The Ins and Outs of the Pediatric Airway

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Case 1: Fast and noisy

- 8 month old BIB parents for noisy breathing
- VS: RR 70, O₂ 94%, T39
  - nasal flaring and retractions
  - crackles throughout
- Wonder if she’ll poop out?
Objectives

• Basic anatomic and physiologic differences between kids and adults

• Airway BLS: monitors, airway adjuncts, BVM

• Airway ALS:
  • Direct laryngoscopy in kids
  • Alternatives to direct laryngoscopy
  • Alternatives to intubation: the LMA
  • The airway disaster: the neck!
Airway: anatomic differences

- Large occiput
- Large tongue/tonsils
- Floppy epiglottis
- More cephalad and anterior airway
- Narrowest at cricoid ring
Anatomic differences

- Secretions easily block airway
- Increased aspiration risk
- Flexible thoracic cage: retractions/paradoxical breathing
- Immature respiratory muscles: tire easily
- Obligate nasal breathers <6 months
Conditions that can cause airway problems

- Genetic/congenital: trisomy 21, Pierre-Robin
- Infection: croup, epiglottis, abscess
- Rheum: JRA
- Burns/trauma
Physiologic differences

- High metabolic rate $\rightarrow$ high O$_2$ consumption

- MV = RR x TV

- TV limited by thorax size

- MV more RR dependent

- RR$\uparrow\uparrow$ with distress
Physiologic differences

- Limited respiratory reserve
- Time to 90% O₂ sat after pre-oxygenation:
  - 6 minutes adult/adolescent
  - 90 seconds if <6 months*

Case 2: Let’s use the propofol

- 2 year old with distal radius fracture
- Propofol for reduction
- O2 sat to 92%, sonorous respirations
- What now?
Airway BLS

- **Monitors:**
  - Basic: pulse ox, HR, BP
  - ETco2 key to early detection of hypoventilation

- **(Re-)Positioning:**
  - Large occiput
  - Roll under shoulders

- **Suction:**
  - Secretions/blood easily obstruct airway
  - Nasal sxn in infants
Airway BLS

- **Airways adjuncts:**
  - NP: nares to tragus
  - OP: mouth to angle of jaw

- **BVM:**
  - 2 person technique
  - bridge of nose to cleft of chin
  - lift face to mask: don’t push mask onto face
Case 3: Code 3 call-14 mo old asthma

- Paramedic ringdown: 14 mo old asthma, declining RR and HR: Doc, should we tube him?
- OOH success with intubation
  * <3yrs old: 56%! * 3-8 yrs: 61%
- No difference in survival or neuro outcome ETT or BVM
- 2010 ACLS: BVM preferred over intubation if transport time short

He’s circling the toilet bowl..

- In ED, pt sleepy, RR 14, O2 90%, minimal air movement
- Asthma meds?
- Silastic therapy?
- Working on the IV...
Airway ALS: RSI or TED? (Tie Em Down)

- **RSI!**: even in neonate (2x greater success, fewer complications)
- IO time
- **Succinylcholine**: black box due to ↑K, arrhythmias, card arrest vs
- **Rocuronium**: longer acting but reversal agent soon (Sugammadex-acts 1-2 min)*

Airway ALS: RSI

- **Atropine?**
  - bradycardia risk
  - < 1 year old or if use succinylcholine

- **Cricoid?**
  - can reduce gastric air but also distort airway
  - 2010 ACLS: “safety and value not clear” so let up if needed

- **NC O2 during intubation?:**
  - why not?
Airway ALS: The tube

- Narrowest portion of airway below cricoid ring
- Who needs a cuff?
Cuff or no cuff: that is the question?

<table>
<thead>
<tr>
<th>Uncuffed tube</th>
<th>Cuffed tube</th>
</tr>
</thead>
<tbody>
<tr>
<td>cheaper</td>
<td>more expensive</td>
</tr>
<tr>
<td>larger tube</td>
<td>smaller tube to make room for cuff</td>
</tr>
<tr>
<td>easier to keep tip in right place</td>
<td>cuff inflation can displace tube</td>
</tr>
<tr>
<td>excessive air leak → may need to change tube</td>
<td>air leak better controlled/tube changes minimized</td>
</tr>
<tr>
<td>greater aspiration risk</td>
<td>reduced aspiration risk</td>
</tr>
</tbody>
</table>

The Verdict: cuffed after 6 years or earlier if air leak control critical to patient management.
ET tube sizing

<table>
<thead>
<tr>
<th>Weight/age</th>
<th>Uncuffed</th>
<th>Cuffed</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;1kg</td>
<td>2.5mm</td>
<td>N/A</td>
</tr>
<tr>
<td>1-3kg</td>
<td>3.0</td>
<td>N/A</td>
</tr>
<tr>
<td>3.5kg to 3mos</td>
<td>3.5</td>
<td>3.0</td>
</tr>
<tr>
<td>4-11mos</td>
<td>4.0</td>
<td>3.0</td>
</tr>
<tr>
<td>1-2 yr</td>
<td>4.5</td>
<td>3.5</td>
</tr>
<tr>
<td>&gt;2yr</td>
<td>age/4 + 4 or 4.5</td>
<td>age/4 + 3.5</td>
</tr>
</tbody>
</table>
Airway ALS: The blade

- **Straight**: easier to lift floppy epiglottis
- **Curved**: less likely to damage mucosa
- **Cardiff pedi laryngoscope**: lifts indirectly but with better line of sight
- **Light source**: LED
What if he didn’t look so bad...

