A is for Airway in Pediatric Trauma

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Conflicts of interest / Disclosures

• None
Outline

• Airway first in pediatric trauma
• Pediatric airway anatomy / physiology
• Airway management
  – Basic airway management
  – Advanced airway management
    • Supraglottic devices
    • Endotracheal intubation
• To intubate or not to intubate?
• Conclusions
Airway First in Pediatric Trauma

“Ensuring a patent airway is the first priority of trauma management and resuscitation…”

But, don’t forget…

“Regardless of how the airway is managed, a cervical spine injury must be considered.”

Prehospital Trauma Life Support, Seventh Edition, 2011 (NAEMT)
Airway First in Pediatric Trauma

• Impaired Neurological Function
  – Flaccid tongue → Obstruction
  – Altered consciousness → Decreased ventilatory drive

• Mechanical Obstruction
  – Tongue
  – Edema
  – Foreign bodies/debris
  – Collapse of bone and/or cartilage
Pediatric Airway Anatomy
Anatomy – Body Proportions

[Diagram showing body proportions at different ages]
Anatomy - External

- Relatively large head
- Prominent occiput
- Short neck
- Underdeveloped chin
- Narrow nares
Anatomy – Internal

- Tongue is larger in proportion to mouth
- Pharynx is smaller
- Epiglottis is larger and flaccid
- Larynx is more anterior and superior
- Narrowest at cricoid
- Trachea narrow and less rigid
Airway - Epiglottis

- Supple
- Omega shaped
- Angled posterior
- May appear edematous
Anatomy – Implications for Management

• Equipment must be variably sized
• Obstruction more likely
• Loose, missing teeth more likely
• Different positioning
• Intubation more difficult
  – Large tongue
  – Vocal cords appear more anterior
  – Epiglottis more likely to obstruct view
  – Mainstem intubation
  – Tracheal edema
Airway Assessment

- Observation
- Level of consciousness
- Position (supine v. lateral v. upright)
- Inspection (Blood, debris, FB, distortion)
- Breath sounds (Noisy?)
- Chest rise, retractions
Normal Respiratory Rates in Children

<table>
<thead>
<tr>
<th>Age (yrs)</th>
<th>Respiratory Rate (bpm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-1</td>
<td>24-38</td>
</tr>
<tr>
<td>1-3</td>
<td>22-30</td>
</tr>
<tr>
<td>4-6</td>
<td>20-24</td>
</tr>
<tr>
<td>7-9</td>
<td>18-24</td>
</tr>
<tr>
<td>10-14</td>
<td>16-22</td>
</tr>
<tr>
<td>14-18</td>
<td>14-20</td>
</tr>
</tbody>
</table>

Harriet Lane Handbook, 18th ed.
Why are infants and young children prone hypoxemia?

- High metabolic rate and O2 consumption
- Prone to develop atelectasis → V/Q mismatch
- Diminished FRC
- Anatomy predisposes to airway obstruction
Infants
High Closing Volumes Promote Atelectasis

Cote et al, A Practice of Anesthesia for Infants and Children, 4th Ed.
**Infant Diaphragm Prone to Fatigue**

### Percentage Type I Muscle Fibers
(Slow Twitch, Fatigue Resistant)

<table>
<thead>
<tr>
<th>AGE</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preterm infant</td>
<td>&lt;10</td>
</tr>
<tr>
<td>Term infant</td>
<td>30</td>
</tr>
<tr>
<td>&gt;1 y.o.</td>
<td>55</td>
</tr>
<tr>
<td>Adult</td>
<td>55</td>
</tr>
</tbody>
</table>
Airway Management
Your management depends on your skills and educational background.

Prehospital Trauma Life Support, Seventh Ed., 2011
Airway Management Pearls

Greater experience  = greater success

More complexity  = longer learning curve
= greater chance of failure
= greater penalty for failure

Evaluate airway before choosing your adjunct!
Essential Skills

• Manual maneuvers
  – Trauma jaw thrust
  – Trauma chin lift

• Suctioning
  – Rigid, Yankauer type suction for oropharynx
  – Soft, flexible, sterile suction catheter for endotracheal tubes

• Insertion of naso and oropharyngeal airways

• Administration of oxygen

• Bag-mask ventilation

• C-spine precautions
Nasal Pharyngeal Airways

- Soft, latex-free
- 12 F to 36 F
- Proper length – distance from naris to tragus
- Proper diameter – estimated by inspection
- Can be used in patients with airway reflexes
- May cause bleeding - consider vasoconstrictor
Oral Pharyngeal Airway

- Plastic, latex free
- Central passage for suctioning
- Use only in unconscious patients
- May cause vomiting, laryngospasm
- May occasionally break teeth or worsen obstruction
Proper sizing of oral airway
Oxygen Concentration achieved by ventilation devices

<table>
<thead>
<tr>
<th>Device</th>
<th>Liter Flow (L/min)</th>
<th>Oxygen Concentration*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>WITHOUT SUPPLEMENTAL OXYGEN</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mouth-to-mouth</td>
<td>N/A</td>
<td>16%</td>
</tr>
<tr>
<td>Mouth-to-mask</td>
<td>N/A</td>
<td>16%</td>
</tr>
<tr>
<td>Bag-mask</td>
<td>N/A</td>
<td>21%</td>
</tr>
<tr>
<td><strong>WITH SUPPLEMENTAL OXYGEN</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nasal cannula</td>
<td>1–6</td>
<td>24%–45%</td>
</tr>
<tr>
<td>Mouth-to-mask</td>
<td>10</td>
<td>50%</td>
</tr>
<tr>
<td>Simple face mask</td>
<td>8–10</td>
<td>40%–60%</td>
</tr>
<tr>
<td>Bag-mask without reservoir</td>
<td>8–10</td>
<td>40%–60%</td>
</tr>
<tr>
<td>Bag-mask with reservoir</td>
<td>10–15</td>
<td>90%–100%</td>
</tr>
<tr>
<td>Nonrebreather mask with reservoir</td>
<td>10–15</td>
<td>90%–100%</td>
</tr>
<tr>
<td>Demand valve</td>
<td>N/A</td>
<td>90%–100%</td>
</tr>
<tr>
<td>Ventilator</td>
<td>N/A</td>
<td>21%–100%</td>
</tr>
</tbody>
</table>

