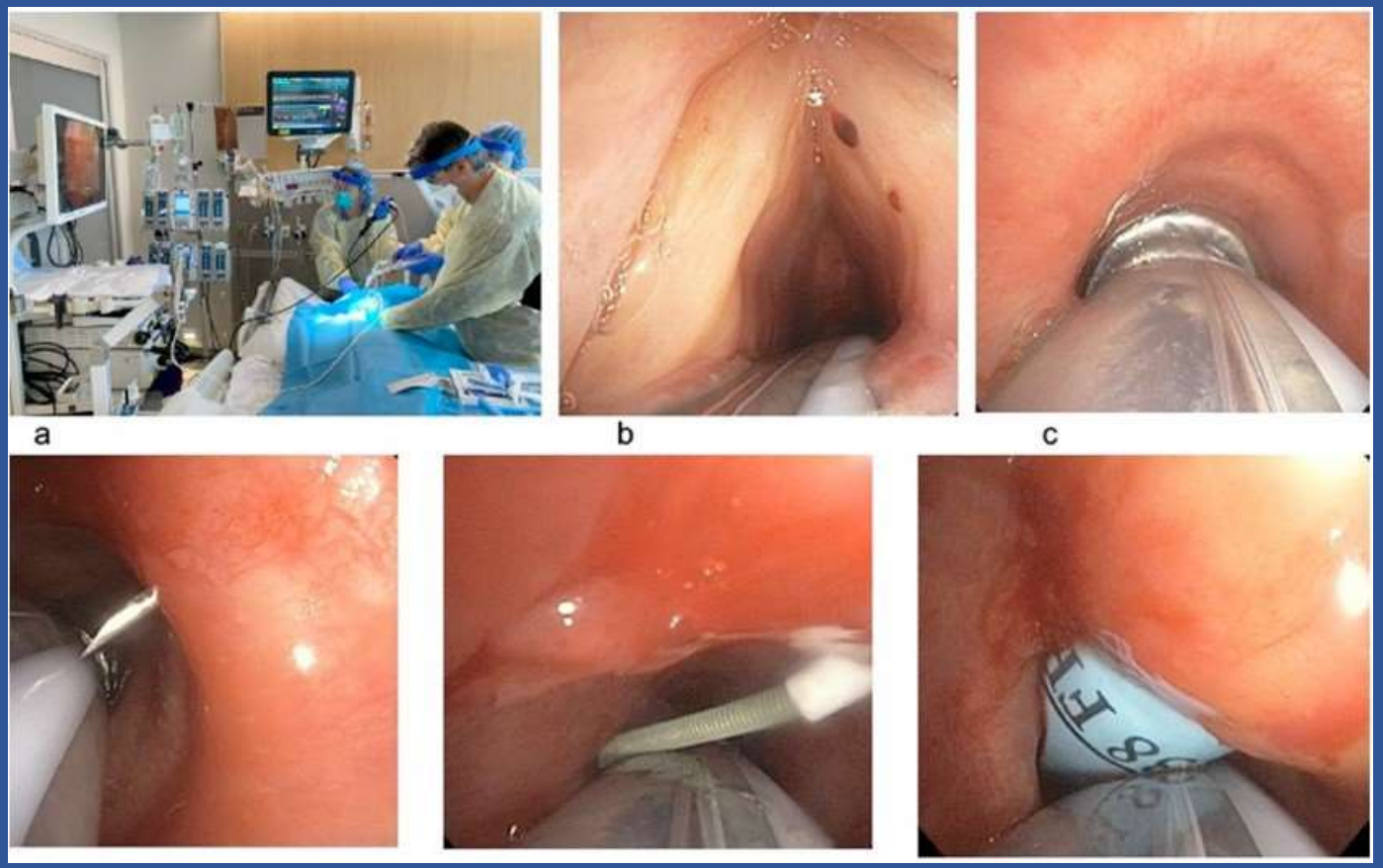


Figure 8 Bronchoscopic images during PDT. (A) Bronchoscopic image of the main carina oriented to 12 o'clock. (B) The same bronchoscopic orientation is maintained in the subglottic space, and the 15G catheter access needle is shown, penetrating the trachea between the 2nd and 3rd tracheal rings at 12 o'clock. (C) Guidewire within the tracheal lumen. (D) Visualization of the 14Fr dilator over the guidewire. (E) Entry of the guiding catheter with the tip of the percutaneous tracheostomy introducer. (F) Visualization of the introducer. (G) Placement of the tracheostomy with appropriate apposition of the cuff. (H) Bronchoscopic view of the distal end of the tracheostomy appearing co-axial. (I) Example of a tracheostomy that is facing the posterior membrane, causing intermittent obstruction.

