Pediatric Airway Panic or Advanced Pediatric Airway Management?

Marianne Gausche-Hill, MD, FACEP, FAAP
Professor of Clinical Medicine
David Geffen School of Medicine at UCLA
Vice Chair and Chief of the Division of Pediatric Emergency Medicine
Director, EMS and Pediatric Emergency Medicine Fellowships
Harbor-UCLA Medical Center
Department of Emergency Medicine
Disclosures

• I have no actual or potential conflict of interest in relation to this program.

• I also assume responsibility for ensuring the scientific validity, objectivity, and completeness of the content of my presentation.
Objectives

• At the end of this session, you will be able to:
  – Outline the process of airway management for children including the unique issues facing emergency physicians caring for critically ill children.
  – Describe the issues and risks associated with pediatric RSI techniques.
  – Discuss assessment and management strategies for a child with a difficult airway.
  – Identify the indications for, and explain use of mechanical ventilation in the pediatric patient.
Pediatric Airway Management

- Know the steps and practice the steps...
  - Position the head
  - Open the airway
  - Oxygen
  - Consider FB maneuvers/removal
  - Suction
  - Airway adjuncts
  - Bag-mask ventilation
  - Consider noninvasive ventilation
  - ETI [with RSI]
  - Difficult airway algorithm (e.g., LMA, device to facilitate intubation [video laryngoscopy], Bougie, King, or surgical airway)

Also...develop a strategy for problem solving!
Pediatric Airway Panic? ... NO

- Pediatric airway tricks of the trade?
  - Towel placement – an easy trick
  - Jaw thrust - cool
  - Adjuncts ...do they work?
  - Cricoid pressure/Sellick maneuver – of limited use
  - Squeeze, release, release – works great
  - Bimanual laryngoscopy – may be useful
  - Cuffed vs uncuffed ET tubes – the cuff has it
  - Laryngeal notch/Laryngeal spasm trigger point – really cool

- Rapid Sequence Intubation (RSI) – differences with kids
  - Atropine? Who knows
  - Etomidate? Out for sepsis

- Assessment and Management – of the Difficult Airway – some tools and techniques available for peds patients
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, also has stopped breathing, and oxygen saturation is dropping 90% - 86% - 80% - 75%
- What do you do now?
Case: 9 month-old boy

- Back to basics…
  - Position the head
  - Open the airway – jaw thrust
  - Suction
  - Oxygen
  - Nasal airway may be useful
  - Bag-mask ventilation
  - Reassess

This is really the bread and butter of Peds Airway Management
Case: 9 month-old boy

• Position the head
  – Possible simple fix…Place a towel under shoulders may place the airway in better alignment for infants

This works great…frees up your hands; no data however…
Case: 9 month-old boy

- Open the airway
  - Tongue is most common cause of airway obstruction
    - Chin lift
    - Jaw thrust
The jaw thrust maneuver is “the bomb”

Studied 16 children undergoing elective adenoidectomy (all had history snoring, trouble breathing or apnea) - Jaw thrust with and without CPAP was the most effective maneuver to overcome upper airway obstruction in children

Studied 30 children (aged 1-10 years) with obstructive sleep apnea undergoing anesthesia- demonstrated that jaw thrust decreased stridor in the neutral position

Randy Jackson, TV’s American Idol
• Oxygen – increasing evidence for harm – limit hyperoxemia – start with 100% - later adjust to achieve O2 sat ≥ 94%

What are the issues?

“In reperfusion injury, hypoxic cells appear to undergo metabolic changes that prime them to create free radicals when oxygen is reintroduced.”

Experimental resuscitation with 100% oxygen has been associated with a variety of concerning physiologic changes when compared with room air resuscitation: increased generation of oxygen radicals, decreased central nervous system sodium-potassium ATPase function and decreased dopamine metabolism.
A Word or Two on 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

My thoughts…hardly ever use these in young children…more likely to use in adolescents or adults
OP Airway

- Procedure for sizing:
  - Corner of mouth to angle of jaw
- Placing the OP airway

Direct Method

Rotation Method
NP Airway

• Nasopharyngeal airway (NP)
  – **Length**: tip of nares to tragus of the ear
  – **Width**: < size of the nostril
  – **Contraindications**: Basilar skull fracture, midface fractures, closed head trauma, bleeding disorder
  – Child<1 year (relative)

