Pediatric Airway Management

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• None
• Hopeful this changes at some point
• Tips appreciated
The Pediatric Airway

- Introduction
- Anatomy / Physiology
- Positioning
- Adjuncts
- Intubation
Introduction

Most pediatric arrests are of **RESPIRATORY** etiology

Pediatric Cardiopulmonary Arrest

Asystole portends a grave prognosis with > 90% morality
Age Distribution of Arrests

![Bar chart showing the age distribution of arrests. The chart indicates that the highest number of arrests occurs in the age group of 6 months to 1 year, followed by the 7-12 month group. There is a significant decrease in the number of arrests as age increases, with very few arrests in the older age groups.]
Infants are Different

- Large Occiput
- Narrow Nares
- Thin Hallow Underdeveloped Mandible
- Large Tongue
- Floppy, Omega Shaped Epiglottis
- High Larynx
- Narrow Subglottis
Anatomy: Nose

- Nose / Pharynx responsible for 50% of total airway resistance
  - Kid’s noses are shorter, flatter, with small circular nares
  - (20 mm in diameter)
- Infant: blockage of nose = respiratory distress
Anatomy: Tongue

- Infant tongue is proportionally large
- Loss of tone with sleep/sedation/CNS dysfunction frequent cause of obstruction
- Loss of tone with sleep, sedation, CNS dysfunction
- Frequent cause of upper airway obstruction

(From Fuhrman and Zimmerman, Pediatric Critical Care, 2016)
Craniofacial Anatomy

Children are NOT Adults

Proffit WR. Contemporary Orthodontics. 2nd ed. St Louis: Mosby; 1993.)
Pediatric Airway Management

- Larynx Anatomical Considerations
  - The infant's larynx is higher (rostral) in the neck & more anterior
    - Infants - C1
    - Six months - C3
    - Adults C4-6
  - The infant's epiglottis is omega shaped (Ω) and angled away from the trachea
  - The narrowest part of the funnel shaped larynx is the cricoid cartilage below the vocal cords

*Furman – Text book of Pediatric Critical Care Ch. 14
Berry, Peds Clinics of NA, 1994*
Epiglottis Location

C 4-5

C 2-3
Anatomical Considerations

**Figure 27: Adult Airway**
Anatomy of adult airway

**Figure 26: Pediatric Airway**
Anatomy of pediatric airway
Anatomy : Larynx

Narrowest point = cricoid cartilage in the child
Anatomy : Epiglottis

- Relatively large size in children
- Omega shaped
- Floppy – not much cartilage
Physiology: Effect of Edema

Poiseuille’s law

\[ R = \frac{8 \pi l}{\pi r^4} \]

- Internal dimensions of trachea in newborn ~ 1/3 of adult (81 x R)
- Radius is the most important determinant of resistance of the airway
  - \( R = 8 \ln/\pi r^4 \)
- Small changes in airway diameter in infants/children due to edema/secrections have greater effect on resistance

Narrowest point = cricoid cartilage in the child
Physiology: Effect Of Edema

Poiseuille’s law \( R = \frac{8nl}{\pi r^4} \)

- \( R = \) resistance
- \( n = \) viscosity
- \( l = \) length
- \( r = \) radius

Resistance rapidly increases as diameter decreases
If radius is halved, resistance increases 16 x
Basic Airway Management

• The Goal of Airway management is to anticipate and recognize respiratory problems and to support or replace those that are compromised or lost

Pediatric Advance Life Support Manual

• An individual must be able to support three specific functions:
  • Protect their airway
  • Adequately ventilate
  • Adequately oxygenate

• Failure to perform one will result in respiratory failure
Basic Airway Management

- There are many simple, non-invasive techniques to support respiration prior to endotracheal intubation
  - Suctioning
  - Positioning of the airway
  - Adjuncts
    - Nasopharyngeal airway
    - Oropharyngeal airway
  - Application of oxygen
  - Application of positive pressure
  - Assistance of ventilation with BVM
POSITIONING

• Use of the chin lift and jaw thrust can help restore flow through an obstructed upper airway by separating the tongue from posterior pharyngeal structures.

• The goal is to line up three divergent axes: oral, pharyngeal and tracheal.
Aligning the Axis

“Sniffing”

towel placed under head

Berry, Peds Clinics of NA, 1994
Airway Positioning <2 years

Towel placed under sholders
Positioning

Airway adjuncts

Oropharyngeal Airways

• Facilitates relief of upper airway obstruction due to a large tongue
• Allows oropharyngeal suctioning
• Prevents compression of a child’s endotracheal tube due to biting

Nasopharyngeal Airways

• Nostril to Tragus
• Contraindications:
  • Basilar skull fracture
  • CSF leak
  • Coagulopathy
Nasopharyngeal Airway

A regular ETT can be cut and used as a nasal airway
Adjuncts: Oral Airway

Wrong size: Too Long
Adjuncts: Oral Airway

Wrong size: Too Short
Adjuncts: Oral Airway

Correct size
Oral Airways
Application of Oxygen

- Nasal canula (23-40%)
- Hood (80 – 90%) infants, (21-50%) older
- Simple face mask (35-60%)
- Non-rebreather mask (80-100%)
  - High flow (10-12 l/min)
  - Reservoir of oxygen
  - Tight-fitting to face
  - Valves to prevent entrainment of room air
Bag-Valve-Mask

• Masks should fit easily over the nose and mouth with no pressure on the eyes. The base of the mask rests on the chin.
• Valves allow unidirectional flow of oxygen to the patient and prevent entrainment of exhaled waste gas into the system.

