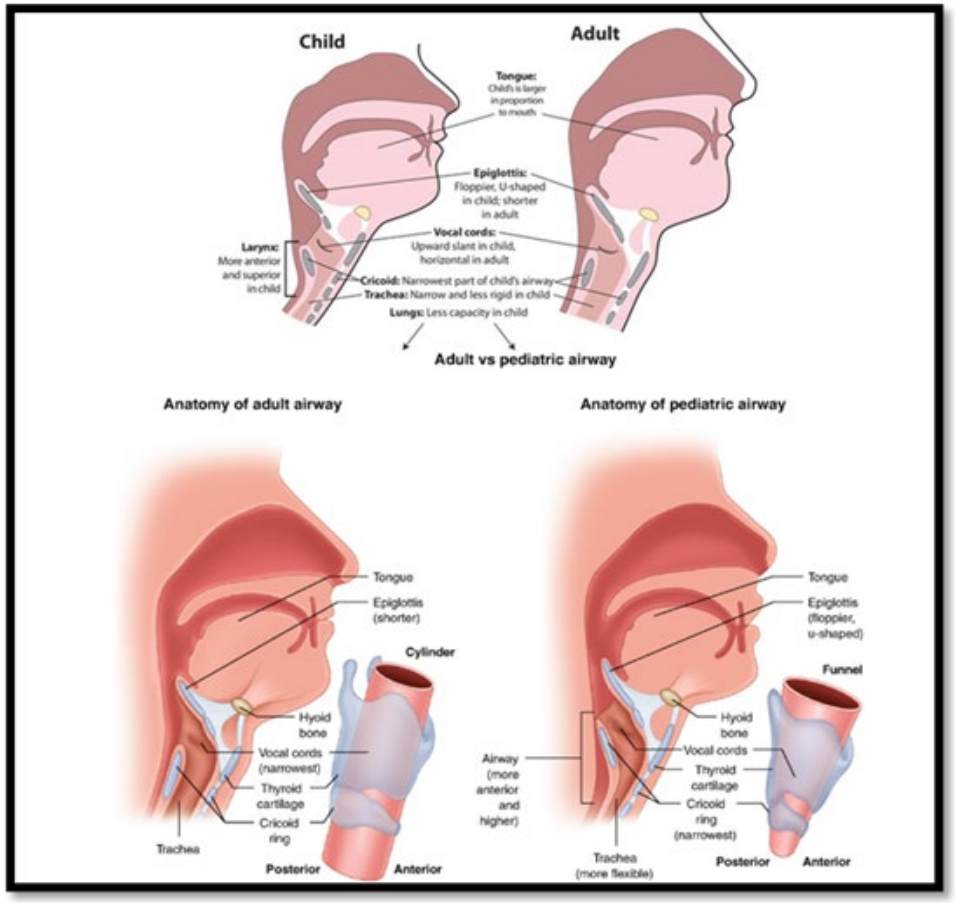
UPMC | CHILDREN'S HOSPITAL OF PITTSBURGH

Pediatric Airway & Respiratory Therapies

June 2025

Pediatric Airway Differences

- Infants and young children fatigue quickly due to their reliance on the diaphragm to create negative pressure and chest wall movement
- Children have smaller and fewer alveoli
  - Limited surface for gas exchange
  - More dead space in the airway
- Obstruction / Narrow airway risk factors:
  - Large tongues with small mouths
  - Inadvertent external pressure applied to soft cartilage of airway
  - Funnel shaped larynx and trachea (narrowest point at cricoid)
  - Larynx is more anteriorly located
  - Glottis sits high and is stiff (creates barrier for ET tube to pass)
- Increase in oxygen consumption due to higher respiratory rate driven by a higher metabolic rate
- Talk it out: what other pediatric differences are important considerations when potentially intubating?



Neurally Adjusted Ventilatory Assist (NAVA)