Ghattas C et al. JTD 2020.

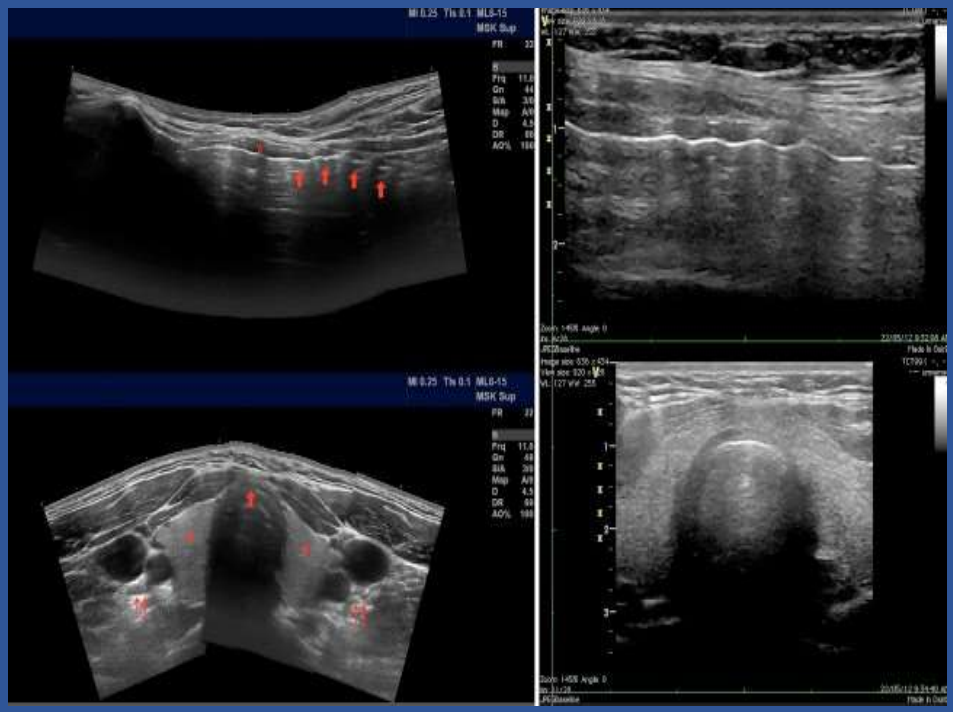
“Side Saddle” Bronchoscopic Perc Trache during COVID



Angel L, et al. *Ann Thorac Surg*. 2020;S0003-4975(20)30603-2.

Ultrasound Guided PDT

- Use to screen any pretracheal vascular structures
- Provide an estimate of skin to trachea distance
- Posterior tracheal wall cannot be visualized with ultrasound due to the tissue-air interface
- No significant difference in complication rate or procedural duration when ultrasound guided PDT is compared to bronchoscopy guided PDT (TRACHUS trial)



Rudas M, et al. *Crit Care*. 2014;18(5):514.
Gobatto AL, et al. *Intensive Care Med*. 2016;42(3):342-351.

