Pediatric Tracheostomy

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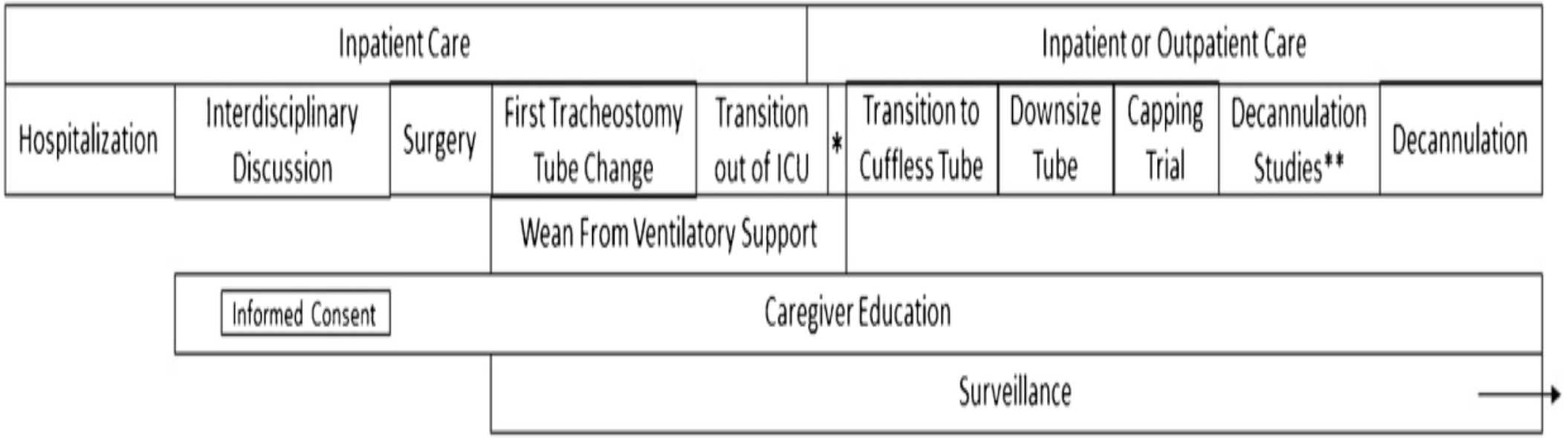
A tracheostomy is a surgical opening into the trachea below the larynx through which an indwelling tube is placed to overcome upper airway obstruction, facilitate mechanical ventilator support and/or the removal of tracheo-bronchial secretions.

Tracheostomy is estimated to be performed in about **0.2%** of pediatric inpatient stays



Indications

- For bypassing acute or chronic upper airway obstruction
- Final step in the management of severe obstructive sleep apnea (OSA)
- Require long-term mechanical ventilation.
- In patients who have poor secretion management and chronic aspiration, a tracheostomy will provide access to deep pulmonary suctioning
- In patients with either congenital or iatrogenic subglottic stenosis

Indications

- Retrospective studies have shown that **the incidence of tracheostomy in children is gradually increasing** (increases in patient population and widening participation in administrative databases.)
- Cardiopulmonary and neurologic indications for tracheostomy have seen the greatest rise over 30 years.
- Craniofacial and traumatic indications for surgery have demonstrated only modest increases.

Indications

The most common indication varies **with the age of the patient**:

- Children with complicated **cardiopulmonary, craniofacial, or upper airway conditions** were likely to undergo tracheostomy between the ages of **4 to 6 months**
- Patients with **neurological disorders or trauma** receive a tracheostomy between the ages of **2 to 3 years**.

Predictors of Mortality

- Most of these studies report mortality rates of **10– 20% for all-cause** after at least 1 year, while one study reported a mortality rate prior to discharge of **8.6%**
- Tracheostomy-specific mortality is low, at rates reported from **0–3.5%**
- All of these were related to either **mucus plugging** or **accidental decannulation**

Tracheostomy Timing

- Although there is consensus that tracheostomy has to be performed in 1 or 2 weeks of ventilation in adult patients, ***no established criteria currently exist regarding time to tracheostomy for children***, and thus each patient is evaluated ***individually.***
- There is no definite consensus about the length of time a child should remain endotracheally intubated before the placement of a tracheostomy.

Tracheostomy Timing

- Previous studies have reported a large variation in tracheostomy placement ranging from 4.3 to 90 days after prolonged ventilation in the pediatric population.
- In a large retrospective study in the United States involving 82 PICUs, on average 6.6% of pediatric admissions received tracheostomy, with high variability in the timing of tracheostomy, ranging from 4.3 to 30.4 days across the units.
- In another study where the frequency of tracheostomy placement was 2% of all pediatric admissions across 29 PICUs in the United Kingdom, the timing was reported to be anywhere from 14 to 90 days after initiation of MV.

Tracheostomy Timing

- A recent survey of Canadian pediatric intensivists, neonatologists, pulmonologists, and otolaryngologists revealed that practice patterns have shifted toward **recommending earlier tracheostomy** compared to 11 years prior

Meta-Analysis › Crit Care Med. 2020 Feb;48(2):233-240. doi: 10.1097/CCM.0000000000004114.

Timing of Tracheostomy in Pediatric Patients: A Systematic Review and Meta-Analysis

Ahmed Abdelaal Ahmed Mahmoud M Alkhatip [1,2], Mohamed Younis [3], Negar Jamshidi [4], Hazem A Hussein [1], Ehab Farag [1], Mohamed K Hamza [5], Mahmoud H Bahr [1], Ahmed Goda Ahmed [1], Amr M Sallam [6], Ilassan Mohamed [5], Mohamed Elayashy [5], Hisham Hosny [5,7], Hany M Yassin [8], Mohamed Abdelhaq [5], Mohamed A Elramely [9], David Reeves [10], Kerry E Mills [11], Ahmed M Kamal [5], Dina Zakaria [5]

Affiliations + expand

PMID: 31939793 DOI: 10.1097/CCM.0000000000004114

Author et al. [Year]	Study Design	Early Tracheostomy (ET)							Late Tracheostomy (LT)						
		n	Mean age	Mean age at ET	ET at (Weeks/ Days)	Mortality	MV Days	LOS (days)	*n*	Mean age	Mean age at ET	ET at (Weeks /Days)	Mortality	MV Days	LOS (days)
Pizza [2017](22)	retrospective	37	0-17 years	6.2 (1.1, 11.4)[1]	≤10 D	3 (8.1%)	5.0 (1.0,8.0)[1]	17.0 (11.5, 29.0)**	33	0-17 years	1.4 (0.0, 13.6)[1]	>10 D	3 (9.1%)	17.0 (14.0, 23.0)[1]	18.0 (14.0, 28.0)**
Lee [2016](23)	retrospective	61	<18 years	1.4 years (0.5–7.9)[2]	<14 D	24 (39.3%)	8.9 (5.7–13)[2]	58.0 (27.5–100)[2]	50	<18 years	1.0 year (0.5–6.9)[2]	≥14 D	22 (44%)	32.2 (20.2–61.5)[2]	114.0 (60.0–168)[2]
Holloway [2015](24)	retrospective cohort	24	23 months (8, 107)	17 months (7,123)[1]	<14 D	1	22 (11,35)[1]	32 (25.5, 47.5)[1]	49	23 months (8, 107)[1]	24 months (8,101)[1]	≥14 D	1	22 days (11,35)[1]	62 (45, 108)[1]
Holscher [2014](25)	retrospective cohort	43	<18 years	14 Years (13–16)[2]	≤7 D	2 (5%)*	14 (11-17)[2]	26 (22–30)[2]	48	<18 years	13 Years (11–14)[2]	>7 D	10 (21%)*	21 (18–24)[2]	37 (29–50)[2]
Lipový [2013](26)	retrospective	18	≤ 18 years	0-18 years	≤3 D	NR	8.89 ± 0.83[3]	47.11± 5.7[3]	13	≤ 18 years	0-18 years	>3 D	NR	11± 1.1[3]	62.08 ± 11.03[3]
Olton [2009](27)	retrospective	7	<17 years	9 years (1,25)[1]	≤10 D	14%	15.7 ± 2.4[3]	52.8± 18.3[3]	10	<17 years	13 years (8.5,46.5)[1]	>10 D	40%	26.1 ± 6.3[3]	79.3± 15.2[3]

- While the early tracheostomy group had statistically significant **reductioin** days of mechanical ventilation, ICU stay, hospital stay, and hospital-acquired pneumonia, the **improvement in risk of mortality did not reach** statistical significance.
- Early tracheostomy was recommended, suggesting that it may have significant benefits without adversely affecting mortality.