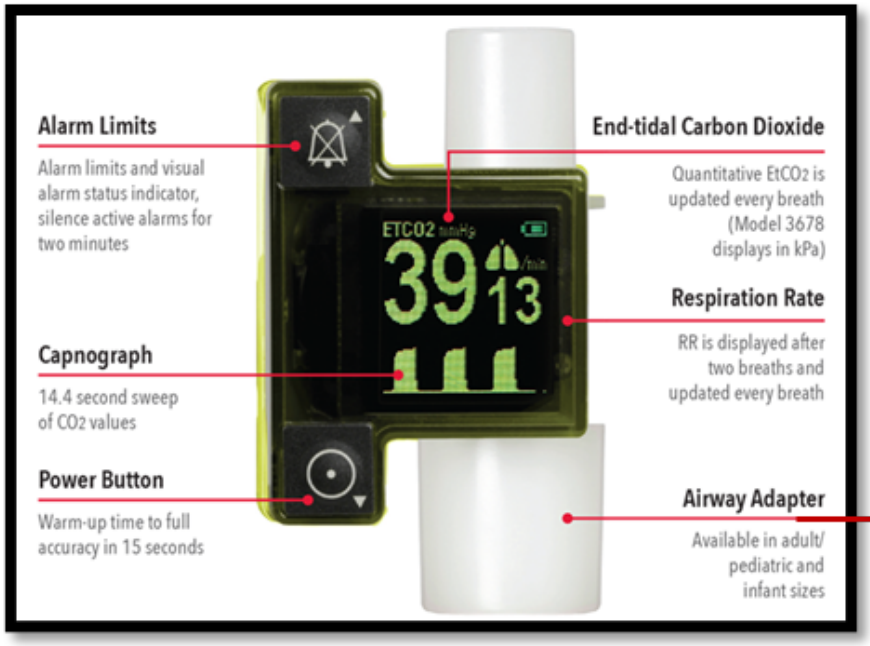
- *Purpose:* synchronizes mechanical ventilation with a patient's respiratory effort
- *Benefits:* this may allow for lower peak airway pressures & less barotrauma
- *Mechanism:* an EDI catheter detects electrical signal from the diaphragm and initiates respiratory support

NAVA Settings

- *Nava level*: the pressure support delivered with each breath. (Typical setting ranges 0.5 – 5 cmH2o/microvolt)
- *Edi peak:* active contraction of the diaphragm. (typical range is between 5 - 15)
- *Edi min*: resting phase of the diaphragm. (typically 2-4)
- *Back-up settings*: if patient is over/under ventilated or the Edi catheter is malfunctioning, ventilation will automatically switch into back-up mode. The active mode will be highlighted on the screen.

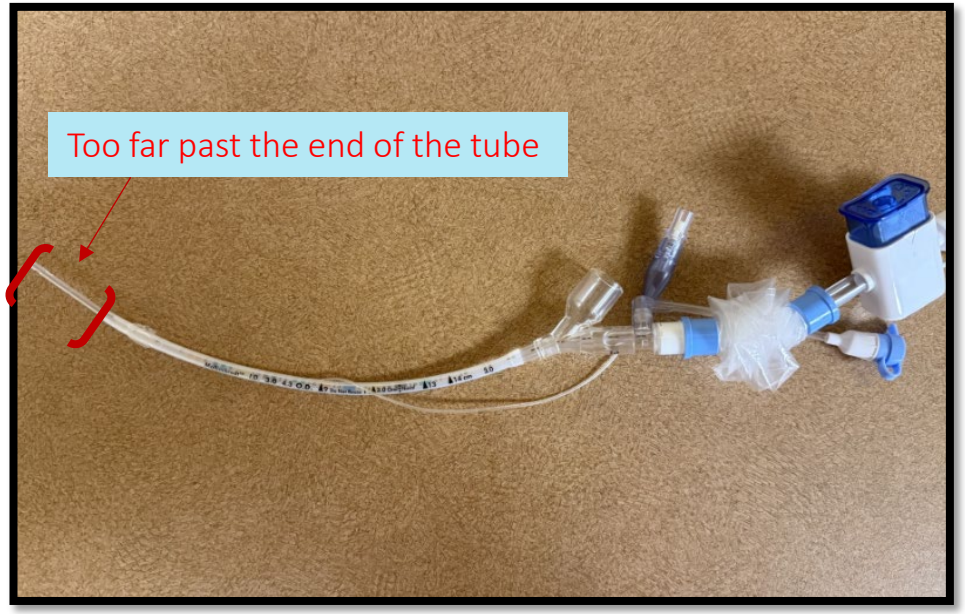
EMMA Capnography

- Portable real-time end tidal carbon dioxide ($EtCO_2$) and respiratory rate measurement system.
  - Replace the colorimetric systems currently used for intubation and tube placement verification.
- EMMA Airway Adapter (white part) is disposable.
- EMMA Device (electronic part) is **not** disposable.
  - After use, clean with alcohol or hydrogen peroxide wipe.
- **Infant** Adapter: 4.0 ETT and smaller
- **Adult/Pediatric** Adapter: 4.5 ETT and larger
- Device powers **off automatically** during the following conditions:
  - No breath detected within 2 minutes of power up
  - No breath detected within 2 minutes & alarm silenced
  - 15 seconds after the EMMA Airway Adapter is removed
- Colormetric devices (purple to yellow) will stay in the airway bags for road trips.



