Not Just Little Adults:
Unique Considerations in the Pediatric Difficult Airway

Sarena N. Teng, MD, FAAP
Pediatric Anesthesiology and Critical Care Medicine
Ochsner Medical Center
New Orleans, LA
Training

Children’s Hospital Colorado

- ACS Level I Pediatric Trauma Center
- Colorado’s Regional Pediatric Trauma Center
Training

Children’s Hospital Colorado

- Seven-State Catchment Area
  - Colorado
  - Montana
  - Wyoming
  - South Dakota
  - Nebraska
  - Kansas
  - New Mexico
Training

Children’s Hospital Colorado

- US New & World Report
  - 3 years in a row – Top 10
  - 2104-15: ranked #6 in the nation

- Parent’s Magazine
  - 2013: ranked #5 in the nation
Per capita consumption of sour cream (US) correlates with Motorcycle riders killed in noncollision transport accident.

Correlation: 92%  Sources: USDA & CDC  tylervigen.com

<table>
<thead>
<tr>
<th>Year</th>
<th>Half-pints (US)</th>
<th>Deaths (US)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>6.1</td>
<td>35</td>
</tr>
<tr>
<td>2001</td>
<td>6.5</td>
<td>34</td>
</tr>
<tr>
<td>2002</td>
<td>6.7</td>
<td>33</td>
</tr>
<tr>
<td>2003</td>
<td>7.5</td>
<td>47</td>
</tr>
<tr>
<td>2004</td>
<td>7.9</td>
<td>54</td>
</tr>
<tr>
<td>2005</td>
<td>8.3</td>
<td>63</td>
</tr>
<tr>
<td>2006</td>
<td>7.9</td>
<td>44</td>
</tr>
<tr>
<td>2007</td>
<td>8.2</td>
<td>56</td>
</tr>
<tr>
<td>2008</td>
<td>7.9</td>
<td>55</td>
</tr>
<tr>
<td>2009</td>
<td>7.8</td>
<td>51</td>
</tr>
</tbody>
</table>

Correlation: 0.916391
Apple stock price on January 1 correlates with Helicopter accidents killing occupant.

<table>
<thead>
<tr>
<th></th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apple stock price on</td>
<td>32.39</td>
<td>72.38</td>
<td>86.29</td>
<td>199.27</td>
<td>85.88</td>
</tr>
<tr>
<td>January 1 (NASDAQ)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Helicopter accidents</td>
<td>42</td>
<td>49</td>
<td>47</td>
<td>69</td>
<td>43</td>
</tr>
<tr>
<td>killing occupant (CDC)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Correlation: 0.948431

Sources: NASDAQ & CDC, tylervigen.com
Objectives

- Understand the unique considerations in pediatric anatomy and physiology relative to adult airways.
- Recognize certain pediatric congenital syndromes or diseases are known to be associated with difficult airways.
- Describe the applications and techniques for the very underappreciated laryngeal mask airway placement as a rescue tool in a difficult airway situation.
Kids: Not Just Little Adults
Pediatric Airway Anatomy

- Larynx higher
- C4: cricoid ring at birth
- C5: Age 6
- C6: Adult
- Narrowest part of the airway: cricoid ring in kids vs glottis in adults
- Vocal cords not at 90° angle to trachea
- Floppy omega shaped epiglottis
Aligning Axes

ADULT

CHILD
Big Occiput
Difficult Airway Evaluation (Adults)

- Mouth opening (3 patient finger breadths)
- Thyromental distance
- Neck circumference
- Neck flexion/extension
- Facial hair
- Mallampati score
Mallampati in Children

- Mallampati score does not accurately predict a poor view of the glottis during direct laryngoscopy in pediatric patients.

