LIFE FLIGHT NETWORK

Pediatric Pearls
A to B

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Life Flight Network

THERE WHEN YOU NEED US®

A

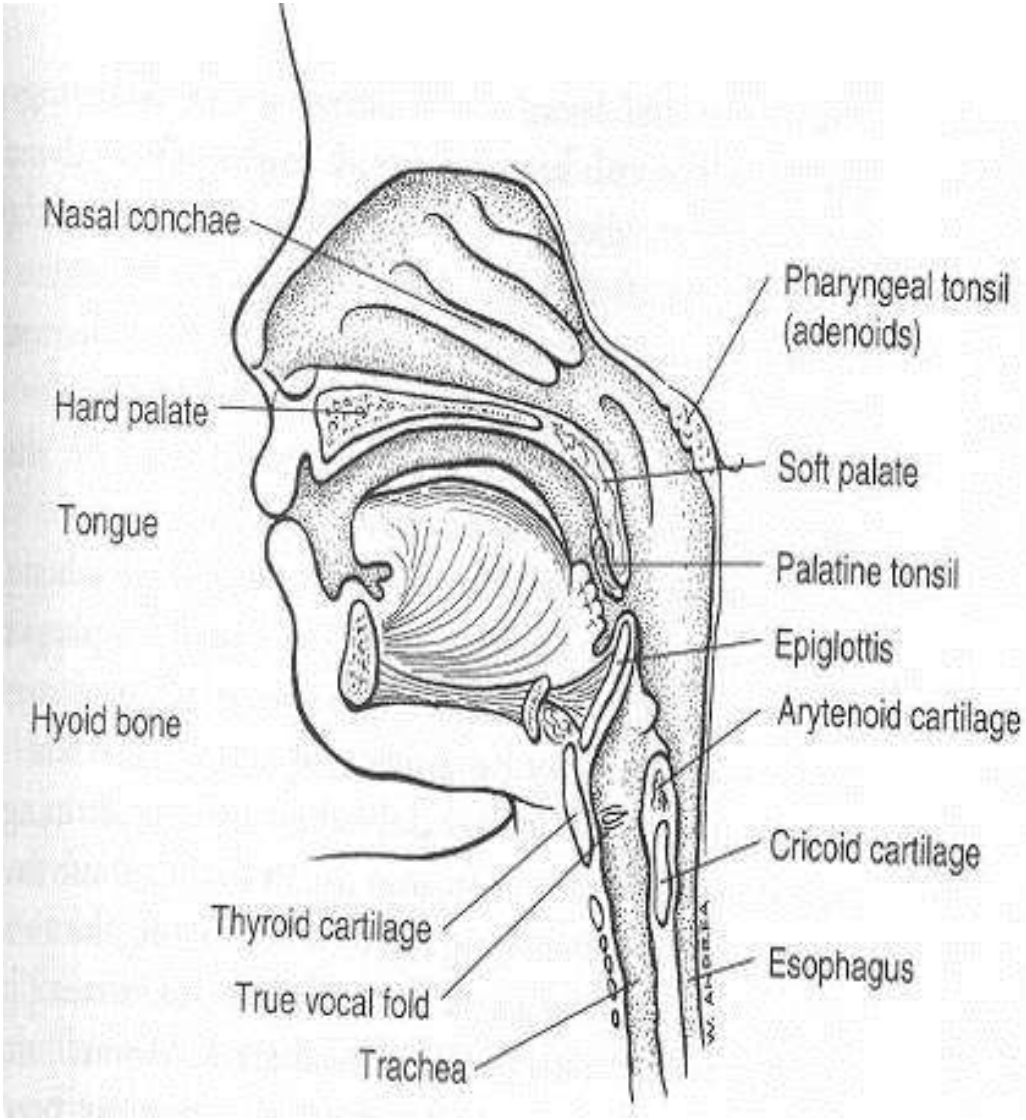
Pediatric Airway

Challenges of the Pediatric Airway

- Age related dosing and equipment
- Anatomical variations based on age
- Anxiety of a sick child
- Fear in the care giver
- Anxiety of parents

