Neonatal larynx and schematic
DEVELOPMENTAL ANATOMY OF THE LARYNX (I)

In infants.....

- tongue proportionally larger
- occiput proportionally larger
- larynx more cephalad
- epiglottis angled from trachea
- short, omega-shaped epiglottis
- vocal folds angled
- narrowing of cricoid ring
Larynx more cepahalad in infants
DEVELOPMENTAL PHYSIOLOGY OF THE AIRWAY (I)

- preponderance of type I muscle fibers
- obligatory nasal breathing
- low apneic threshold
- sensitivity genioglossus muscle to halothane (& presumably sevoflurane)
DEVELOPMENTAL PHYSIOLOGY OF THE AIRWAY (II)

**Apneic threshold**

**Obligate nasal breathing**
AIRWAY PATENCY IN ANESTHETIZED CHILDREN

- immobile maxillary block
- mobile mandibular block obstructs
- loss of genioglossus tone (Motoyama)
- adenoidal hypertrophy
- non-invasive maneuvers / CPAP
- artificial airways
AIRWAY MANAGEMENT: SOAP

Suction
Oxygen
Airway Equipment
Pharmacology (monitoring)
you open your E cylinder oxygen container by slowly turning the valve CCW until fully open. The pressure in the cylinder is 650 psi.

Assuming flow of 4 LPM, how many minutes of oxygen remain?
COMPRESSED GAS CYLINDERS (II)

- E cylinders contain ~ 660 liters
- working pressure ~ 2000 psi
- the tank is ~ 1/3 full (220 L)
- 45 minutes of oxygen remaining
- USA - oxygen tanks are green
- INTL - oxygen tanks are white
ROUTINE AIRWAY EQUIPMENT

- laryngoscope
- breathing bag
- oral airways
- suction catheter
- tonsil-tip suction

- endotracheal tubes
- stylets
- masks (± LMA)
- extra blades
- pharmacology
CORRECT PLACEMENT OF ORAL AIRWAYS

Tip just cephalad to angle of mandible - OPTIMAL

Tip posterior to angle of mandible - pushes epiglottis down & worsens obstruction

Tip above angle of mandible - kinks the tongue
THE LARYNGEAL MASK AIRWAY

• one of the supraglottic devices
• steep learning curve
• doesn’t “seal” airway
• may provide temporizing ventilation in “cannot intubate”
• adjunct for intubation ± FOB

<table>
<thead>
<tr>
<th>Patient weight (kg)</th>
<th>LMA size</th>
<th>Cuff volume (ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 5</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>5-10</td>
<td>1.5</td>
<td>7</td>
</tr>
<tr>
<td>10-20</td>
<td>2</td>
<td>10</td>
</tr>
<tr>
<td>20-30</td>
<td>2.5</td>
<td>14</td>
</tr>
<tr>
<td>30-50</td>
<td>3</td>
<td>20</td>
</tr>
<tr>
<td>50-70</td>
<td>4</td>
<td>30</td>
</tr>
<tr>
<td>70-100</td>
<td>5</td>
<td>40</td>
</tr>
</tbody>
</table>
ENDOTRACHEAL INTUBATION

- ensures airway patency
- airway protection
- pulmonary toilet
- IPPB with FiO2 of 1.0
- positioning other than supine (±)
KEYS TO SUCCESSFUL ENDOTRACHEAL INTUBATION

• adequate SOAP prep
• optimize patient position
• adequate mouth opening
• tongue well swept to left
• control of epiglottis
• external manipulation larynx
• watch through the cords
OPTIMIZING PATIENT POSITION

• first described by Jackson 1913
• Bannister & Macbeth “sniffing” 1944
  ▪ slight neck flexion & extend a-o joint
• Adnet (2001) MRI criteria – sniffing no better than simple extension – both better than neutral
  ▪ axes are not aligned in sniffing position
    (as depicted by the “classic” diagram above)
KEYS TO SUCCESSFUL ENDOTRACHEAL INTUBATION

• adequate SOAP prep
• optimize patient position
• adequate mouth opening
• tongue well swept to left
• control of epiglottis
• external manipulation larynx
• watch through the cords
### BURP (backward upward pressure)

*Better view than mandibular advancement – best view with BOTH*

<table>
<thead>
<tr>
<th>Procedures</th>
<th>C</th>
<th>M</th>
<th>B</th>
<th>BM</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Laryngeal view</strong></td>
<td>III</td>
<td>II</td>
<td>II</td>
<td>I</td>
</tr>
<tr>
<td><strong>Cormack-Lehane</strong></td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td><strong>Rating score</strong></td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>
# Suggested Laryngoscope Blades

<table>
<thead>
<tr>
<th>AGE</th>
<th>MILLER</th>
<th>MAC</th>
<th>WIS-HIPPLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>preemie</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>neonate</td>
<td>0-1</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>newborn – 18 months</td>
<td>1</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>18 months - 5 years</td>
<td></td>
<td></td>
<td>1.5</td>
</tr>
<tr>
<td>5-12 years</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>&gt; 12 years</td>
<td>2-3</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>AGE</td>
<td>SIZE (ID mm)</td>
<td>DEPTH (cm)</td>
<td></td>
</tr>
<tr>
<td>----------------------</td>
<td>--------------</td>
<td>------------</td>
<td></td>
</tr>
<tr>
<td>preemie</td>
<td>2.5 – 3.0</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>term &lt; 6 months</td>
<td>3.0 – 3.5</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>6 – 9 months</td>
<td>3.5 – 4.0</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>9 - 18 months</td>
<td>4.0 – 4.5</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>18 – 24 months</td>
<td>4.5</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>3 years</td>
<td>4.5 – 5.0</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>5 years</td>
<td>5.0 – 5.5</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>10 years</td>
<td>6.0 ± cuff</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>14 years</td>
<td>6.5 – 7.0 cuff</td>
<td>18 - 20</td>
<td></td>
</tr>
</tbody>
</table>
RATIONALE FOR UNCUFFED ETT IN CHILDREN

