Global Health
Emergency Medicine

Procedural Session: Pediatric Airway Management

Slides prepared by Julianna Deutscher

Builds on previous GHEM lectures:

Pediatric Basic Life Support, Muluwork Tefera

Introduction to Airway Management, Eileen Cheung

Please also note:

- The information in this presentation and the video recording is up to date as of the date it was recorded: [insert presentation date]
- It has not been updated to include any subsequent advances in practice, and the information presented in this video does not replace hospital, health centre, or governmental guidelines.

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Disclosure Statement

- I have not received any financial or in-kind support from any commercial organization and have no conflicts of interest to declare.

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Preparation:

- **Readings:**
- Tintinalli's 9th Edition, Ch28 Non-invasive Airway Management, p173-179
- Tintinalli's 9th Edition, Ch29A, Tracheal Intubation, p179-190
- Tintinalli’s 9th Edition, Ch 29B, Mechanical Ventilation, p190-193
- Tintinalli’s 9th Edition, Ch30, Surgical Airway, p198-199
- **Videos:**
  - Peds RSI, University of Florida EM: https://www.youtube.com/watch?v=Wxal2dIyPVI
  - Peds Needle Cricothyrotomy, Dr. Gore: https://www.youtube.com/watch?v=BrpzH5G-VHM
  - Alternative set-up for needle cricothyrotomy, EM Capetown: https://www.youtube.com/watch?v=fNRDWN2OdpY

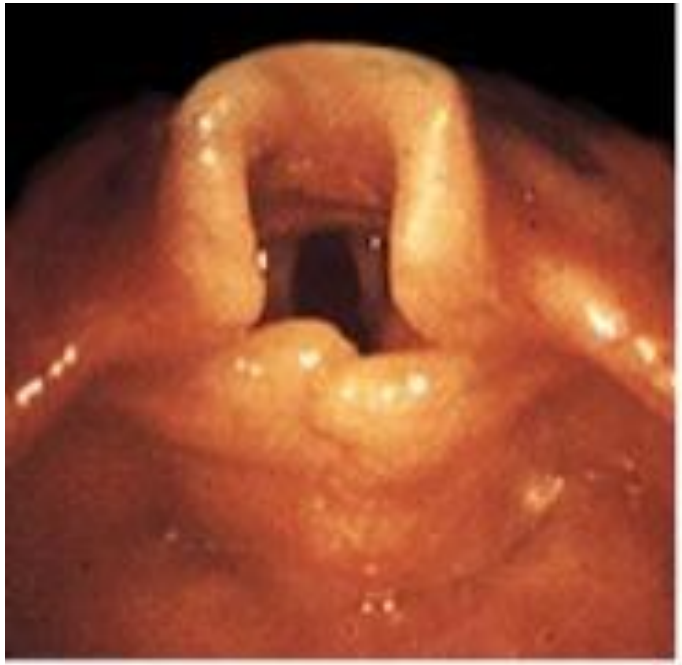
Learning Objectives:

- Describe the anatomical and physiological differences in the pediatric airway
- Demonstrate knowledge of appropriate sizing for pediatric airway equipment
- Understand indications and contraindications for rapid sequence intubation
- List appropriate medications for pediatric rapid sequence intubation and their doses
- Describe approach to management of laryngospasm
- Describe steps in performing needle cricothyrotomy

Anatomical Differences in Pediatric Airway

- Larger tongue: Collapse and obstruct airway --> Use OPA/NPA
- More anterior airway: Challenging to visualize cords --> Optimize positioning, video laryngoscope if available
- Large tonsils and adenoids: Prone to bleeding, more challenging NPA insertion
- Narrow subglottic region: Prone to airway collapse and inflammation