- Thus, after 2 weeks of intubation in a child, one should consider tracheostomy evaluation, provided the child is stable on the ventilator

Tracheostomy Sizing

- The size of the tracheostomy tube in children is very important.
- Tracheostomy tubes are labeled according to the size of their inner diameter in millimeters and are generally available in half sizes.
- Most manufacturers provide both shorter (neonatal) and longer (pediatric) tube lengths.
- Generally, the smallest tube capable of giving adequate air exchange is chosen.
- A larger diameter tube may be required for ventilator-dependent patients to prevent significant air leak

Tracheostomy Sizing

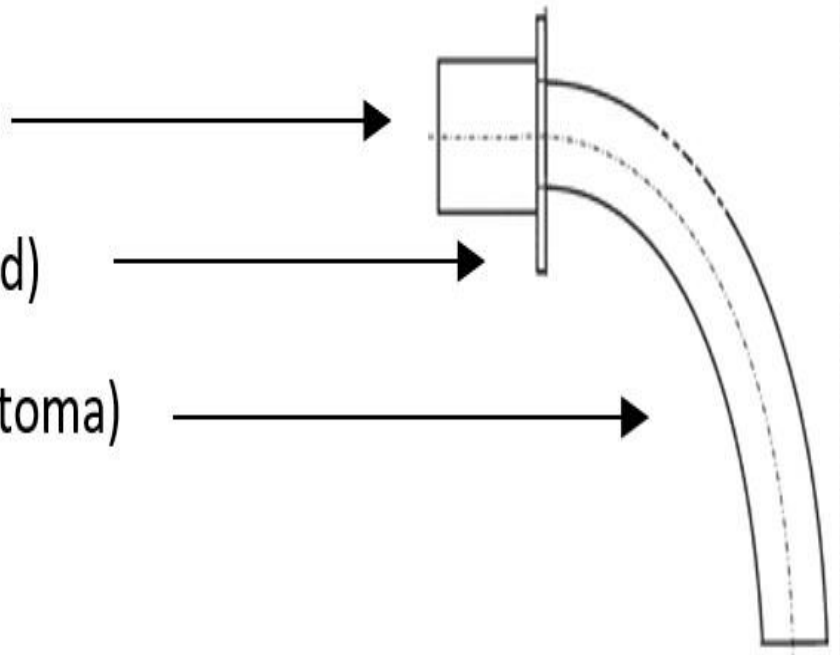
- An age-appropriate tracheostomy tube size can be estimated by using the endotracheal tube **(ETT) formula for children 1 y of age:**

(age in years/4) 4 mm internal diameter of ETT

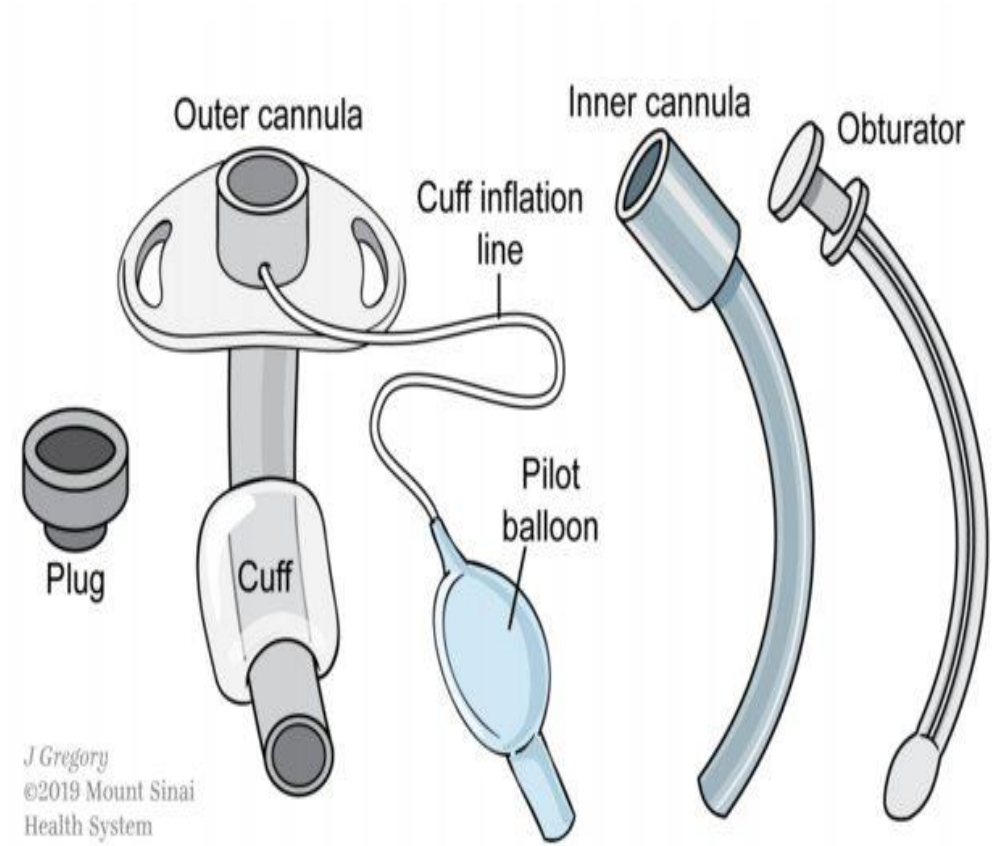
This can then be converted to the appropriately sized tracheostomy tube

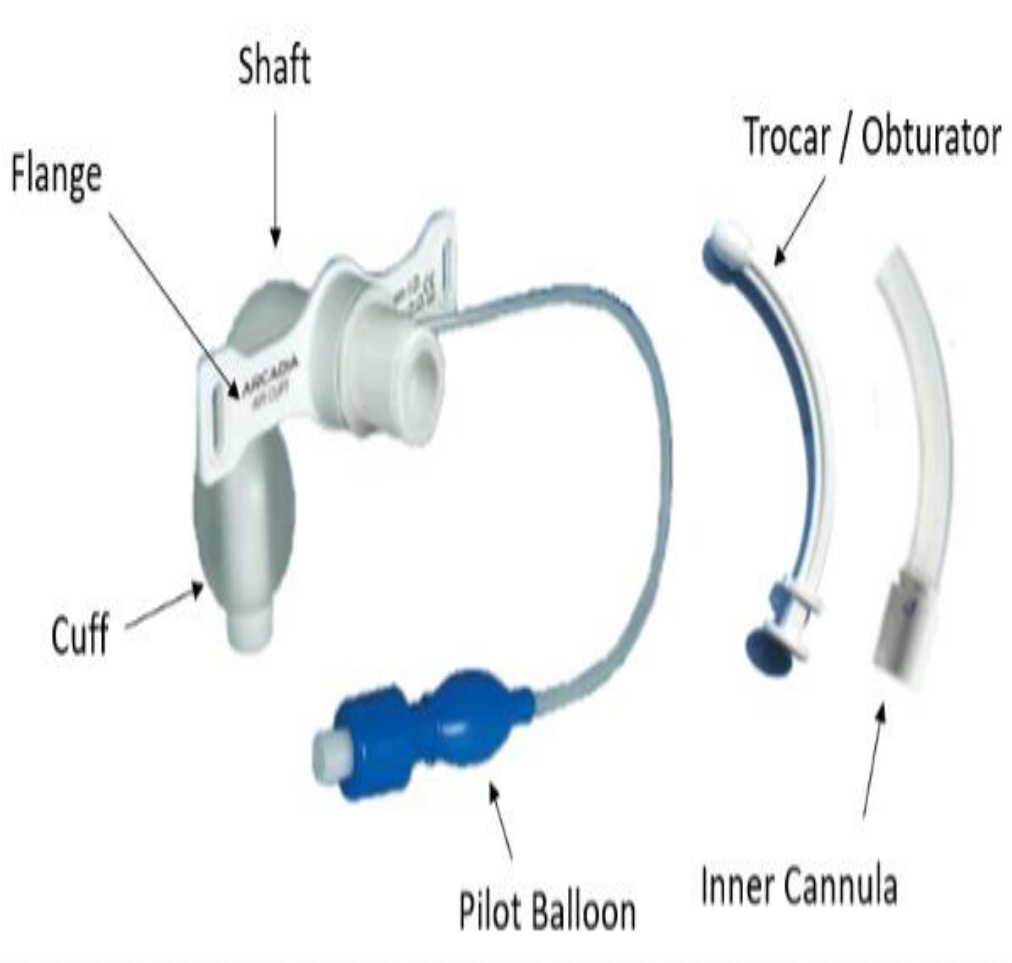
They have:

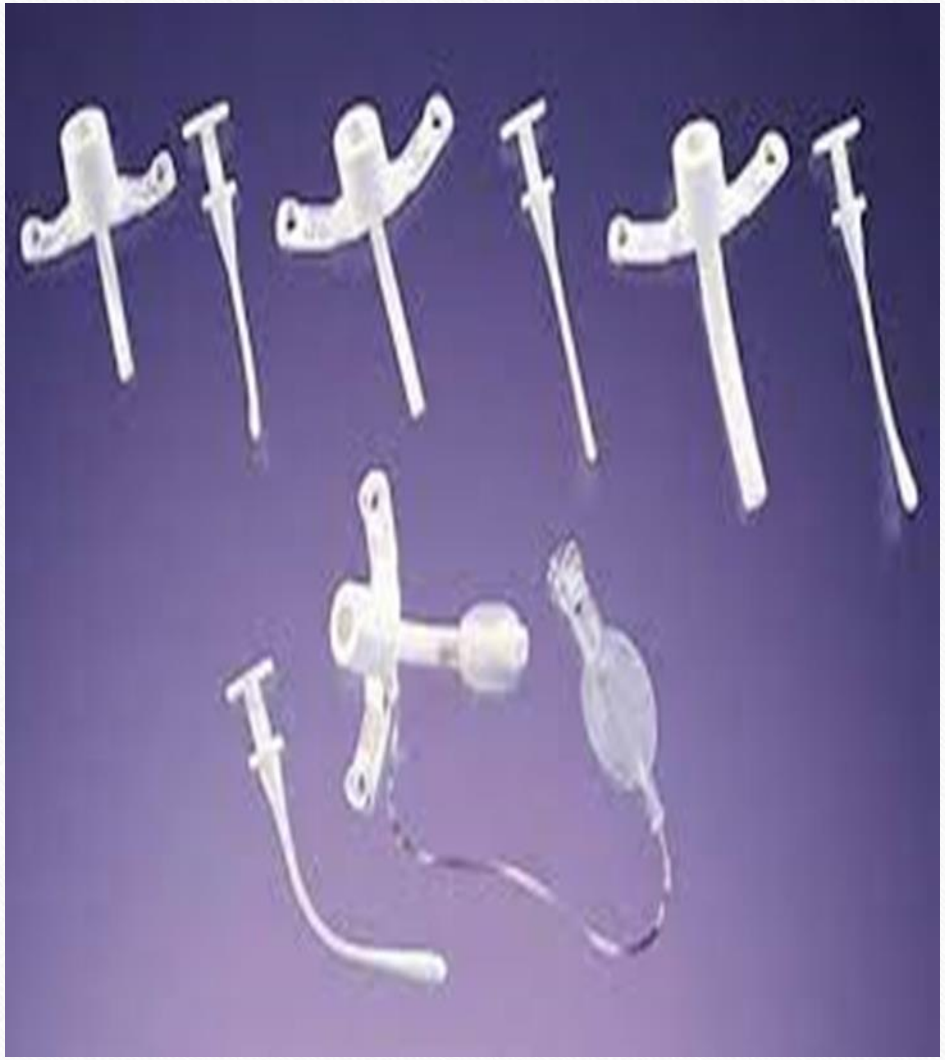
- 15mm extension (can be without this)
- Flange or neck plate (where the ties are inserted)
- Cannula (the part that is inserted through the stoma)

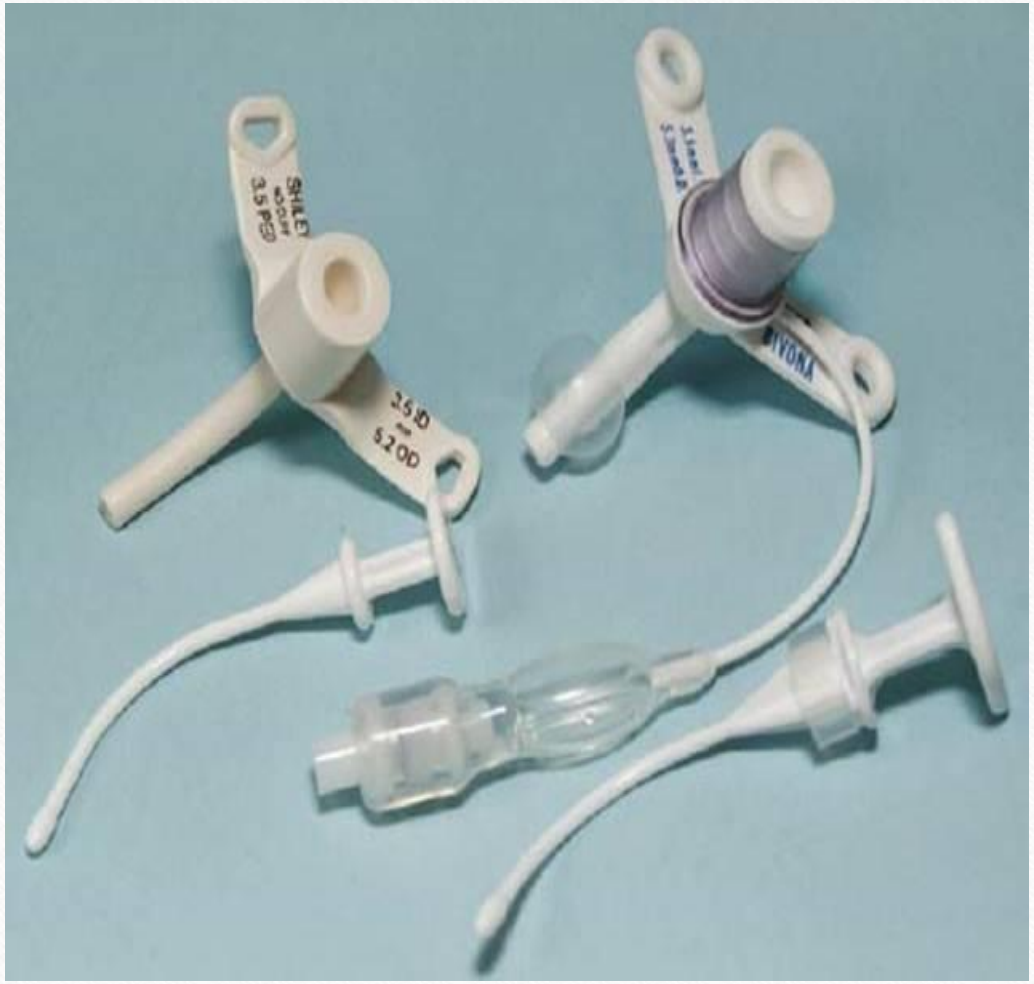


Tracheostomy Components









Description	Previous Product Code	New Product Code
Neonatal Trach Tube, Cuffless	NEO	**NEF**
Neonatal Trach Tube with Cuff	N/A	**NCF**
Pediatric Trach Tube, Cuffless	PED	**PEF**
Extra long Pediatric Trach Tube, cuffless	PDL	**PELF**
Pediatric Trach tube, cuffed	PDC	**PCF**
Extra Long Pediatric Trach Tube, cuffed	PLC	**PLCF**

SIZE	PRODUCT DESIGNATION	I.D.	O.D.	LENGTH	QTY PER BOX	
3.0	3.0 NEO	3.0 mm	4.5 mm	30 mm	1	NEO
3.5	3.5 NEO	3.5 mm	5.2 mm	32 mm	1	
4.0	4.0 NEO	4.0 mm	5.9 mm	34 mm	1	
4.5	4.5 NEO	4.5 mm	6.5 mm	36 mm	1	
3.0	3.0 PED	3.0 mm	4.5 mm	39 mm	1	PED
3.5	3.5 PED	3.5 mm	5.2 mm	40 mm	1	
4.0	4.0 PED	4.0 mm	5.9 mm	41 mm	1	
4.5	4.5 PED	4.5 mm	6.5 mm	42 mm	1	
5.0	5.0 PED	5.0 mm	7.1 mm	44 mm	1	
5.5	5.5 PED	5.5 mm	7.7 mm	46 mm	1	
5.0	5.0PDL	5.0 mm	7.1 mm	50 mm	1	PDL
5.5	5.5PDL	5.5 mm	7.7 mm	52 mm	1	
6.0	6.0PDL	6.0 mm	8.3 mm	54 mm	1	
6.5	6.5PDL	6.5 mm	9.0 mm	56 mm	1	
4.0	4.0PDC	4.0 mm	5.9 mm	41 mm	1	PDC
4.5	4.5PDC	4.5 mm	6.5 mm	42 mm	1	
5.0	5.0PDC	5.0 mm	7.1 mm	44 mm	1	
5.5	5.5PDC	5.5 mm	7.7 mm	46 mm	1	
5.0	5.0PLC	5.0 mm	7.1 mm	50 mm	1	PLC
5.5	5.5PLC	5.5 mm	7.7 mm	52 mm	1	
6.0	6.0PLC	6.0 mm	8.3 mm	54 mm	1	
6.5	6.5PLC	6.5 mm	9.0 mm	56 mm	1	

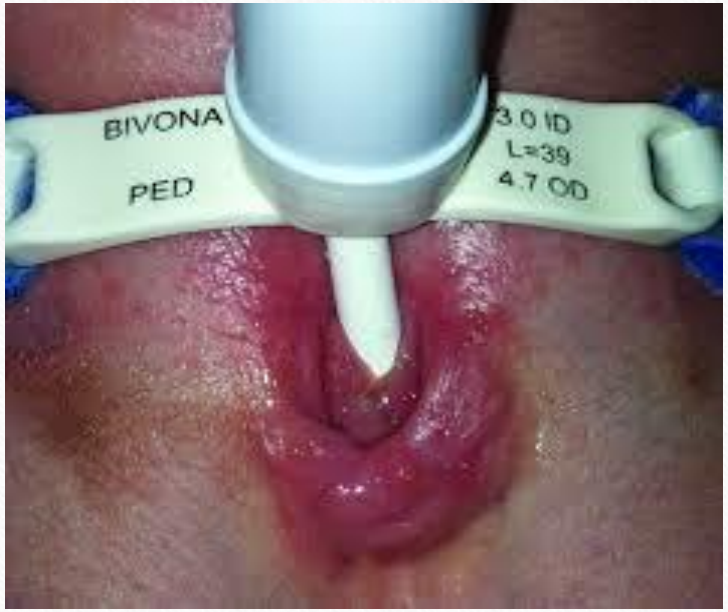


Table 1. Pediatric Tracheostomy Sizes: Cross-Reference of Bivona and Shiley Tube Sizes