Kopp, Anesthesiology 1995

- Standard values for thyromental and horizontal mandibular lengths do not exist for the pediatric population.
Anatomic Factors Associated with a Difficult Airway

- Small mouth, limited mouth opening or short interincisor distance
- Short neck, limited neck mobility
- Mandibular hypoplasia
- Poor mandibular translation
- Obesity
- Mucopolysacharridoses
- High arched narrow palate

Wheeler *Pediatric Critical Care Medicine* 2007
Midface Hypoplasia

Difficult bag mask ventilation

Pfeiffer Syndrome

Type I  Type II  Type III

Apert’s Syndrome

Crouzon Syndrome
Hypoplastic Mandible

Micrognathia = difficult intubation

Treacher Collins Syndrome

Goldenhar Syndrome

Pierre Robin Syndrome
Macroglossia

Difficult bag and difficult intubation

Hurler’s Syndrome

Down’s Syndrome

Hunter’s Syndrome

Beckwith Wiedemann
Macroglossia and the Difficult Airway
Positioning issues

Klippel Feil Syndrome

Down’s Syndrome

Epidermolysis Bullosa

Achondroplasia

Arthrogryposis
Anticipate Unanticipated Difficult Airways
Difficult Laryngoscopy

1.35%

- Age less than 1 year
- Cardiac surgical patients
- ASA Status III and IV
- Mallampati III or IV

Difficult laryngoscopy is 1.5-8% in general adult surgical patients.

Difficult intubation occurs with a similar incidence


Difficult Mask Ventilation

- In adults 1.4 - 5%
  
  Kheterpal Anesthesiology 2009, Langeron Anesthesiology 2000

- 2.1% in non-obese children
  
  Tait, et al Anesthesiology 2008

- 3% in ASA I & II patients aged 1-5yo
  
  Aggarwal et al., J Anesth Clin Res 2012, 3:11

- Inability to mask ventilate has an even lower incidence, 0.001%-0.02%
  
  Kopp, Anesthesiology 1995
Pediatric vs. Adult Physiology

- Lower functional residual capacity (FRC), with closing volume closer to FRC >> atelectasis
- Higher CO\(_2\) production
  - 100-150ml/kg/min vs adults 60ml/kg/min
- Higher metabolic rate (O\(_2\) consumption)
  - 7-9ml/kg/min compared to 3ml/kg/min adults
- Tidal volume (ml/kg) is relatively consistent with adults, so kids need a higher RR to achieve a higher minute ventilation to eliminate CO\(_2\)
To intubate or not to intubate?

If you only have a hammer, you tend to see every problem as a nail.

(Abraham Maslow)

Can’t intubate, can’t ventilate!
Anticipate the Unexpected

SUCCESS

IDEA

PLAN

ACTION

A, B, C & D
The humble LMA
Pediatric Unexpected Difficult Airway Algorithm

Weiss, Ped Anesth 2010
Laryngeal Mask Airways


Copyright © The McGraw-Hill Companies, Inc. All rights reserved.
Contraindications

- Complete upper airway obstruction
- Morbid obesity
- Prone positioning
- Full stomach
- High airway pressures
- Possible tracheal injury
LMA in Prone Position

Placement of Laryngeal Mask in the Prone Position

Sergio Granados-Tinajero MD*, John Domínguez MD**, Víctor M. Whizar-Lugo MD+

*Coordinator Centros Afiliados en México al Proyecto Comité Europeo para la Enseñanza de la Anestesiología-Federación Mexicana de Colegios de Anestesiología, A.C.
**Clínica LEDA de Cirugía Plástica y Medicina Hiperbárica.
Tijuana B.C., México.

Granados-Tinajero, Anestesia en México 2009;21(2): 139-142
LMA in Morbidly Obese

Use of intubating laryngeal mask airway in a morbidly obese patient with chest trauma in an emergency setting

Tripat Bindra, Sanjay K Nihalani1, Poonam Bhadoria1, Sonia Wadhawan1
Department of Anesthesia and Intensive Care, SGIMSR, Amritsar, 1Maulana Azad Medical College, New Delhi, India

LMA Tips

- Anesthetized patient ⇔ obtunded patient!
- DO NOT put your finger in an obtunded patient’s mouth!
- Not a lot of room in pediatric mouths
LMA Placement

marhaba2000: LMA insertion
http://www.youtube.com/watch?v=96e46PyARaU
LMA Positioning

- Epiglottis
- Glottic opening
- Posterior cartilages
- LMA mask
- LMA tube
- LMA tube
- LMA mask
- Trachea
## LMA Sizing

