

Tracheotomy

Avraham Kohanzadeh, BA, Benjamin Wajsberg BA, Meryl B. Kravitz, MD, Christina J. Yang, MD

1. General Considerations:

- A. Indications^{1,2,3}
 - a. Upper airway obstruction such as:
 - i. Vocal cord paralysis, subglottic stenosis
 - ii. Craniofacial abnormalities, micrognathia
 - b. Cardiopulmonary causes such as:
 - i. Respiratory failure, prolonged intubation, failure to extubate, bronchopulmonary dysplasia, restrictive lung disease
 - ii. Congenital heart disease, Restrictive lung disease, Pulmonary hypertension, Pneumonia
 - c. Neurological impairment, aspiration, pulmonary toilet
 - d. Trauma such as:
 - i. Maxillofacial fractures, laryngotracheal trauma, cervical spine or brain injury
 - e. Average age of children undergoing tracheostomy is 3.15 years of age.⁴
- B. Contraindications²
 - a. No absolute contraindications
 - b. Considerations: prognosis, patient/caregiver/family wishes, ventilator settings
- C. Advantages: bypass airway obstruction, ventilator management, sedation and ventilator weaning, voice.
- D. Pertinent Anatomy⁵
 - a. Anatomical landmarks:
 - i. Superior thyroid notch: Superior border of the thyroid cartilage which sits in front of the larynx and above thyroid gland. The pediatric larynx is situated more superior and anterior in the neck, at the level of the C3/C4, as compared to the adult larynx at C6/C7. As such, the hyoid bone frequently overlies thyroid cartilage notch in children.

¹ Line WS Jr, Hawkins DB, Kahlstrom EJ, MacLaughlin EF, Ensley JL. Tracheotomy in infants and young children: the changing perspective 1970–1985. *Laryngoscope* 1986;96:510–515.

² Fuller C, Wineland AM, Richter GT. Update on Pediatric Tracheostomy: Indications, Technique, Education, and Decannulation [published online ahead of print, 2021 Apr 15]. *Curr Otorhinolaryngol Rep*. 2021;1-12. doi:10.1007/s40136-021-00340-y

³ Shirawi N, Arabi Y. Bench-to-bedside review: early tracheostomy in critically ill trauma patients. *Crit Care*. 2006;10(1):201. doi:10.1186/cc3828

⁴ Carron JD, Derkay CS, Strobe GL, Nosonchuk JE, Darrow DH. Pediatric tracheotomies: changing indications and outcomes. *Laryngoscope*. 2000;110(7):1099-1104. doi:10.1097/00005537-200007000-00006

⁵ Lee, K.-J., Chan, Y., & Goddard, J. C. (2016). *K. J. Lee's essential otolaryngology: head & neck surgery*. New York: McGraw-Hill Education.

- ii. Cricoid cartilage: inferior to the thyroid cartilage. The cricoid cartilage is the major palpable landmark superiorly as the thyroid notch is often obscured. In pediatric patients the cricoid is softer and more flexible.
- iii. Sternal notch
- iv. Platysma: Superficial muscle that extends from the clavicle to angle of the mandible. This muscle functions to produce slight movements of the neck, lower lip, and mouth.
- v. Infrahyoid muscles: 4 pairs of muscles at the anterior neck: The sternohyoid, sternothyroid, thyrohyoid and omohyoid. These muscles function to depress the hyoid bone and larynx during swallowing and speech.
- vi. Thyroid isthmus: central and small part of the thyroid gland that connects the right and left lobes. It sits directly anterior to the trachea and is covered by the strap muscles.
- vii. Larynx: The structure that connects the inferior pharynx with the trachea. It extends from the epiglottis to the lower border of the cricoid cartilage, including the thyroid cartilage as well as the vestibular folds and vocal cords.
- viii. Vessels:
 - 1. Anterior jugular veins: arise near the hyoid bone and pass downward along the midline of the neck, draining into the subclavian near the sternal notch.
 - 2. Innominate artery and vein: may be visible or palpable at inferior aspect of dissection (near the sternal notch)