Tracheostomy Complications

Early

Late

Complications

- Early (within 7-10 days)
  - Bleeding
    - Immediate – compression/suture/cautery
  - Obstruction
  - SQ Emphysema(1.4%)/PTX(0.8%)
    - False tract or guidewire malposition (lateral or posterior wall)
  - Infection
  - Tube Dislodgement
- Late (after 7-10 days)
  - Bleeding
    - Late – after 3-4 weeks – TIF (<1%) – avoid low trach
  - Tracheal Stenosis (3-12%)
    - Avoid Cartilage fracture
    - Avoid High trach close to cricoid cartilage – for possible future surgical repair
  - Tracheomalacia
  - TE Fistula (rare)

Tracheal Stoma Healing Concerns

- Most tracts begin to close within the first 48 hours following decannulation
  - Completely or almost completely closed by 7 days.
- If tract persists after 3-6 months → Tracheocutaneous Fistula (TCF)
- Risk factors for TCF
  - Prolonged tracheostomy
  - Corticosteroid use
  - Advanced age
  - Malnutrition
- Treatment
  - Cauterization
  - Excision
  - Rare and refractory cases, surgical closure of the fistula.

Fernandez-Bussy S et al. JOBIP 2015.
Goldenberg D et al. Otolaryngol Head Neck Surg 2000.

Tracheostomy Management

Trache Bundle

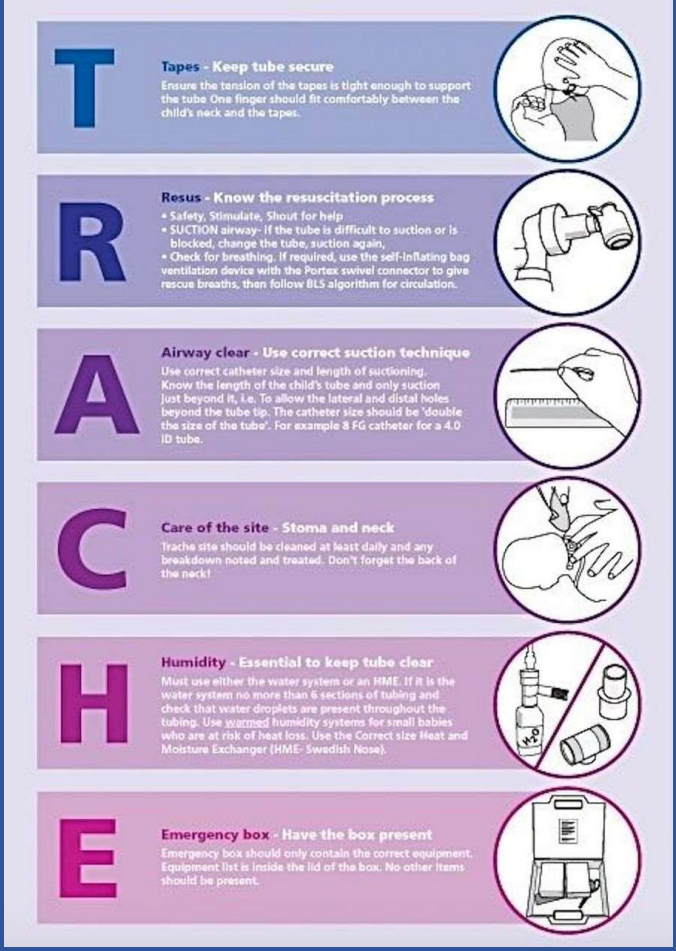
Accidental Decannulation

Cuff Leak Management

Post-Op Care

- Early
  - Monitor VS
  - Monitor for post proc complications
    - Bleeding
    - PTX
  - Suction q2-3 hrs and prn
    - Monitor for bleeding
  - Monitor cuff pressures
  - Resume prior vent settings once sedation has cleared
- Later
  - Monitor stoma for infection/bleeding
  - Change dressing 2-3X daily
  - SLP evaluation
  - Wean vent after 24 hrs
  - Can change trach 7-14 days later
  - Regular Maintenance
    - Daily inner cannula cleaning
    - Maintenance of cuff pressures (20-30cmH20)
    - Suctioning
    - Humidification

Tracheostomy Management "Trache Bundle"



- T – Tapes – Keep Tube Secure
- R – Resus – Know Resus Process
- A – Keep Airway Clear
- C – Care of Site – stoma/neck
- H – Humidity
- E – Emergency Box available

Hall A *et al. Archives of Disease in Childhood* 2017.