  I use these a lot!
NP Airway

Insert with beveled side toward the septum

• Lubricate the airway
– On right insert directly into the nares
– On left insert until resistance is felt then rotate 180 degrees into position
Bag Mask Ventilation

• Steps:
  – Size face mask
  – Choose bag [Adult, Pediatric, Infant/Small Child, Neonatal]
  – Attach bag to oxygen
  – EC-Clamp
  – Control rate and volume delivered
Bag Mask Ventilation

• **Size Mask**
  - Measure from the bridge of the nose to the cleft of the chin
  - Avoid direct compression of the eyes [vagal]
Bag Mask Ventilation

- **BAG SIZE**
  - Adult
    - 800-1200 mL
  - Pediatric
    - 750 mL
  - Infant
    - 290-500 mL
  - Neonatal
    - 80-120 mL

Watch Out! Bag could be too small
Bag Mask Device

- Volume issues are key
- Choose the device that has adequate volume for the patient
  - Make a newborn resuscitation bag – put neonatal bag in there with BOA kit, UVC line equipment, small blades and ETTs, Meconium aspirator
- Physiologic tidal volume is 6-8 mL/kg – add some for dead space of bag-mask device – so can estimate amount of air to achieve chest rise = 10 mL/kg

You do the math
Volume for Chest Rise

- Neonate – 3 kg = 3 \times 10 = 30 \text{ mL}  
  
  2 tablespoons of air

- Toddler – 14 kg = 14 \times 10 = 140 \text{ mL}  

Too small a bag won’t work – bigger is better
Bag Mask Ventilation

- EC- Clamp
  - “C” holds mask to face
  - “E” pulls chin into mask – makes a clamp
  - 3 fingers on the jaw line
    - Infants - avoid pressure on submental area
    - Only 1 finger may fit on jaw line

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

• Ventilation rates:
  – Neonates - 30/min [Squeeze, release]
  – Infants  - 10-20/min [Squeeze, release, release]
  – Children – 8-10/min [Squeeze, release, release]

Slower rates are best – too hard and too fast will cause gastric distension – use Squeeze–Release-Release-Release
AHA 2010…Minute Ventilation

• Avoid excessive ventilation of infants and children during resuscitation from cardiac arrest; insufficient data to identify optimal tidal volume or rate
  – Animal studies show excessive ventilation decreases cerebral perfusion pressure, ROSC and survival
  – Excessive ventilation increases intrathoracic pressure impedes venous return, reduces CO and cerebral and coronary blood flow
  – During CPR ventilate 8-10 times per minute for infants and children

DON’T BAG TOO FAST!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
What if no chest rise?

- Reposition try again
- Consider FB in airway or other airway obstruction

National surveys show 17% of EDs do not have pediatric Magill forceps... Check your ED for these!!!!!!!!!!
Case: 18 month-old girl

- An 18 month old is brought in by mother with fever, cough, and respiratory distress
- You place the girl on oxygen and obtain a chest radiograph; RML/RLL pneumonia is diagnosed
- Her respiratory rate is 80 per min; she is retracting in all fields, and is now listless
- You make the decision to perform endotracheal intubation

**What maneuvers can be performed during ETI to assist in visualization of the cords in children?**
Case: 18 month-old girl

- **Jaw thrust**
  
  I use jaw thrust all the time to improve laryngoscopic view and I think it works well (Young-Chang, et al: *Anesth Analg* 2004)

- **Cricoid pressure**
  
  My 2 cents worth: Cricoid problematic in children because of compressible trachea...use common sense approach

- **BURP**

  No studies in children

- **Bimanual laryngoscopy**

  Alternative – may work better in children as small differences in hand placement can change the view dramatically – have assistant put hand on laryngeal structures and you manipulate his/her hand into optimal position
AHA Recommendation 2010
Cricoid Pressure

• Cricoid pressure – routine use to prevent aspiration during endotracheal intubation is NOT recommended; in children more likely to cause problems than assist

• Discontinue if it impedes ventilation

Bimanual laryngoscopy

Laryngoscopist uses right hand to manipulate airway structures until view is optimized – then assistant maintains view.

