Pediatric Airway Management

Dr. Daryoush Sheikhzadeh

Goals

- Decision-making
- Basics
- Intubation
- Rescue devices
- Medications
- Ventilators
- Broselow

Decision-making

- What do I need to accomplish (why ETT)?
- How aggressive should I be (BLS vs. ALS)?
- What is my back-up plan?
- What is the long-term picture?

Reasons to Manage Airway

- Inadequate oxygenation
  - Low O_2
  - Pneumonia
  - CHF
- Inadequate ventilation
  - High CO_2
  - Asthma/COPD
- Inadequate protection
  - AMS
  - Airway trauma
- Anticipated course
  - Hematomas
  - Long transports

BLS vs. ALS

- We think intubation is easy
- We are not good at it
  - Prehospital success rate as low as 70%
- We can manage many patients with BLS

Who Should Be Intubated?

De-emphasized under new ACLS/PALS guidelines

For out-of-hospital cardiac arrest, bag-mask ventilation results in the same resuscitation outcomes as advanced airway interventions such as endotracheal intubation.

RSI can kill patient

Who Should Be Intubated?

- Gausche, et al in Los Angeles, 2000
  - Randomized trial comparing BVM, intubation
  - 830 patients under 12 years
- No difference in survival or neurologic outcome
- No difference in complication rate
  - 2% esophageal intubation all died
  - 14% tube dislodged (6% unrecognized)
  - 24% wrong sized tube

Should we be intubating ANY pediatric patients?!?!

Predicting the Difficult Airway

- Difficulty ventilating
  - Facial trauma
  - Obesity
  - Obstructions
  - Stiff lungs (asthma)
- Difficulty intubating
  - External factors (obesity)
  - Evaluate mouth opening
  - Obstruction
    - Smaller airways
  - Neck mobility (trauma)

The Debate on Prehospital Pediatric Intubation Continues…

Back-up Plan

- Can’t ventilate or basics not working
  - Consider adjuncts (OPA/NPA/positioning)
  - Intubation?
- Can’t intubate
  - Rescue devices
- Can’t rescue
  - Surgical procedure
- Okay to stick with basics if working

It’s Not Okay to Continue with Failed Techniques

Long-Term Issues

- Securing the tube
  - Tape vs. ties
  - Commercial devices
  - Restraints

Long-Term Issues

- Sedation
  - Agent and administration (drip vs. bolus)
  - Paralytics?
- Ventilator management
- What if the tube comes out?

Basics

- Positioning
- Adjuncts
  - OPA - good choice if tolerated
  - NPA - easy to tear mucosa
- Effective BVM use is most important skill
  - Get a good seal (two person better)
  - Don’t over ventilate
- Don’t forget the suction

Intubation - Preparation

- Preoxygenate
  - Monitors - ECG, pulse ox
  - Sellick's ?? (The routine use of cricoid pressure does not reduce the risk of regurgitation during bag-mask ventilation and may impede intubation success).
  - Good basics

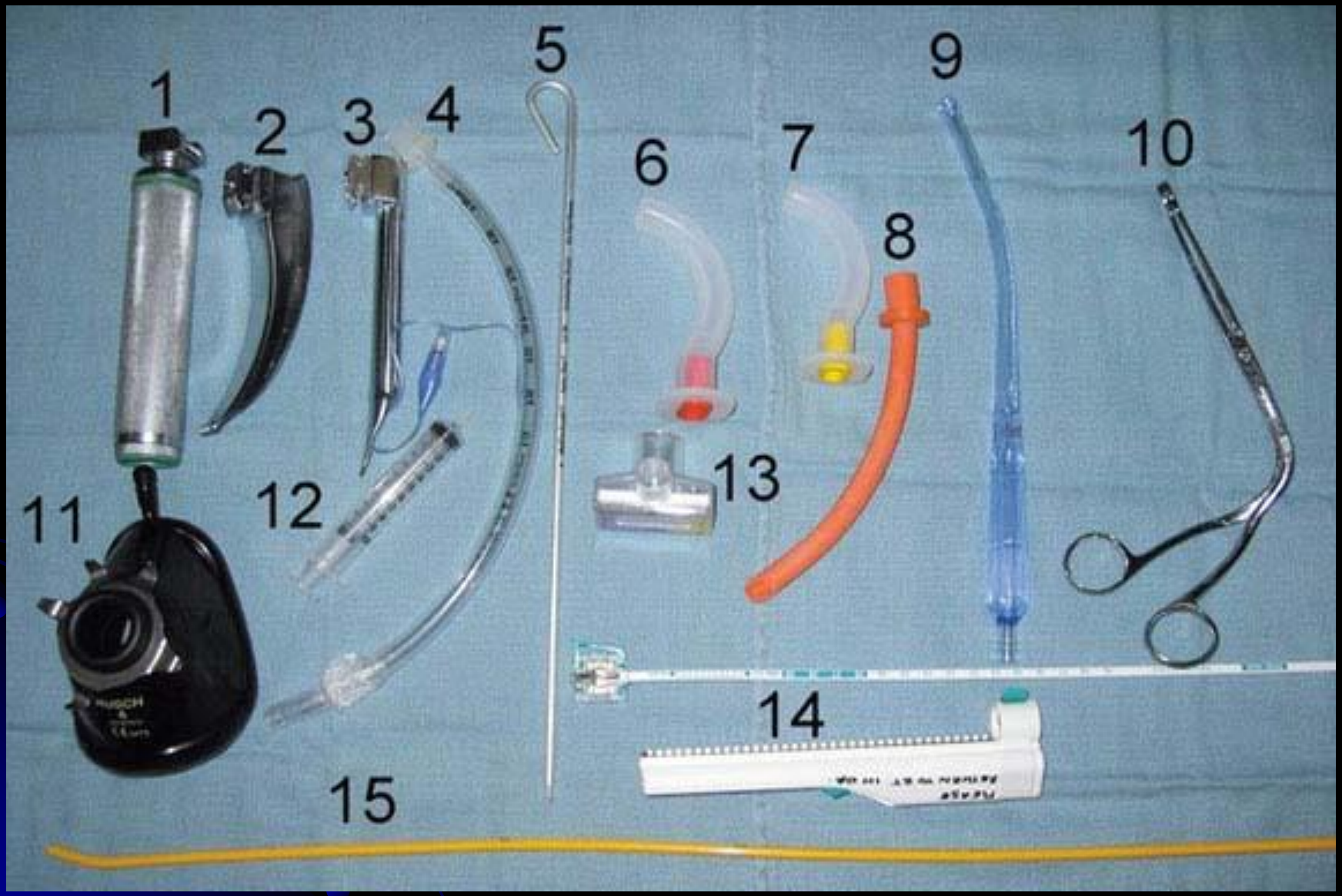
- Equipment selection
- Miller vs. Mac
- Cuffed vs. uncuffed
- ETT size
- Positioning

Airway Equipment

- Straight blade to age 2?
  - Better able to control epiglottis?
  - Choose for comfort
- Smaller tubes
  - Less stability
  - More resistance

Airway Equipment

- Suction
- Magill forceps
- Stylet
- Tube check and securing devices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1. Laryngoscope handle – an instrument used to visualize the larynx
2. Macintosh III laryngoscope blade
3. Miller laryngoscope blade
4. Cuffed endotracheal tube – a catheter that is placed inside the trachea to maintain a patent airway.
5. Stylet – a probe that assists with intubation
6. Large oral airway – a device that opens an airway by preventing the tongue from covering the epiglottis
7. Small oral airway – same as the large oral airway (but smaller)

8. Nasal airway – similar to the oral airway, but goes through the nose
9. Yanker suction tip – oral suctioning tool
10. McGill Forceps – aid passage of endotracheal tubes
11. Face mask
12. Syringe
13. Carbon dioxide detector
14. Tracheal light
15. Bougie – similar in function to a stylet but more elastic

Preparing for Intubation

- *Appropriate ETT for ≥1 yo: (age/4) + 4*

  Term infant: 3.0-3.5 ID

  6 mo: 3.5-4.0 ID

  1 yo: 4.0-4.5 ID

- *Cuffed ETT's decreases the need for endotracheal tube changes*

- *Remember SOAPME*

SOAPME

***S**uction equipment*

***O**xygen: O2 flowmeter, preoxygenate 2-3 min, manual resuscitator bag with mask*

***A**irway equipment: ETT, stylet, syringe (cuffed ETT), laryngoscope and blade, lubricating gel, OPA*

***P**osition, pharmacy, personnel: supine, rolls for positioning, bed height up*

***M**onitors*

***E**TCO2 detector*

Tube Size

- ETT size
  - (Age in years/4) + 4
  - Diameter of nare
  - Diameter of pinky
  - Broselow tape
  - Have one size smaller and larger

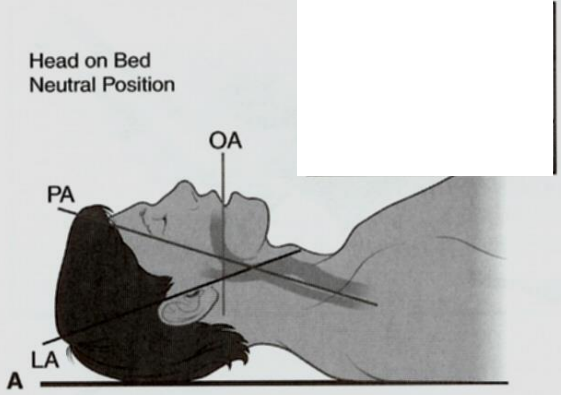
Tube Placement

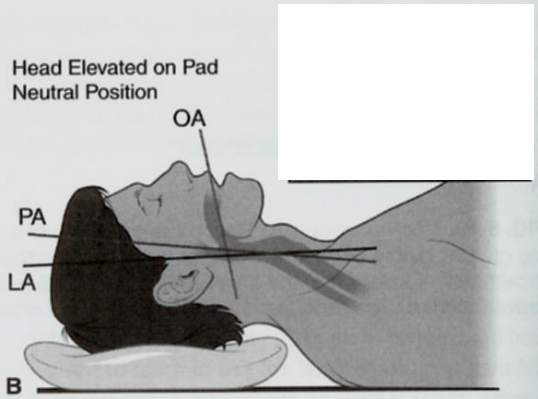
- ETT depth – use the black line
  - (Age in years/2) + 12
  - ETT internal diameter x 3