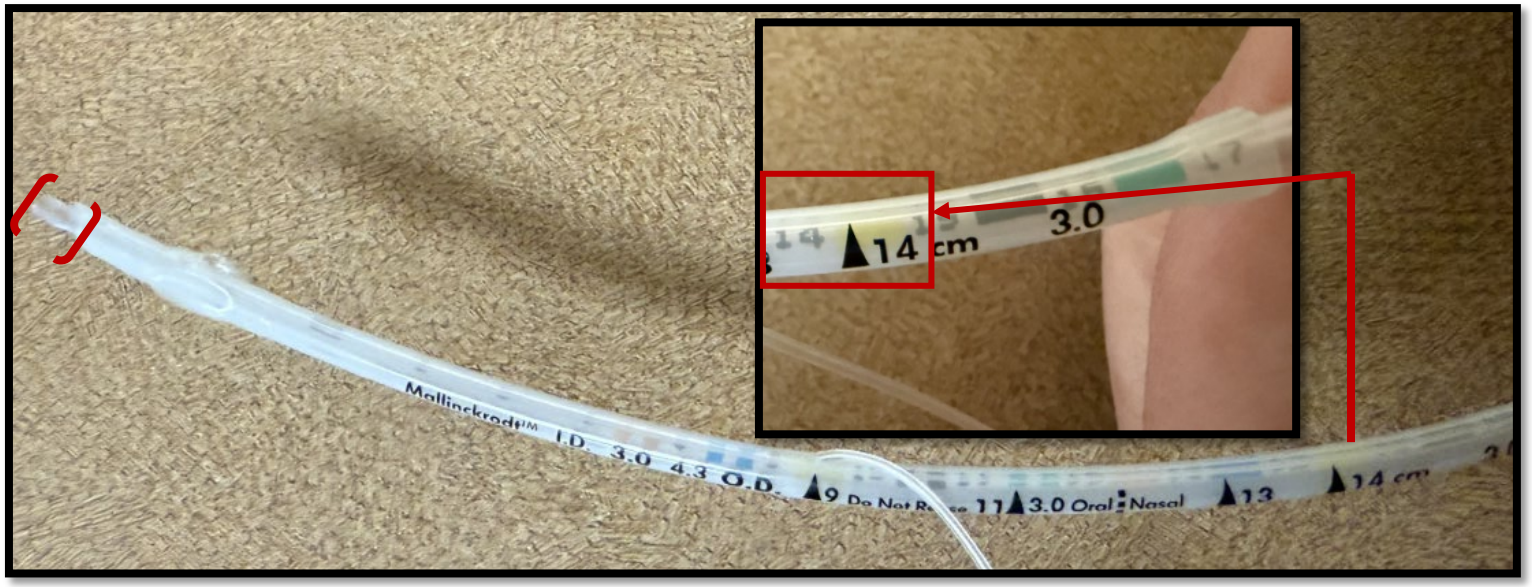
Endotracheal Tube Suctioning

- Advancing the entire suction catheter too far can cause damage to the airway tissue and stimulate the vagal nerve (causing bradycardia & hypoxia)



- Align the number on the suction catheter with the last number of the ETT (closest to the Y-connection of suction and vent. tubing)
  - Advance the catheter so the numbers align to clear the ETT **OR**
  - Advance the catheter to the colored box to the right to clear right below the tube.

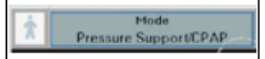
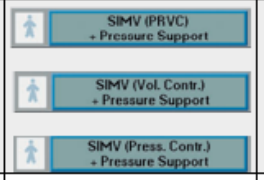
- Example:
  - This 3.0 ETT has an end mark of 14 cm before the bifurcation of the ventilator tubing and in-line suction catheter.
  - Advance the catheter number to align with the 14cm mark on the ETT or align with the yellow box to clear beneath the tube.



Pediatric Modes of Ventilation

- Talk it out: what are some differences between using pressure control and PRVC in the pediatric cardiac patient?