Anatomical Differences in Pediatric Airway



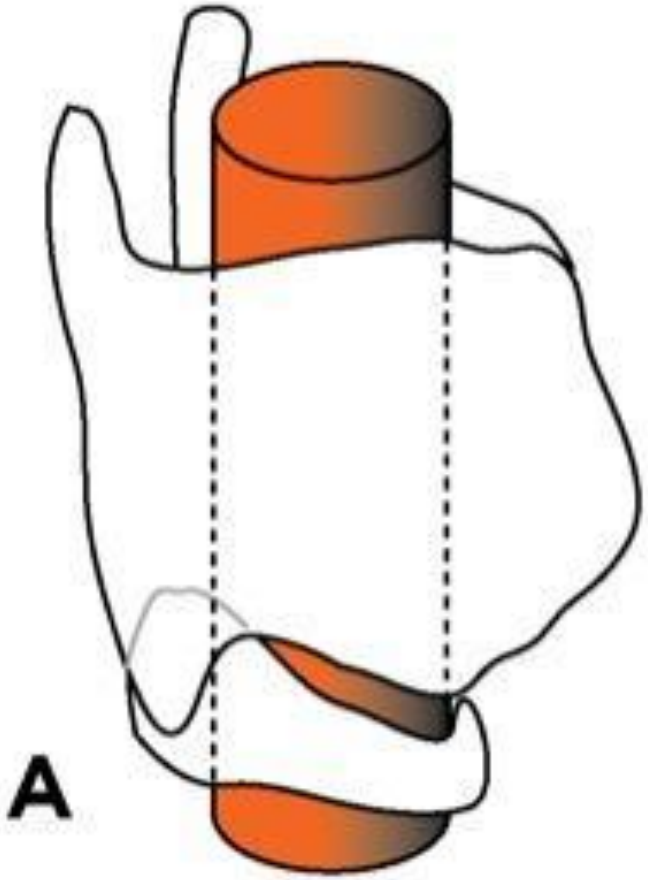
Infant

Toddler

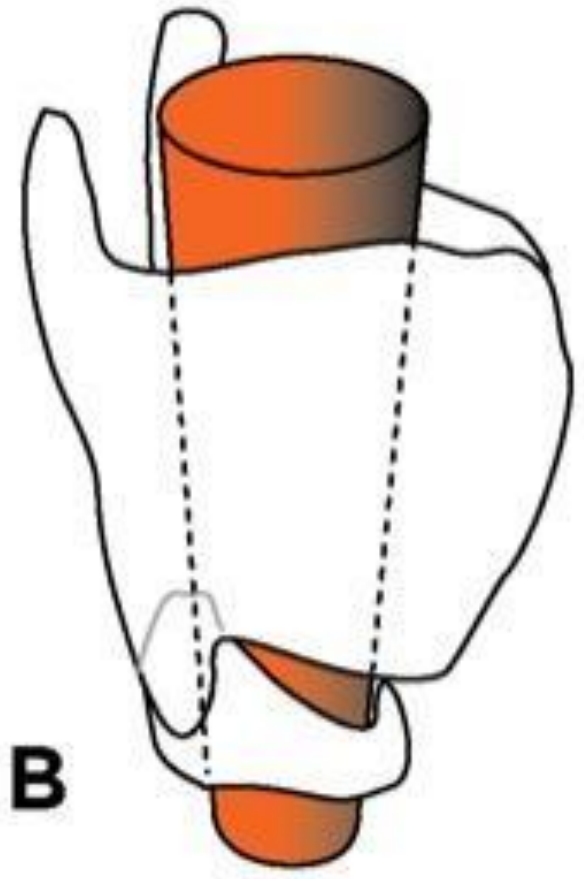
Adult

Anatomical Differences in Pediatric Airway

- Adult larynx is cylindrical
- Infant larynx is funnel-shaped