2. Preoperative Preparations

A. Evaluation:

- a. History
 - i. Indication for surgery
- b. Physical exam to assess indication for procedure and begin pre-operative planning
 - i. Note patient's neck anatomy with attention to accessibility of anatomic landmarks; thyroid cartilage, cricoid, sternal notch; scars and lines
 - ii. Assess risk of C-spine injury, particularly in patients with history of trauma or down syndrome. Children with down syndrome should have flexion and extension films performed prior to operation.⁶
 - iii. Special attention and planning is needed for patients with obstructive issues and compressive masses or growths.
- c. Flexible Laryngoscopy and bronchoscopy to exclude treatable causes of obstruction. This may also be done perioperatively.
- d. Chest X-ray to establish position trachea and detect pulmonary disease that may improve post-operatively. 6
- e. Selection of tracheostomy tube⁷
 - i. Pediatric tubes are single lumen and are mostly made of PVC (eg, Shiley) or silicone (eg, Bivona). Metal tubes are also available for patients with adverse reactions.

⁶ Shott SR. Down syndrome: analysis of airway size and a guide for appropriate intubation. *Laryngoscope*. 2000;110(4):585-592. doi:10.1097/00005537-200004000-00010

⁷ Fuller C, Wineland AM, Richter GT. Update on Pediatric Tracheostomy: Indications, Technique, Education, and Decannulation [published online ahead of print, 2021 Apr 15]. *Curr Otorhinolaryngol Rep*. 2021;1-12. doi:10.1007/s40136-021-00340-y

- ii. Optimal size depending on clinical indications for the procedure and size of the airway.
 - 1. Important considerations include speech, adequate air entry, easy suctioning, clearance of secretions, and ventilator dependency⁸.
 - 2. The ETT tube formula for children >1 y of age : $(\text{age in years}/4) + 4 =$ internal diameter of ETT⁹.
 - 3. An oversized tube can cause tracheal mucosa injury with ulceration, bleeding, fistulization, or stenosis.
 - 4. A tube that is too long may migrate into the right bronchus.
 - 5. Children with Trisomy 21 have much smaller airways and this should be considered when selecting an appropriately sized tube.¹⁰
- iii. Cuffed and Uncuffed tubes:
 - 1. Uncuffed tracheostomy tubes are preferred except in cases where there is a ventilatory requirement³.
- f. Consent for surgery
 - i. Complications of surgery, in general, should be disclosed and consulted with the patient such as infection, bleeding, local tissue damage, nerve injury and scarring.
 - ii. Potential complications:
 - 1. Intraoperative¹¹
 - a. Air leak: Pneumomediastinum, pneumothorax
 - b. Acute hemorrhage: thyroid gland, innominate artery
 - c. Injury to local structures: Recurrent laryngeal nerve injury, esophagus, cricoid cartilage
 - d. Creation of false passage or tracheal tear
 - 2. Early Postoperative Complications¹²
 - a. Hemorrhage
 - b. Accidental early decannulation
 - c. Dysphagia and aspiration
 - d. Wound infection
 - e. Tube/ventilation obstruction (most likely a mucous plug)
 - f. Subcutaneous emphysema
 - g. Pneumothorax
 - 3. Late postoperative complications^{13,14}
 - a. Tube/ventilation obstruction
 - b. Accidental decannulation: minimized by stay sutures

⁸ Watters KF. Tracheostomy in Infants and Children. *Respir Care*. 2017;62(6):799–825. doi:10.4187/respcare.05366

⁹ Singh NC et al, Physiological responses to endotracheal and oral suctioning in paediatric patients: the influence of endotracheal tube sizes and suction pressures. *Clin Intensive Care*. 1991; 2: 345-350.

