University Hospitals™
Case Medical Center

Rainbow Babies
& Children's Hospital

A is for Airway in Pediatric Trauma

Paul A. Tripi, M.D.
Chief, Division of Pediatric Anesthesiology
University Hospitals Case Medical Center
Rainbow Babies and Children's Hospital

September 16, 2011

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…

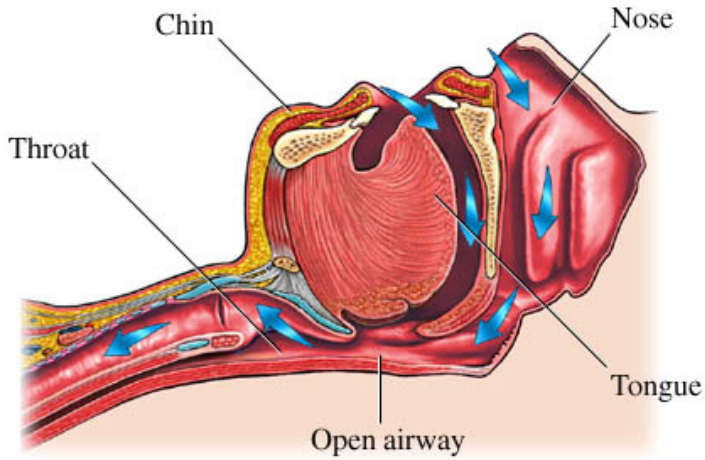
"Regardless of how the airway is managed, a cervical spine injury must be considered."

Prehospital Trauma Life Support, Seventh Edition, 2011 (NAEMT)

Airway First in Pediatric Trauma

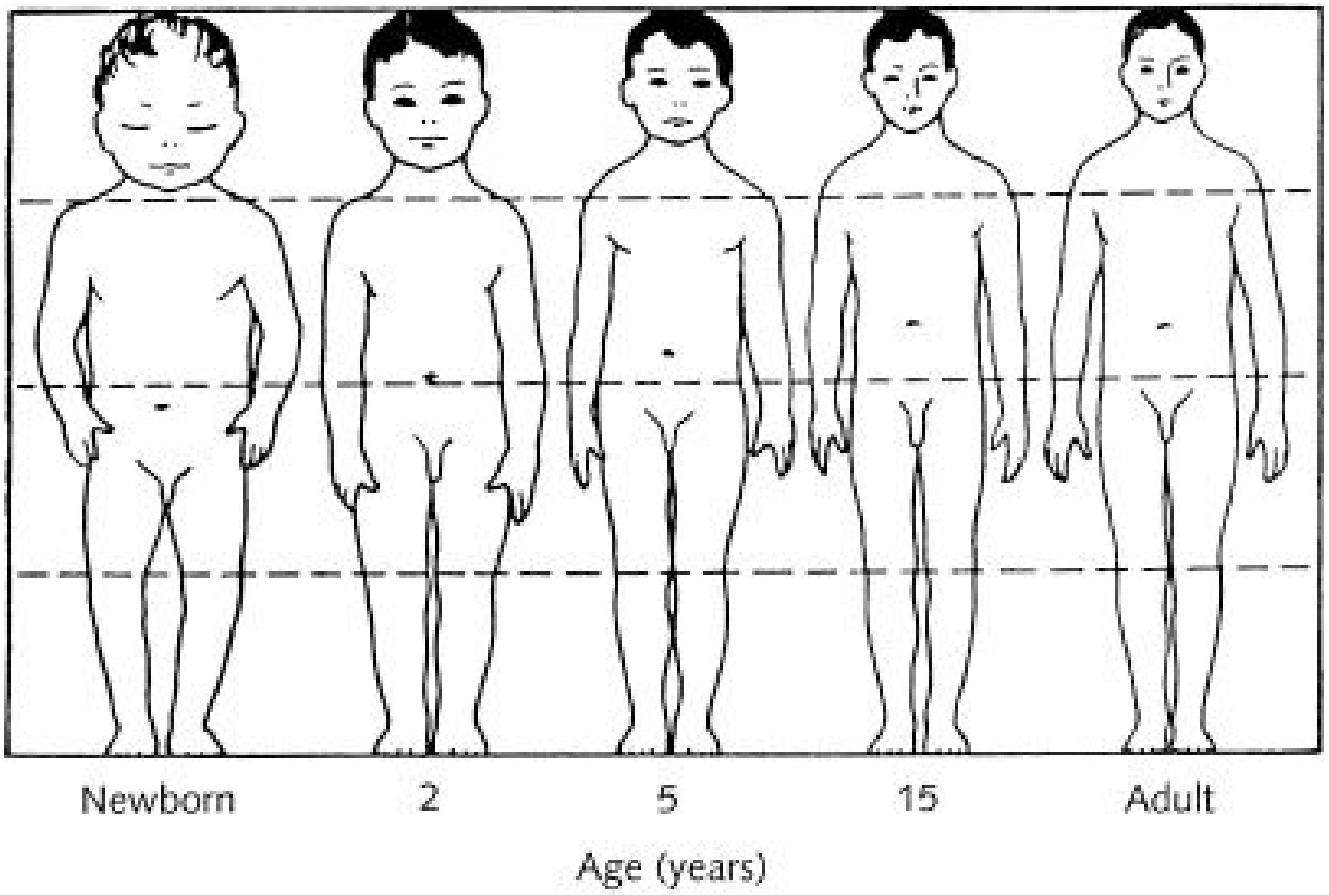
- Impaired Neurological Function
  - Flaccid tongue → Obstruction
  - Altered consciousness → Decreased ventilatory drive

