Airway Tricks of the Trade

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Disclosures

• I have no relevant financial relationships to disclose.

• I do not intend to discuss unapproved uses of commercial products.
Objectives

• At the end of this session, you will be able to:
  – Outline pediatric airway management approach and techniques from basic to advanced.
  – Discuss best practices for pediatric airway management and how to optimize oxygenation and ventilation.
  – Outline controversies in ETI and RSI and integration of cognitive practice.
  – Describe approach the use of video laryngoscopy and its potential impact on the visualization of the difficult airway.
What’s New?

- Cricoid pressure not recommended
- Emphasis on bag-mask ventilation
- Cuffed ET tubes preferred
- Atropine in RSI algorithm to prevent bradycardia – is no longer recommended
- High flow nasal cannula during apneic period of RSI
- Less etomidate – more ketamine in RSI
- Difficult airway – video laryngoscopy and new extraglottic/supraglottic devices
- Sugammadex available in U.S. for reversal of rocuronium
Case: 9 month-old boy

- 9 month-old boy brought in by paramedics with a history of fever presents with seizure at home
- On arrival, patient has stopped seizing, he also has stopped breathing, and oxygen saturation is dropping 90% - 86%- 80% - 75%
- What do you do now?
Airway Management Process

- Position the head
- Open the airway
  - If no air movement consider FB maneuvers/removal
- Consider airway adjuncts to keep airway open
- Oxygen if breathing and risk for hypoxia
- Suction if secretions
- Bag-mask ventilation if apnea or concern for hypoventilation
  - If no chest rise consider FB maneuvers/removal
- ETI [with RSI] – high flow nasal cannula during apneic period
- Difficult airway algorithm (e.g., Video laryngoscopy, extraglottic devices or surgical airway)

Reassess quickly after each intervention
Position the head and open airway

- Midline
- Avoid excessive flexion or extension
- Towel under shoulders or bump under head to achieve position
- Jaw thrust VERY useful in children in relieving obstruction
Airway adjuncts

- **Oropharyngeal airway (OP)**
  - May need in unconscious patient to keep tongue from occluding posterior pharynx
  - Cannot use in patients with an intact gag reflex

- **Nasopharyngeal airway (NP)**
  - Use in a semi conscious patient to keep the airway open
  - Excellent for use in overdose patients or seizure patients
Bag Mask Ventilation

- **Steps:**
  - Size face mask
  - Choose bag [Adult, Pediatric, Infant/Small Child, Neonatal]
  - Attach bag to oxygen
    - Bag size can be too small
    - Neonatal bags keep with newborn resuscitation kit
      - All EDs should have infant and adult bag
  - EC-Clamp
  - Control rate and volume delivered
Bag Mask Ventilation

• EC- Clamp
  – “C” holds mask to face
  – “E” pulls chin into mask – makes a clamp
  – 3 fingers on the jaw line

Doing BMV is as “EC” (easy) as “1-2-3”
Bag Mask Ventilation

- Too much cricoid pressure may lead to airway obstruction
- If no chest rise with BMV – lighten cricoid pressure
- AHA 2015 Guidelines de-emphasize use of cricoid pressure

My 2 cents – more harm than good
Bag-Mask Ventilation

Control rate and volume

Give only amount of air needed to get chest to rise

Say Squeeze (just until chest rise initiated) then say release, release

Slower rates are best – during CPA no more than 6-10 per minute
What if no Chest Rise?

- Reposition head
- Suction
- Release cricoid pressure
- Consider foreign body aspiration
Foreign Body Aspiration

- Begin with BLS maneuvers
  - Infant: Back blows (5) and chest thrusts (5)
  - Child:
    - If conscious, abdominal thrusts/Heimlich Maneuver (5 per cycle)
    - If unconscious perform chest compressions
- ALS maneuvers if BLS fails
  - Use Magill forceps to remove the foreign body
Realities....

• ED Residents get few experiences in intubating children (Ave < 10 in residency)
• ED physicians get few experiences in clinical practice average ED sees < 13 kids per day
• Need strategies to keep up skills for ED physicians
• ED physicians are experts at airway management in adults
Solutions

• Cognitive practice
• Use tools to assist
• Simulation/ Mock Codes
• Know where your equipment is and how to use it
• Seek continuing education
Endotracheal Intubation (ETI)

• Preparation is key
  – Equipment and staff
• Consider RSI as a number of studies have shown reduction in complications with its use
• Have a contingency plan if ETI fails
Endotracheal Intubation (ETI)