¹⁰ Shott SR. Down syndrome: analysis of airway size and a guide for appropriate intubation. *Laryngoscope*. 2000;110(4):585-592. doi:10.1097/00005537-200004000-00010

¹¹ Carr MM, Poje CP, Kingston L, Kielma D, Heard C. Complications in pediatric tracheostomies. *Laryngoscope*. 2001;111(11 Pt 1):1925–1928. doi:10.1097/00005537-200111000-00010

¹² Gumussoy M. Pediatric Tracheotomy: Comparison of surgical technique with early and late complications in 273 cases. *Pak J Med Sci*. 2019;35(1):247-251. doi:10.12669/pjms.35.1.132

¹³ Gumussoy M. Pediatric Tracheotomy: Comparison of surgical technique with early and late complications in 273 cases. *Pak J Med Sci*. 2019;35(1):247-251. doi:10.12669/pjms.35.1.132

¹⁴ Carr MM, Poje CP, Kingston L, Kielma D, Heard C. Complications in pediatric tracheostomies. *Laryngoscope*. 2001;111(11 Pt 1):1925–1928. doi:10.1097/00005537-200111000-00010

- c. Suprastomal and tracheal granuloma
- d. Subglottic or tracheal stenosis
- e. Suprastomal collapse
- f. Tracheocutaneous fistula following decannulation
- g. Aspiration pneumonia
- h. Ventilator failure due to tube leak

3. Nursing Considerations

- A. Room Setup:
 - a. See Basic Soft Tissue Room Setup
 - i. Use ENT supply pack instead of basic soft tissue pack
- B. Instrumentation and Equipment
 - a. Standard:
 - i. Tracheostomy Tray
 - ii. Bipolar Forceps Tray
- C. Medications (Specific to nursing)
 - a. 0.5% lidocaine with 1:100,000 epinephrine
 - b. 4% lidocaine, plain
- D. Prep and Drape
 - a. Standard prep, 10% povidone iodine
 - b. Drape
 - i. Towels to square off incision site on neck, from chin to chest, from shoulder to shoulder
 - ii. Tape patient's eyes and mouth guard or wet gauze to protect the teeth
 - iii. Clear sterile drape used over the head around the mouth, improving anesthesia and access to endotracheal tube
 - iv. Split sheet
 - c. Consider a shoulder roll and donut to improve exposure
- E. Special considerations:
 - a. Have variety of types and sizes of tracheostomy tubes available
 - b. If using a cuffed tracheostomy tube, test it by inflating the cuff and placing it in a cup of water. If bubbles are seen the tube is faulty.
 - c. Moisten the tube with saline before handing it to the surgeon for insertion.
 - d. Sutures and a trach tie will be used to keep the tracheostomy tube in place. A drain sponge will also be placed.
 - e. Ensure the obturator is with the patient when leaving the room.

4. Anesthesia Considerations^{15,16}

- A. General
 - a. Surgery performed under general anesthesia. In some patients, it may be necessary to perform the operation using only local anesthetic.

¹⁵ Cochrane LA, Bailey CM. Surgical aspects of tracheostomy in children. *Paediatr Respir Rev.* 2006;7(3):169-174. doi:10.1016/j.prrv.2006.06.005

¹⁶ Fuller C, Wineland AM, Richter GT. Update on Pediatric Tracheostomy: Indications, Technique, Education, and Decannulation [published online ahead of print, 2021 Apr 15]. *Curr Otorhinolaryngol Rep.* 2021;1-12. doi:10.1007/s40136-021-00340-y

- b. Although patients are typically endotracheally intubated, a rigid ventilating bronchoscope can be used to keep the airway open in unstable circumstances.
- c. Mask ventilation can be used in specific patients where intubation is not feasible.
- d. Compared to adults, pediatric patients have a significantly reduced oxygen reserve capacity and the anesthesia team should be prepared to respond and restore airway access in emergencies.
- e. The patient is placed in a supine position, with the neck hyperextended. In most cases, the bed will be turned 180° counterclockwise from the anesthesiologist.