Pediatric Airway Anatomy

Pediatric Airway Anatomy



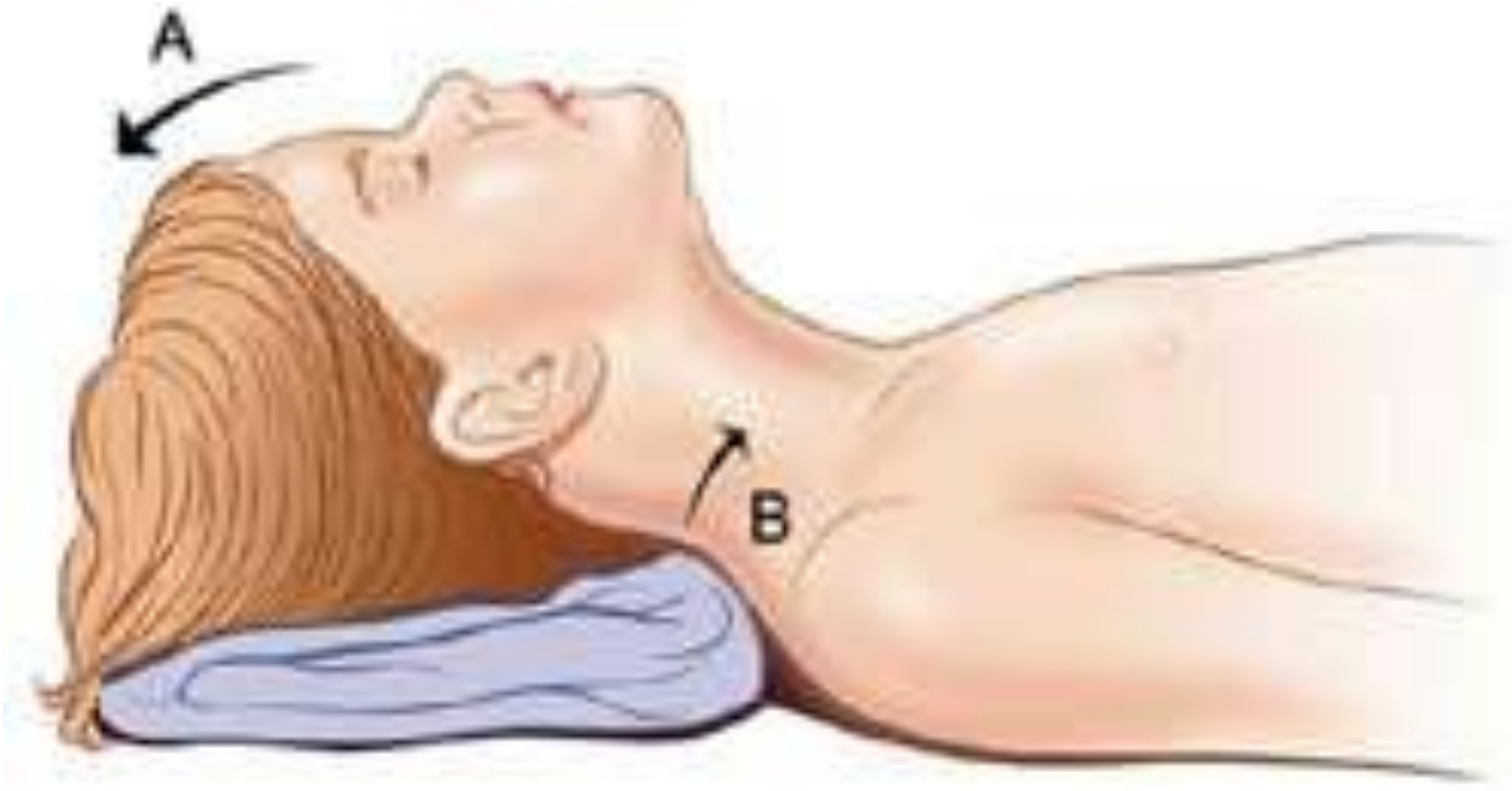
Tongue

- Potential site of airway obstruction
  - Difficult ventilation
  - Loss of tone with sleep, sedation or CNS dysfunction
  - Posterior displacement of the tongue may cause severe airway obstruction

Occiput

- A child's head/occiput are proportionately larger than an adult's
- Neck flexion while supine
  - Leads to obstruction
- Overcome with the sniffing position
  - Roll placed under back (infant) for BVM
  - None – small child
  - Roll placed under occiput in older children

Sniffing Position



Nasal Passage

- Increased mucosa and lymphoid tissue
- Nasal airway is primary pathway for normal breathing in the infant
  - Warming, humidification, particle filtration
- Compromised breathing with increased secretions, NGT placement, nasal congestion

Larynx

- Newborns
  - Larynx at the base of the occiput/C1 to C4
- Enables epiglottis to lock the larynx into the nasopharynx by passing up behind the soft palate
- Provides a direct air channel from the nares to the lungs, allowing liquids to pass on the sides into the esophagus