Intubation - Positioning

- Goal is to align three axes
  - OA/PA/LA
- Medical positioning
  - Head tilt chin lift
  - Towels (older = head, younger = shoulders)
- Trauma positioning
  - Manual in-line stabilization

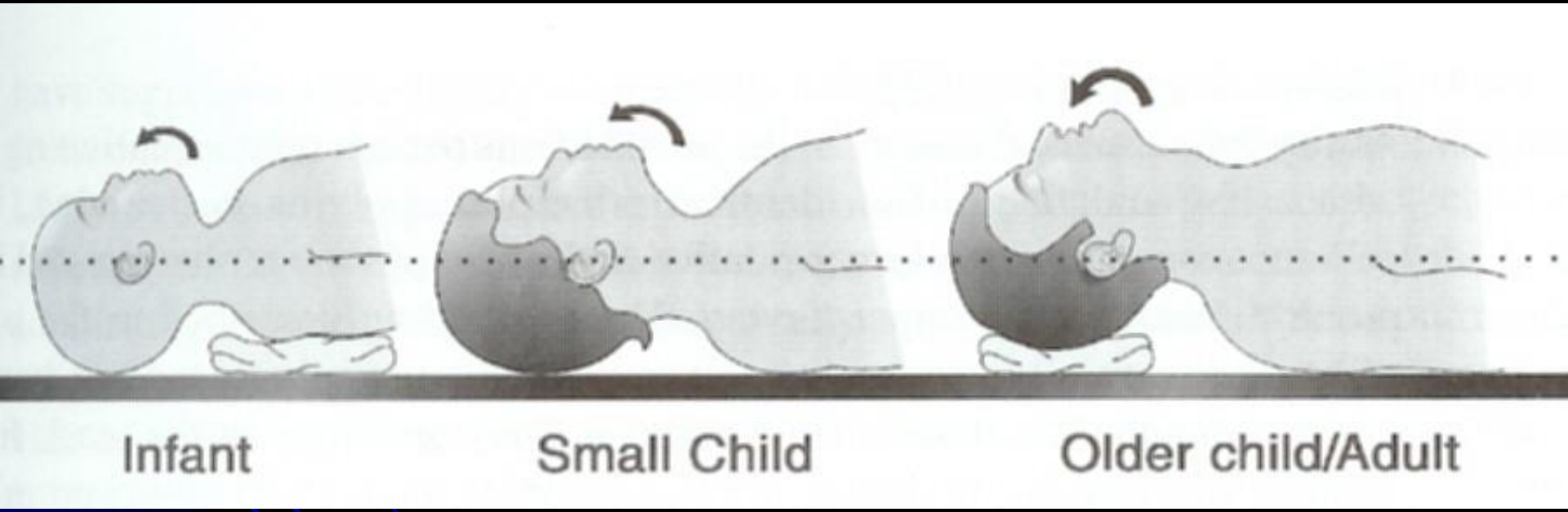
Positioning- Medical vs. Trauma





Adapted from Walls et al. Manual of Emergency Airway Management. 2nd Ed. 2004.

Positioning



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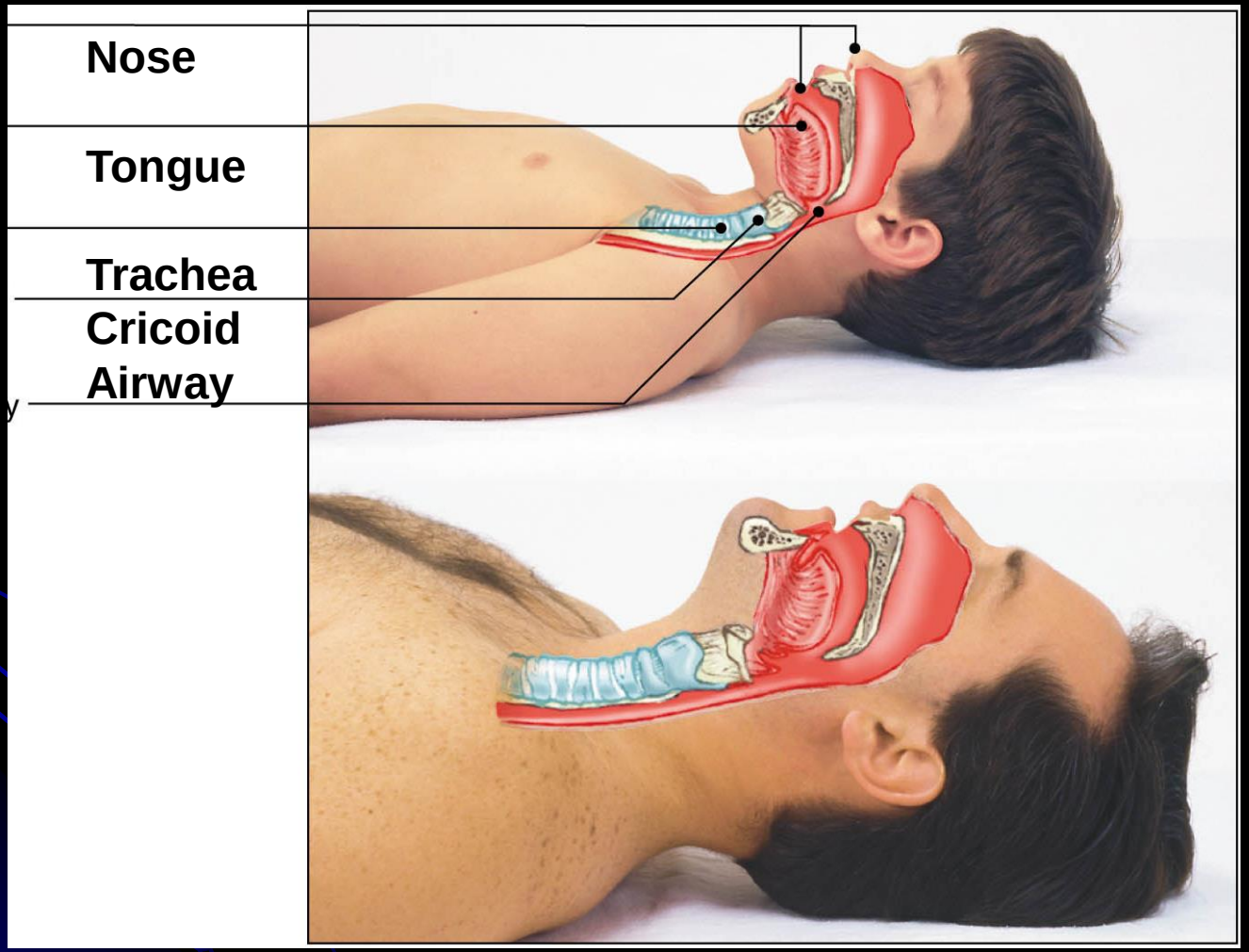
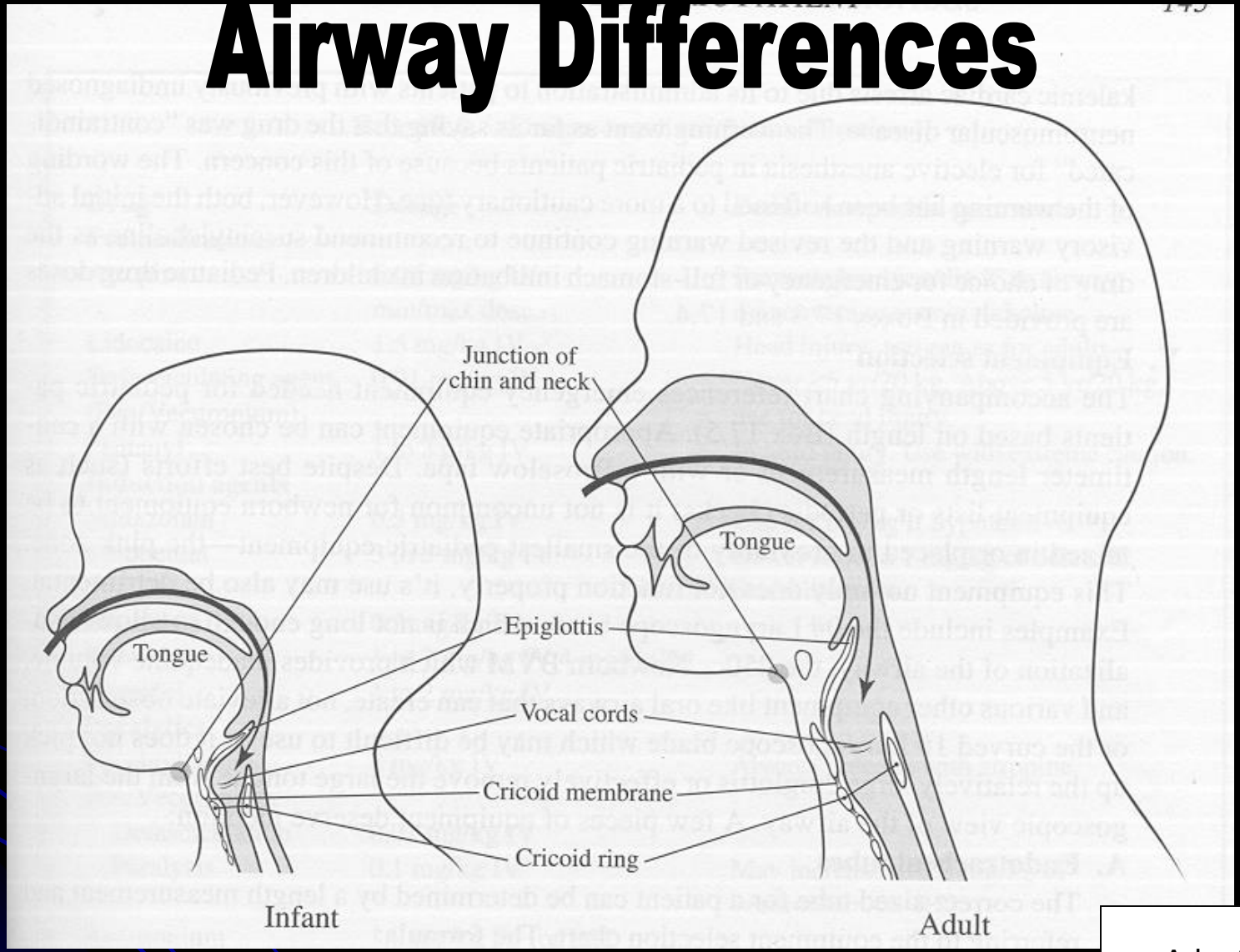
Intubation - Approach