Accidental Tracheostomy Decannulation

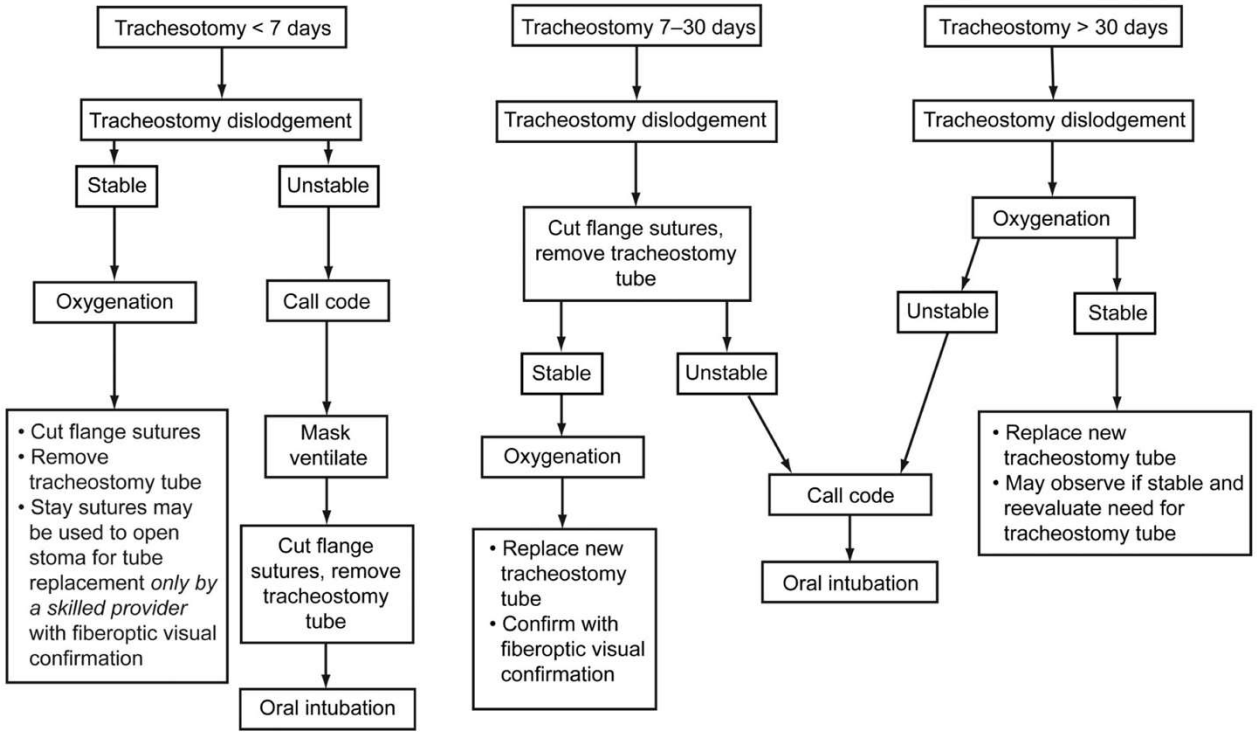


Fig. 4. Algorithm for managing unplanned tracheostomy tube dislodgement. (Adapted from illustrations courtesy of Stanley Nasraway MD, Tufts Medical Center, Boston, Massachusetts.)

Table 1. Conditions Associated With Accidental Tracheostomy Decannulation

Altered mental status
Increased pulmonary secretions
Patient changing position in bed
Lack of clinically indicated limb restraints
Inadequately secured tracheostomy tube

O'Connor H, White A. Respir Care 2010;55(8):1076 –1081.

Got a cuff leak?