Larynx

- Two separate anatomic pathways
  - Respiratory tract from the nose to the lungs
  - Digestive tract from the mouth to the stomach
- Large Tongue
  - Entirely within the oral cavity
- High Glottis
- Difficult line of vision from mouth to the larynx during laryngoscopy
  - Anterior Airway

Anatomic Changes in Childhood

- Occurs after the second year of life
- Posterior 1/3 of tongue descends into the neck, forming upper anterior pharyngeal wall
- By 7 years, the larynx lies between C3 and C6
- In adulthood, the larynx lies between C4 – C7

Anatomy

- In adults, the vocal cords and trachea are of equal dimensions

- In newborns, the narrowest portion of the airway is the cricoid ring
  - Tight ET tubes may lead to cricoid damage, subglottic stenosis (more on this later)

Preoxygenate

- 5 minutes of 100% oxygen or 8 deep breaths over 60 seconds
  - Time before sats < 90%
    - 70 kg pt -- 8 minutes
    - 120 kg pt -- 3 minutes
    - **10 kg child -- 4 minutes**
- Time for sats 90% → 0%
    - 70 kg pt -- 120 seconds
    - **10 kg child -- 45 seconds**

Airway Equipment

- Suction Device
- Oxygen source
- Bag Valve Mask
- ET Tube
  - 1 size smaller and larger
- Laryngoscope blade & Handle
- $ETCO_2$ Detector
- Tube Holder
- Alternate Airway Equipment
  - OPA, Combitube, King airway, LMA, cric. kit
- RSI Medications

Equipment Sizes

- ET Tube
  - Diameter = (age/4) + 4
  - Width of child's 5th finger
  - Depth = Tube Size x 3
- Laryngoscope Blade
  - Based on Length base (Broselow) Tape

Laryngoscope use

- Use the correct size blade
  - Miller 0 - premature infant or small newborn
  - Miller 1 - normal newborn to 12 kg (2 years)
  - Miller 2 - 13 to 24 kg (7 years)
  - Miller 3 - 25 kg + (8 years +)
  - Macintosh may be used after 2 years of age
- Too small a blade can get you into trouble
- Don’t insert blindly. Watch the tip of the blade go where you want it.
- If the epiglottis is large and floppy, consider using the Mac blade like a Miller (lift the epiglottis)

Laryngoscope use

- Spend an extra 3-5 seconds sweeping the tongue completely out of the way.
- If you don’t do this, the laryngoscope displaces the tongue posteriorly, and it occludes the view

ET Tube Dogma

- Because of the funnel shaped larynx:
  - Tight fitting ETT may cause edema and trouble upon extubation
- Uncuffed ETT preferred for patients < 8 years old

What PALS says

- Cuffed tubes may be preferred in certain circumstances …poor lung compliance, high airway resistance, or large glottic air leak - really any sick kid

Comparison of cuffed and uncuffed endotracheal tubes in young children

- Weiss M, et al: *Br J Anesthes* 2009; *103 (6): 867-873*
  - 2246 children RCT (1119/1127 cuffed/uncuffed)
  - Post-extubation stridor was noted in 4.4% of patients with cuffed and in 4.7% with uncuffed tubes

Cuffed vs. uncuffed endotracheal tubes

- Using the standard formula for tube size (age/4) + 4, uncuffed tubes were incorrectly sized in 23% of cases.
- In another study, tube changes due to significant air leaks occurred in 28-30% of patients with uncuffed tubes.
- These problems did not occur with cuffed tubes.

PALS: Sizing Cuffed vs. uncuffed endotracheal tubes

- Uncuffed
  - < 1 year old: 3.5 mm ET tube
  - 1-2 year old: 4.0 mm ET tube
  - > age 2: (yrs/4) + 4 = mm ET tube
- Cuffed
  - < 1 year old: 3.0 mm ET tube
  - 1-2 year old: 3.5 mm ET tube
  - > age 2: (yrs/4) + 3.5 = mm ET tube

PALS: Sizing Cuffed vs. uncuffed endotracheal tubes

- Bottom line:
  - Use a length-based resuscitation tape (e.g. Broselow)
  - If cuffed tubes are not listed, use the uncuffed size minus 0.5 mm.