- Remember, much different than adults
- Externally
  - Larger head/occiput
  - Head flexes forward and can obstruct
- Internally
  - Larger tongue
  - Friable tissues
  - Different angles and shapes

Airway Differences



Airway Differences



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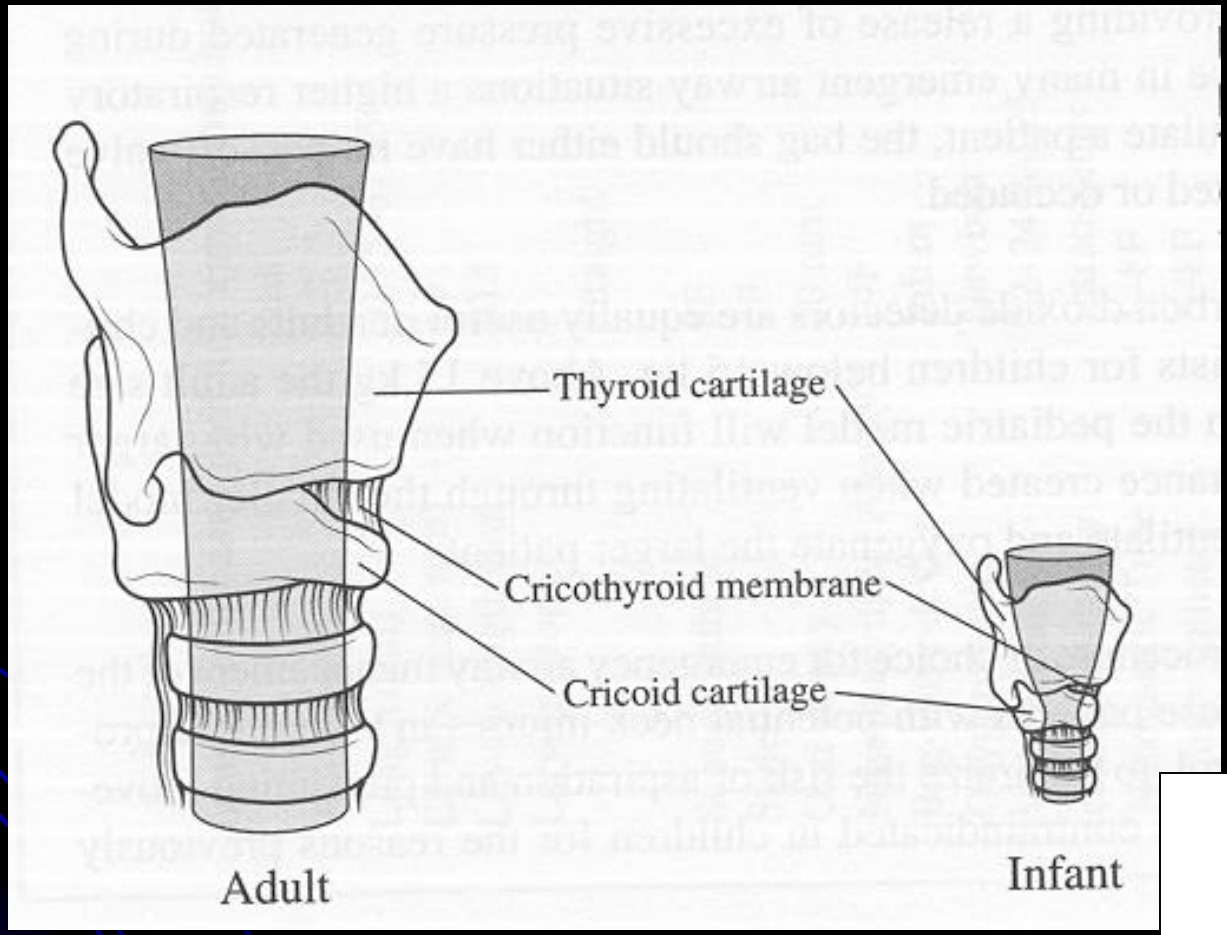
Airway Shape



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Intubation - Approach

- Further differences
  - “Pinker” vocal cords worsen visualization
  - Different location of narrowest point
    - More precise ETT choice
    - Air leak vs. trauma/stenosis
    - Peds cuffed tubes?
  - Smaller cricothyroid membrane
    - No surgical crics in children
    - Needle crics difficult

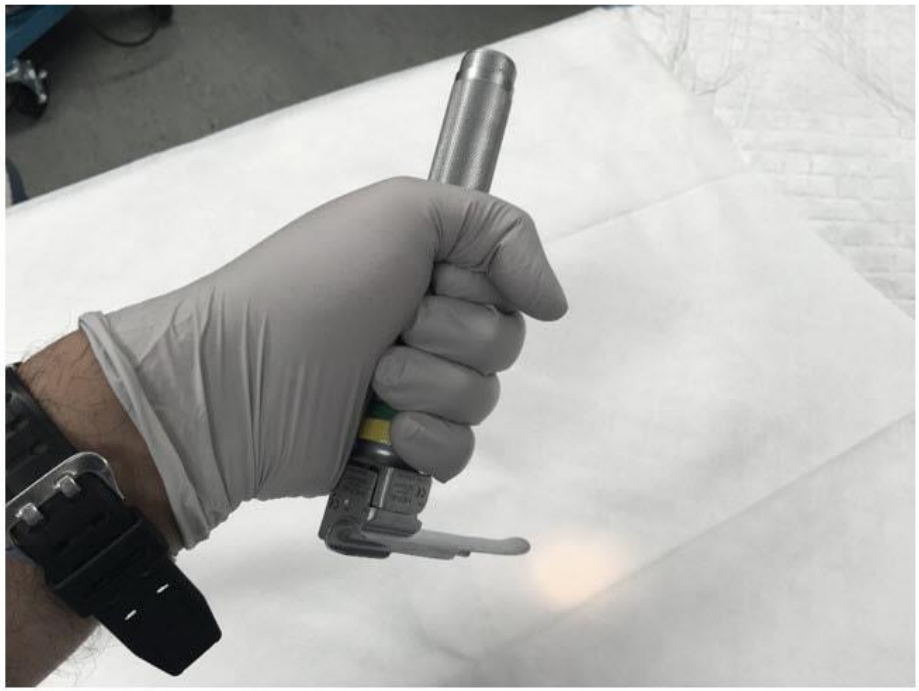
Other Considerations

- More gastric insufflation with BVM
- Different oxygenation abilities
  - Higher basal usage
  - Less residual lung capacity
  - Quicker desats during intubation
    - 10 kg to 90% in <4 minutes (vs. 8 for adult)
- More likely to have vagal response

Intubation - Techniques

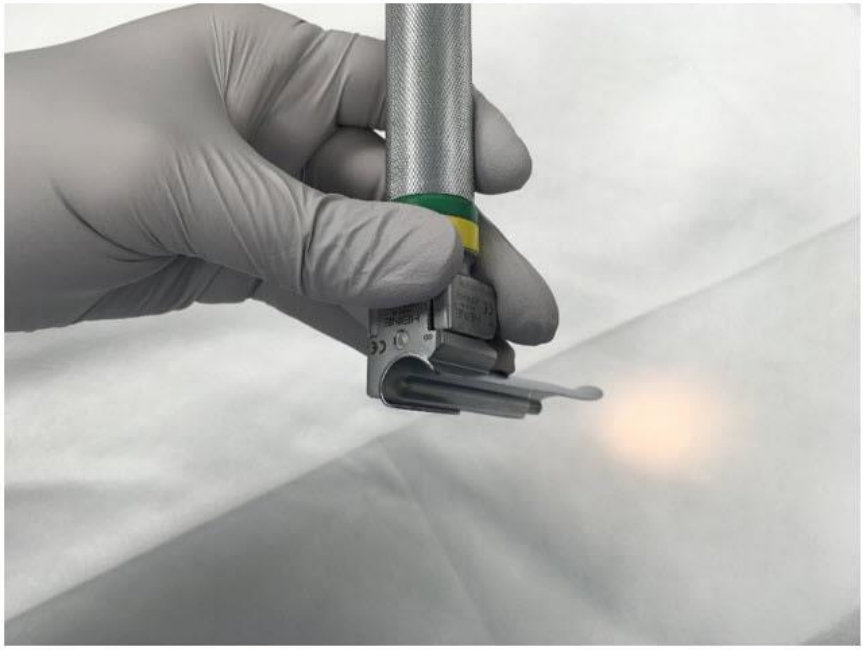
- Always enter from the right corner
- Tongue control is critical
- Lift the epiglottis with the Miller
- Slide the Mac into the vallecula
  - Can lift the epiglottis if needed

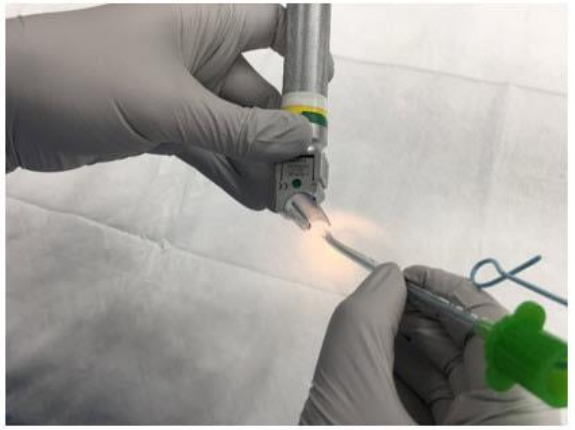
The classic technique using the full grip of the handle DOES NOT afford precise control