Brand and Tube	Size	ID (mm)	OD (mm)	Length (mm)	MRI (Yes/No)
Bivona					
Neonatal cuffless and TTS cuffed	2.5	2.5	4.0	30	No
	3.0	3.0	4.7	32	No
	3.5	3.5	5.3	34	No
	4.0	4.0	6.0	36	No
Neonatal Flextend TTS cuffed	3.0	3.0	4.7	32	No
	3.5	3.5	5.3	34	No
	4.0	4.0	6.0	36	No
Pediatric cuffless and TTS cuffed	2.5	2.5	4.0	38	No
	3.0	3.0	4.7	39	No
	3.5	3.5	5.3	40	No
	4.0	4.0	6.0	41	No
	4.5	4.5	6.7	42	No
	5.0	5.0	7.3	44	No
	5.5	5.5	8.0	46	No
Pediatric Flextend cuffless and TTS cuffed	3.0	3.0	4.7	39	Yes
	3.5	3.5	5.3	40	Yes
	4.0	4.0	6.0	41	Yes
Adult cuffless	5.0	5.0	7.4	60	Yes
	6.0	6.0	8.8	70	Yes
Adult TTS cuffed	5.0	5.0	7.3	60	Yes
	6.0	6.0	8.7	70	Yes
	7.0	7.0	10.0	80	Yes
Shiley					
Neonatal cuffless	3.0	3.0	4.5	30	Yes
	3.5	3.5	5.2	32	Yes
	4.0	4.0	5.9	34	Yes
	4.5	4.5	6.5	36	Yes
Pediatric cuffless	3.0	3.0	4.5	39	Yes
	3.5	3.5	5.2	40	Yes
	4.0	4.0	5.9	41	Yes
	4.5	4.5	6.5	42	Yes
	5.0	5.0	7.1	44	Yes
	5.5	5.5	7.7	46	Yes
Pediatric cuffed	4.0	4.0	5.9	41	Yes
	4.5	4.5	6.5	42	Yes
	5.0	5.0	7.1	44	Yes
Adult cuffed (LPC) and cuffless (CFS)	4	5.0	9.4	62	Yes
	6	6.4	10.8	74	Yes

Pediatric tracheostomy tubes: approximate sizes

	Shiley	Holinger	Portex	Bivona	Berdeen	ETT	Suction
Premature	00	00	3.0	2.5-3.0	---	2.5-3.0	6 Fr
Newborn	0	0	3.0	3.0-3.5	3.5	3.0-3.5	6 Fr
0-6 mo	0-1	1-2	3.5	3.5-4.0	3.5-4.0	3.5-4.0	6-8 Fr
6-12 mo	1-2	2-3	4.0	4.0-4.5	4.0-4.5	4.0-4.5	8 Fr
12-24 mo	3	3	4.5	4.5-5.0	5.0	4.5-5.0	8 Fr
3-6 yr	4	4	5.0	5.0	5.0	5.0	8-10 Fr
7-10 yr	4	5	5.0	5.0-6.0	6.0	6.0	10 Fr
10-12 yr	6	6	6.0	6.0-7.0	6.0	7.0	10 Fr
12-14 yr	6	6	7.0	7.0	7.0	7.5	10 Fr

Tracheostomy Tube Types

- Before the 1960s, tracheostomy tubes were made from stainless steel or silver.
- These tubes caused very minimal stomal tissue reaction but did not conform to the airway well and could cause significant irritation and bleeding of the tracheal mucosa.
- Shortly followed by the introduction of a more anatomically shaped tracheostomy tube made of polyvinyl chloride (PVC).
- The majority of pediatric tracheostomy tubes are made of **PVC (eg, Shiley)** or **silicone (eg, Bivona)**, which cause minimal tissue reaction.
- Metal tubes can still be manufactured on an individual patient basis and can be very helpful in those with severe incalcitrant stomal issues.

Cuffed and Uncuffed Tubes

Pediatrics tracheostomy tubes are generally uncuffed and do not have an inner tube due to the smaller tracheal diameter and to avoid reducing the lumen further.

Indications for cuff tracheostomy tube

- To ensure the prescribed ventilation pressures are delivered to the lungs
- Minimize the risk of aspiration of pharyngeal secretions and stomach contents into the airways
- Minimize the risk of aspiration pneumonia

- Most children **initially require a cuffed tracheostomy** to allow for sedated mechanical ventilation during the healing period.
- Once patients **wean from mechanical ventilation**, the cuff is deflated and eventually the tube can be **exchanged for an uncuffed model** that allows for more airflow through the upper airway with the recovery of voice.

- Bivona cuffed tubes are available in all sizes in both neonatal and pediatric sizes, down to a 2.5-mm neonatal cuffed tube.
- Shiley cuffed neonatal and pediatric tubes are available from a 3.0-mm size.
- The silicone Bivona neonatal and pediatric TTS tracheostomy tubes have a low-volume high-pressure tight to shaft (TTS) cuff that is inflated with sterile water using a minimal leak technique.
- The TTS cuff, when inflated, seals the trachea for a ventilated patient, and when deflated, the cuff rests tight to the shaft of the tube with the appearance and profile of an uncuffed tube.
- This allows the tube to be used for weaning patients from a ventilator, without having to change to an uncuffed tube, and also aids in speaking.

- The TTS cuff is inflated with sterile water because the cuff is made of silicone, which is gas-permeable and would allow diffusion of air through the cuff over time.
- Bivona Aire-Cuf neonatal and pediatric tracheostomy tubes are also available but are less commonly used.
- The Aire-Cuf tracheostomy tube provides a traditional cuff option and is ideal for short-term to medium-term ventilator support.
- **The Shiley cuffed pediatric tracheostomy tubes are inflated with air.**

- **Bivona FlexTend tracheostomy** tubes are now stocked in some institutions because they are used so frequently.
- **FlexTend tubes** have a permanent flexible tube extension on the proximal side of the neck flange, which helps to keep connections away from the neck, chin, and stoma and also helps to prevent circuits from getting disconnected.
- This tube type is commonly used in **small infants with short, fat necks**