Alternative – works better in children as small differences in hand placement can change the view dramatically – have assistant put hand on laryngeal structures and you manipulate his/her hand into optimal position.
Case: 18 month-old girl

- *What size tube should we use and should it be cuffed?*

  Short answer for sizing of ETT – Use the Broselow Tape
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: \((\text{Age}/4) + 4\)
• Other methods: These are not practical
  – Width of the child's little finger nail
  – Size of nare
<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>
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</table>
Ballpark ETT size

- Premature infant (2.5-3.0 mm tube)
- Newborn 3.0-3.5 mm tube
- Up to 6 months of age 3.5 mm tube
  - 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 tube
### MGH Simple Calculation Method

<table>
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<tr>
<th>Age in Years</th>
<th>Weight (kg)</th>
<th>ETT Size</th>
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<tr>
<td>1</td>
<td>10</td>
<td>4</td>
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<tr>
<td>5</td>
<td>20</td>
<td>5</td>
</tr>
<tr>
<td>8-10</td>
<td>30</td>
<td>6</td>
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</tbody>
</table>

Extrapolate in between ages…a 2 year old 4.5mm tube
Cuffed Endotracheal Tubes

- Will the cuff cause pressure on the cricoid cartilage leading to pressure necrosis?
- Short answer….NO


2246 children RCT (1119/1127 cuffed/uncuffed)

Post-extubation stridor was noted in 4.4% of patients with cuffed and in 4.7% with uncuffed TTs (P=0.543).

TT exchange rate was 2.1% in the cuffed and 30.8% in the uncuffed groups (P<0.0001).
Pediatric Advanced Life Support Recommendation

- Cuffed vs. uncuffed endotracheal tubes
  - Cuffed tubes may be preferred in certain circumstances ...poor lung compliance, high airway resistance, or large glottic air leak - really any sick kid
  - American Heart Association suggests...ETT sizing
    - Uncuffed (age (yrs)/4) + 4 = mm ID
    - Cuffed (age (yrs)/4) + 3.5 = mm ID [2010]
  - ½ less than standard formula (except for 3.0 mm)
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
**Depth of tube placement**

- Watch vocal cord marker go past the cords

Depth of tube placement in cm can be calculated as $3 \times$ 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

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Diagram:

- **b**: Epiglottis
- **c**: Epiglottis lifted
Laryngoscopic anatomy

- Macintosh blade inserted into vallecula
- Vocal cords
- Arytenoid cartilages
- Epiglottis
- Glottis
- Esophagus
ET placement
Confirmation of tube placement

- Clinical assessment
- $\text{CO}_2$ detection or monitor
- Esophageal detection device (EDD)
  - Bulb or syringe
- Chest radiograph
- Pulse oximetry
Case: 4 year-old boy

- 4 year-old boy BIB father for swallowing a quarter
- The quarter is lodged in his esophagus and GI asks you to sedate while they endoscopically remove the FB
Case: 4 year-old boy

• After receiving 16 mg (1mg/kg) of ketamine the boy’s oxygen saturation drops to 79%

• You suspect laryngospasm…
Laryngospasm

- Laryngospasm is 2-3 times more common in pediatric patients
- Defined as decreased distance between aryepiglottic fold and vestibular region resulting in decreased space between vocal cords
- High risk group:
  - Age < 6 years [infants at HIGHEST risk]
  - Recent respiratory illness
  - Recent use of LMA
Laryngeal Spasm Trigger Point

• Larson P. Laryngospasm – the best treatment. Anesthesiology 1998
  – Comments on >40 years experience in the use of pressure in the “laryngeal notch”
    • Technique: Pressure with finger tips (long finger) applied to retroauricular depression – laryngeal spasm trigger point while maintaining the oxygen mask over the face and elevating the mandible (jaw thrust)

OK this is really cool
Laryngospasm Management

• Pressure in laryngeal spasm trigger point or laryngeal notch - along with jaw thrust maneuver
• Initiate positive pressure ventilation with bag-mask device
• If cannot maintain oxygenation and ventilation then RSI

Burgoyne LL, et al. Intervention steps for treating laryngospasm in pediatric patients
*Pediatric Anesthesia* 2008; Rate of laryngospasm 1/1000
Case: 3 year old in Septic Shock

- A 3 year old male is brought in by paramedics after 5 days of fever
- He is poorly responsive and limp
- Vital signs: T 39°C; HR 140; RR 70 and shallow; BP 70/p mmHg; Pulse ox 84% on RA
- You decide to intubate him using RSI

What medications will you use?
3 year-old male

Tough issue…
- Atropine?
- Lidocaine?
- Midazolam?
- Etomidate?
- Ketamine?
- Succinylcholine?
- Rocuronium?