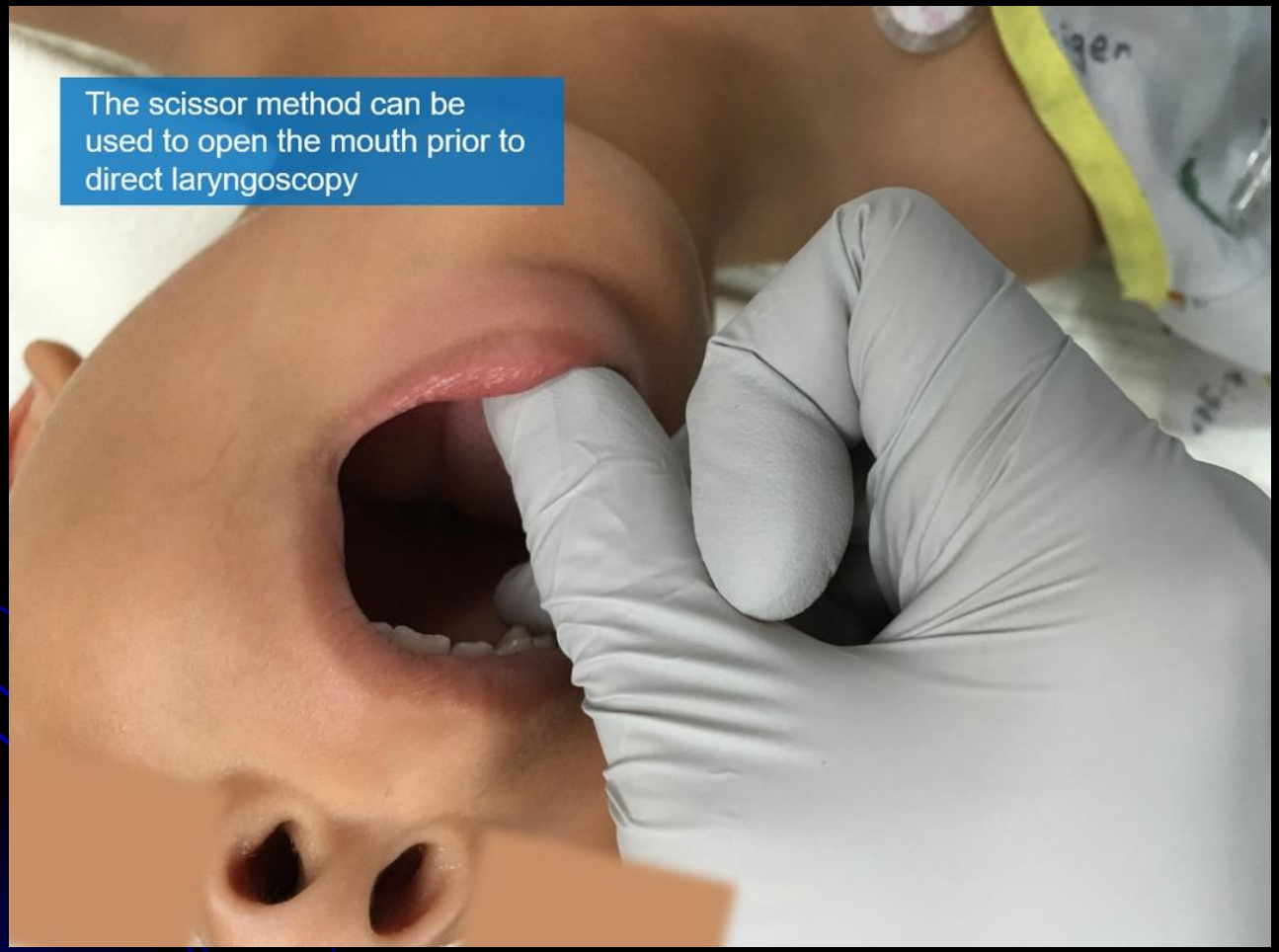
A better way to hold the laryngoscope!

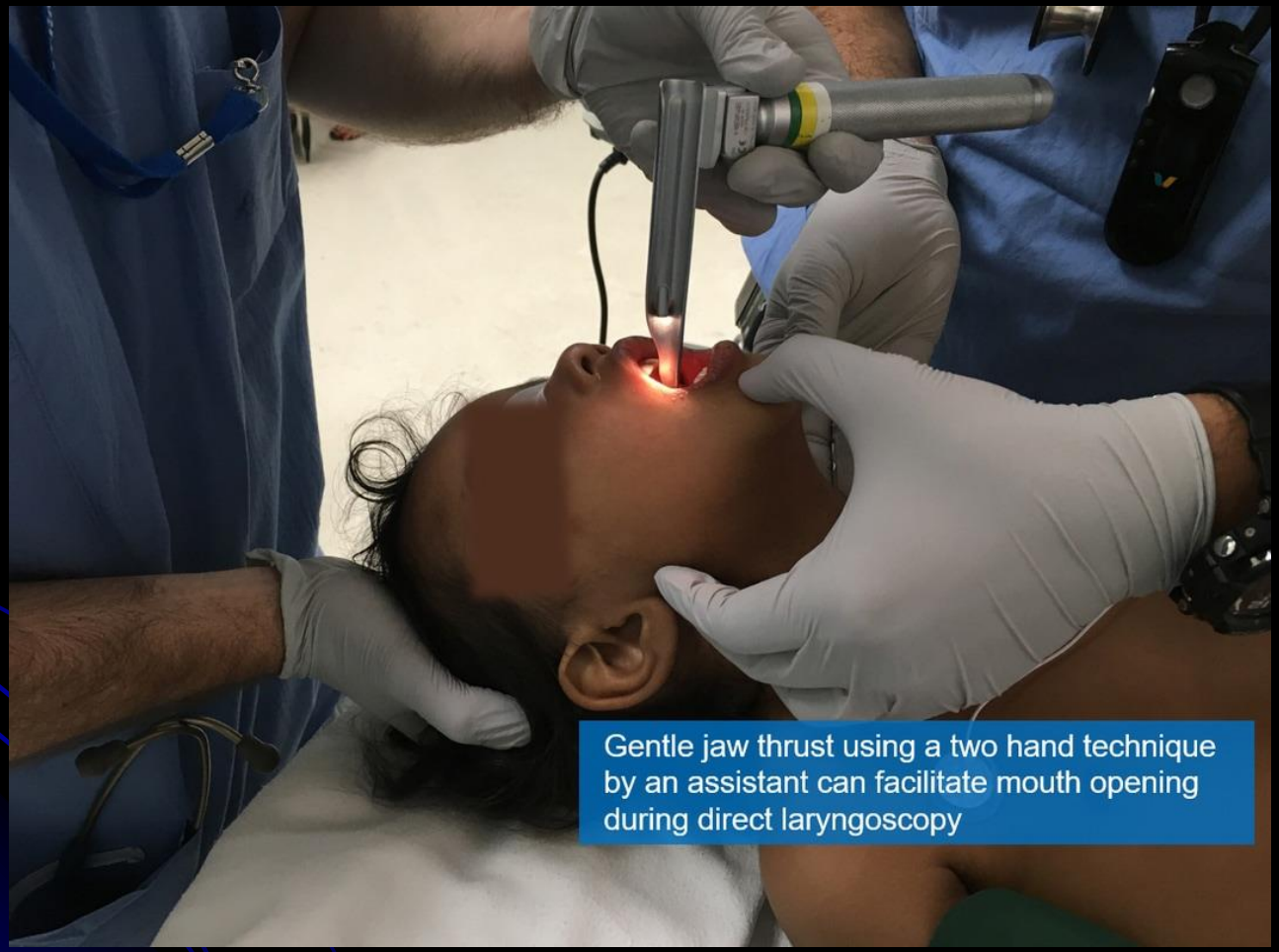
Grasping the handle near the hinge as shown with the thumb stabilizing the base of the blade affords better precision and control.