**THE MOST IMPORTANT SKILL TO HAVE**

• **PRACTICE PRACTICE PRACTICE**
  • Anesthesiologist typically happy to have you
  • ETCO2 monitors help determine if effective
  • Multiple intubation attempts kill kids
Bag-Mask Ventilation

- Clear, plastic mask with inflatable rim provides atraumatic seal
- Proper area for mask application—bridge of nose extend to chin
- Maintain airway pressures <20 cm H2O
- Place fingers on mandible to avoid compressing pharyngeal space
- Hand on ventilating bag at all times to monitor effectiveness of spontaneous breaths
- Continuous positive pressure when needed to maintain airway patency

Signs of Respiratory Distress

• Tachypnea
• Tachycardia
• Grunting
• Stridor
• Head bobbing
• Flaring
• Inability to lie down
• Agitation

• Retractions
• Access muscles
• Wheezing
• Sweating
• Prolonged expiration
• Pulsus paradoxus
• Apnea
• Cyanosis
Indications for Intubation

1. $\text{PaO}_2 < 60 \text{ mmHg with Fio}_2 \geq 0.6$ (no congenital heart disease)
2. $\text{PaCO}_2 > 50 \text{ mmHg}$ (acute/ unresponsive to other therapy)
3. Upper airway obstruction
4. Neuromuscular weakness
   (NIF $< -20$, vital capacity $< 12-15 \text{ ml/kg}$ (ch. 55 Furman))
5. Absent protective airway reflexes (cough, gag)
6. Hemodynamic instability
7. Therapeutic hyperventilation (TBI)
8. Pulmonary toilet
9. Emergency drug administration
Indications for intubation

• Recognize the neurological indication for intubation
  • Child who has *ingested a central nervous system depressant*
  • Loss of airway protective reflexes

• Understand that intubation may be indicated despite good respiratory function,
  • Head trauma or increased ICP*

• Know that intubation may be indication prior to the onset of respiratory failure
  • Patients with muscle weakness*

• Intubation prior to the onset of respiratory failure*
  • Hemodynamic instability
Impending Respiratory Failure

- Reduced air entry
- Severe work
- Cyanosis despite $O_2$
- Irregular breathing / apnea
- Altered Consciousness
- Diaphoresis
Respiratory Failure

• Hypoxic respiratory failure
• Hypercarbic respiratory failure
Hypoxemia

Mechanism

- Inadequate inspiratory partial pressure of oxygen
- Global alveolar hypoventilation
- Right to left shunt
- V/Q mismatch
- Incomplete diffusion equilibrium

Distinguishing Attribute

- Low barometric pressure or FIO2
- High PaCO2
- Little change with extra oxygen
- Good response to O2
- Good response to O2
Laryngeal Mask Airways

- **Size**
  - 0-5 kg  # 1
  - 5-10 kg  # 1.5
  - 10-20 kg  # 2
  - 20-30 kg  # 2.5
  - 30-50 kg  # 3
  - > 50 kg  # 4
  - Very tall  # 5

- **Between sizes?**
  - Use higher number & less air
  - Better anatomic fit
Intubation – Clinical Pearl 😊

- Larynx cephalad and anterior in children
  - Practitioner may need to be lower than patient and look up
Laryngoscope Blades

Macintosh

Miller
Intubation Technique

Better in younger children with a floppy epiglottis

Straight Laryngoscope Blade – To pick up the epiglottis
Intubation Technique

Curved Laryngoscope Blade – placed in the vallecula

Better in older children who have a stiff epiglottis ~ 8 years
**Intubation**

<table>
<thead>
<tr>
<th>Age</th>
<th>kg</th>
<th>ETT</th>
<th>Length (lip)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Newborn</td>
<td>3.5</td>
<td>3.0 - 3.5</td>
<td>9</td>
</tr>
<tr>
<td>3 mos</td>
<td>6.0</td>
<td>3.5</td>
<td>10</td>
</tr>
<tr>
<td>1 yr</td>
<td>10</td>
<td>4.0</td>
<td>12</td>
</tr>
<tr>
<td>2 yrs</td>
<td>12</td>
<td>4.5</td>
<td>12</td>
</tr>
</tbody>
</table>

**Children > 2 years:**

ETT size: \( \text{Age/4} + 4 \)

ETT depth (lip): \( \text{Age/2} + 12 \)
Technique: Intubation

How far does it go in?
Preparation for Endotracheal Intubation

- Needed personnel
- Monitoring
- Endotracheal tubes, laryngoscope blades - variety of sizes
- Adjuncts (styles, oral airway, securing mechanism)
- Suctioning equipment
- BVM attached to oxygen at proper flow
- Access/Medications - sedation/RSI pack

- L.O.S.E.R.
  - Light (blade)
  - Oxygen, Bag, Mask
  - Suction
  - ETT, ETCO2
  - Rx - Drugs
Confirm Placement

• Colorimetric CO$_2$ detector
• Look
• Listen
  • Remember that infants can easily transmit breath sounds to the stomach
  • There’s nothing better than watching the ETT go through the cords
Post-intubation considerations

• Bilateral breath sounds before tube secured
• ETCO2
• Mist in the ETT
• Chest x-ray ordered
  • Tube migration into right mainstem or esophagus
• NGT in place for gastric decompression
• Suctioning the tube following placement
• Ventilator settings provided