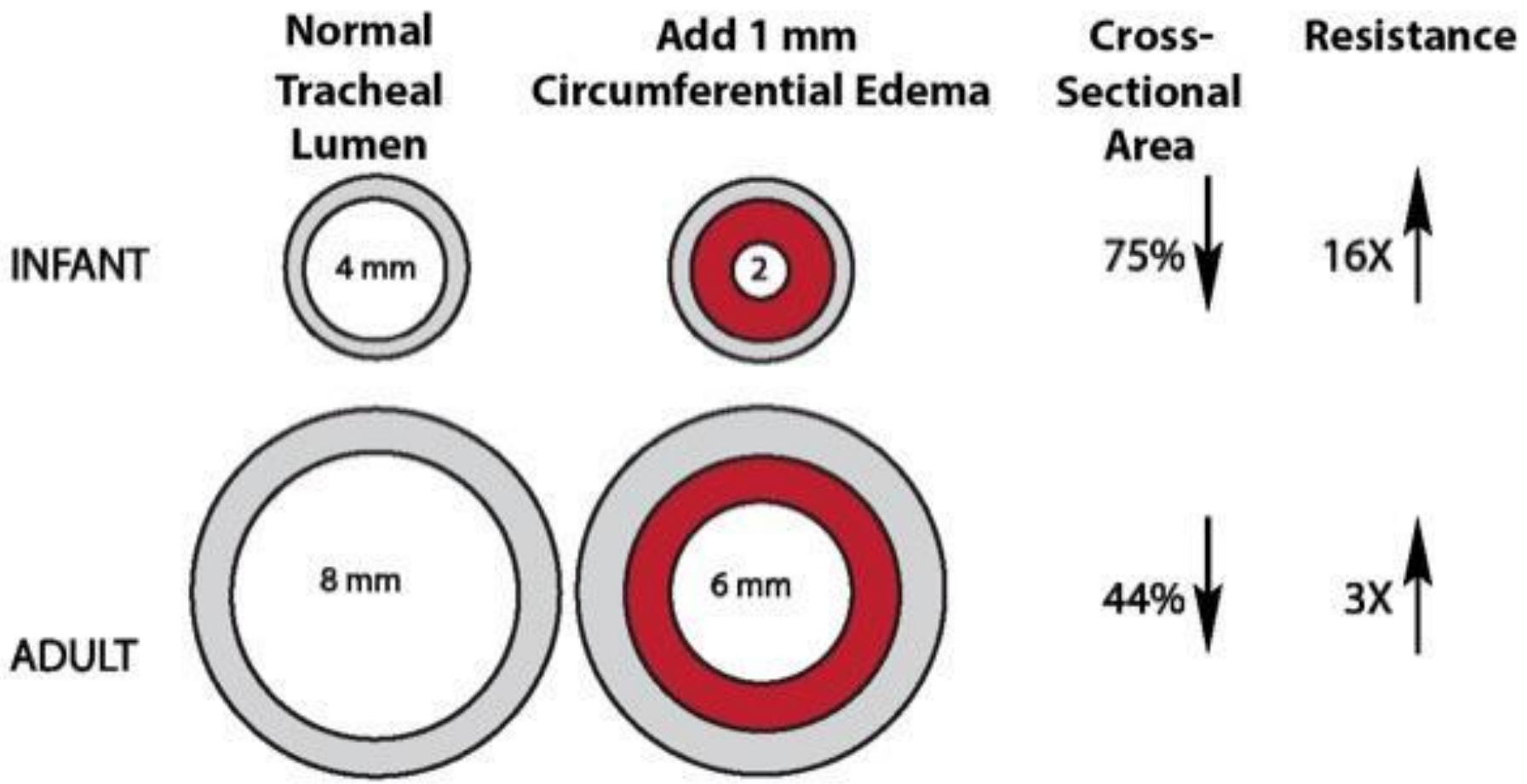


Adult



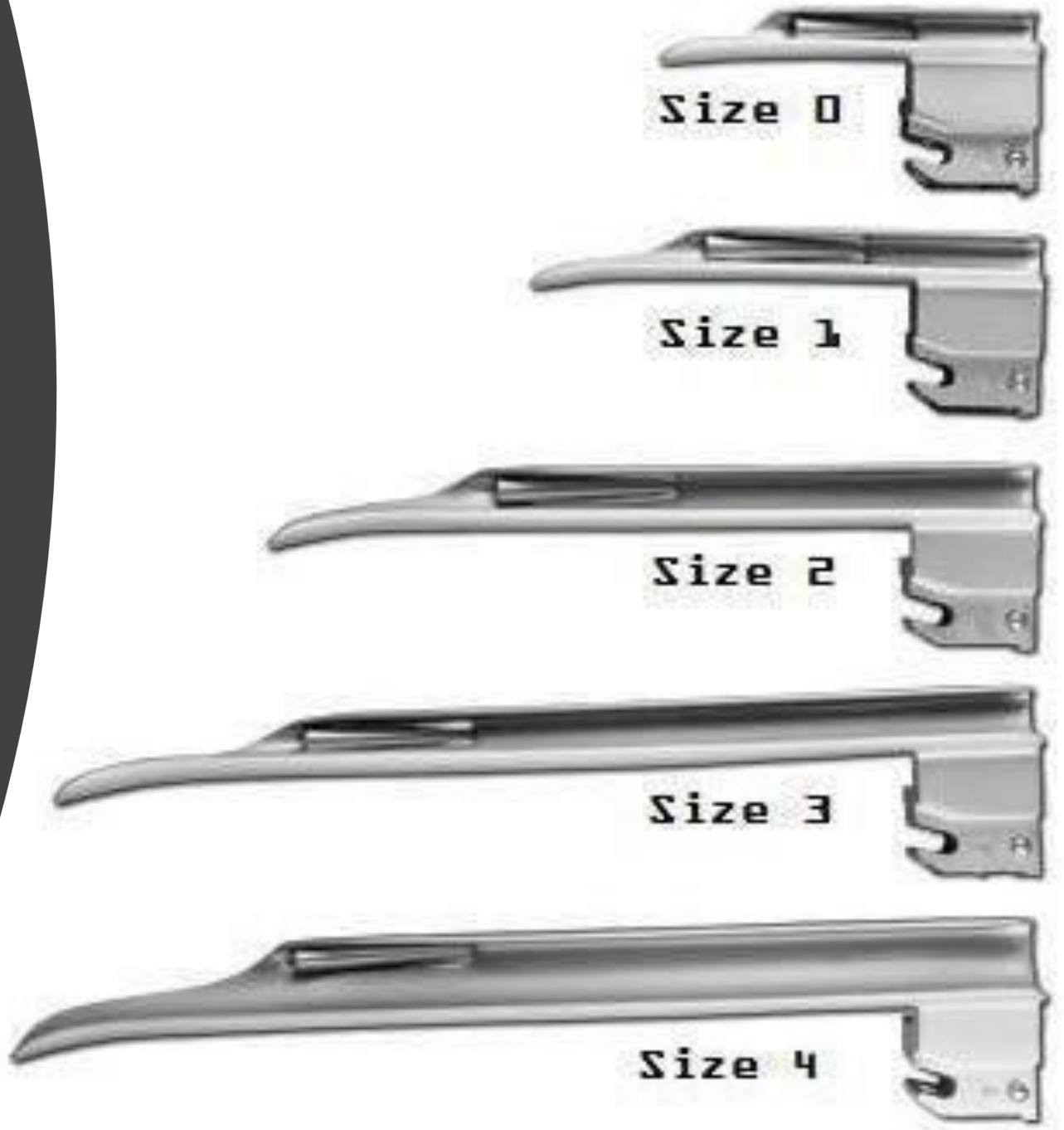
Infant

Anatomical Differences in Pediatric Airway



Anatomical Differences in Pediatric Airway

- Large floppy epiglottis: More likely to obstruct view of vocal cords