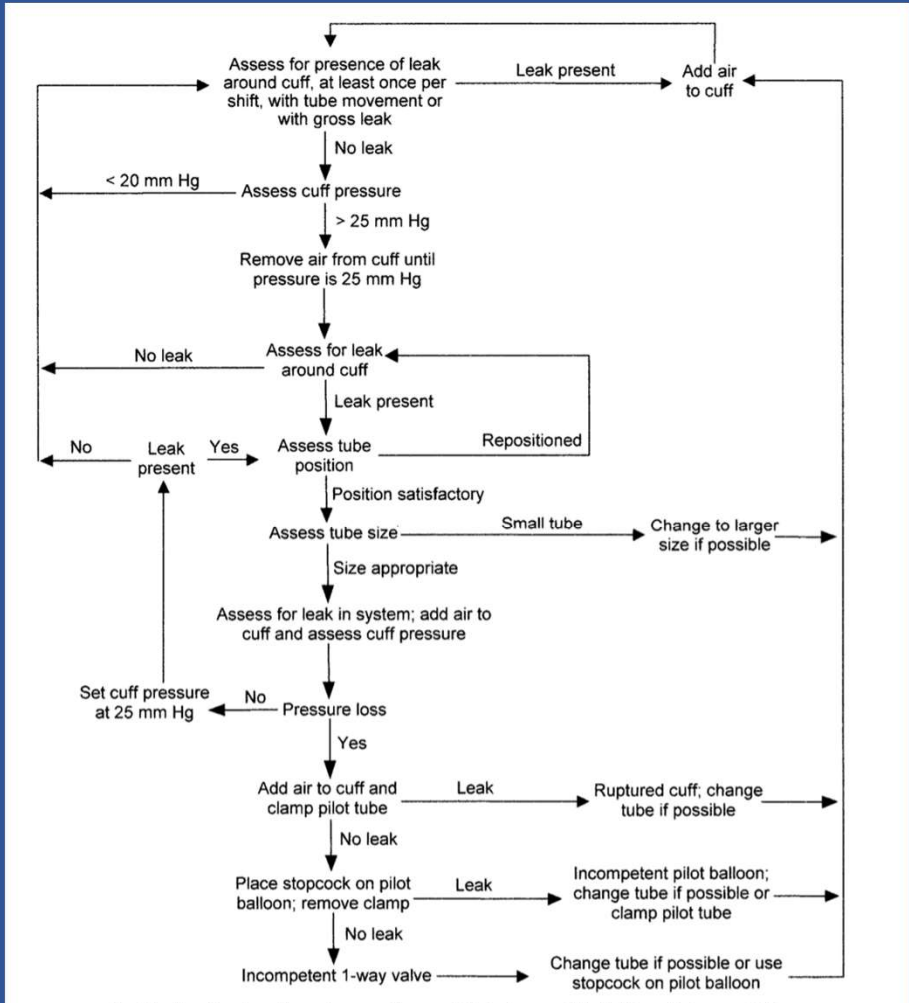


Fig. 15. Algorithm to address issues with an artificial airway cuff leak. (From Reference 18.)