- Mechanical Obstruction
  - Tongue
  - Edema
  - Foreign bodies/debris
  - Collapse of bone and/or cartilage



Pediatric Airway Anatomy

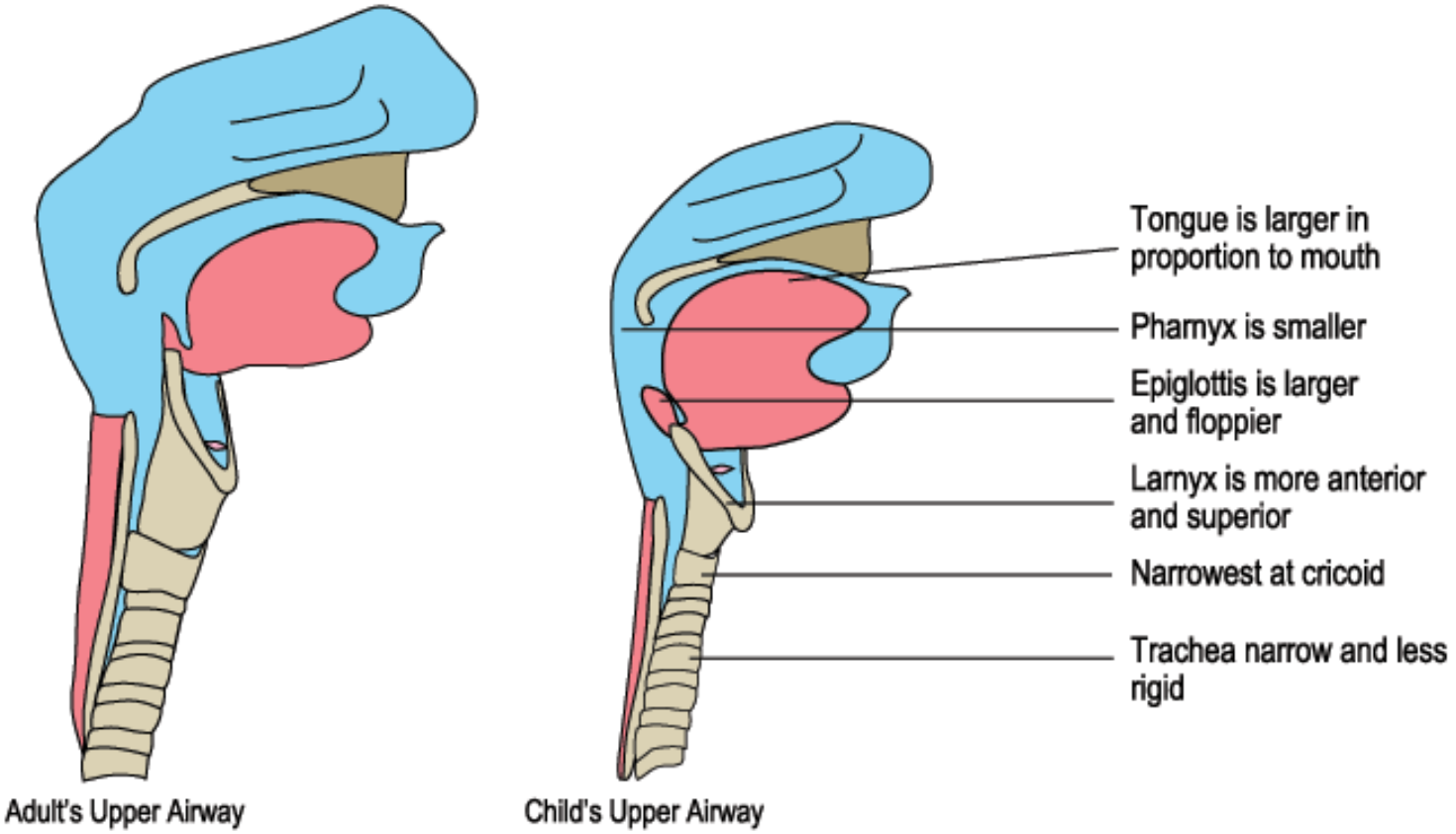
Anatomy – Body Proportions



Anatomy - External

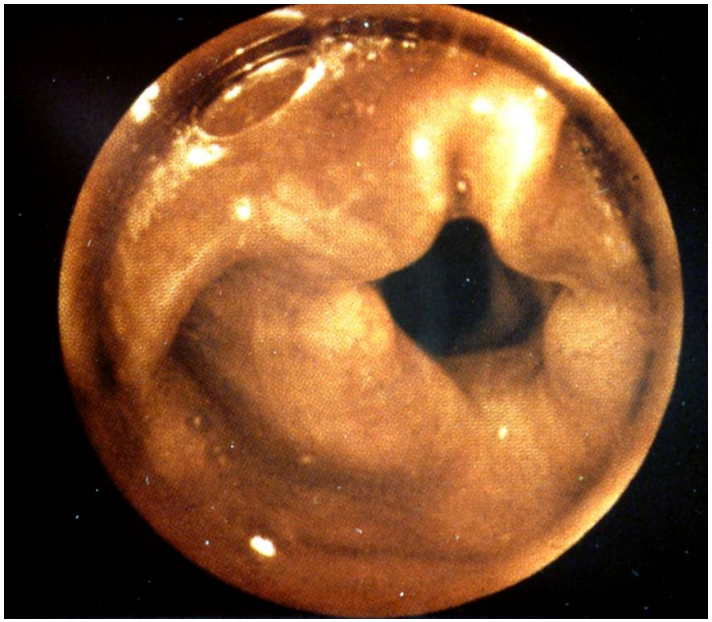
- Relatively large head
- Prominent occiput
- Short neck
- Underdeveloped chin
- Narrow nares

Anatomy – Internal



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 consiousness
- Postion (supine v. lateral v. upright)
- Inspection (Blood, debris, FB, distortion)
- Breath sounds (Noisy?)
- Chest rise, retractions

Normal Respiratory Rates in Children

Age (yrs)	Respiratory Rate (bpm)
0-1	24-38
1-3	22-30
4-6	20-24
7-9	18-24
10-14	16-22
14-18	14-20