ADULT

INFANT
COMPARISON OF CUFFED AND UNCUFFED ENDOTRACHEAL TUBES IN YOUNG CHILDREN
KHINE HH ET AL. ANESTHESIOLOGY 86:627, 1997

• 488 pts < 8 years undergoing GETA
  ▪ uncuffed size (mm ID) = (age + 16) / 4
  ▪ cuffed size (mm ID) = (age/4) + 3

• appropriate in 99% (vs. 77%) p < 0.001
• advantages - ↓ laryngoscopies, ↓ FGF, ↓ OR anesthetic
• incidence of croup 1.2% vs. 1.3% (ND)
CONFIRMING PLACEMENT OF ETT

**ARE WE IN?**
- auscultation of BS
- symmetrical chest movement
- listen over stomach
- detection of CO2

**WELL POSITIONED?**
- identify carina
- chest radiograph
- palpation of cuff
PHARMACOLOGY OF AIRWAY MANAGEMENT: INDICATIONS

• facilitate a/w management
• reduce a/w trauma
• blunt rises ICP /IOP /MAP
• diminish airway reactivity
• reduce “stress” response
• facilitate transport / procedures
• humane considerations
PHARMACOLOGY OF AIRWAY MANAGEMENT: CONTRA-INDICATIONS

• insufficient expertise
• insufficient monitoring / equipment
• insufficient personnel
• during CPR
• ± hemodynamic instability
• potential loss of airway
# Airway Pharmacology: Sedatives and Analgesics

<table>
<thead>
<tr>
<th>DRUG</th>
<th>DOSE (mg/kg)</th>
<th>SIDE EFFECTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>fentanyl</td>
<td>0.001-0.003</td>
<td>n/v; hypoventilation</td>
</tr>
<tr>
<td>midazolam</td>
<td>0.05-0.15</td>
<td>hypoventilation, especially if combined with opioids</td>
</tr>
<tr>
<td>thiopental</td>
<td>1-6</td>
<td>apnea, hypotension</td>
</tr>
<tr>
<td>propofol</td>
<td>1-3</td>
<td>apnea, hypotension, painful injection</td>
</tr>
<tr>
<td>ketamine</td>
<td>0.5-2</td>
<td>apnea, secretions, ICP</td>
</tr>
<tr>
<td>lidocaine</td>
<td>1-1.5</td>
<td></td>
</tr>
<tr>
<td>DRUG</td>
<td>DOSE (mg/kg)</td>
<td>SIDE EFFECTS</td>
</tr>
<tr>
<td>--------------</td>
<td>-------------</td>
<td>-------------------------------------------------------</td>
</tr>
<tr>
<td>succinylcholine</td>
<td>1-2</td>
<td>bradycardia, hyperkalemia in at-risk pts</td>
</tr>
<tr>
<td>rocuronium</td>
<td>0.8-1.2</td>
<td>pain, precipitation with TPL</td>
</tr>
<tr>
<td>vecuronium</td>
<td>0.1-0.3</td>
<td>slow onset unless higher dose</td>
</tr>
<tr>
<td>pancuronium</td>
<td>0.1</td>
<td>heart rate increase slow onset and offset</td>
</tr>
<tr>
<td>atracurium</td>
<td>0.3-0.6</td>
<td>histamine release slower onset</td>
</tr>
</tbody>
</table>
MANAGEMENT OF “FULL STOMACH”

• **risk factors**
  - ingestion (delayed pain, stress, opioids)
  - obesity, GERD
  - esophageal pathology

• **pharmacologic adjuncts**

• **airway management options**
  - awake intubation or tracheostomy
  - rapid sequence induction (RSI)
RAPID SEQUENCE INDUCTION *

• metoclopramide and/or H-2 blocker (if time)
• consider decompression gastric contents
• denitrogenation (FiO$_2$ 1.0)
• rapid IV induction with rapid onset NMB
  ▪ sux, rocuronium, high dose vecuronium
• Sellick’s maneuver
• apneic oxygenation vs. gentle PPV
• cricoid maintained until successful intubation

* RSI COVERED MORE FULLY IN A SEPARATE POWERPOINT PRESENTATION
CANNOT INTUBATE: BE PREPARED

- call for help
- “best” laryngoscopy
- multi-handed mask ventilation
- LMA
- emergency oxygenation
- definitive (surgical) airway

emergency cricothyrotomy
THE DIFFICULT AIRWAY: INTRODUCTION

IMPORTANCE OF RECOGNITION (RISK FACTORS)

• access
  ▪ positioning (neck)
  ▪ mouth opening
  ▪ macroglossia

• visualization
  ▪ micrognathia

• target
  ▪ tumors, infection etc.