- Equipment:
  - Suction
  - Oxygen
  - ET tube
  - Stylet (1 cm from end of tube)
  - Laryngoscope with appropriate blade
  - Pediatric Magill forceps
  - CO₂ detector
## Calculation of ETT size - preemies

<table>
<thead>
<tr>
<th>Weight (kg)</th>
<th>Tube size (mm)</th>
<th>Depth of tube (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 kg</td>
<td>2.5 mm</td>
<td>7 cm</td>
</tr>
<tr>
<td>2</td>
<td>3.0</td>
<td>8</td>
</tr>
<tr>
<td>3</td>
<td>3.0 - 3.5</td>
<td>9</td>
</tr>
</tbody>
</table>

Memorize this or put on a card – no good rule
Calculation of ET tube size

- Charts based on weight or length
- Measurement from a length-based resuscitation tape (Broselow Tape)
- Greater than 1 year of age can calculate tube size:
  - Based on age > 1 year:
    - \((\text{Age}/4) + 4\) Uncuffed
    - \((\text{Age}/4) + 3.5\)
Ballpark ETT size

- Premature infant (2.5-3.0 mm tube)
- Newborn 3.0-3.5 mm tube (Miller 0 or 1 blade)
- Up to 6 months of age 3.5 mm tube (Miller 1 blade)
  - note should measure child with the length-based resuscitation tape - measure from top of head to infant or child's heel
- At one year of age need at least a 4.0 mm uncuffed tube
# MGH Quick Method tube Sizing

<table>
<thead>
<tr>
<th>Age</th>
<th>Diameter</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 yr</td>
<td>4 mm (uncuffed)</td>
<td>10 kg</td>
</tr>
<tr>
<td></td>
<td>3.5 mm (cuffed)</td>
<td></td>
</tr>
<tr>
<td>3 yrs</td>
<td>4.5 mm</td>
<td>15 kg</td>
</tr>
<tr>
<td>5 yrs</td>
<td>5 mm (uncuffed)</td>
<td>20 kg</td>
</tr>
<tr>
<td></td>
<td>4.5 mm (cuffed)</td>
<td></td>
</tr>
<tr>
<td>7 yrs</td>
<td>5.5 mm</td>
<td>25 kg</td>
</tr>
<tr>
<td>9-10 yrs</td>
<td>6 mm (cuffed)</td>
<td>30 kg</td>
</tr>
</tbody>
</table>

Extrapolate in between (e.g. 3 year old = 4.5mm ETT)
Cuffed vs Uncuffed Tubes

• Sizing:
  – ½ less than standard formula

• When do you use a cuffed tube?
  – Any patient that may require high pressures to ventilate
  – Can use it in any critically ill or injured infant or child
  – Studies show same frequency of subglottic stenosis with cuffed tubes and less need for tube exchange
Laryngoscope Blade Size

Miller

Macintosh
Blade size

- 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

Miller 2 after age 2
Depth of tube placement

- Watch vocal cord marker go past the cords
- Depth of tube placement in cm can be calculated as 3 X size of tube:
  - (Example: 3.5 mm tube would be placed at 10.5 cm at the lip)
- Depth can also be determined by use of a length-based resuscitation tape or by use of an illuminated ETT
ET placement
Confirmation of tube placement

- Clinical assessment
- Endtidal CO₂ detection or monitor
- Esophageal detection device (EDD)
  - Bulb or syringe
- Chest radiograph
- Pulse oximetry

ETT is too low
Complications post ETI

• **DOPE:**
  - Dislodgement
  - Obstruction/Oxygen
  - Pneumothorax
  - Equipment fails
Rapid Sequence Intubation (RSI): 7 Steps

• Preparation
• Preoxygenation
• Pretreatment
• Paralysis with induction
• Protection and positioning
• Placement of ET tube in trachea
• Postintubation management

Order and steps dependent on clinical situation

Pediatric Anesthesia

EDITORIAL

Pediatric airway management in the emergency department: in urgent need of CPR

• Placement of ET tube in trachea
• Postintubation management
Simplify RSI

• Oxygenate– sedate – paralyze - intubate
Preoxygenation

– Add 100% oxygen
  • Remember infants become hypoxic quickly – relatively small reservoir in nasopharynx and lung
  • High metabolic rate vs adults

– High flow nasal cannula (5-15 L per min) can prevent hypoxia during apneic period

Pretreatment

• Atropine [0.02 mg/kg; max 0.5 mg]
  – There is no evidence to support the *routine* use of atropine as a premedication to prevent bradycardia in emergency pediatric intubations.
  – There is no evidence to support a minimum dose of atropine when used as a premedication for emergency intubation – dose by weight at 0.02 mg/kg
Sedative Selection