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

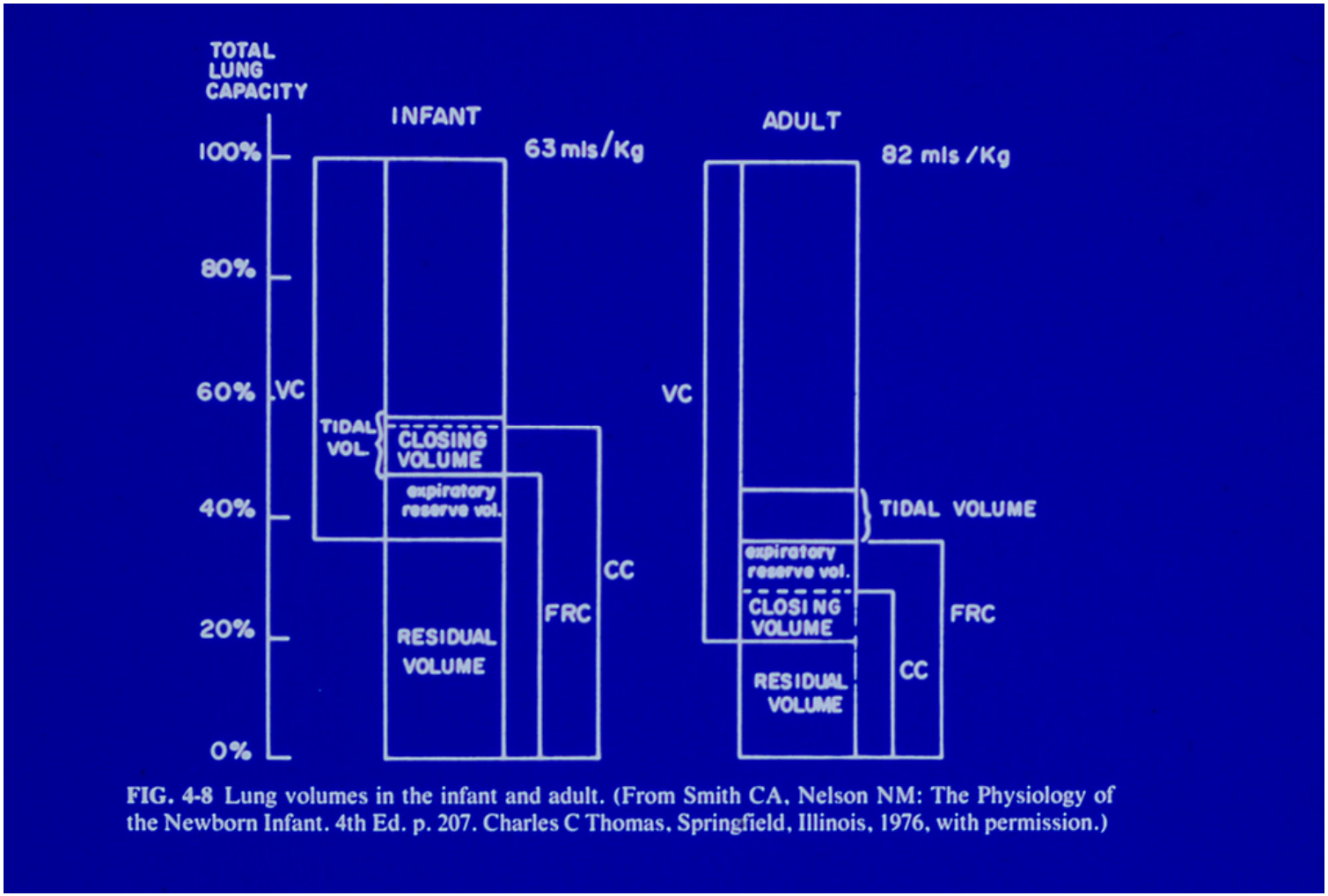


FIG. 4-8 Lung volumes in the infant and adult. (From Smith CA, Nelson NM: The Physiology of the Newborn Infant. 