5. Operative Procedure^{17, 18}

- A. Position the operating table towards the anesthesiologist as the ET tube will require repositioning later during the surgery.
- B. With the patient in the supine position, situate a sandbag or jelly roll beneath the shoulders to secure the head and neck in a midline stance.
- C. With the patient's neck hyperextended, palpate, identify and mark the hyoid bone, cricoid cartilage and suprasternal notch. Mark the skin, midway between the cricoid cartilage and suprasternal notch. The incision will be made midway between these two landmarks (corresponding with the 2nd and 3rd tracheal rings).
- D. Inject the planned incision site with roughly 0.5cc of 0.5% lidocaine with 1:100,000 epinephrine
- E. Drape and prepare the patient for operation in a sterile manner
- F. A vertical incision is made 1cm above the suprasternal notch, midway between the aforementioned landmarks, cutting through the skin and platysma. In infants and smaller children, a vertical skin incision is utilized to minimize the need for dissection lateral to the trachea, reducing the risk of pneumothorax through damage to the superiorly positioned pleural apices. The risk of this occurring in older children is reduced and a horizontal skin incision is preferred due to better cosmetic outcomes.
- G. Dissection is continued midline, through the deeper fat and platysma layers, using bipolar cautery to ensure the surgical field is kept dry and to expose deeper tissues. Depending on the size of the patient, tissue layers may be retracted laterally using either Sen retractors or an Arm-Navy.
- H. If necessary, the anterior jugular vein can be laterally retracted or ligated using the bipolar cautery.
- I. Relocate and identify the trachea through palpation in order to prevent unintended injury to local structures in the area.
- J. Continue to dissect until the underlying strap muscles are reached and exposed. Using both electrocautery and blunt scissor dissection techniques, divide the strap muscles vertically along the median raphe and retract them laterally to expose the thyroid isthmus and trachea. Superior to the thyroid isthmus will be the cricoid cartilage. In older children, the cricoid cartilage is typically visible, while in neonates it can sometimes only be identified through direct palpation of the cricoid prominence using fine curved artery forceps.
- K. The deep cervical fascia is encountered, with the thyroid isthmus overlying the trachea. The isthmus should be dissected free from the trachea and surrounding soft tissue. A small area

¹⁷ Cochrane LA, Bailey CM. Surgical aspects of tracheostomy in children. *Paediatr Respir Rev.* 2006;7(3):169-174. doi:10.1016/j.prrv.2006.06.005

¹⁸ Fuller C, Wineland AM, Richter GT. Update on Pediatric Tracheostomy: Indications, Technique, Education, and Decannulation [published online ahead of print, 2021 Apr 15]. *Curr Otorhinolaryngol Rep.* 2021;1-12. doi:10.1007/s40136-021-00340-y

of the cricoid can be skeletonized to expose a plane along the airway, deep to the isthmus. A clamp may then be used to slide along this plane, in a superior to inferior fashion. The isthmus can then be lifted off the airway and safely divided. Hemostasis can be achieved with cautery or via suture ligation of the divided isthmus bilaterally.

- L. Identify the anterior tracheal wall and proceed to clean off any remaining soft tissue from the tracheal surface.
- M. Two stay sutures, using 4-0 prolene, nylon, or vicryl, are vertically placed in the submucosal plane, on either side of the midline tracheotomy, between tracheal rings 2 and 4. A cricoid hook may also be used to pull the cricoid superiorly, stabilizing the laryngotracheal complex.
- N. The anesthesia team is notified that the tracheal incision will be performed. If the ET tube is cuffed, it is advanced or deflated by the Anesthesia team.⁶
- O. A vertical incision is made through the 2nd and 3rd and tracheal rings at midline.
 - a. Cauterization with bipolar cautery for hemostasis may be necessary - notify Anesthesia as FiO₂ of inhalational agents may be volatile.
- P. Use a hemostat or tracheal (Trusseau) dilator to dilate the incision to visualize the lumen and prepare it for the tracheostomy tube.
- Q. The anesthesiology team will deflate the cuff of the endotracheal tube and retract it to just above the tracheal incision and below the vocal cords.
- R. The tracheostomy tube is placed in the tracheal lumen using the obturator. The obturator is removed and the tube is connected to the ventilatory circuit, confirming position with end-tidal carbon dioxide return on the capnograph.
- S. Once end-tidal is confirmed, the retractors and cricoid hook are removed.
- T. A flexible bronchoscopy is performed to confirm the position of the tip of the tracheostomy tube 2 -3 rings above the carina and the absence of blood or mucus in the lower airway.
- U. Depending on the size of the incision and the tracheostomy tube, the lateral aspects of the incision may need to be sutured to prevent air leakage.
- V. The tracheostomy is secured around the neck under the surgeon's discretion of tracheostomy ties, skin suture, or combination of the two.
- W. Remove the shoulder roll from beneath the patient's shoulders and place the neck in a flexed position prior to applying tape to secure the tracheostomy tube.
- X. A drain sponge may be placed around the tube to collect secretions.
- Y. The stay sutures should be labeled left and right and be easily accessible and secured. They are often taped to the patient's chest wall.
- Z. Following the operation, auscultate the chest to make certain there is uniform air entry bilaterally.