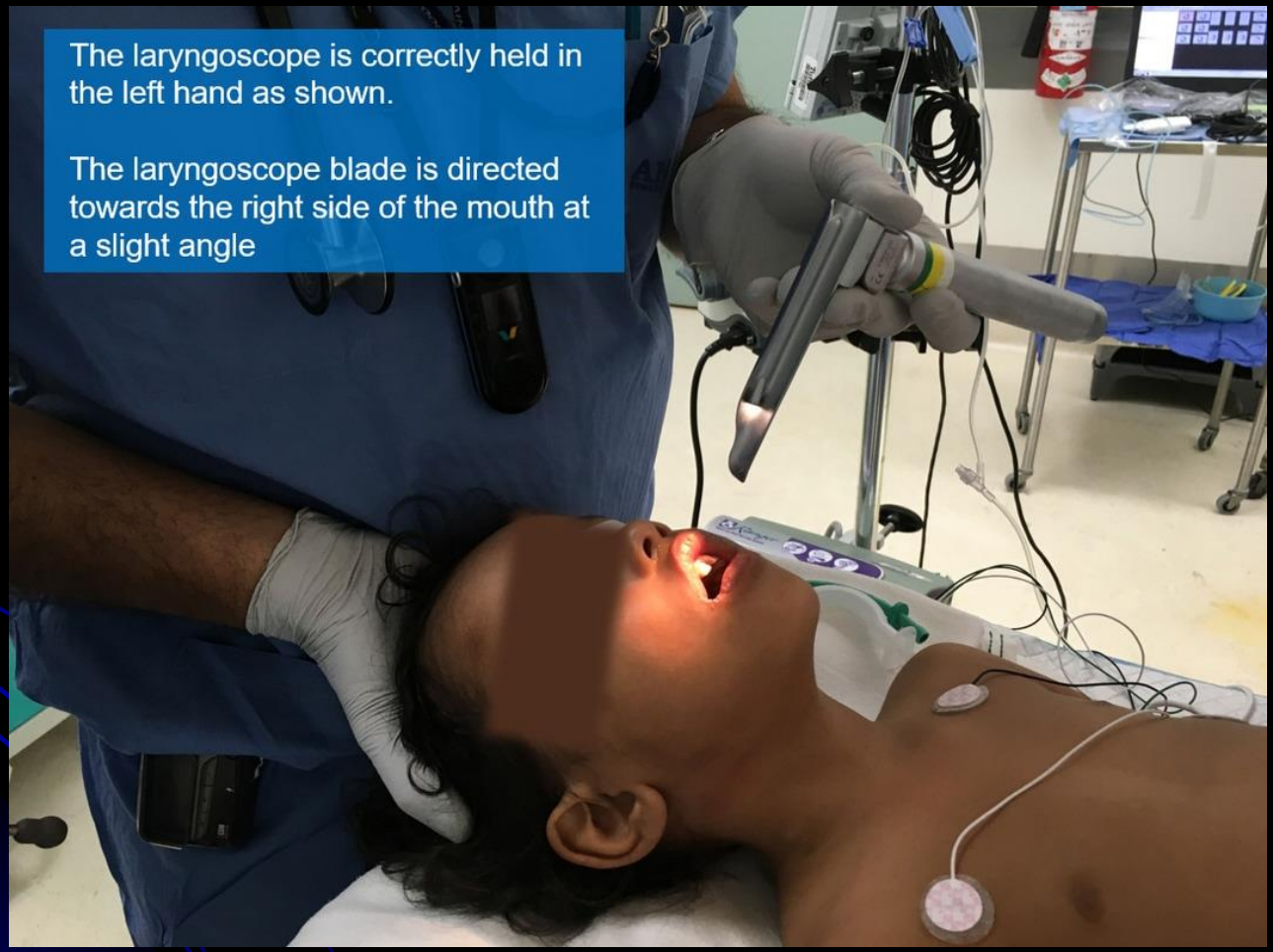




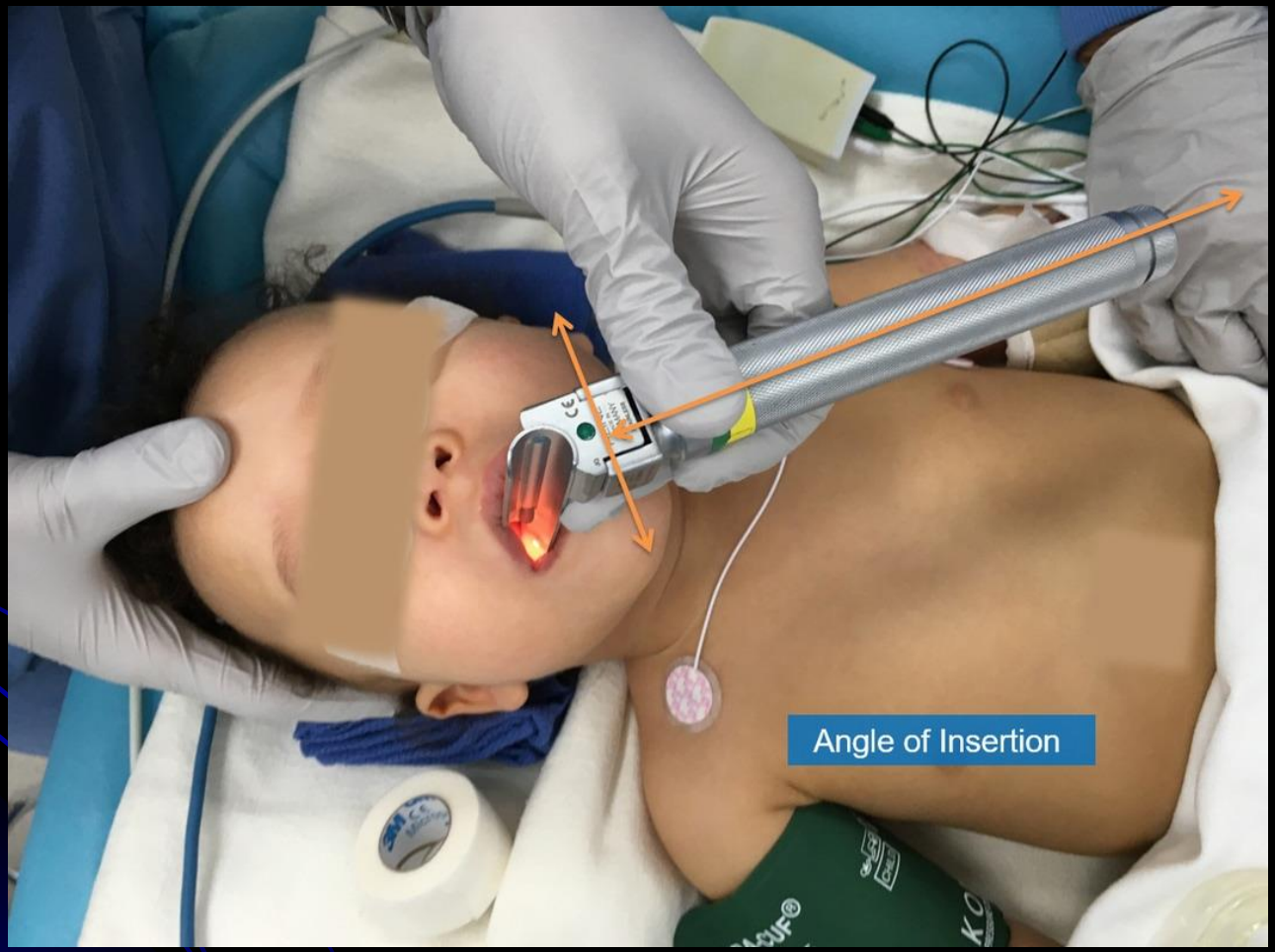

Gentle neck extension is generally all what is required to open the mouth during direct laryngoscopy