4th Ed. p. 207. Charles C Thomas, Springfield, Illinois, 1976, with permission.)

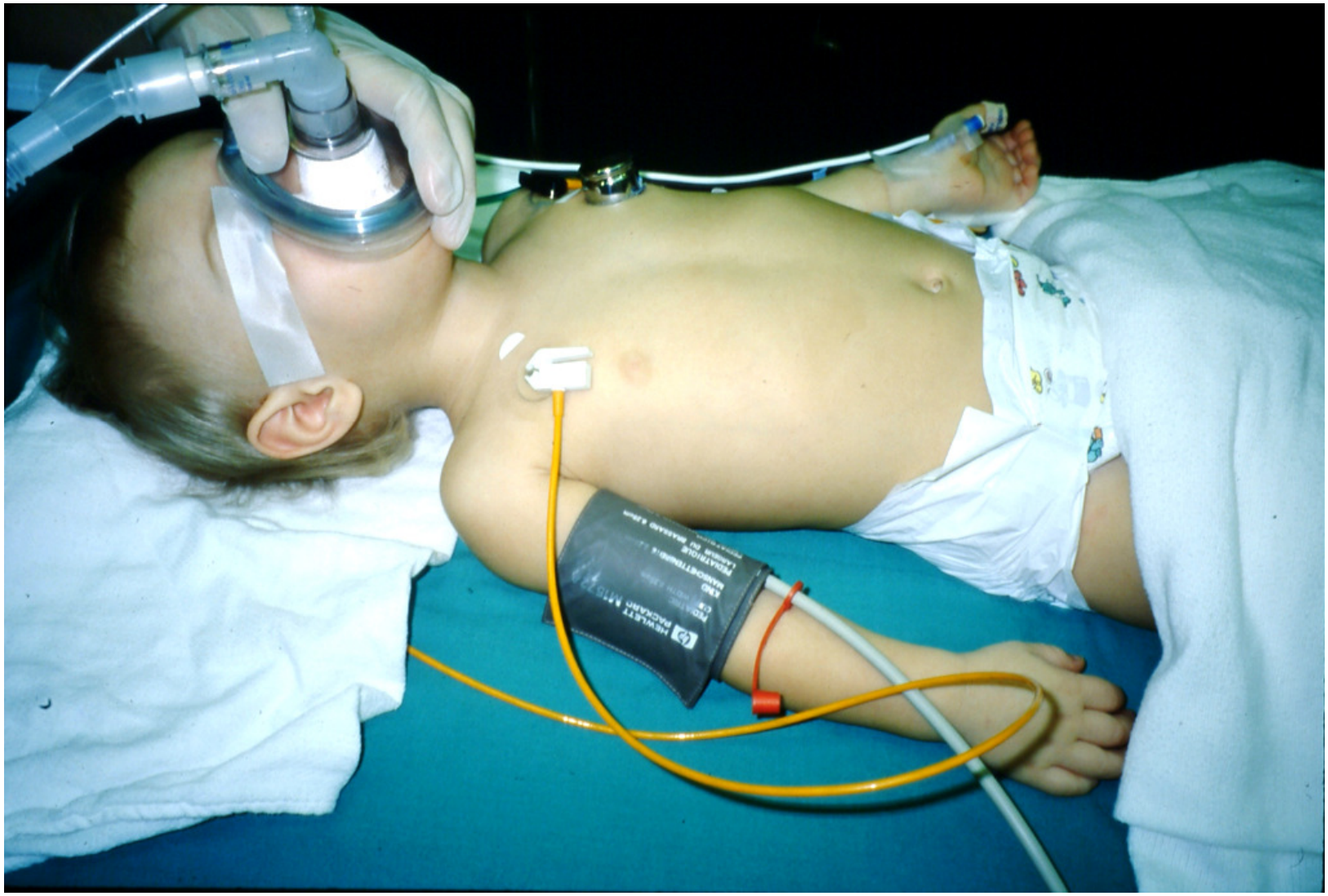
Cote et al, A Practice of Anesthesia for Infants and Children, 4th Ed.