6. Postoperative Care¹⁹

- A. Operative dictation template
- B. Surgical Video
- C. Post-operative Care
 - a. The patient should undergo a chest radiograph in the immediate postoperative period, to confirm correct placement and length of the tracheostomy tube and to ensure there is no pneumothorax.
 - b. The patient should be admitted to a supervised setting prior to the first tracheostomy tube change.

¹⁹ Cochrane LA, Bailey CM. Surgical aspects of tracheostomy in children. *Paediatr Respir Rev.* 2006;7(3):169-174. doi:10.1016/j.prrv.2006.06.005

- i. The patient's obturator and second back-up tracheostomy tube should always be accessible in case of accidental decannulation requiring urgent tracheostomy tube replacement.
- ii. Ensure air humidification
- iii. Suction tube every 4 hours and as needed
- iv. Assess neck skin every 4 hours for signs of symptoms of infection and breakdown. A barrier dressing may be applied to prevent skin breakdown.
- v. Head of bed elevated 30 degrees (VAP prevention bundle)
- c. The timing of the first tracheostomy tube change is at the discretion of the surgeon, most commonly between 5 and 7 days. 6
- d. Prior to discharge from the hospital, the caregivers must be educated and comfortable in routine care of the tracheostomy tube.

7. Suggested Reading/Additional Information

- a. Mitchell RB, Hussey HM, Setzen G, et al. Clinical consensus statement: tracheostomy care. *Otolaryngol Head Neck Surg.* 2013;148(1):6–20. doi:10.1177/0194599812460376
- b. Watters KF. Tracheostomy in Infants and Children. *Respir Care.* 2017;62(6):799–825. doi:10.4187/respcare.05366
- c. Fuller C, Wineland AM, Richter GT. Update on Pediatric Tracheostomy: Indications, Technique, Education, and Decannulation [published online ahead of print, 2021 Apr 15]. *Curr Otorhinolaryngol Rep.* 2021;1-12. doi:10.1007/s40136-021-00340-y

D. CPT Codes²⁰:

1. Tracheotomy:

Documentation of CPT codes must distinguish between tracheostomies that were planned vs. emergencies. The utilized technique during surgery, percutaneous vs. conventional or open, in addition to the incision site, transtracheal vs. over the cricothyroid membrane, must be distinguished when documenting CPT codes.

Example CPT Codes:

- a. 31600 - Tracheostomy, planned (separate procedure). Also used for “percutaneous” tracheostomy procedures
- b. 31601 - Tracheostomy, planned (separate procedure), in children under 2 years of age. Also used for “percutaneous” tracheostomy procedures
- c. 31603 - Tracheostomy, emergency procedure; if the initial incision made in the neck is transtracheal
- d. 31605 - Tracheostomy, emergency procedure; if the initial incision made in the neck is over the cricothyroid membrane

2. Tracheostomy Changes:

- a. 31502 - Tracheostomy tube change before fistulous tract formation

²⁰ Esposito T, Reed R, Adams RC, et al. Acute Care Surgery Billing, Coding and Documentation Series Part 2: Postoperative Documentation and Coding; Documentation and Coding in Conjunction with Trainees and Advanced Practitioners; Coding Select Procedures *Trauma Surgery & Acute Care Open* 2020;5:e000586. doi: 10.1136/tsaco-2020-000586