- Non-invasive ventilation:
  - CPAP or PPV
  - Face mask, nasal mask* or helmet*
  - Improve gas exchange and work of breathing
Non-invasive ventilation

- **Indications**: >1 yr hypoxic, CO2 nl or low-pneumonia, bronchiolitis, asthma

- **Contraindications**: AMS, vomiting, impaired gag, advanced resp failure, HD instability

- **Limited studies**: Try it early
What about heliox?

- Less dense, better laminar flow, easier to breathe in

- Min 60% concentration: use only if O2 requirement not >40%

- Bronchiolitis: decreased resp score/no change intub rate or PICU LOS*

- Asthma: some improve in pulm function in severe cases#

* Liet, Cochrane Database 2010
# Rodrigo, Cochrane Database 2006
Case 4: 5 or 15?

- 5 yo morbidly obese
  fever/SOB x 2 days

- VS: RR 40, O2 88% on NRB, HR 150
  PE: tripoding, BS↓ with crackles both bases, no wheeze

- What next?
Direct laryngoscopy? Maybe not...

- **Alternatives to the ETT**
  - LMA Classic
  - LMA Proseal
    - Good data for efficacy in kids
  - LMA Fastrach-intubating (>10 yrs)
  - Combitube (>4 feet tall)

- **Alternatives to direct laryngoscopy**
  - Lighted stylet (e.g. Trachlight)
  - Optical stylet (e.g. Shikani)
  - Video laryngoscopy (e.g. Glidescope)
  - Fiberoptic laryngoscopy
LMA: Love My Airway

- **Classic:**
  - basic model, reusable
  - 90% 1st pass/99% overall (lower in infants)
  - complic rate <10% (infants↑)

- **Proseal:** 2nd generation
  - reusable, gastric port, bite block
  - better seal than classic
  - slightly lower 1st pass success

- **Fastrach:**
  - intubating, >30kg only
# LMA sizing

<table>
<thead>
<tr>
<th>Size</th>
<th>Weight range</th>
</tr>
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<tbody>
<tr>
<td>1.0</td>
<td>&lt;5kg</td>
</tr>
<tr>
<td>1.5</td>
<td>5-10kg</td>
</tr>
<tr>
<td>2.0</td>
<td>10-20kg</td>
</tr>
<tr>
<td>2.5</td>
<td>20-30kg</td>
</tr>
<tr>
<td>3.0</td>
<td>30-50kg</td>
</tr>
<tr>
<td>4.0</td>
<td>50-70kg</td>
</tr>
</tbody>
</table>
Direct laryngoscopy: so retro!

- **Stylets**: slip tube over

- **Lighted stylet** (e.g. Trachlight, Tube Stat):
  - good if blood/ secretions but not edema/masses
  - look for light mid neck

- **Optical stylet** (e.g Shikani):
  - shapeable with built-in fiberoptic scope
  - secretions not good
Airway video games

- Glidescope, Airtraq, Storz
- See around the corner: No need for direct line of sight to see glottis/place tube
- Great for c-spine patients
- Secretions/blood are a killer
- Tendency to focus on monitor → oral trauma
Do video games work better?

• 200 kids direct laryngoscopy vs Glidescope

• Improved view **but**

  • 97 vs 90% 1st pass success

  • Took longer (24 vs 36 sec)

Expensive airway video games

- **Fiberoptics:**
  - Pediatric scope availability?
  - Cannot use if excessive secretions
  - Nasal easier than oral - awake/nasal only in teenagers
  - Easiest via intubating LMA
Can’t intubate/Can’t ventilate!!

- 8 month old with respiratory distress

- Respiratory arrest!
  - BVM: unable to ventilate
  - Reposition/suction/oral airway → still unable to ventilate

- What next???
Airway disaster plan

- BVM
- Laryngoscopy
- LMA
- GO TO THE NECK
When is it time to go to the neck?

- Can’t intubate/can’t ventilate
- All attempts at oxygenation are failing
- Child not waking up soon
- Vitals deteriorating due to hypoxia
Big guys vs little guys

- Cricothyroid membrane: 13 x 12mm (adult) vs 2.5 x 3mm (neonate).
- Landmarks tough: prominent hyoid and cricoid rings
- >8 years: surgical or percutaneous approach
- <8 years: needle/catheter only
Needle cricothyroidotomy

- Extend neck with roll, adipose towards mandible, quick prep
- Any tracheal site below thyroid cartilage
- 14G angio on 10cc syringe (or Ventilation Catheter <VBM, Germany>)
- Insert until free flow air then advance catheter
Trans-tracheal ventilation

- **Jet ventilation:**
  - tubing connects to angiocath
  - makeshift: cut sidehole into oxygen tubing

- **Bag ventilation:**
  - 3.0 ETT adapter
  - 8.0 ETT adapter inserted in 3cc syringe barrel

- Allow time for passive exhalation
Pediatric airway pitfalls

- Failure to practice alternative techniques
- Failure to monitor properly and understand airway BLS
- Failure to anticipate difficult airway and have range of equipment available
- Prolonged attempts → trauma/bleeding in airway
- Spending too long placing IV → go to IO
- Failure to move to the neck when all else fails