Infant Diaphragm Prone to Fatigue

PERCENTAGE TYPE I MUSCLE FIBERS
(SLOW TWITCH, FATIGUE RESISTANT)

AGE	%
Preterm infant	<10
Term infant	30
>1 y.o.	55
Adult	55

Airway Management



Your management depends on your skills and educational background

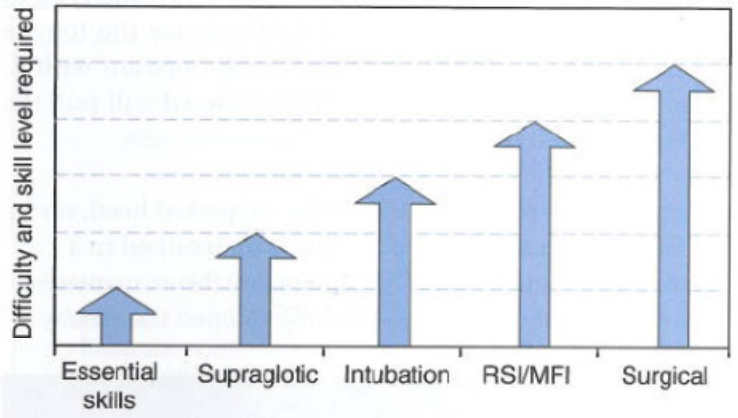


FIGURE 7-9 Airway skills.

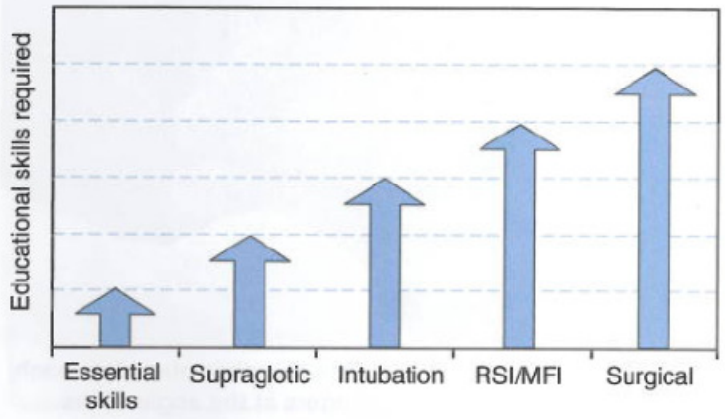


FIGURE 7-10 Educational skills required.

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

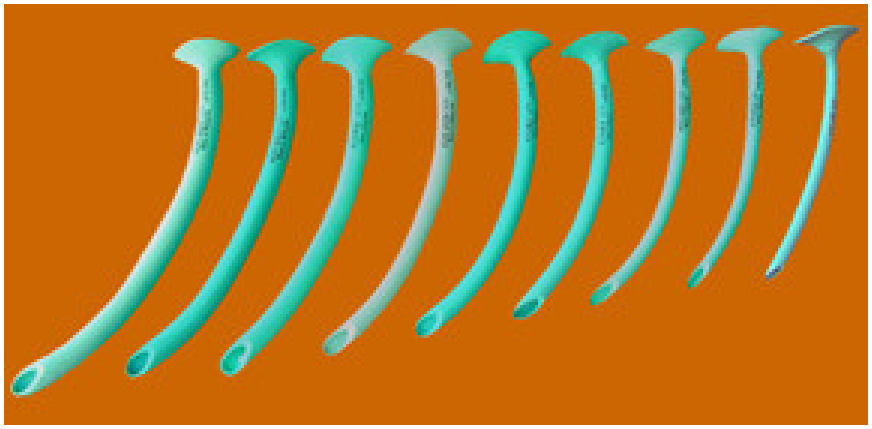
Evaluate airway before choosing your adjunct!