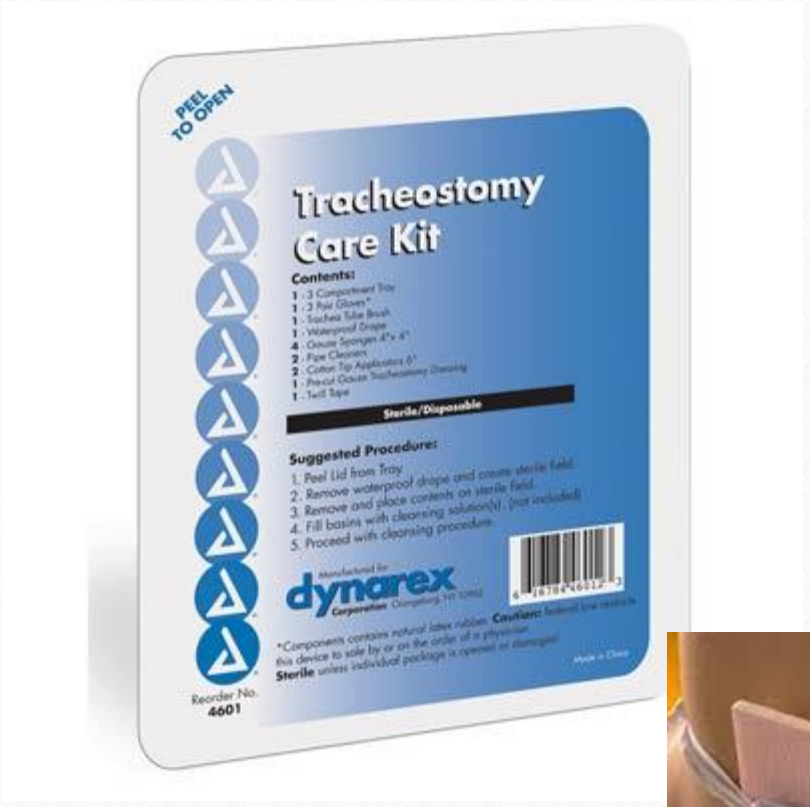
Tracheostomy cuff management

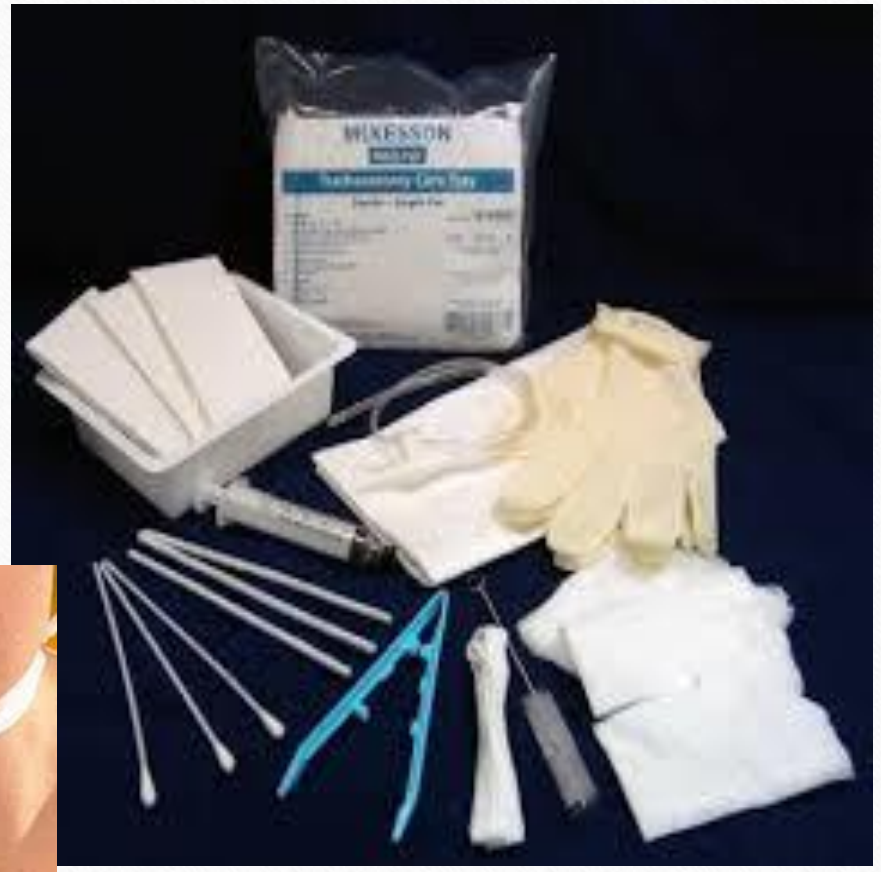
- The aim of tracheostomy cuff management is to use the minimum occlusive volume/minimum cuff pressure required.
- The cuff volume/pressure is to be checked at least every 8 hours and any time as required to prevent complications associated with tracheostomy tube placement.
- If the cuff pressure is too high this can lead to reduced capillary blood flow to the tracheal mucosa with subsequent risk of tissue damage and tissue necrosis leading to ischemic changes, subglottic and tracheal stenosis.
- Suction via above cuff port if this is available/present

- Ensure the head of the bed is elevated at least 15 degrees
- Suction the oropharynx if indicated to remove any pooled secretions before cuff deflation to minimize risk of aspiration
- Perform routine tracheostomy tube suction procedure
- Suction via above cuff port if this is available/present
- Attach a 5 - 10 ml syringe to the pilot balloon and deflate the cuff
- Record the volume of air (water) withdrawn from the cuff balloon.
- If required repeat suction of tracheostomy tube
- Using a stethoscope listen for a leak around the tracheostomy tube during hand (spontaneous) ventilation
- If necessary gradually re-inflate the cuff by adding air in 0.5 -1ml increments until the leak just disappears
- Re-check cuff pressure with manometer - *ensure these remain below or within the "safe" range below 25mmHg*

Tracheostomy Kit

- **A tracheostomy kit is to accompany the patient at all times and this must be checked each shift by the nurse caring for the patient to ensure all equipment is available.**
- A key concept of tracheostomy management is to ensure patency of the airway (tracheostomy tube). A blocked or partially blocked tracheostomy tube may cause severe breathing difficulties and this is a medical emergency. Immediate access to the tracheostomy kit (equipment) for the individual patient is essential.


PEEL TO OPEN
Tracheostomy Care Kit
Contents:
Sterile/Disposable
Suggested Procedure:
1. Peel Lid from Tray
dynarex
Reorder No.
4601

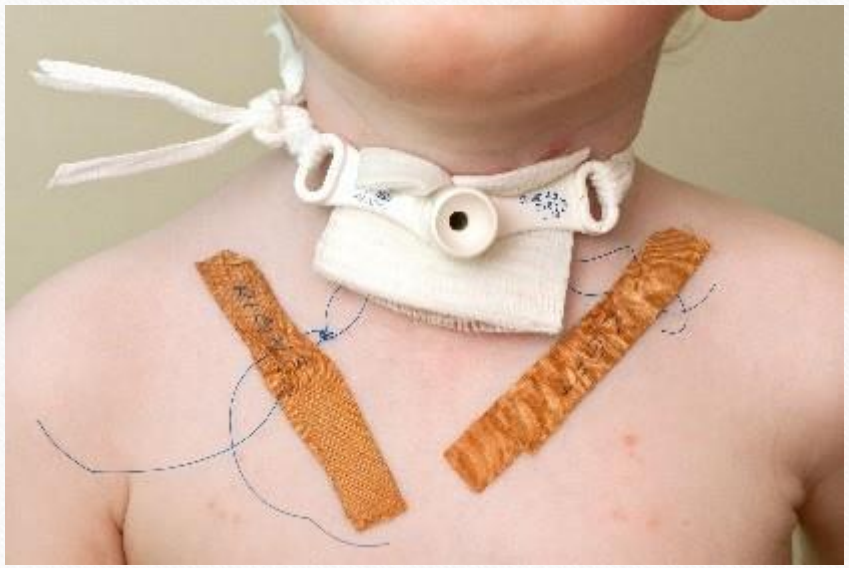

MCKESSON

Special safety considerations

- It is recommended that **all patients have continuous pulse oximetry (SpO2) during all periods of sleep (day and night) and when out of line of sight of competent caregiver.**
- All children 6 years and under are to have cotton ties only to secure the tracheostomy tube.
- Children 6 years and over who are considered Velcro ties.
- For patients with a newly established tracheostomy it is recommended that **tracheal dilators** are available at the patient's bedside **until after the first successful tube change.**

- **An information sheet** that provides specific data regarding the date of last tracheostomy tube change, type and size of tracheotomy tube, (including inner diameter, outer diameter, length cuffed or uncuffed tube, cuff inflation, suctioning distance, critical alert if applicable), should be placed above each patient's bed.

  - The comfort of the patient is imperative throughout the post-operative period.
  - Pain should be managed
  - Have a non-critical airway i.e. these children are able to breathe and maintain their airway in the event of accidental decannulation.



Patient has a Tracheostomy Insitu

Upper airway abnormality: Yes/No

Tracheostomy tube details/type:
Size: ID (mm)
Size: OD (mm)
Distal Tube Length (mm):
Inner tube: No/Yes or N/A
Re-usable Tube: No /Yes

Suction: ***Suction Pressure 80 – 120mmHg (10 – 16 kPa)***
Catheter _____ FG to Depth _____(cm)

Emergency spare smaller tube details/ type
Size: ID (mm)
Size: OD (mm)
Distal Tube Length (mm):

Tracheostomy tube change date last done and date due:

In an emergency: call MET – 2222
Follow emergency tracheostomy management procedure

Post-operative management of a new tracheostomy

- Ensure the tracheostomy equipment kit is present at the bedside with the patient.
- Patients return from theatre with stay sutures (nylon sutures) inserted on either side of the tracheal opening.
- The stay sutures are taped to the chest and **clearly labelled left and right**.
- The stay sutures should remain in situ and securely attached to the chest wall until the first or second successful tube change.
- **Trache stoma maturation** takes approximately **5 – 7 days** after insertion of the tracheostomy tube **or 2 – 3 days if stoma maturation sutures are placed**.

Stoma care

- Care of the stoma is commenced in the immediate post-operative period, and is ongoing.
- Inspect the stoma area at least daily to ensure the skin is clean and dry to maintain skin integrity and avoid breakdown.
- Daily cleaning of the stoma is recommended using 0.9% sterile saline solution.
- After daily cleaning, ensure dressing inserted at stoma site.
- Once daily dressing change following cleaning of the stoma area or more frequently if required.

Stoma care

- Peristomal skin breakdown and pressure ulcers are an important concern in the perioperative period in pediatric tracheostomy tube placement.
- Pressure ulcers occur nearly 10% of all tracheostomies.
- Maltodextrin gel and/or silver alginate sponges has been demonstrated to be effective in improving stoma and wound breakdown in these patients.
- This can be used as a preventive measure or after the development of injury.