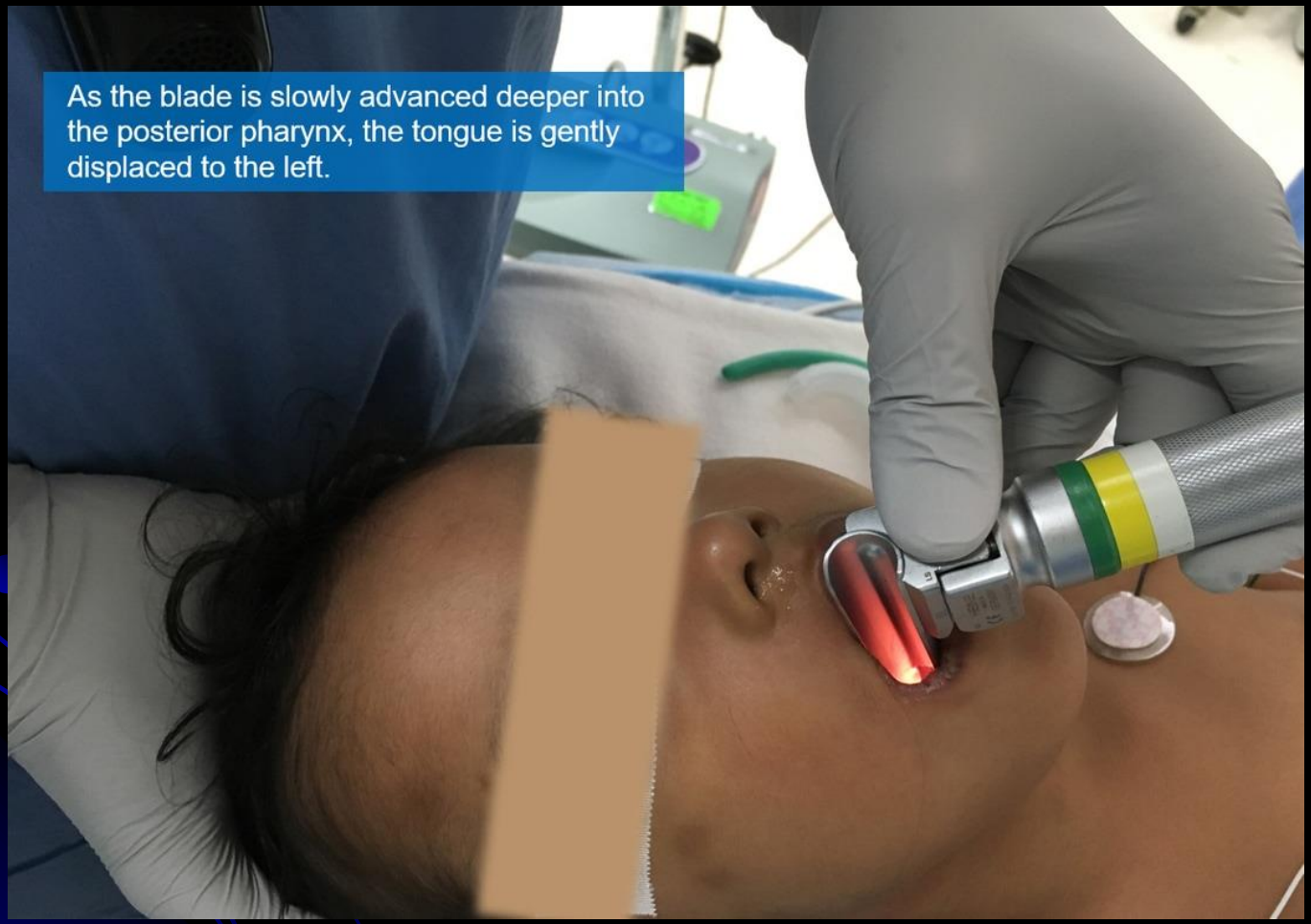

The scissor method can be used to open the mouth prior to direct laryngoscopy

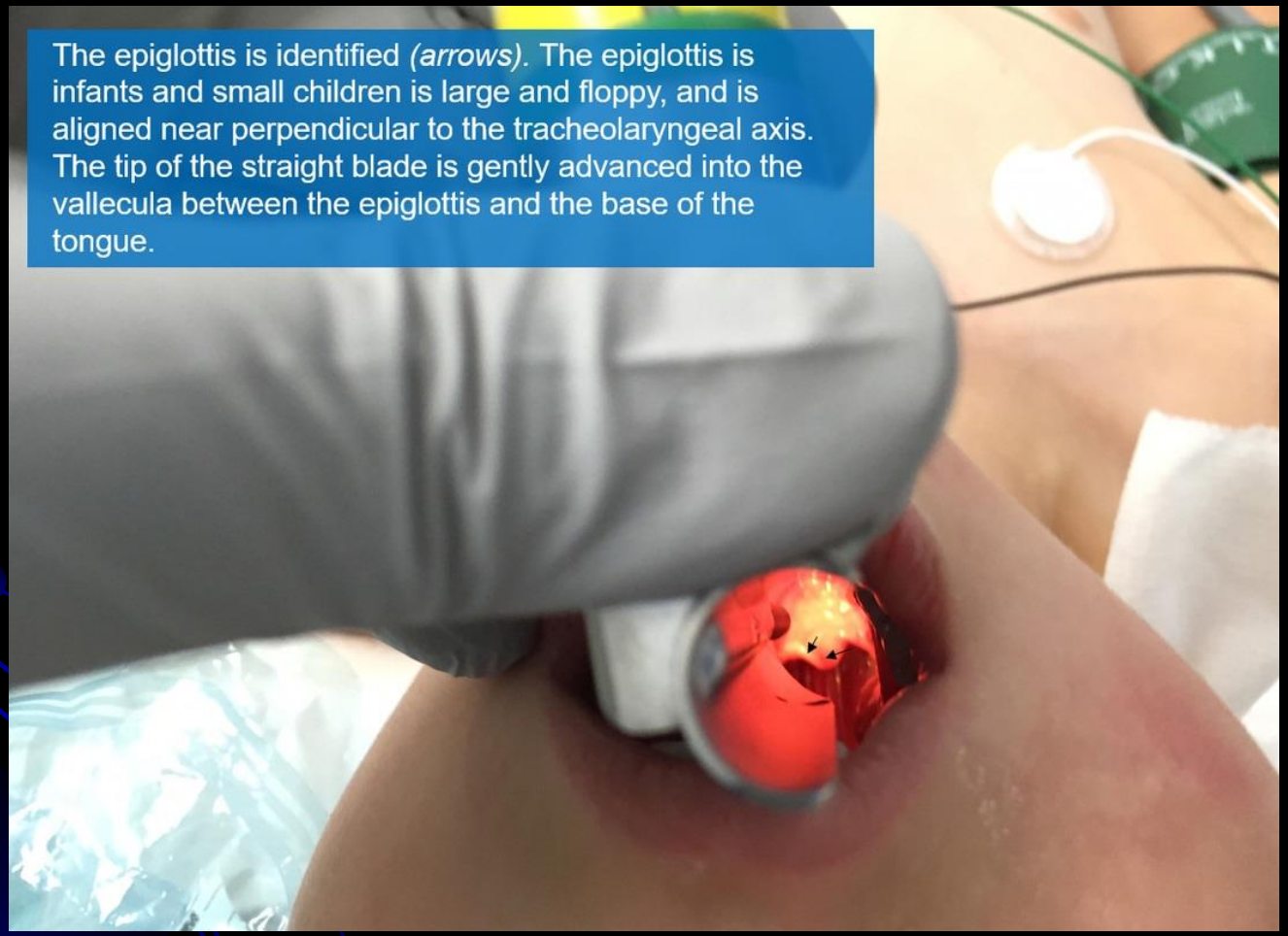

Gentle jaw thrust using a two hand technique by an assistant can facilitate mouth opening during direct laryngoscopy


The laryngoscope is correctly held in the left hand as shown.
The laryngoscope blade is directed towards the right side of the mouth at a slight angle

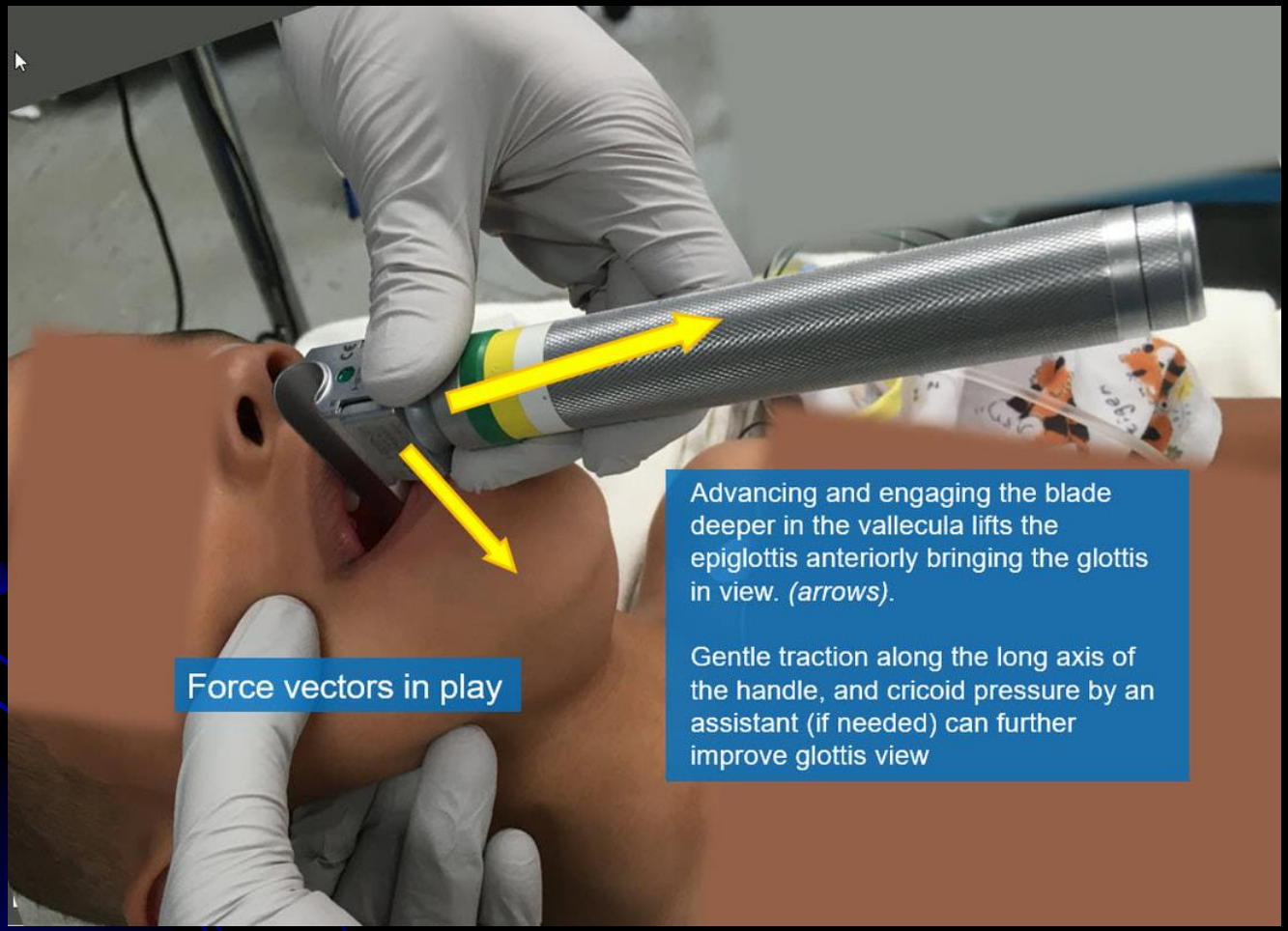

A straight blade is gently inserted along the right side of the mouth at a slight angle.

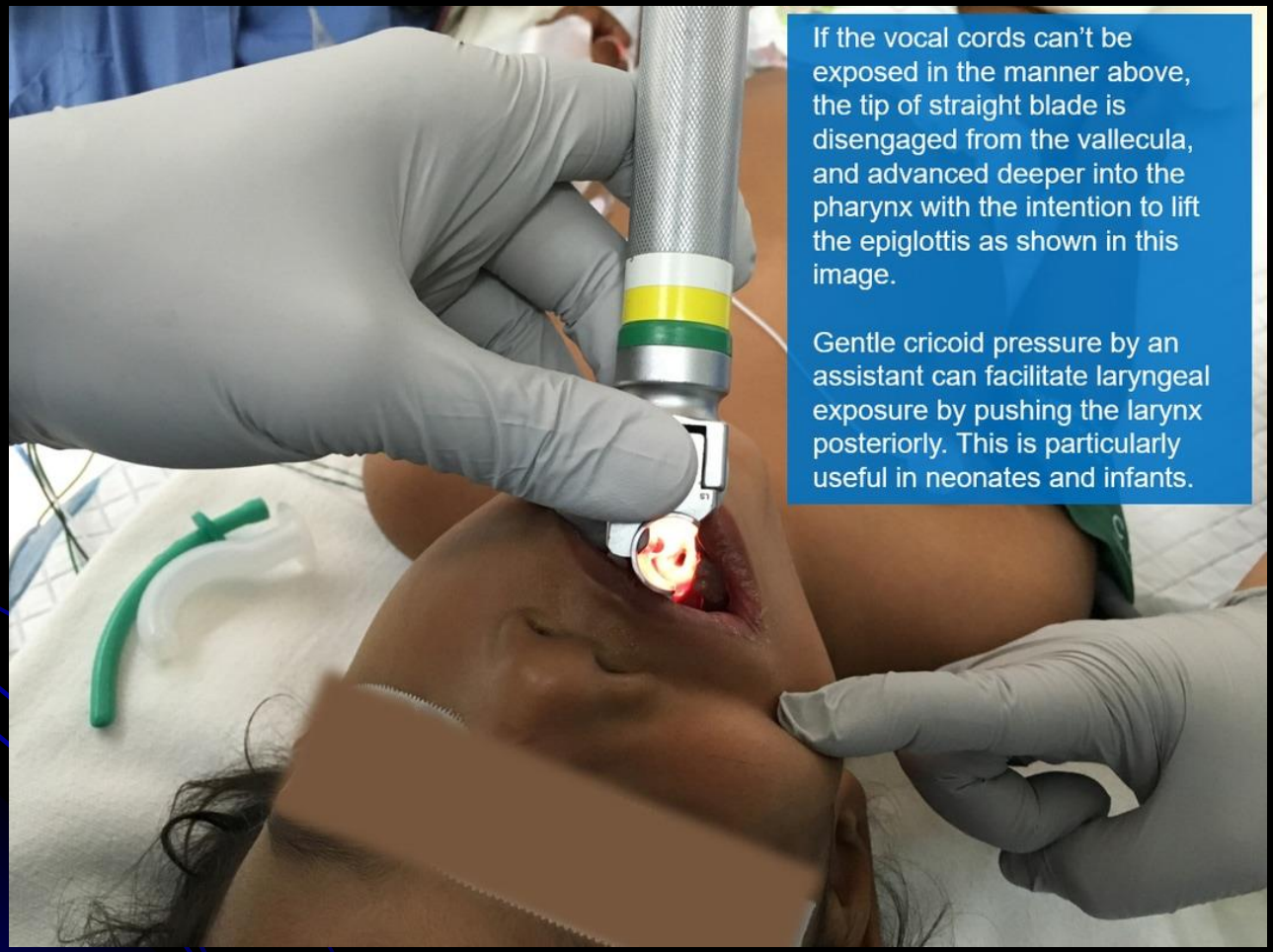

Angle of Insertion


As the blade is slowly advanced deeper into the posterior pharynx, the tongue is gently displaced to the left.