Post Intubation Management

- Verification of Tube Placement
  - Visualization
  - $ETCO_2$
  - Auscultation
- Secure the tube with tape or commercial device
  - Head/neck immobilization in small children to avoid neck movement and dislodgement

Other Airways

- Combitube®
  - Small Adult is smallest size
  - Must be 4 foot tall.
- King airway
  - Small Pediatric sizes available now
- i-Gels
  - 4 pediatric sizes
  - Smallest is 2-5kg

King Airway

	Pediatric				Adult		
Tube Size	Size 0	Size 1	Size 2	Size 2.5	Size 3	Size 4	Size 5
Connector Color	Transparent	White	Green	Orange	Yellow	Red	Purple
Patient Criteria	<5 kg	5-12 kg	12-25 kg 90-115 cm	25-35 kg 105-130 cm	4-5 feet (122-155 cm)	5-6 feet (155-180 cm)	greater than 6 feet (>180 cm)
Recommended Cuff Volume	10 ml	20 ml	35 ml	40-45 ml	50-60 ml	70-80 ml	80-90 ml
Maximum Cuff Pressure				60 cm H_2O			
External Diameter of the Tube	9 mm	9 mm	14 mm	14 mm	17.6 mm	17.6 mm	17.6 mm
Bronchoscopy Via Ventilation Lumen	< 3.0 mm	< 3.0 mm	< 4.0 mm	< 4.0 mm	< 6.0 mm	< 6.0 mm	< 6.0 mm
Suction Catheter	10 Fr	10 Fr	16 Fr	16 Fr	18 Fr	18 Fr	18 Fr

B

Pediatric Breathing (and ventilation)

Hypoxia

- Hypoxia in Children
  - First sign: Anxiety/ Fear/ Irritable
  - Second sign: Lack of engagement
  - Third sign: Bradycardia
  - Fourth sign: Loss of consciousness
  - Develops quickly in children
    - Higher metabolic rate increases consumption
    - Minimal reserve capacity

Signs of Respiratory Distress

- Rapid breathing
- Grunting
- Inability to lie down
- Agitation
- Accessory muscle usage
- Retractions
- Tachycardia
- Apnea

Basic Airway

- Positioning
  - Jaw thrust vs. Chin lift
  - Oral airway
    - Sizing
    - Insertion techniques
    - Contraindications
  - Nasal airway
    - Sizing
    - Insertion techniques
    - Contraindications

Bag Valve Mask Ventilation

- Must fit over the nose, cheeks, mouth, and chin
- Place in sniffing position
  - In line stabilization
  - Jaw thrust
- OPA – from corner of mouth to angle of jaw
- NPA – from nares to tragus of ear
- Inspect for foreign body

Bag Valve Mask Ventilation

- Pediatric/Adult Size bag – chest rise
  - Pop off valve 35-45 cm of water
- A skill that needs practice!
- 1 or 2 person ventilation

Reasons to Intubate

- Failure to Oxygenate – low SpO_2
- Failure to Ventilate – high CO_2
- Expected Clinical Course

Primum non nocere….

- You can cause harm or death with intubation and a ventilator.
  - Doesn’t mean you shouldn’t use the tools
  - Why you are here today
  - Practice doesn’t make perfect, but it helps

Rate Matters

- Look at the patient before you intubate
  - Rate
  - Effort
  - Why are they in tachypneic
    - Hint: it may have nothing to do with airway or lungs.
- Minute Ventilation (?)
- Disease Process
- Metabolic demands

I:E Ratio

- Inspiratory Rate can be too fast
- Expiratory phase can be too short
- Anatomy versus disease process

Ventilation strategy

These are for healthy Lungs, normal metabolic demands

- < 1 year Rate = 25 – 30
- 1 – 5 years Rate = 20 – 25
- 5 – 12 years Rate = 15 – 20
- >12 years Rate = 12 – 15

Ventilation strategy

- Tidal Volume should be appropriate
  - Be aware of Peak inspiratory pressure, but not afraid of it.
  - Ok if needed up to 25-30 cm/H_2O
  - Healthy lungs 16-20 cm/H_20
- Remember PEEP. Start with 5 cm/H_2O
  - If you are bagging place a peep valve
  - Asthma patients are the exception that may do better without peep.

Asthma Patients

- Very high threshold to intubate
- Peep may not be beneficial
- Lower Respiratory Rates
- Very long expiratory phase
- May require high peak inspiratory Pressures
- Measure Pplat

Asthma Patients

- The recommended method to monitor patients for hyperinflation and injurious airway pressures is Pplat, the average end-inspiratory alveolar pressure.
- Pplat is measured using an end-inspiratory pause. Values > 30 cm H_2O indicate hyperinflation and excessive airway pressures.
- Of note, peak airway pressure (Ppeak) measurements do not correlate with patient outcomes and therefore are not useful for assessing hyperinflation.
  - Ventilator Management of the Intubated Patient With Asthma, Michael E. Winters, MD December 13, 2010

Slide Title

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Thank You