Common Terminology & Modes of Ventilation

Pressure Support (PS)		Spontaneous mode of ventilation. The patient initiates the breath, and the ventilator delivers support with the preset pressure level. This can be used with other modes of ventilation.
Pressure Control (PC)		Control of airway pressure = pressure is fixed throughout inspiration and flow will decrease throughout inspiration. Flow & tidal volume are dependent on pressure.
Pressure Regulated Volume Control (PRVC)		Ventilator adjusts peak inspiratory pressure (PIP) to target a specific tidal volume. Ventilator will automatically adjust the PIP to target tidal volume and allows for "auto-weaning."
Synchronized Intermittent Mandatory Ventilation (SIMV)		Patient receives mandatory breaths that are controlled or assisted by the ventilator. These are synchronized with the breathing efforts of the patient who can breathe spontaneously between the breaths. This can be used in conjunction with PS, PC, VC, or PRVC.
Volume Control (VC)		Control of tidal volume = flow is fixed throughout inspiration Pressure will increase at a constant gradient to maintain flow throughout the breath. The pressure changes to ensure delivery of the tidal volume during inhalation.
High Frequency Oscillating Ventilation (HFOV)	**Frequency**: measured in Hertz (1 HZ = 60 breaths per cycle).	A ventilatory technique in which very small tidal volumes are delivered at high frequencies. Expiration is active and oscillating device that generates the high-pressure waveform is a reciprocating piston that promotes emptying of the lung. Used for lung protection and minimizing atelectrauma when conventional mechanical ventilation is not sufficient. **Amplitude**: controls the distance the diaphragm travels from its resting position and is the "wiggle" of the chest. Titrated to achieve desired CO_2 elimination. **Mean Airway Pressure:** provides constant distending pressure to keep lungs inflated and optimize volume area for gas exchange. Oxygenation is dependent of MAP and FiO_2.

Pediatric Oxygen Delivery Options

- Talk it out: what other pediatric differences are important considerations in escalation of respiratory devices? When would you consider using a blender with oxygen flow?

Oxygen Delivery Options for Respiratory Support

Device	Flow Rate	FiO2	Notes
Nasal Cannula 	Infant (0-12 months): 1-2 L/min Pediatric & Adult: 1-4 L/min (max 6L for older patients)	Each liter adds ~ 4% FiO_2 1 LPM = 24% 2 LPM = 28% 3 LPM = 32%	• Low flow meters can be used for infants to achieve <0.5 L/min • Cannula sizes are available in infant, pediatric, and adult • Low flow system can have great fluctuation in FiO2 delivery • Higher rates can cause headache or dry mucous membranes
Simple Face Mask 	6-10 L / min	40-60%	• Flow rate must be at least 6L/min • Mask sizes available in pediatric and adult
Venturi Mask 	Blue: 2L/min Yellow: 4L/min White: 6L/min Green: 8L/min Pink: 8L/min Orange:12L/min	Blue: 24 % Yellow: 28% White: 31% Green: 35% Pink: 40% Orange: 50%	• Mask can be utilized with any size connection
Non-Rebreather 	10-15 L / min	80-90% (not 100% because there may not be a perfect seal to the face)	• Valve #1 is between face mask and reservoir bag and does not allow air from outside or exhaled air into the bag. Only oxygen flows from the bag into the mask. • Valve #2 allows exhaled air to flow into the atmosphere but does not allow outside air to enter. • Reservoir bag should be inflated when connected to oxygen
High Flow Nasal Cannula 	2-60 L / min **Initiate:** 2 L / kg / min	21-100 %	• Must be set up by RT • <2L = not enough flow through the heating pot and can make the plastic tubing hot in nares

Pediatric Oxygen Flow

- Rate in which oxygen is delivered to supplement the patient's tidal volume
  - Measured in Liters per Minute (L/min)
- Every increase by 1 L/min equates to about a 4% increase in FiO_2, starting from 24%
- Use flowmeters to adjust based on patient's work of breathing
  - Standard (pediatric/adult): 1-15 LPM
  - Low flow (neonate/infant): 1/8 – 3.5 LPM

Below 1L Flow

Standard Flow

Pediatric Oxygen Fraction of Inspired Oxygen (Fi02)

- Percentage or concentration of oxygen inhaled by a person
  - Natural air 21% oxygen
  - If nasal cannula is connected to the flow meter on the blender, the nurse will be able to adjust the FiO2 based on patient's saturations and not effect the flow
- Oxygen blenders allow oxygen concentration to be adjusted between 21%-100%
- Ability to keep the same flow but titrate FiO_2 on blender to give concentrated oxygen
  - Flow is needed to support the extra FiO_2 delivery
- Adjust FiO_2 to compensate for patient desaturations

Resources

- Rossor, T. E., Hunt, K. A., Shetty, S., & Greenough, A. (2017). Neurally adjusted ventilatory assist compared to other forms of triggered ventilation for neonatal respiratory support. *The Cochrane database of systematic reviews*, *10*(10), CD012251. https://doi.org/10.1002/14651858.CD012251.pub2

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- Lippincott. (2024). Intubation with direct visualization, assisting, pediatric. Retrieved, April 30, 2025, from: Lippincott® Solutions
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