http://blog.peta.org/archives/IntubationCartoonsm.JPG
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
RSI:

• Preparation:
  – Differences in children...have more sizes of ETTs available; medication modifications; monitoring is key
  – Individualize protocol to your patient
  – Always have contingency plan in case unsuccessful with first attempt
  – Consider Head and Neck Surgery and anesthesia standby in difficult cases
RSI:

• Preparation - airway equipment:
  – Manual resuscitator and appropriate size mask
  – Laryngoscope, ETT (two sizes available; appropriate size based on length or other calculation and 1/2 size smaller) and stylet
  – Rescue device/supraglottic airway
  – Consider surgical airway available and physician who can perform it
Preoxygenate

– Add 100% oxygen
– Remember infants become hypoxic quickly
– If possible avoid positive pressure ventilation during this period
– High flow nasal cannula (5-15 L per min)
Pretreatment

- **Atropine** [0.02 mg/kg; min 0.1 mg; max 0.5 mg]
  - Pathophysiology
    - Paucity of sympathetic nerves to ventricles makes them less electrically stable
    - Sympathetic-parasympathetic imbalance results in accelerations and decelerations
  - Guidelines (APLS)
    - Use in infants < 1 year
    - Children 1-5 years who receive succinylcholine
    - Others who receive second dose of succinylcholine
Reviewed literature on use of atropine to prevent bradycardia in children during RSI

112 papers found – 2 presented best evidence

- “Evidence from these two studies would indicate that the incidence of reflex bradycardia in children during rapid sequence intubation (RSI) is much lower than previously thought.”
- “Furthermore, it does not appear the paralysing agent used significantly contributes to incidences of bradycardia.”
- “It appears that hypoxia, not foregoing pre-treatment with atropine, is a stronger predictor of patients who will develop reflex bradycardia following RSI.”
Atropine

• Pros
  – Young infants < 12 months at risk for bradycardia especially if hypoxic
  – Atropine appears to be effective in preventing bradycardia associated with administration of succinylcholine even in neonates
  – Kids tolerate tachycardia much better than bradycardia…give it

• Cons
  – Masks the ability to monitor heart rate for important physiologic changes
  – Atropine increases a patient’s temperature and risk of malignant hyperthermia (RARE)
  – Increases ventricular arrhythmias (RARE)
  – Relaxes lower esophageal sphincter with possible increased the risk of aspiration
Pretreatment

• **Common sense guideline** (not completely evidenced based)
  – <12 months – consider giving it especially if using succinylcholine [controversial] at least have it available
  – Or…just have it available when you need it

• **Other drug for pretreatment** (not great data here as well)
  – Lidocaine [1.5 mg/kg, slow IVP]
    • Head trauma main indication
    • Attenuate adrenergic response to laryngoscopy
    • Decreases rise in ICP and IOP

• **Allow enough time for medications to take effect**
Etomidate (0.2-0.4 mg/kg)

- Onset: Less than 1 min [my experience <30 s]
- Duration: 5 to 20 min
- Advantage: Minimal respiratory depression, lowers ICP and cerebral metabolic rate, few cardiovascular effects
- Disadvantage: Myoclonic excitation (might resemble seizures)

Etomidate inhibits 11 β-hydroxylase [enzyme in final step of cortisol production]

Controversial with single dose use ….no randomized trial in children; 2011 systematic review in Intensive Care Med – shows increased adverse events and mortality - **NOT recommended in recent Sepsis Guidelines**
Thiopental (2-6 mg/kg)

- Onset: 30-60 sec
- Duration: 5 to 30 min
- Advantage: Lowers ICP, lowers cerebral metabolism and oxygen demand, anticonvulsant
- Disadvantage: Respiratory and myocardial depression. Avoid in hypotension or patients in shock. May occasionally cause laryngospasm. May cause tissue necrosis if extravasates.

Use in patients with increased ICP who are hemodynamically stable
Midazolam (0.1-0.2 mg/kg)

- Onset: 1 to 2 min
- Duration: 20 to 30 min
- Benefits: Reversible, amnestic, anticonvulsant, less likely to cause myocardial depression
- Cautions: Variable dose to achieve unconsciousness. Titration may be required which limits its use in RSI. Can cause respiratory depression and hypotension.