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

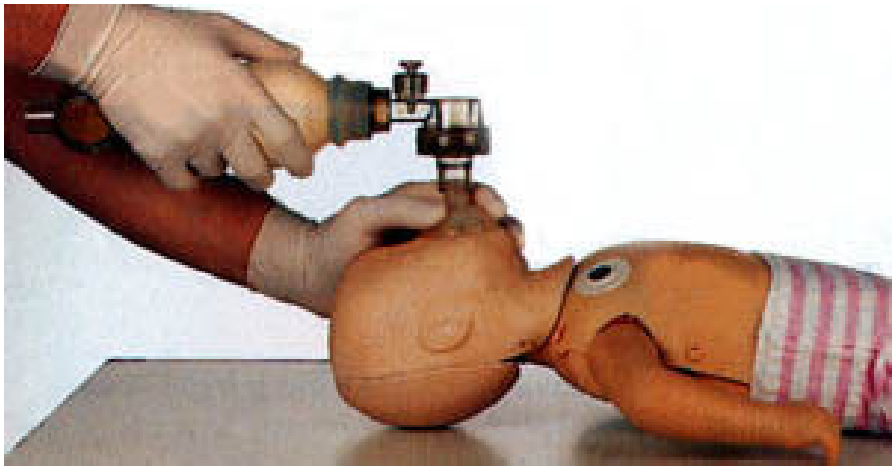
Oxygen Concentration achieved by ventilation devices

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

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

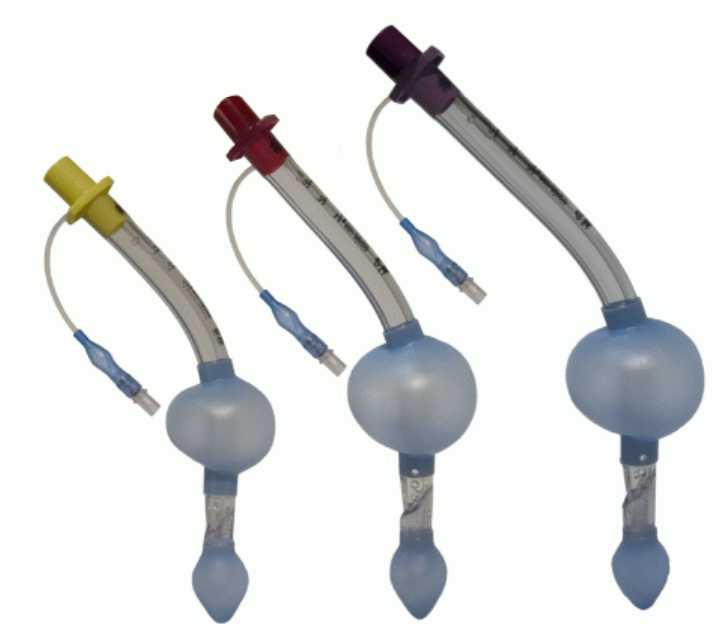
- Fast, easy insertion
- Laryngoscopy not needed
- VC visualization not needed
- Any patient position
- Minimal training
- Easy to stay proficient
- Avoids esophageal ventilation
- Rescue for failed intubation

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

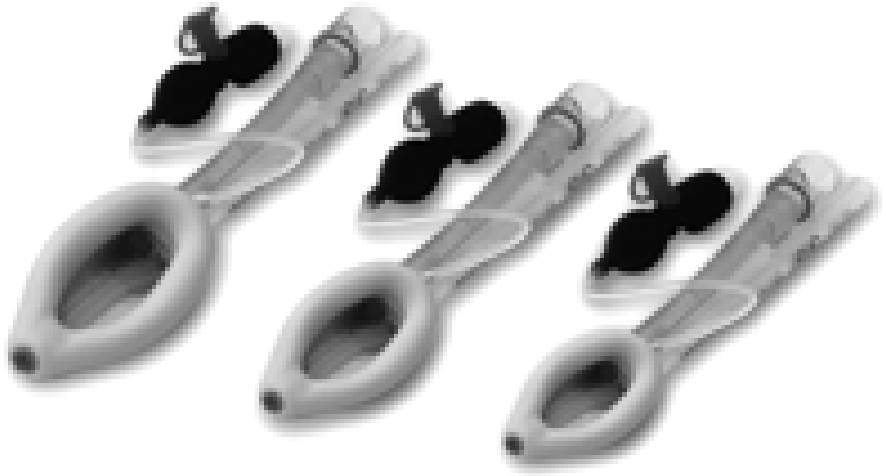
- Single lumen tube with interconnected distal and proximal cuff
- Sizes for all ages
- Easy to insert, minimal training
- May protect from aspiration
- Dual lumen for gastric drainage