- Clearly explain the procedure to the patient and their family/carer
- Perform hand hygiene
- Use a standard aseptic technique using non-touch technique
- Position the patient. Infants and young children may lay on their back with a small rolled towel under the shoulders. An older child may prefer to sit up in a bed or chair.
- Perform hand hygiene and apply non-sterile gloves
- Remove fenestrated dressing from around stoma
- Inspect the stoma area around the tracheostomy tube
- Perform hand hygiene and apply non-sterile gloves
- Clean stoma with cotton wool applicator sticks moistened with 0.9% sodium chloride. Use each cotton wool applicator stick **once only** taking it from one side of the stoma opening to the other and then discard in waste.
- Continue cleaning stoma area as above with a new cotton wool applicator stick each time until the skin area is free of secretions, crusting and discharge.
- Allow skin to air dry or use a dry cotton wool applicator stick to dry.
- Insert the fenestrated gauze under the flanges (wings) of the tracheostomy tube to prevent chafing of the skin.
- Dispose of waste, remove gloves, and perform hand hygiene.
- **Avoid** using any powders or creams on the skin around the stoma unless prescribed by a doctor or respiratory nurse consultants as powders or creams could cause further irritation.

Emergency Management

- The majority of children with a tracheostomy are dependent on the tube as their primary airway.
- Cardiorespiratory arrest most commonly results from tracheostomy obstructions or accidental dislodgement of the tracheostomy tube from the airway.
- Obstruction may be due to thick secretions, mucous plug, blood clot, foreign body, or kinking or dislodgement of the tube.

Emergency Management

- **Early warning signs** of obstruction include: suction catheter not passing through tracheostomy tube, child with minimal leak suddenly able to vocalise/talk,
- **General signs of obstruction** - any physiological changes due to airway obstruction including tachypnoea, increased work of breathing, noisy breathing – grunting/abnormal breath sounds, tachycardia and a decrease in SpO2 levels, change in level of consciousness - anxiety, restlessness or agitation
- **Late signs of obstruction** - cyanosis, bradycardia and apnoea - do not wait for these to develop before intervening.

IN HOSPITAL EMERGENCY TRACHEOSTOMY MANAGEMENT AND CPR

Danger

- Check for dangers to yourself or the child
- If safe to do so, remove the danger, or remove the child from the danger.

Response

- Check for a response by touching and talking to the child, call their name.
- No response? - firmly pinch the cartilage on their ear (infants/toddler), trapezius pinch (older child)

Send for Help

- If there is no response from the child:
  - Press Emergency buzzer & Call MET 2222 (RCH)

Airway

- **Airway** (tracheostomy tube patency) assess if the child is able to breath via their tracheostomy tube?
- **Is the tube dislodged? Look – Extend** patient's neck slightly (lift chin or place small roll under shoulders)
- **Suction the tracheostomy tube** - Remove any attachments – Humidifier / Speaking Valve.
- If tube is blocked or you cannot pass the suction catheter, immediately remove tracheostomy tube (deflate cuff if applicable) and change with same sized tube, or change inner cannula if one present
- **1st** - attempt to insert same size tube
- **2nd** - attempt to insert smaller tube, use water based lubricant/gel if unable to insert.
- **3rd** - Insert suction catheter through smaller size tube to guide tracheostomy in to stoma

Patent tracheostomy insitu | **No patent tracheostomy insitu**

Breathing

Look, Listen and Feel for chest rise and fall, and air movement. If child not breathing:

Patent tracheostomy insitu	No patent tracheostomy insitu
• Deliver rescue breaths via tracheostomy tube: Attach resuscitation bag (+ oxygen flow 10 -15 lpm) and give 2 effective rescue breaths.	• Deliver rescue breaths via nose/mouth with face mask. Cover tracheostomy stoma with gauze and tape if required to prevent air leak • **Obstructed upper airway and no patent tracheostomy tube in situ**? If possible deliver rescue breaths via the tracheostomy stoma with face mask.

- Observe for rise and fall of chest and **reassess breathing**
- Attempt access of stoma using smallest available tracheostomy tube.
- Prepare for oral intubation, or intubation of stoma using ETT where upper airway is obstructed.

Circulation

- Check for pulse for a maximum of 10 seconds, or check for signs of life (moving, breathing, responsive)
- If pulseless, bradycardic, or no signs of life commence CPR @ 120 compressions/minute
- 15 compressions: 2 breaths - 2 rescuers
- 30 compressions: 2 breaths - single rescuer
- Continue CPR until child recovers or help arrives

Complications

Complications can be classified by timing:

- **Intraoperative; early (usually defined as the first postoperative week)**
- **Late**
- **Post-decannulation.**

Complications in the first post-tracheostomy week

- Blocked tube (occluded cannula / mucous plugging)
- Bleeding from the airway/tracheostomy tube
- Stomal erosion
- Infection or cellulitis at the stoma site
- Air leak including Pneumothorax, pneumo-mediastinum or subcutaneous emphysema
- Respiratory and/or cardiovascular collapse
- Dislodged tube or accidental decannulation
- Granulation tissue in the trachea or at the stoma site
- Tracheo-oesophageal fistula

Late complications

- Acute airway obstruction
- Blocked tube (occluded cannula or mucous plugging)
- Infection (localised to stoma or tracheo-bronchial)
- Aspiration
- Tracheal trauma - bleeding
- Dislodged tube
- Stomal or tracheal granulation tissue
- Tracheal stenosis
- Tracheomalacia
- Tracheocutaneous fistula
- Peristomal skin breakdown and pressure ulcers

Complications of Tracheostomy in Children

- Complications of tracheostomy are well reported, occurring in 15% of adult patients
- less is known specifically about complications in children following tracheostomy.
- Between 15 and 19% of children experience a tracheostomy-related complication.

Table 3. Complications of Pediatric Tracheostomy: Early and Delayed Complications

Early Complications	Delayed Complications
Air leak	Airway obstruction
Pneumothorax	Mucus plugging
Subcutaneous emphysema	Accidental decannulation
Pneumomediastinum	Stomal problems
Hemorrhage	Granulation tissue
Thyroid gland	Tracheocutaneous fistula
Aberrant vessels	Tracheal lesions
Innominate artery	Granuloma: suprastomal/distal
Injury to surrounding structures	Suprastomal collapse
Cricoid cartilage	Subglottic stenosis
Esophagus	Hemorrhage
Recurrent laryngeal nerve	Stomal
Pulmonary edema	Tracheal mucosa
Respiratory arrest	Tracheo innominate fistula (rare)
Injury caused by tube placement	Tracheoesophageal fistula (rare)
Tracheal tear/fistula	Swallowing problems
Main bronchus cannulation	
Airway obstruction	
Mucus plugging	
Accidental decannulation	

Humidification

- A tracheostomy tube bypasses the upper airway and therefore prevents the normal humidification and filtration of inhaled air via the upper airway.
- Unless air inhaled via the tracheostomy tube is humidified, the epithelium of the trachea and bronchi will become dry, increasing the potential for tube blockage.

- Tracheal humidification can be provided by:
- **heated humidifier**
- **Heat and Moisture Exchanger (HME)**
- **Tracheostomy bib filter**

Heated humidification

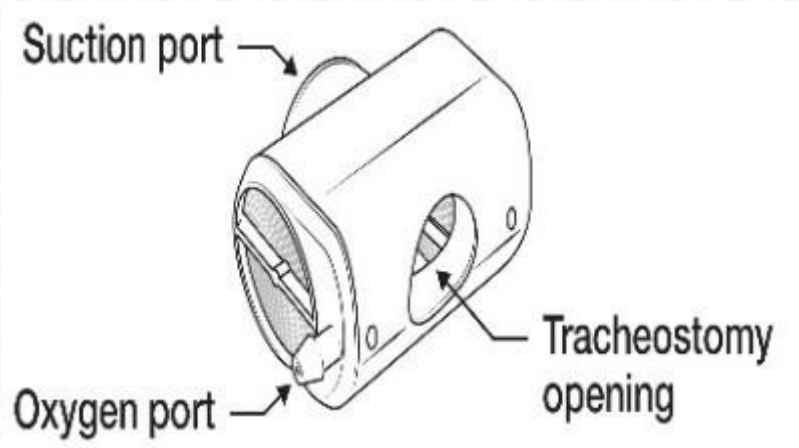
- Devices which deliver gas at body temperature saturated with water prevents the thickening of secretions. The temperature is set at 37°C delivering a temperature ranging from 36.5°C - 37.5°C at the tracheostomy site