Comment – our PICU team likes to use this
Ketamine (1-4 mg/kg)

- Onset: 1-2 min Duration: 30-60 min
- Advantage: Bronchodilator, limited respiratory depression sympathomimetic, less likely to cause myocardial depression.
- Disadvantage: Inject slowly to avoid vomiting; may increase oral secretions, increases ICP (but recent data shows increases CPP), might cause emergence reactions which not an issue with RSI

Comment: Some concern with long term effects on developing brain in animals – no data in humans yet

Recommended as sedative of choice in recent Sepsis Guidelines
Propofol (2-3 mg/kg)

- Onset: 1-2 min  
  Duration: 30-60 min
- Advantage: Ultra short acting
- Disadvantage: Hypotension, hypoxia, bradycardia [caution with egg/soy bean allergy]

Anesthesia likes to use this in the OR but these are generally healthy patients – still concern with use routinely for RSI in the ED
RSI Sedation:

- **Fentanyl:** (1-4 μg/kg IV) potent narcotic
  - Causes ↑ ICP, seizures, respiratory depression and chest wall rigidity
  - Reversible with naloxone (0.1 mg/kg)
  - Advocates say it reduces fasiculations

- **Methohexital:** (1-1.5 mg/kg) barbiturate
  - Used in patients with increased ICP who are hemodynamically stable
  - Causes histamine release; caution in asthmatics
  - Can cause tissue necrosis if extravasates

Comment: I don’t use either one of these – but methohexital very short acting
Sedative Selection

- Hypotension: Ketamine if concerned about sepsis
- Bronchoconstriction: Ketamine
- Head injury without hypotension (or signs of shock): Etomidate or thiopental or midazolam
- Head injury with hypotension: Etomidate or ketamine
Paralyzing Agent Selection

- Physician preference
- Onset time: Succinylcholine faster
- Duration: Succinylcholine shorter
- Adverse effects: Fewer with rocuronium
- Intubation conditions: Favors succinylcholine because of rapid onset
  [recent Cochrane database review 2008]
Neuromuscular Blocking Agents

• Succinylcholine 2-3 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
  – Shorter duration (plasma cholinesterase hydrolyzes), higher risk of adverse effects

Do not under dose in children…can give 2-3 mg/kg in young infants [greater volume of distribution]

• Rocuronium 1 mg/kg
  – Competitively block ACH transmission at the postjunctional cholinergic nicotinic receptor
  – Onset 1-3 min, duration 25-35 min
  – Longer duration, but less potential for adverse effects
Sugammadex

- Sugammadex exerts its effect by forming very tight water-soluble complexes at a 1:1 ratio with steroidal neuromuscular blocking drugs
  - Rocuronium > vecuronium >> pancuronium
- Sugammadex is a selective relaxant binding agent
  - Dose: 0.07 mg/kg – or 4 mg for an adult – reversal in 1 minute

Not yet ready for prime time
As not yet approved by FDA
Ventilator Management:

- Ventilator settings are adjusted based on patients clinical status
  - Chest rise, pulse oximetry, peak inspiratory pressure, end tidal CO$_2$ and blood gas analysis
  - Selection of tidal volume based on the following generally 6-8 mL/kg:
    - Visible chest excursion simulating normal breathing
    - Audible air entry
    - Diminution of dyspnea
Ventilator Management

• Intermittent mandatory ventilation rates/inspiratory time are age dependent
  – < 2 years 20-25/min (i time ~0.5-0.6)
  – 2-10 years 15-24/min (i time ~0.6-0.75)
  – >10 years 12-16/min (i time ~0.75-1)

• FIO$_2$ – want lowest amount to maintain oxygenation O$_2$ sat >90%; may start at 100% but dial down quickly

• PEEP 4-5 cm H$_2$O

• Peak inspiratory pressure >35 cm H$_2$O TV too high; <20 cm H$_2$O may be too low to initiate chest rise
GUIDELINES FOR INITIATION OF MECHANICAL VENTILATION IN CHILDREN

Choose Familiar Mode (SIMV, PRVC)

\[ \text{FiO}_2 = 1.0 \]

- **Obstructive Disease**
  - PEEP 3-4 cm/H\(_2\)O
  - To determine rate, bag patient to assess expiratory time (usually rate <10)

- **Other**
  - PEEP 4-5 cm/H\(_2\)O
  - PIP 16-24 cm/H\(_2\)O
  - Pressure Control

- **Severe Lung Injury**
  - PEEP 8-10 cm/H\(_2\)O
  - VT 8-10 cc/kg
  - VT 5-8 cc/kg
  - Volume Control