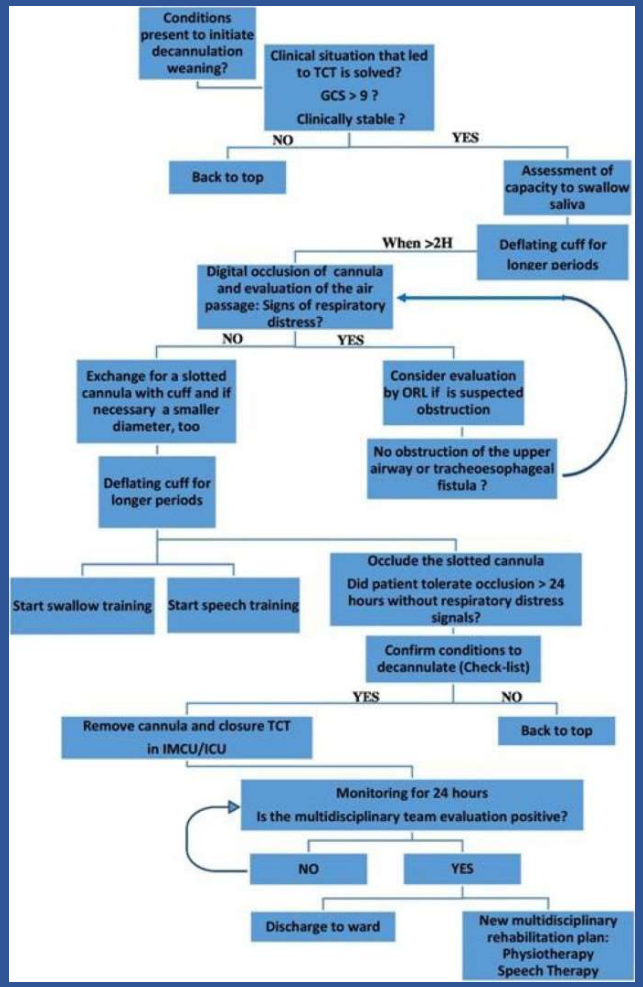
Hess D. Respir Care 2005

Tracheostomy Decannulation

De-cannulation

- Depends on institutional protocol and practice
- The process starts once the patient is weaned from MV, has strong cough and is able to clear secretions
- Downsizing > placement of speaking valve. Usually a fenestrated or cuffless tracheostomy tube
- Then, cap the trach tube for 48-72 hrs. The trach tube can be removed
- Bronchoscopic examination is indicated if the patient is unable to tolerate capping

Decannulation Assessment



Duro C et al. Int Care Med Exp. 2015.

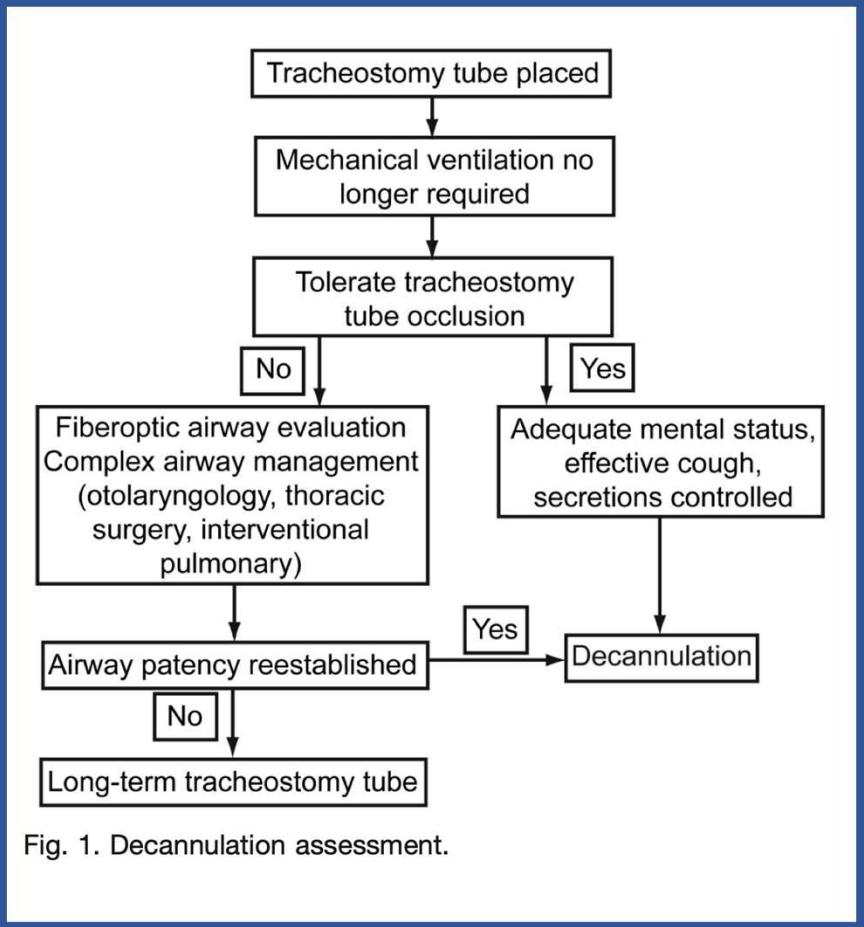


Fig. 1. Decannulation assessment.

O'Connor H, White A. Respir Care 2010;55(8):1076 –1081.

Wrapping Up

Conclusions

Conclusions

- PDT is safe and cost effective
- No different in outcomes between early and late trach placement
- Understand and be comfortable with anatomy/US/Bronch
- Choose the right trach – they are not a 1 size fits all
- Monitor patients carefully for complications
- Best way to get good – Do more and see more
- Design trach protocols

Thank you. Questions/Concerns?