<table>
<thead>
<tr>
<th>LMA</th>
<th>Bodyweight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>&lt;5</td>
</tr>
<tr>
<td>1.5</td>
<td>5–10</td>
</tr>
<tr>
<td>2</td>
<td>10–20</td>
</tr>
<tr>
<td>2.5</td>
<td>15–30</td>
</tr>
<tr>
<td>3</td>
<td>30–50</td>
</tr>
<tr>
<td>4</td>
<td>50–70</td>
</tr>
<tr>
<td>5</td>
<td>&gt;70</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LMA&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Tracheal tube size ID (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3.0 uncuffed</td>
</tr>
<tr>
<td>1.5</td>
<td>3.5 uncuffed</td>
</tr>
<tr>
<td>2</td>
<td>4.5 uncuffed</td>
</tr>
<tr>
<td>2.5</td>
<td>5.0 uncuffed</td>
</tr>
<tr>
<td>3.0</td>
<td>6.0 cuffed</td>
</tr>
<tr>
<td>4</td>
<td>7.0 cuffed</td>
</tr>
<tr>
<td>5</td>
<td>7.5 cuffed</td>
</tr>
</tbody>
</table>

<sup>a</sup> LMA size

---

Weiss, Ped Anesth 2010
LMA use in Neonates

- Size 1 LMA can be used in babies 2.5-5kg.
- Insertion is successful in more than 90% of neonates on the first attempt after minimal expertise, a finding consistent with the finding in adults.
- Average insertion time was 8.6 seconds.

Patterson, Anesthesiology 1994
Bigger is Better

- If in between sizes, use the bigger LMA.
- “If the LMA is too small there is increased frequency of malpositioning and a tendency for the clinician to overinflate the cuff in an attempt to improve the efficacy of the seal.”

Asai, Anaesthesia 2000
Fill ’er up

Alternative to completely deflating cuff

Partially or completely fill the cuff with air to avoid the need for digital assistance

Jaw lift/jaw thrust to open mouth then advance LMA
Intubating LMA
LMA Sizing

The pilot balloon of cuffed endotracheal tubes will not fit in an LMA smaller than a size 3!

Weiss, Ped Anesth 2010

<table>
<thead>
<tr>
<th>LMA</th>
<th>Bodyweight (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>&lt;5</td>
</tr>
<tr>
<td>1.5</td>
<td>5–10</td>
</tr>
<tr>
<td>2</td>
<td>10–20</td>
</tr>
<tr>
<td>2.5</td>
<td>15–30</td>
</tr>
<tr>
<td>3</td>
<td>30–50</td>
</tr>
<tr>
<td>4</td>
<td>50–70</td>
</tr>
<tr>
<td>5</td>
<td>&gt;70</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LMA</th>
<th>Tracheal tube size ID (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3.0 uncuffed</td>
</tr>
<tr>
<td>1.5</td>
<td>3.5 uncuffed</td>
</tr>
<tr>
<td>2</td>
<td>4.5 uncuffed</td>
</tr>
<tr>
<td>2.5</td>
<td>5.0 uncuffed</td>
</tr>
<tr>
<td>3.0</td>
<td>6.0 cuffed</td>
</tr>
<tr>
<td>4</td>
<td>7.0 cuffed</td>
</tr>
<tr>
<td>5</td>
<td>7.5 cuffed</td>
</tr>
</tbody>
</table>
Snip the aperture bars!

NON-Disposable LMA
DO NOT cut these

Disposable LMA - ok to snip

Intubating LMA
“Gum Elastic Bougie”
a.k.a. Eschmann
a.k.a. Tube Exchanger
Intubating through an LMA

- Make sure the aperture bars (grille) are snipped, or your ETT will not pass.

- Be mindful of size! Cuffed ETT balloons will not fit through a small <3.0 LMA tube.

- Be mindful of short ETT’s not clearing the LMA tube. May need alligator forceps for extra length.
Now You Know...

Lots of differences exist between kids’ and adults’ airways. Remember the shoulder roll to help align axes.

Several common congenital syndromes are associated with difficult pediatric airways. Knowing is half the battle.

LMAs are a great rescue airway tool and can be used/modified for intubation in the can’t intubate/can’t ventilate situation.
Never trust a baby!

And never let ‘em see you sweat!
References


References

- Asai T, Brimacombe J. Review article: cuff volume and size selection with the laryngeal mask airway. *Anaesthesia* 2000; 55: 1179–84