**Termiology Key:**
- SIMV - Synchronized Intermittent Mandatory Ventilation
- PRVC - Pressure Regulated Volume Control
- VT -- Tidal Volume
- PIP - Peak Inspiratory Pressure
- PEEP - Peak End Expiratory Pressure
- i time -- Inspiratory Time

**Assess:**
1 - Chest rise
2 - Auscultation: equal, full expiration
3 - Saturation
4 - End tidal CO\(_2\)
5 - PIP ≤ 30 cm/H\(_2\)O
6 - Auto-PEEP: flow-time graphic, auscultation

**Rates:**
- Neonates 25-35
- Infants 20-30
- Children 15-25
- Adolescents 12-16

**i times:**
- Neonates 0.5 sec
- Toddlers/Children 0.7 sec
- Adolescents 0.8-1 sec

**Pressure Support:**
- 5-10 cm/H\(_2\)O if used

*Courtesy of Dr. Tom Kallay, Torrance, CA*
Case: 2 year-old boy

- Mother rushes into triage with a 2 year-old boy with a craniofacial abnormality
- The child is obtund with gasping respirations and skin color is pale
- The nurse calls for a physician and places the child immediately in the resuscitation room
- You attempt BMV but are unable to get a seal; $O_2$ sat is 70%; small jaw makes ETI impossible
- What is your next airway option?
Management techniques:

- Consider placement of OP or NP airway/ BMV
- Supraglottic airway - Laryngeal mask airway (LMA), many other brands Air Q, i-gel...
- Intubate using other methods
  - Video laryngoscopy
  - Lighted stylet or Lightwand or Trachlight
- Rescue devices – Laryngeal tube/King Airway
- Cricothyrotomy (needle and otherwise)
- Other
  - Fiberoptic intubation [need to develop the skill]
  - Elastic Gum Bougie (not for kids- age 14 years+)
  - Combitube (not for kids – age 14 yrs +)
Anticipating a Difficult Pediatric Airway

Physical examination of the airway:

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

- ED often don’t know until you attempt intubation…
  - Cormack and Lehane View 3 or 4
  - Cannot intubate after 3 attempts
  - Cannot perform adequate BMV to maintain oxygenation and cannot intubate
Supraglottic devices

- Laryngeal mask airways
  Introduced in 1983 by Brain AIJ: *Br J Anaesthes*
- Similar devices now made by many manufacturers
• Placed above the laryngeal inlet to direct gases into the lungs
LMA - Unique™

- Single use, disposable version of LMA Classic™
- Sizes 1-5
- Cost $109/for 10

http://www.lmana.com/unique.php
### LMA Unique™ Quick Reference

<table>
<thead>
<tr>
<th>Mask Size</th>
<th>Patient Size</th>
<th>*Maximum Cuff Volume (Air)</th>
<th>Largest ETT ID (mm)</th>
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<tbody>
<tr>
<td>1</td>
<td>Neonates/Infants up to 5 kg</td>
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<tr>
<td>1 1/2</td>
<td>Infants 5-10 kg</td>
<td>7 mL</td>
<td>4.0</td>
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<td>Infants/Children 10-20 kg</td>
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<td>Children 30-50 kg</td>
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<td>5</td>
<td>Adults 70-100 kg</td>
<td>40 mL</td>
<td>7.0 cuffed</td>
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### LMA Unique™ Airway Kits

- LMA Unique™ Pediatric Emergency Kit (1 of each size: 1, 1 1/2, 2, 2 1/2)
- LMA Unique™ Adult Emergency Kit (1 of each size: 3, 4, 5)
- LMA Unique™ Complete Emergency Kit (1 of each size: 1, 1 1/2, 2, 2 1/2, 3, 4, 5)
LMA Supreme™