The epiglottis is identified *(arrows)*. The epiglottis is infants and small children is large and floppy, and is aligned near perpendicular to the tracheolaryngeal axis. The tip of the straight blade is gently advanced into the vallecula between the epiglottis and the base of the tongue.

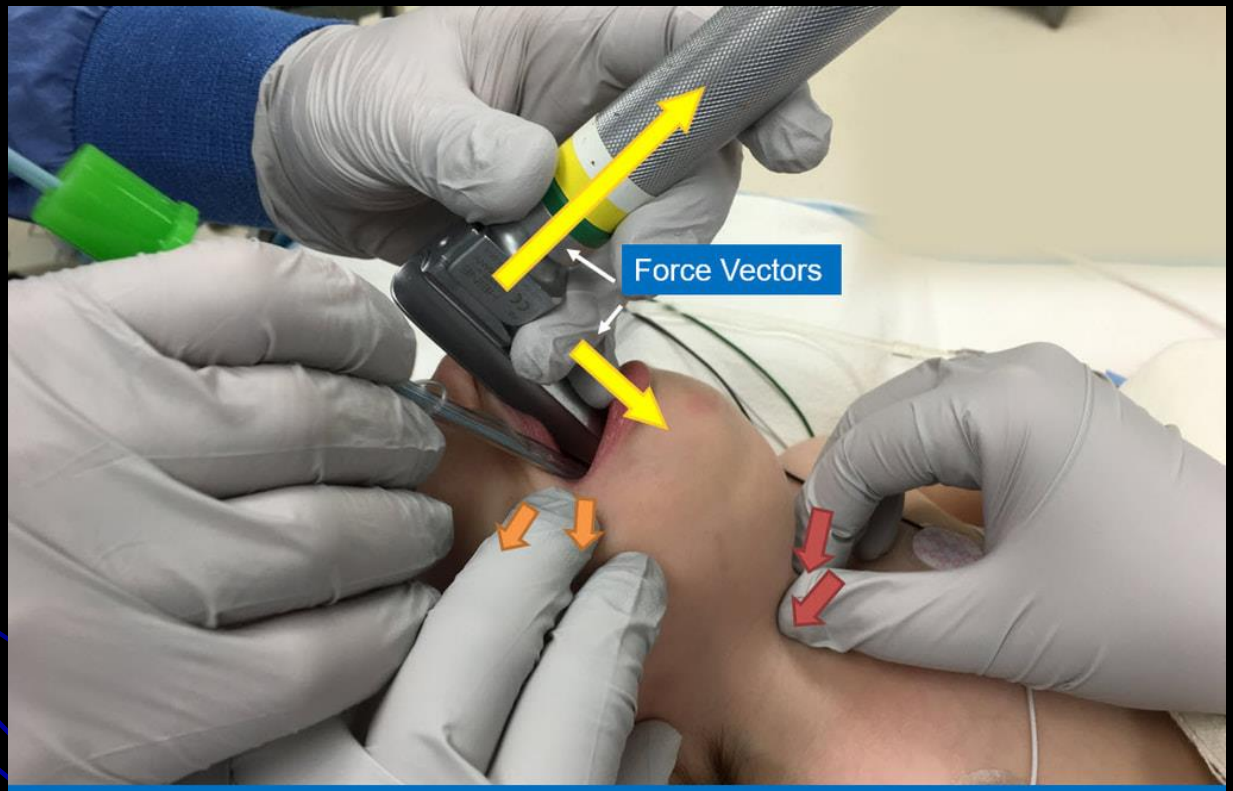
This image demonstrates the INPROPER way to insert a laryngoscope blade into the mouth. Notice how the tongue is being displaced to the right side of the blade. The bulging tongue can significantly hamper visualization of the glottic structures


Force vectors in play
Advancing and engaging the blade deeper in the vallecula lifts the epiglottis anteriorly bringing the glottis in view. *(arrows)*.
Gentle traction along the long axis of the handle, and cricoid pressure by an assistant (if needed) can further improve glottis view

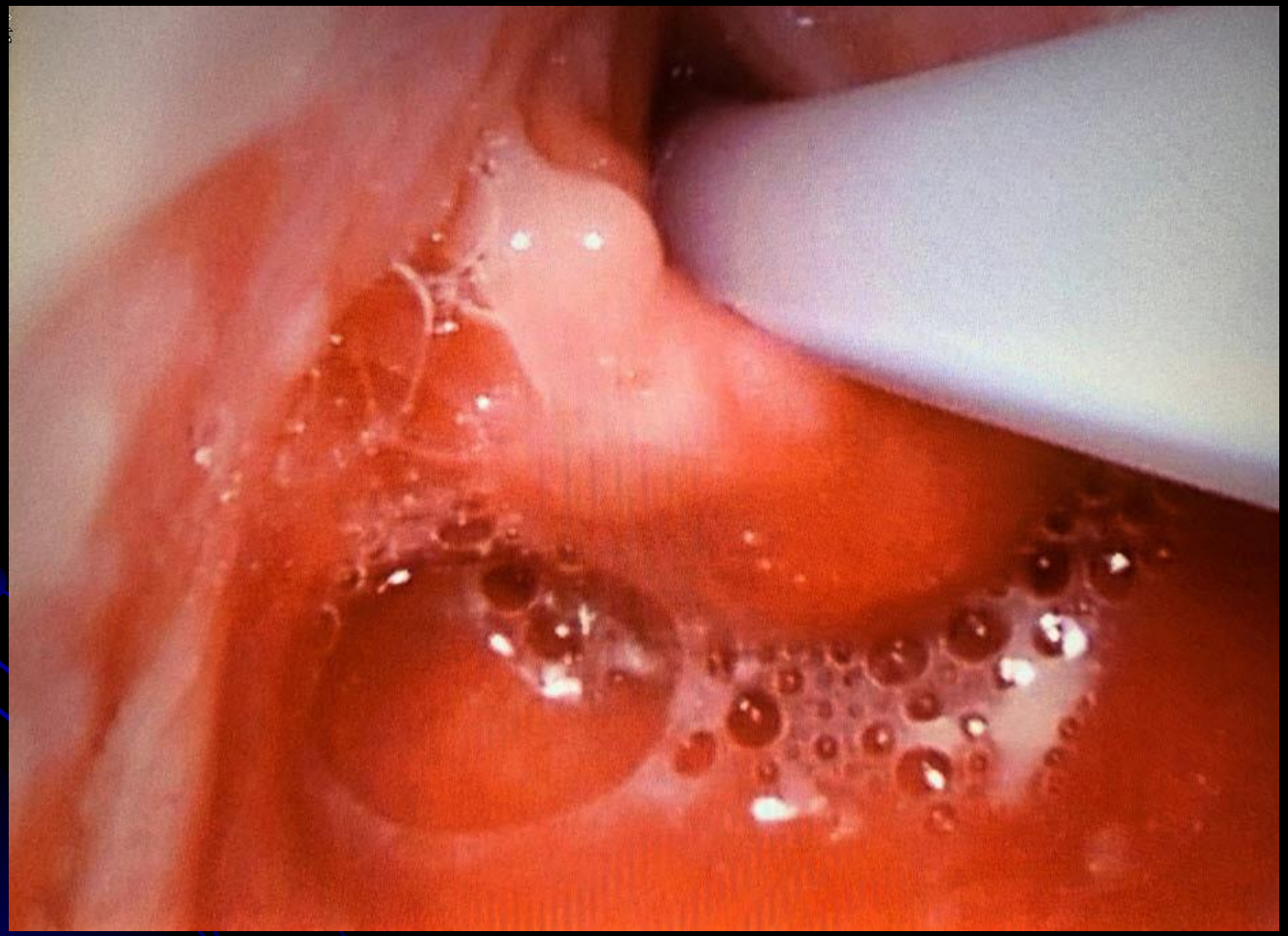


If the vocal cords can't be exposed in the manner above, the tip of straight blade is disengaged from the vallecula, and advanced deeper into the pharynx with the intention to lift the epiglottis as shown in this image.

Gentle cricoid pressure by an assistant can facilitate laryngeal exposure by pushing the larynx posteriorly. This is particularly useful in neonates and infants.



The ETT is advanced into the mouth at an angle from the side along the groove of the blade. Gentle traction to the right angle of the mouth *(orange arrows)* by an assistant can improve view and facilitate passage of the ETT. Gentle cricoid pressure by an assistant *(red arrows)* can also improve glottic view.



Intubation - Trouble-shooting

- Can’t see the cords
  - Look for landmarks
  - Control the tongue
  - BURP maneuver if epiglottis seen
- Another attempt needed (limit number)
  - Reposition
  - Change something (blade, tube)
- Avoid hypoxia

Blind Techniques

- Exist but need practice for proficiency
- Digital intubation
  - Small work area
- Blind nasotracheal intubation
  - Tough angles for tube placement
  - Remember anatomic differences
  - Contraindicated until >10 years old

In general, blind techniques not useful in children

Intubation - Confirmation

- Visualize tube passing through cords
- Breath sounds and epigastric sounds
- End Tidal CO_2 ($ETCO_2$)
- Commercial devices
  - Not effective on uncuffed tubes
  - Be careful if used in children

REMINDER:
It's Not Okay to Continue with Failed Techniques

Rescue Devices

- LMAs (laryngeal mask airway)
- I-LMAs (intubating LMA)
- Combitube
- Bougie
- Pick one or two and practice
  - Need to be comfortable before crisis

LMA

- Used in any age
- Easy to place
- Few complications
- Contraindications:
  - Gag reflex
  - FBs
  - Airway obstruction
  - High ventilation pressure
- Does not secure airway