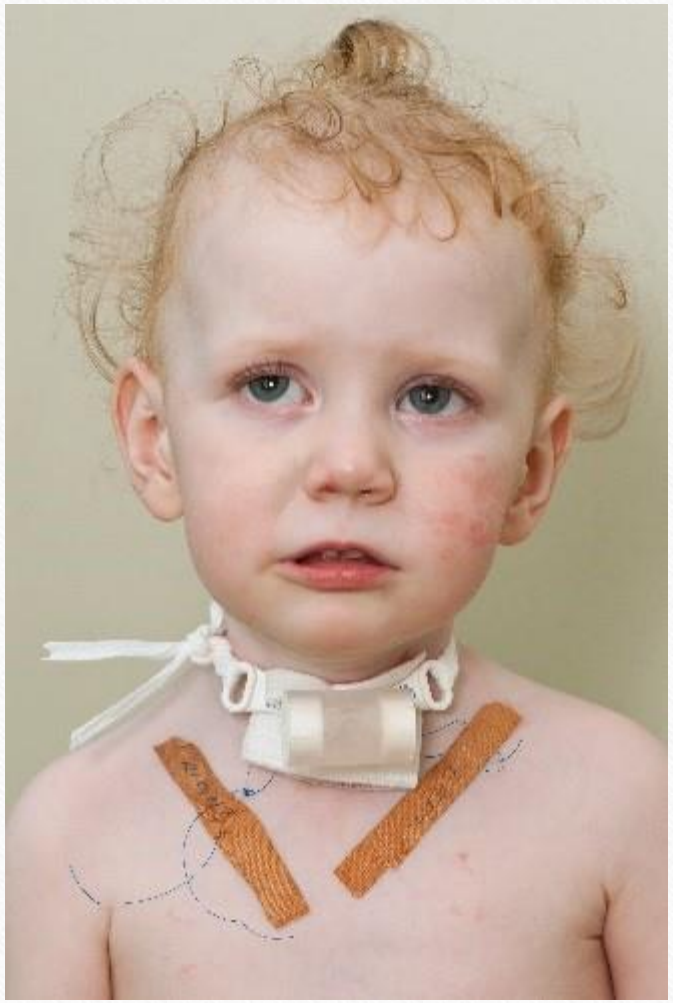
- **Indications for the use of heated humidification include**:
  - Oxygen delivery via tracheostomy mask
  - Mechanical Ventilation or continuous positive airway pressure support (CPAP)
  - Respiratory infection with increased secretions
  - Management of thick secretions

Heat Moisture Exchanger (HME)

- Contains a hygroscopic paper surface that absorbs the moisture in expired air. Upon inspiration the air passes over the hygroscopic paper surface and moistens and warms the air that passes into the airway.

  - HME is recommended for all patients with a tracheostomy tube.
  - HME fit directly onto the tracheostomy tube.
  - **Do not wet the HME filter prior to use**
  - HME are changed daily or as needed if the filter appears to be excessively moist or blocked.
  - For small infants <10kg some HME filters may not be suitable.
  - HME with oxygen and suction port are suitable for low flow oxygen administration


Suction port
Tracheostomy opening
Oxygen port



Tracheostomy bibs

- Consist of a specialized foam that traps the moisture in the expired air, upon inspiration the foam moistens and warms the air that passes into the airway.
    - These are changed daily or more frequently as required.
    - Tracheostomy bibs are reusable - hand wash in warm water using a mild detergent/soap, then rinse thoroughly and allow to air dry.
    - Tracheostomy bibs should be discarded monthly or more frequently if discoloured or the material is damaged.

Suctioning

- Suctioning of the tracheostomy tube is necessary to remove mucus, maintain a patent airway, and avoid tracheostomy tube blockages. The frequency of suctioning varies and is based on individual patient assessment.
    - Audible or visual signs of secretions in the tube
    - Signs of respiratory distress
    - Suspicion of a blocked or partially blocked tube
    - Inability by the child to clear the tube by coughing out the secretions
    - Vomiting
    - Desaturation on pulse oximetry
    - Changes in ventilation pressures (in ventilated children)
    - Request by the child for suction (older children)

Suctioning -Safety considerations

- Tracheal damage may be caused by suctioning. This can be minimised by using the appropriate sized suction catheter, appropriate suction pressures and only suctioning within the tracheostomy tube.
- The depth of insertion of the suction catheter needs to be determined prior to suctioning.
  Using a spare tracheostomy tube of the same type and size and a suction catheter insert the suction catheter to measure the distance from the length of the tracheostomy tube 15mm connector to the end of the tracheostomy tube.

  Ensure the tip of the suction catheter remains with-in the tracheostomy tube.

Suctioning -Safety considerations

- Record the required suction depth on the tape measure placed at the bedside and in the patient records.
- Attach the tape measure to the cot/bedside/suction machine for future use.
- Use pre - measured suction catheters to ensure accurate suction depth
- The pressure setting for tracheal suctioning is 80-120mmHg (10-16kpa).
- It is recommended that the episode of suctioning (including passing the catheter and suctioning the tracheostomy tube) is completed within 5-10 seconds.

Tracheostomy tube size (in mm)	3.0mm	3.5mm	4.0mm	4.5mm	5.0mm	6.0mm	7.0 mm and >
Recommended suction catheter size (Fr)	7	8	8	10	10	10 -12	12

Decannulation in Infants and Children

Evidence to Date

- Decannulation as soon as the child's underlying conditions permit is therefore advisable and is the ultimate goal shared by patient, family, and provider alike.
- Acute decannulation failures can be catastrophic, and this risk should be minimized.
- Children with tracheostomy tubes may become candidates for decannulation through resolution of the underlying airway abnormality, natural expansion of the cross-sectional area of the airway with growth, or surgical procedures designed to open narrowed airways.
- It is paramount that decannulation be undertaken only after being determined safe and appropriate.
- **Decannulation failure** rates **vary from 6.5 to 21.4%**

American Academy of Otolaryngology and Head and Neck Surgery Consensus 2013

- First, no ventilatory support should be required for a period of 3 months before decannulation, which could vary from 2 to 4 months, depending on the time of the year.
- Second, there should be no aspiration events, such that a tracheostomy would still be needed for suctioning to maintain pulmonary toilet.
- A flexible laryngoscopy should be performed to document a patent airway with **at least one mobile vocal cord.**
- Removal of any obstructing suprastomal granulation should be performed at the time of bronchoscopy before a decannulation attempt.

American Academy of Otolaryngology and Head and Neck Surgery Consensus 2013

- **A daytime tracheostomy tube capping trial** is recommended for those children **of at least 2 y of age** leading up to decannulation.
- If the child tolerates capping, options before decannulation to assess for readiness may include:
  - **A capped sleep study,**
  - **A capped exercise test,**
  - **A nighttime capping trial while hospitalized and being observed.**

American Academy of Otolaryngology and Head and Neck Surgery Consensus 2013

- **In younger or smaller children**, **the small size of the trachea** in relation to the tracheostomy tube may preclude capping, and the decannulation protocol should be tailored to the individual patient.
- These recommendations serve as a guideline based on the existing evidence, and it was stated in the report that there remains room for further discussion and research on the subject

Readiness for Decannulation

Clinical readiness for decannulation involves:

- Cessation of the need for mechanical ventilation for at least 3– 6 months
- Resolution of the original indication for tracheostomy.
- A supplemental oxygen requirement should not preclude a decannulation trial as long as the child can tolerate oxygen administration via nasal cannula.
- Comorbidities affecting the need for tracheostomy, including cardiac, pulmonary, or neurologic conditions, should have improved or resolved.

Readiness for Decannulation

- Certain assessments of airway form and function are important in all patients before decannulation:
- **Microlaryngoscopy and bronchoscopy evaluate airway patency at all levels**
- **Polysomnography (PSG) assesses sleep-related upper-airway physiology**.

Ideal Decannulation Protocol

- Tracheostomy size reduction and clinical observation
- Complete airway evaluation (flexible laryngoscopy and direct laryngoscopy bronchoscopy)
- Capping trial at home during the day
- Capped PSG
- Admission for decannulation and post-decannulation observation for 24 – 48 h
- Noninvasive ventilation (NIV)

Downsize Tracheostomy Tube Size and Clinical Observation

- The child's tracheostomy tube is initially downsized to **the smallest tolerated uncuffed tube according to the patient's age and size.**
- In infants, this tube is a size 3.0 uncuffed tube.
- Although a size 2.5 tracheostomy tube is available, its lumen is so small that it is rarely used outside of a hospital setting due to the concern for mucous plugging of the tube and difficulty suctioning, a potentially fatal complication.

Airway Evaluation

- A flexible laryngoscopy should be initially performed with the child awake to assess vocal cord movement and supraglottic collapse.
- Tonsils and adenoids should be evaluated, and if there is evidence of obstructive adenotonsillar hypertrophy, surgical treatment should be performed.
- **A direct laryngobronchoscopy evaluates airway patency at all levels and is necessary for not only diagnostic evaluation but also therapeutic treatment of the airway.**

Airway Evaluation

- Spontaneous ventilation during this procedure with the tracheostomy removed from the airway is paramount to assess any dynamic collapse or obstruction, especially suprastomal collapse and tracheomalacia.
- Suprastomal granulation tissue should be removed.
- **Favorable direct laryngobronchoscopy has been reported as an excellent predictor of successful decannulation**.

Role of Capping

- The use of capping and downsizing is a common part of many decannulation protocols, although its implementation **is not universal.**

- Studies supporting capping report that the reduction and occlusion of tube diameter not only predict decannulation success but also acclimate the child to the changing airway physiology that accompanies tracheostomy tube removal (ie, increased dead space and use of the mouth and nose)

Role of Capping

- However, a blocked size 3.0 tracheostomy tube will **occupy a much greater proportion of the airway in younger children** than in older ones; thus, many younger children may not tolerate blocking of the tube
- **The decreases in the cross-sectional area** of the airway in **these young children** may be to such a degree that those who do not tolerate capping may in fact still tolerate decannulation.