- **Fixation Tabs** Help Maintain Proper Cuff Depth
- **Integral Bite Block**
- The Unique Elliptical Airway Tube is Stable in Situ and Allows for Easy Placement and No Kinking
- Larger Pre-Curved Cuff for Improved Fit and Effective Seal
- Molded Fins Protect Airway from Epiglottic Obstruction
- Reinforced Tip and Molded Distal Cuff Resist Folding

www.lmanorthamerica.com
### LMA Supreme™

<table>
<thead>
<tr>
<th>LMA Size</th>
<th>Patient weight (kg)</th>
<th>MAX cuff inflation volume (ml)</th>
<th>Largest Size OG/NG Tube</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Neonates/Infants up to 5 kg</td>
<td>5 ml</td>
<td>6 Fr</td>
</tr>
<tr>
<td>2</td>
<td>Infants 10-20 kg</td>
<td>12 ml</td>
<td>10 Fr</td>
</tr>
<tr>
<td>3</td>
<td>Children 30-50 kg</td>
<td>30 ml</td>
<td>14 Fr</td>
</tr>
<tr>
<td>4</td>
<td>Adults 50-70 kg</td>
<td>45 ml</td>
<td>14 Fr</td>
</tr>
<tr>
<td>5</td>
<td>Large adults 70-100 kg</td>
<td>45 ml</td>
<td>14 Fr</td>
</tr>
</tbody>
</table>
LMA – Sizing on Broselow Tape

- Sizing found on Broselow-Luten Tape (2002 edition or greater)
LMA Sizing

- Size and mL needed to inflate the cuff on the side
Other Devices

- **Air-Q** – able to intubate through the device – 3 studies in children

- **i-gel** – single-use with non-inflatable cuff composed of thermoplastic elastomer and soft gel cuff – has airway tube and gastric tube [one study in 50 children in OR – good insertion rates and few complication rates]
Lightwand or Lighted Stylet

- Available in all sizes (down to 2.5 mm)

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Infant</td>
<td>2.5-4.0 mm</td>
</tr>
<tr>
<td>Child</td>
<td>4.0–6.0 mm</td>
</tr>
<tr>
<td>Adult</td>
<td>6.0 –10.0 mm</td>
</tr>
</tbody>
</table>
Esophageal/Tracheal Combination Tube

• Esophageal/tracheal combination tube (Combitube (Nellcor, Pleasanton, CA))
  – Double-lumen airway passed blindly into the mouth until the patient’s upper incisors are between 2 transverse indicator bars
• Placed in esophagus in >90% of patients
• 2 sizes available (small 4 ft and standard >5 ft)

Not really an option for most kids <14 years of age
King Laryngeal Airway

• King systems –
  Laryngeal tube
  (Noblesville, IN)
  – Supraglottic airway
device with a single
lumen
  – Passed blindly into the
esophagus
  – Available in 5 sizes
  – Can be used in children
    >12 kg or 36 inches
  – Few data in children

http://www.kingsystems.com
– Insertion success in manikin models high 95%
– Complications; no peds data
– Not clear difference between King System model and German version

Data in Air Medical situations: Ritter SC, et al: 2010; King LT-D easier to place than ETI
# King Laryngeal Tube

<table>
<thead>
<tr>
<th>Size</th>
<th>Patient</th>
<th>Patient Size</th>
<th>Color</th>
<th>Cuff Vol</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Child</td>
<td>12-25 kg 30-45 in/90-115 cm</td>
<td>Green</td>
<td>25-35 ml</td>
</tr>
<tr>
<td>2.5</td>
<td>Child</td>
<td>25-35 kg 41-51 in/105-130 cm</td>
<td>Orange</td>
<td>30-40 ml</td>
</tr>
<tr>
<td>3</td>
<td>Adult</td>
<td>4-5 ft/122-155 cm</td>
<td>Yellow</td>
<td>45-60 ml</td>
</tr>
<tr>
<td>4</td>
<td>Adult</td>
<td>5-6 ft/155-180 cm</td>
<td>Red</td>
<td>60-80 ml</td>
</tr>
<tr>
<td>5</td>
<td>Adult</td>
<td>&gt;6 ft/ &gt;180 cm</td>
<td>Purple</td>
<td>70-90 ml</td>
</tr>
</tbody>
</table>
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
Video Laryngoscopy (VL) Contrast to Direct Laryngoscopy (DL)

• Open mouth with thumb pressure on chin or scissor move (DL and VL)
• VL blade inserted in midline with avoidance of tongue sweep (DL)
• Hand action different in tipping blade to view the larynx (VL)
• Airway is displayed on monitor or other screen (VL)
• External manipulation of larynx may be needed to visualize the airway (DL and VL)
# Video Laryngoscopy in Pediatrics