LMA Sizing

LMA Size	Patient Size
1	Neonate / Infants < 5 kg
1 ½	Infants 5-10 kg
2	Infants / Children 10-20 kg
2 ½	Children 20-30 kg
3	Children/Small adults 30-50 kg
4	Adults 50-70 kg
5	Large adult >70 kg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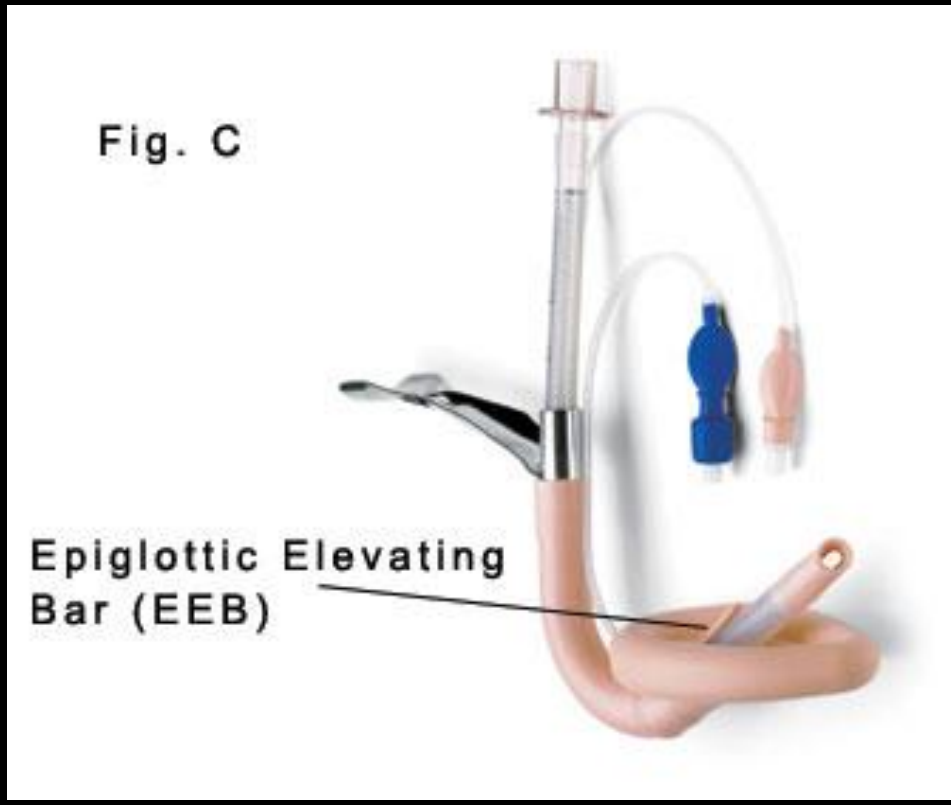
I-LMA

- Only sizes 3, 4, 5
- Same rules and sizing as LMA
- Need special armored tube for intubation
- New similar devices exist
- Leave LMA portion in place in field



Combitube

- Two sizes
  - Small (4 to 5.5 feet tall)
  - Regular (over 5.5 feet tall)
  - Not useful in most kids
- Easy to place
- Contraindications
  - Gag reflex
  - Esophageal disease
  - Caustic ingestions
  - FBs/Airway obstruction

Bougie

- Replaces stylet
- Able to use with poor view
  - Feel tracheal rings
  - Feel carina
- Intubate over it
  - Keep blade in place
  - Two person technique
- Need to practice

Other Toys

- Lighted stylet
- Flexible fiberoptic scopes
- Rigid fiberoptic scopes
  - Bullard
  - Shikani
- Video laryngoscopy

Surgical Airways - Cricothyrotomy

- Indications (only if >10 years old)
  - Failed airway
  - Failed ventilation
- Predictors of difficulty
  - Previous neck surgery
  - Obesity
  - Hematoma or infection

Cricothyrotomy - Techniques

Open

- Locate CTM
- Stabilize larynx/prep
- Incise skin
  - Vertical
  - Horizontal through CTM
- Insert spacer/dilator
- Insert cuffed tube
- Check breath sounds

Closed

- Locate CTM
- Stabilize larynx/prep
- Insert needle
  - Direct inferiorly
  - Insert guidewire
  - Remove needle
- Small skin incision
- Insert dilators/UC tube
- Check breath sounds

Cricothyrotomy - Complications

- Bleeding
- Laryngeal or tracheal injury
- Infection
- Pneumomediastinum
- Subglottic stenosis

Surgical Airways - Needle Cric

- Same indications (all ages, tougher if young)
- Must use with TTJV (jet ventilator)
  - Cannot use with superior airway obstruction
- Similarly difficult patients

Needle Cricothyrotomy - Procedure

- Identify CTM and stabilize/prep larynx
- Insert needle on syringe, direct inferiorly
  - Large bore needle (12-16 gauge)
  - Catheter over needle
- Advance catheter
- Connect to TTJV (BVM for infants - 3.0 ETT)
  - Oxygen pressure (20-30 psi)
  - 1 second on/2-3 seconds off

Needle Cricothyrotomy - Complications

- Similar complications to other crics
  - Pneumothorax/subcutaneous emphysema
  - Barotrauma
  - Esophageal injury
  - Obstruction

TTJV

What About RSI?

Rapid Sequence Intubation

- Does increase intubation success
- You stop intrinsic breathing
  - You can kill them
- Little place for peds in prehospital setting

RSI Medications

- Same as adults
  - Lidocaine
  - Etomidate
  - Succinylcholine
  - Vecuronium
- Remember atropine
- Consider ketamine

Pretreatment - Lidocaine

- Mechanism: Decrease ICP, bronchospasm
- Indications: Asthma, head injury
- Contraindications: Allergy
- Dosage: 1.5 mg/kg 3 minutes before ETT

Pretreatment - Atropine

- Mechanism: Blunt vagal response
  - Prevent bradycardia from intubation
  - More prevalent in children
- Indications: All children <10 years old
- Contraindications: Allergy
- Dosage: 0.02 mg/kg 3 minutes before ETT

Induction - Etomidate

- Mechanism: Hypnotic, not analgesic
  - Most hemodynamically stable
  - Inhibits excitation
- Indications: All inductions
  - Less protection from bronchospasm
  - No ICP issues
- Contraindications: None (careful in shock)
- Dosage: 0.3 mg/kg for induction (15-45 sec)

Induction - Ketamine

- Mechanism: PCP derivative
  - Analgesia, anesthesia, amnesia
  - Little respiratory or hemodynamic effect
  - Increases cerebral oxygen demand
- Indications: RAD, children?, hemodynamics
- Contraindications:
  - Elevated ICP (worsens)
  - Re-emergence in adults (hallucinations)
- Dosage: 1-2 mg/kg for induction (45-60 sec)

Paralysis - Succinylcholine

- Mechanism: Depolarizing agent
  - Binds to NMJ and fires
- Indications: Paralysis w/ fasciculation
- Contraindications/Complications:
  - Hyperkalemia (Burns, crush, renal failure)
  - Increased ICP, globe injury
  - Prolonged blockade, MH
- Dosage: 1.5-2 mg/kg (2 for younger)
  - Rapid onset, brief duration (30 secs – 4 min)

Paralysis - Vecuronium

- Mechanism: Nondepolarizing agent
  - Competitive blockade at NMJ
- Indications:
  - Pretreatment before SCh (no fasciculations)
  - Paralysis
- Contraindications: None (difficult airway)
- Dosage: 0.1-0.15 mg/kg in 90-120 secs
  - Lasts 60 minutes
  - 1/10th dose for pretreatment

Last but not least…

Broselow Tape

- Lubitz, et al. (1998)
- Most accurate 3.5 - 25 kg
- More accurate than RN or MD
- 94% vs 63%

Broselow Tape

- Rowe, et al. (1998)
- Calculation error rate 3%
- Recheck increases to 10%
- Under stress, up to 25%

Broselow Tape

- Equipment sizes
  - Airway adjuncts
  - Intubation equip
  - Oxygen delivery
  - Vascular access
  - Defibrillation
  - NGT, suction caths
  - BP cuff
  - Chest tubes
  - Foley
- Medications
  - Antiarrhythmics
  - Arrest medications
  - Anticonvulsants
  - Overdose meds
  - Increased ICP meds
  - Induction agents
  - Paralytics
  - Vasopressors
  - IV drips

Broselow Tape

Pediatric Resuscitation Supplies* Based on Color-Coded Resuscitation Tape

Equipment	Newborn/ Small infant (3-5 kg)	Infant (6-9 kg)	Toddler (10-11 kg)	Small Child (12-14 kg)	Child (15-18 kg)	Child (19-22 kg)	Large Child (24-30 kg)	Adult (≥32 kg)
Resuscitation bag	Infant	Child	Child	Child	Child	Child	Child/adult	Adult
O_2 mask	Newborn	Newborn	Pediatric	Pediatric	Pediatric	Pediatric	Adult	Adult
Oral airway	Infant/small child	Infant/small child	Small child	Child	Child	Child/small adult	Child/small adult	Medium adult
Laryngoscope blade (size)	0-1 straight	1 straight	1 straight	2 straight	2 straight or curved	2 straight or curved	2-3 straight or curved	3 straight or curved
Tracheal tube (mm)	Premature infant 2.5 Term infant 3.0-3.5 uncuffed	3.5 uncuffed	4.0 uncuffed	4.5 uncuffed	5.0 uncuffed	5.5 uncuffed	6.0 cuffed	6.5 cuffed
Tracheal tube length (cm at lip)	10-10.5	10-10.5	11-12	12.5-13.5	14-15	15.5-16.5	17-18	18.5-19.5
Stylet (F)	6	6	6	6	6	14	14	14
Suction catheter (F)	6-8	8	8-10	10	10	10	10	12
BP cuff	Newborn/ infant	Newborn/ infant	Infant/child	Child	Child	Child	Child/adult	Adult
IV catheter (G)	22-24	22-24	20-24	18-22	18-22	18-20	18-20	16-20
Butterfly (G)	23-25	23-25	23-25	21-23	21-23	21-23	21-22	18-21
Nasogastric tube (F)	5-8	5-8	8-10	10	10-12	12-14	14-18	18
Urinary catheter (F)	5-8	5-8	8-10	10	10-12	10-12	12	12
Defibrillation/ cardioversion external paddles	Infant paddles	Infant paddles until 1 yr or 10 kg	Adult paddles when ≥1 yr or ≥10 kg	Adult paddles	Adult paddles	Adult paddles	Adult paddles	Adult paddles
Chest tube (F)	10-12	10-12	16-20	20-24	20-24	24-32	28-32	32-40

*Adapted from the Broselow Pediatric Resuscitation Tape, with permission from Armstrong Medical Industries, Lincolnshire, Ill. Modified from Hazinski MF, ed.

Broselow Tape

- 8 color codes (6-36 kg)
- Broselow-Luten Emergency System
  - Color-coded bags with equip
  - Quicker, more efficient

Summary

- Think carefully about your goals
- Assess your options
- Good BLS is the most important skill
- Intubate or not?
- Have a back-up plan
- Use your Broselow

Questions?