Laryngeal Mask Airway

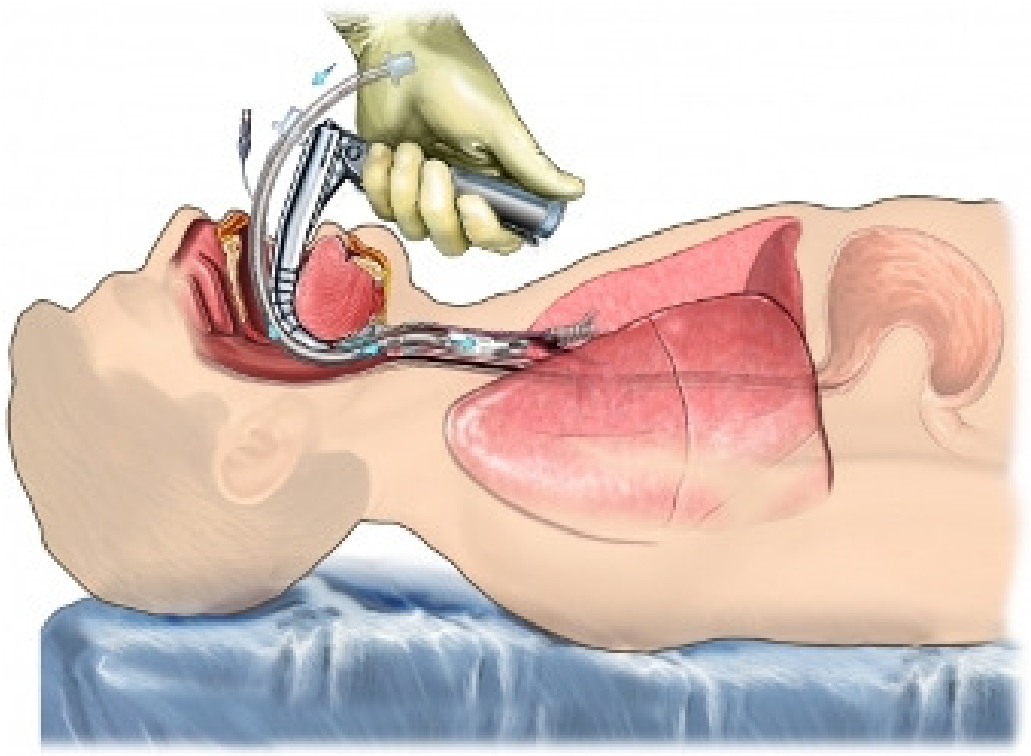
- Developed in 1980s for use during anesthesia
- Easy to insert, less training needed than ETI
- Does not protect against aspiration
- Cuff can leak at low pressures,
- Proseal (sizes 1.5, 2, and 2.5) less leak plus drainage tube

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

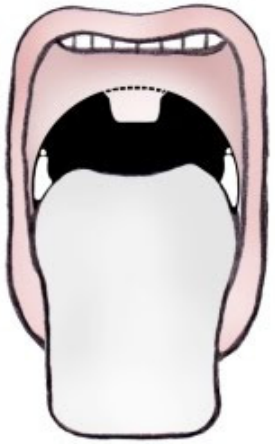
- Heavy mark(s) at cords
- Position tip 3 x I.D. from gums
- Depth (cm.) = 12 + (Age/2)
- Insert until R mainstem, then withdraw 2 to 3 cm.
- Bilateral breath sounds

Predicting Difficult Intubation

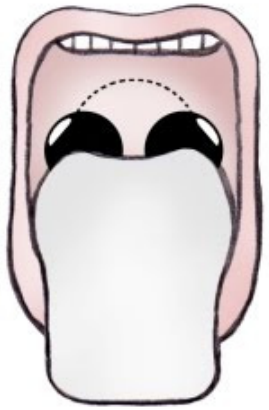
- Prominent upper incisors, overbite
- High arched palate
- Restricted temporo-mandibular joint movement
- Limited mouth opening
- Decreased submental space (< 6 cm for adults)
- Short, thick neck or immobility (e.g. C-spine precautions!)
- Hoarseness or stridor
- Obesity