<table>
<thead>
<tr>
<th>Device</th>
<th>Classification</th>
<th>Patient Size</th>
<th>Manufacturer/ Distributer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airtraq</td>
<td>Channeled device/optical laryngoscope</td>
<td>Infant, child, adolescent</td>
<td>Prodel/ King Systems</td>
</tr>
<tr>
<td>Berci-Kaplan DCI C-MAC</td>
<td>VL</td>
<td>Neonate, infant, child, adolescent</td>
<td>Karl Storz Endoscopy</td>
</tr>
<tr>
<td>Glidescope AVL, PGVL, Cobalt, Ranger</td>
<td>VL</td>
<td>Neonate, infant, child, adolescent</td>
<td>Verathon Medical</td>
</tr>
<tr>
<td>McGrath Series 5</td>
<td>VL</td>
<td>Adolescent</td>
<td>Aircraft Medical/ LMA North America</td>
</tr>
<tr>
<td>Pentax AWS</td>
<td>VL, channeled device</td>
<td>Adolescent</td>
<td>Pentax/ Ambu</td>
</tr>
<tr>
<td>Truvieview EVO2</td>
<td>Optical laryngoscope with video capability</td>
<td>Infant</td>
<td>Truphatek International</td>
</tr>
<tr>
<td>Angulated Video-Intubation laryngoscope</td>
<td>VL</td>
<td>Child, adolescent</td>
<td>Volpi [Not available in US]</td>
</tr>
</tbody>
</table>
GlideScope® Video Laryngoscope

- Introduced for pediatric use in 2005
- For many physicians used routinely vs just for the difficult airway
- All three models (AVL, PGVL, Ranger) have pediatric sized blades
- Reuseable blades
- $8000-15000 for device – blades $10-15 each
- More studies published on this device in children than any other type of video laryngoscopy
- Compared MacIntosh laryngoscopy vs Glidescope in 203 children 3 months to 17 years of age
- Video laryngoscopy improved the view in 62% of patients with C/L View ≥ 2

Armstrong J, et al Anesthesia 2010
- Compared laryngoscopy with GlideScope Video laryngoscopy in 18 children with history of difficult airways
- GlideScope yielded improved views p=0.003; no difference in time to optimal view
GlideScope®

- Successful tracheal intubation in children with severe retro or micrognathia as well as craniofacial abnormalities has been reported using the GlideScope.


Cobalt Video Laryngoscope
With VL the C-L view was grade 1 vs grade 4 with standard DL.
Pediatric GlideScope (Cobalt GVL Stat) was compared to the Miller laryngoscope in a randomized study of 32 anesthetists by assessing the time taken to tracheal intubation under normal and difficult intubation conditions in a pediatric manikin.

There was no difference in time taken to tracheal intubation using the GlideScope or Miller laryngoscope under normal or difficult conditions.

34% of participants said that they would definitely use the GlideScope in an emergency compared with 66% who would be willing to use the Miller laryngoscope.

Conclusions

• Increasing use of video laryngoscopy for routine intubations
• Still primarily used for the difficult airway
• Devices vary in cost and portability
• GlideScope most widely used at this point but others have advantages
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
Needle Cricothyrotomy

• Indications
  – Can’t ventilate with BMV or LMA, failed ETI
  – High airway FB obstruction
A 3-mL syringe with the plunger removed may be used as an adapter between the catheter and a 7.5 mm ID endotracheal tube. Alternately, a 3.0 mm ID endotracheal tube connector can be inserted directly into the catheter hub. Both methods can be used to connect the catheter to a standard self-inflating resuscitation bag.

Percutaneous transtracheal ventilation via three-way stopcock

PTV setup utilizing a three-way stopcock.

Percutaneous transtracheal ventilation via Y-connector or oxygen tubing side port.

PTV setups utilizing a Y-connector and oxygen tubing with a cut side port.

ENK Oxygen Flow Modulator

- 6.0 Fr catheter 5 and 7.5 cm in length
- Needle gauge 15

www.cookmedical.com
Pediatric Airway Management

- Practice tips and techniques
- Standard approach to airway management
- Children can be daunting because of sizing issues...keep tools available to help!

Questions???
References

• Jaw thrust:

• Cricoid Pressure
References

- American Heart Association
References

• Use of cuffed ET tubes in children:

• Atropine
References

- **RSI**
References

• Bimanual laryngoscopy:

• Laryngospasm trigger point:
Supraglottic Devices

Video Laryngoscopy: References


Video Laryngoscopy: Websites

- [http://www.aircraftmedical.com](http://www.aircraftmedical.com)