• Hypotension: Ketamine if concerned about sepsis
• Bronchoconstriction: Ketamine
• Head injury without hypotension (or signs of shock): Etomidate or midazolam
• Head injury with hypotension: Ketamine
Neuromuscular Blocking Agents

- **Succinylcholine 2 mg/kg**
  - ONLY depolarizing NMB: Binds to the Ach receptor on the motor endplate and depolarizes the postjunctional neuromuscular membrane
    - Onset 30-60 sec, duration 3-8 min

- **Rocuronium 1 mg/kg**
  - Competitively block ACH transmission at the postjunction cholinergic nicotinic receptor
    - Onset 1-3 min, duration 25-35 min
    - Longer duration, but less potential for adverse effects
Sugammadexex (Bridion)

Primary end point: time from start of BRIDION or neostigmine administration to recovery of the TOF ratio \((T_4/T_1)\) to 0.9

- **BRIDION 2 mg/kg \((n=48)\)**
  - Median time: 1.4 minutes
  - Quartiles \((Q_1, Q_3)\): 1.2, 1.7 minutes

- **Neostigmine 50 \(\mu g/kg\) + glycopyrrolate 10 \(\mu g/kg\)^3 \((n=48)\)**
  - Median time: 21.5 minutes
  - Quartiles \((Q_1, Q_3)\): 9.8, 42.0 minutes

Reversal agent for Rocuronium
Not yet approved for use in children
RSI in “Sick Kids”

- Oxygen by face mask or if needed – high flow nasal cannula oxygen, or nasal CPAP for respiratory distress and hypoxemia

- If require intubation - cardiovascular instability is less likely after appropriate cardiovascular resuscitation (give fluids first if possible)

- Consider early pressor – push dose epi
Hi Flow Nasal Cannula

2L/kg/min – PARIS trial

Franklin D et al. A Randomized Trial of High-Flow Oxygen Therapy in Infants with Bronchiolitis. NEJM 2018. PMID: 29562151
Anticipating a Difficult Pediatric Airway

Physical examination of the airway:

- Short neck and/or limited range of motion (<35° from horizontal)
- Mandibular hypoplasia
- Macroglossia (Down)
- Small mouth or poor mouth opening
- Mallampati Class III and IV are difficult airways to manage
Grading Intubation Difficulty

- ED often don’t know until you attempt intubation…defined by
  - Cannot perform adequate BMV to maintain oxygenation
  - Cannot intubate after 3 attempts
  - Cormack and Lehane View 3 or 4
Difficult Airway Management

- Consider placement of OP or NP airway/ BMV
- Supraglottic/Extraglottic airway - Laryngeal mask airway (LMA), iGel, Air-Q, Laryngeal tube/King Airway
- Intubate using other methods
  - Video laryngoscopy
  - Lighted stylet or Lightwand
  - Fiberoptic intubation
- Other
  - Elastic Gum Bougie (not for kids- age 14 years+)
- Cricothyrotomy (needle children < 6 years?) – if other rescue devices fail and cannot BMV
Supraglottic devices

- Laryngeal mask airway (LMA) Introduced in 1983 by Brain AIJ: *Br. J Anaesthes*
- Similar devices now made by many manufacturers
LMA – Sizing on Broselow Tape

• Sizing found on Broselow-Luten Tape

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**Equipment**

- E.T. Tube
- E.T. Insertion Length: 16.5 cm
- Stylet: 14 French
- Suction Catheter: 10 French
- Laryngoscope: 2 Straight or Curved
- BVM
- Oral Airway: 70 mm
- *Nasopharyngeal Airway: 24 French
- *LMA
Video Laryngoscopy

• Routine or the difficult airway?
• Why use it?
  – Offers expanded view
  – Magnified view enhances visualization
  – Can be performed with neutral neck position
  – Can be performed with reduced oral opening
  – Educational advantages – share the view or record attempt for teaching, performance improvement
  – Increasing use in academic centers
Other Advanced Alternatives:

• Needle Cricothyrotomy
  – No real guidelines on age – based on ability to find surgical landmarks for open technique
  – Multiple ages listed in textbooks
  – Experts state school age 6-8 years

• Cricothyrotomy
  – Same technique as in the adult
  – If can locate anatomy can perform procedure
Pediatric Airway Management

- Cognitive practice allows for thinking through scenario before it happens.
- Plan for stepwise management and understand devices at your disposal and their benefits and challenges.
- Ketamine favored over etomidate for RSI.
- Sugammadex available for reversal of rocuronium.
- Have a difficult airway kit/process.
Questions?

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