Role of Polysomnogram

- The role of capped PSG in the decannulation process has recently gained wider acceptance, although its routine use is debatable
- Dynamic factors (obstructive sleep apnea, tracheomalacia, pharyngeal hypotonia, and associated neuromuscular disorders) that influence upper-airway patency are usually more apparent during sleep, when muscular tone is decreased.
- In this cases,PSG is thus an ideal modality to evaluate for readiness for decannulation; however, evaluation by PSG can be expensive, and pediatric PSGs are not widely available

Role of Polysomnogram

- **A capped sleep study** usually requires the child to first tolerate the tracheostomy capped for **between 4 and 6 h during the day.**
- Parameters such as apnea-hypopnea index (AHI), obstructive index, and maximal end-tidal CO2 are valuable in predicting successful tracheostomy decannulation.
- They concluded that an AHI < 1.7 correlated with successful decannulation.

Role of Polysomnogram

- The literature supports that a favorable PSG with tracheostomy capping is complementary to endoscopic assessment in patients with complex airway problems.
- Overall, the length of ICU admission following decannulation is being decreased secondary to the performance of pre-admission capped sleep studies.
- Larger studies are needed, however,to validate specific PSG parameter thresholds in all pediatric patients undergoing decannulation.

Noninvasive Ventilation

- NIV may be used to facilitate decannulation in children who no longer need a tracheostomy for structural upper-airway obstruction but have **severe obstructive sleep apnea and/or require nocturnal ventilatory support**.
- Thus, in selected patients with **obstructive sleep apnea or lung disease**, NIV may represent a valuable tool to treat the recurrence of obstructive symptoms after decannulation and may facilitate early weaning from tracheostomy in children who have failed repeated decannulation trials.

Some Notices:

- Decannulation protocols vary widely in these reports, with success rates ranging from **67 to 94%.**
- There was also significant disagreement in how "**failure**" was defined.
- While most would define a failure as re-insertion of a tracheostomy tube after removal, some groups obtained PSG with a capped tube, while others obtained it immediately upon decannulation.

Table 2 Recent publications, pediatric decannulation protocols

Primary author, year	Patient population	*N*	Standardized decannulation protocol	Inpatient nights required (if specified)	Failure rate (first decannulation, if multiple)	Risk factors for failure
Cristea, 2016 [60•]	< 18 y/o	210	Admission MLB or sleep endoscopy; decannulation in sleep lab with immediate PSG; formal PSG	1	20.4%	
Lee, 2016 [68•]	< 18 y/o	30	Downsize to 3-mm tube; awake capping; admission with overnight pulse oximetry; formal capped PSG; decannulation; discharge	2	13.3%	
Beaton, 2016 [67•]	< 18 y/o	45	MLB; trach tube downsize; trach tube capping; decannulation; overnight observation; discharge	4	44.5%	-
Banyopadhyay, 2016 [61•]	< 18 y/o	189	MLB with temporary decannulation; admission with decannulation and immediate PSG; overnight PSG; discharge	1	22.2%	Prematurity, decannulation based on parental expectations of success, dysphagia, craniofacial/genetic comorbidities, hydrocephalus, BPD
Wirtz, 2016 [62•]	< 18 y/o	35	Sleep endoscopy ± MLB with temporary decannulation; PICU admission with decannulation; discharge	1+	5.7%	-
Maslan, 2017 [63•]	< 18 y/o	46	No fixed protocol, most underwent MLB and PSG	Variable	2.1%	-
Pozzi, 2017 [64•]	< 18 y/o in inpatient rehab	68	Inpatient capping trials with continuous pulse oximetry; fiberoptic laryngoscopy; selective PSG only	N/A (inpatient for rehab)	0%	
Seligman, 2019 [65•]	0–5 y/o	26	MLB; change to fenestrated trach tube when awake; inpatient overnight pulse oximetry; decannulation; half-day pulse oximetry; discharge	1	15.3%	-
Morrow, 2019 [66•]	0–21 y/o with brain or spinal cord injuries who underwent PSG for decannulation	38	Capped PSG during inpatient stay; selective airway endoscopy	N/A (inpatient for rehab)	0%	-

Some Notices:

- Only one study reported a sufficient number of failed decannulations to analyze the **risk factors** for failure.
- These included a history of prematurity, dysphagia with a history of gastrostomy tube placement, craniofacial or genetic syndromes, hydrocephalus, BPD, and the decision to decannulate primarily based on the parental expectation of success.

Some Notices:

- Polysomnography parameters predicting decannulation failure were reported by two studies
- The studies demonstrated agreement in their findings, with decannulation failure predicted by overall apnea-hypopnea index (AHI) (3.35 and 1.70 for the successful decannulation groups versus 18.5 and 12.8 for the unsuccessful decannulation groups) and mean oxygen saturation nadir (87.58% and 89% for the successful groups versus 82% and 78.57% for the unsuccessful groups).

Decannulation trial

- This procedure is usually performed within 6 weeks prior to admission for decannulation
- The decannulation process is performed in the hospital as an in-patient.
- This is usually a 3 – 4 day admission.
- The patient is observed with 1:1 nursing supervision for at least 8 hours post decannulation.
- If complications with the decannulation are anticipated the patient should be nursed 1:1 for the first 24 hours post decannulation

Decannulation trial - Day 1

- The tracheostomy tube is downsized
- Baseline observations including heart rate, respiratory rate, SpO2 (haemoglobin-oxygen saturation), and work of breathing are recorded.

- The tube is capped (occluded using a decannulation cap) and the child is observed for any signs of increased respiratory effort or respiratory distress

Decannulation trial - Day 1

- If the child is unable to tolerate the downsizing and capping of the tracheostomy tube a medical review is required as the trial of decannulation may not proceed and the tube may be upsized back to the previous size.
- If the child tolerates downsizing and capping of the tracheostomy tube ,additional monitoring: Overnight oximetry monitoring and sleep diary are recorded throughout the night.
- The child is to be reviewed in the morning by the admitting team to determine whether the decannulation trial goes ahead or not.

Decannulation – Day 2

- Decannulation is usually performed between the hours of 9am and 10am
- Decannulation **should not** be performed unless a member of the medical team is present in the ward at the time of decannulation
- Occasionally the trial of decannulation is unsuccessful requiring the need to **re-insert the tracheostomy tube.**
- Ensure the child has been fasted **for 2 hours prior** to the decannulation
- If no evidence of respiratory distress, an occlusive dressing is applied to stoma site to ensure an airtight seal and reassess patient for any sign of respiratory distress.

Decannulation – Day 2

Monitor the patient's vital signs :

15 minutely for the first hour

- Half hourly for the next 4 hours
- Hourly for 24 hours
- Continuous pulse oximetry (SpO_2) during all periods of sleep (day and night) post decannulation for 24 hours.
- Offer light diet 2 hours after decannulation (unless contraindicated)
- Encourage the child to undertake their normal activities while on the ward.

Avoid suctioning the stoma unless otherwise indicated in an emergency situation as this may cause trauma.

The child is to remain on the ward for 24 hours post decannulation and should not leave

Stoma site care post decannulation

- The stoma site is covered by a small gauze square and then by an occlusive dressing (sleek™/tegaderm™) until it has closed or no secretions are seeping out.
- Assess occlusive tracheal stoma dressing for air leaks every shift and document absence or presence of these air leaks in medical record.
- Stoma site to be assessed and cleaned and dressing applied daily or more frequently if indicated.
- Observe for skin reactions to dressing used – if redness or irritation trial alternative dressing.

Decannulation - Day 3

- Patient may leave the ward if the parent team has assessed the patient to have a "safe airway"
- Encourage usual activities to assess exercise tolerance – if age appropriate consider exercise testing/respiratory function tests
- Encourage coughing to clear secretions from upper airway if required.
- If the child is not coughing and clearing secretions well, gentle oropharyngeal suction (only) may be performed. Contact the physiotherapist for support.

- Referral to speech pathology should be considered if the child does not resume normal voice production following decannulation or inadequate swallow

Decannulation - Day 4

Discharge home

- The child is usually discharged home when they're considered by the medical team to have a safe airway post decannulation.
- The average hospital length of stay post decannulation is 36 - 48 hours, however this maybe longer if clinically indicated.
- Following a successful decannulation the family are able to return all tracheostomy and suctioning equipment on discharge from hospital but are encouraged to keep the pulse oximeter until seen at follow up outpatient appointment.

Decannulation - Day 4

- Advise the family/caregiver to observe for and contact the hospital and/or medical team if **any episodes of**:
  - Increased Work of Breathing
  - Tachypnoea/bradypnoea
  - SpO_2 desaturation
  - Restlessness/anxiety
  - Colour change/ Cyanosis
  - Unable to clear secretions – gagging
  - Exercise limitations
  - Unable to eat or drink as usua


Help
Your Little
Superhero
Fight Bad
Breath
Bugs


THANK YOU