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

Mallampati Exam

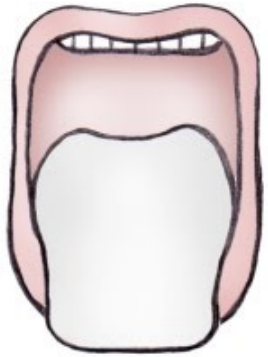


Class 1



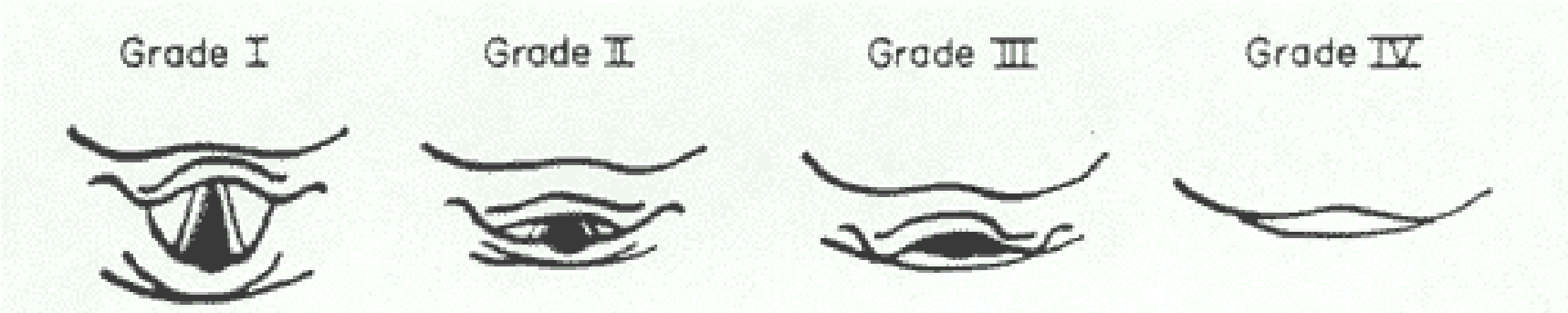
Class 2

Class 3



Class 4

Laryngoscopic Grading System Cormack and Lehane

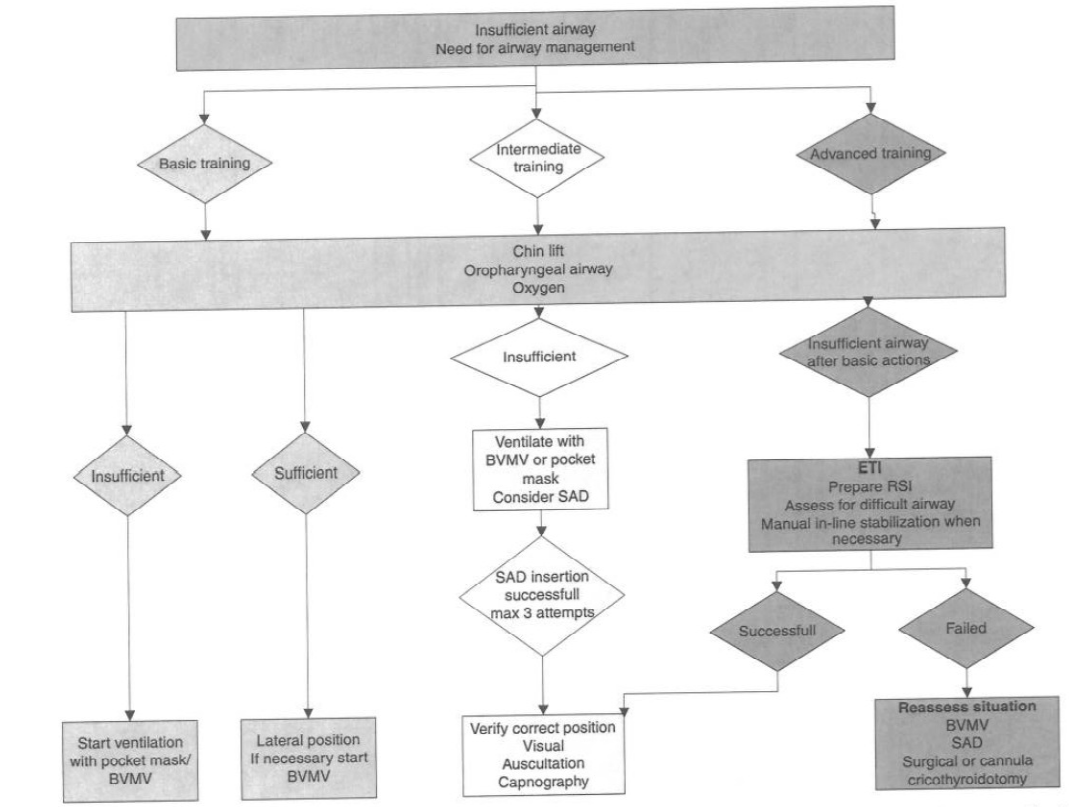


Does endotracheal intubation improve outcome after TBI?

- 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.



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