Prehospital Trauma Life Support, 7th Ed, 2011
Bag-Valve-Mask Ventilation

• Foundation upon which all other airway procedures are performed
• Repeated practice is critical
• Adequate seal and ventilation can be challenging
• Hazards: Gastric insufflation, aspiration
Supraglottic Devices

Advantages

- Fast, easy insertion
- Laryngoscopy not needed
- VC visualization not needed
- Any patient position
- Minimal training
- Easy to stay proficient
- Avoids esophageal ventilation
- Rescue for failed intubation

Disadvantages

- Aspiration can still occur
- Airway reflexes should be absent
- Esophageal injury
- Inadequate ventilation if malpositioned or wrong lumen is ventilated
- Appropriate sizes for infants, children not always available
Laryngeal Tube

- Single lumen tube with interconnected distal and proximal cuff
- Sizes for all ages
- Easy to insert, minimal training
- May protect from aspiration
- Dual lumen for gastric drainage
Laryngeal Mask Airway

- Developed in 1980s for use during anesthesia
- Easy to insert, less training needed than ETI
- Does not protect against aspiration
- Cuff can leak at low pressures,
- Proseal (sizes 1.5, 2, and 2.5) less leak plus drainage tube

Classic LMA

Proseal LMA
Endotracheal Intubation
Endotracheal Intubation

**Advantages**
- Airway isolation
- Control of ventilation
- Use with 100% oxygen
- Protects against aspiration
- Avoids gastric insufflation
- Allows tracheal suctioning
- Medication administration

**Disadvantages**
- Takes time
- Requires skill, experience
- Hypoxia, ↓HR during procedure
- Trauma (cords, teeth, trachea)
- Unrecognized esophageal placement is fatal
- Too shallow, too deep
- Cervical spine injury
- May be difficult / impossible, even for high-level providers
Choosing the right tube

• Use a cuffed endotracheal tube
• Special design with thin wall, low pressure cuff is available
• If 2 years or older, use the following sizing formula: Internal diameter = 4 + (Age/4)
• If younger:  
  < 2 kg, use a 2.5  
  > 2 kg, use a 3.0  
  FT newborn, consider 3.5  
  At about 10 m.o., consider 4.0
Achieving a mid-tracheal position

- Heavy mark(s) at cords
- Position tip 3 x I.D. from gums
- Depth (cm.) = 12 + (Age/2)
- Insert until R mainstem, then withdraw 2 to 3 cm.
- Bilateral breath sounds
Predicting Difficult Intubation

- Prominent upper incisors, overbite
- High arched palate
- Restricted temporo-mandibular joint movement
- Limited mouth opening
- Decreased submental space (< 6 cm for adults)
- Short, thick neck or immobility (e.g. C-spine precautions!)
- Hoarseness or stridor
- Obesity

Gupta et al., *Ind J Anaesth*, 2005
Mallampati Exam

Class 1

Class 2

Class 3

Class 4
Laryngoscopic Grading System
Cormack and Lehane
Does endotracheal intubation improve outcome after TBI?

- von Elm et al reviewed literature in 2009
- 17 studies (6 adult, 5 children, 3 mixed)
- 15,335 patients
- 1985 to 2004
- Findings: “Evidence did not support any benefit from pre-hospital intubation and mechanical ventilation after TBI
- Conclusions:
  - Data insufficient to make any general recommendations
  - Most studies retrospective, low methodological quality
  - Few critical outcomes examined, except in-hospital mortality
  - Inconsistent results among studies
  - Factors, including organization of EMS services, skill of provider, risk of procedure failure, and transport times must influence decision-making
Airway Management Algorithm for Prehospital Providers

P. Berlac et al.

Insufficient airway
Need for airway management

Basic training
- Insufficient
  - Ventilate with BVMV or pocket mask
  - Consider SAD

Intermediate training
- Insufficient
  - Ventilate with BVMV or pocket mask
  - Consider SAD

Advanced training
- Insufficient airway after basic actions
  - ETI
  - Prepare FFDI
  - Assess for difficult airway
  - Manual in-line stabilization when necessary

Chin lift
Oropharyngeal airway
Oxygen

Sufficient
- Start ventilation with pocket mask
- If necessary start BVMV

SAD insertion successful max 3 attempts

Successful
- Verify correct position
  - Visual
  - Auscultation
  - Capnography

Failed
- Reassess situation
  - BVMV
  - SAD
  - Surgical or cannula cricothyrotomy
Conclusions

- Timely and appropriate airway management is critical to successful trauma outcomes in children.
- Providers must understand differences between pediatric and adult anatomy and physiology.
- Infant/pediatric airway management is often more challenging than in adults.
- All pre-hospital providers must master essential skills.
- Use of airway adjuncts will be dictated by experience, skill level, and situation.
- Role of endotracheal intubation by pre-hospital providers is yet to be fully defined.
Thank You