- Traditional approach of using Miller blade, particularly in less than 2yo
- Evidence suggests similar success with Macintosh

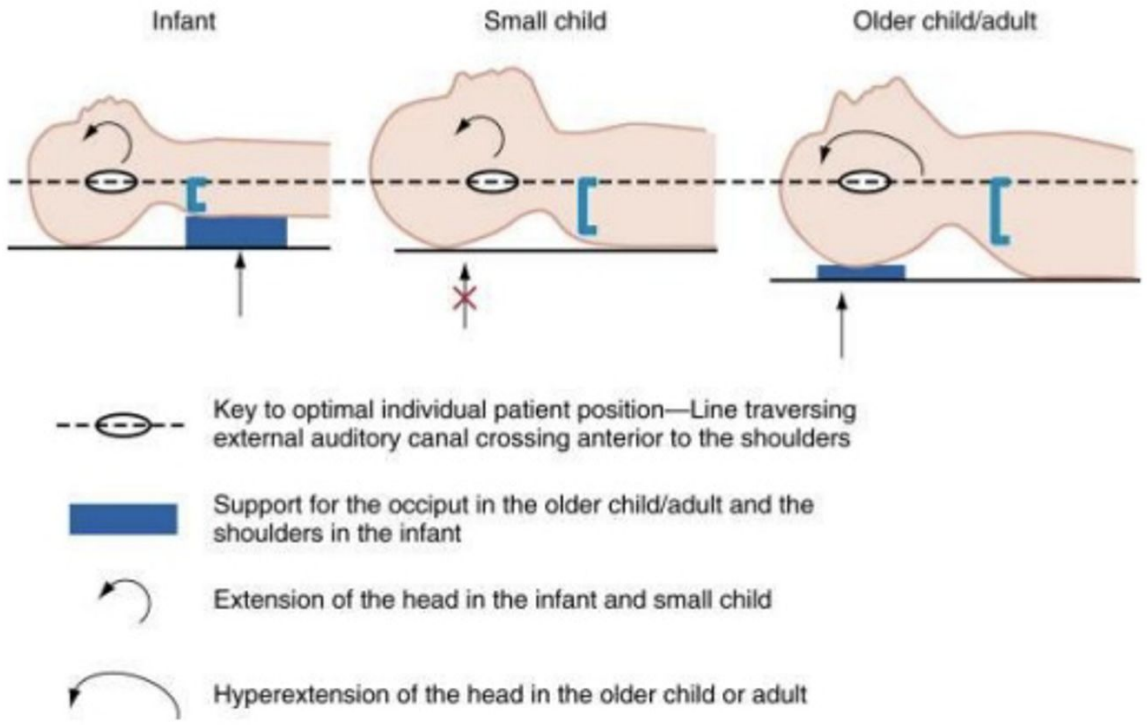


Anatomical Differences in Pediatric Airway

Infant has larger occiput: Changes approach to positioning

- <6mo: roll under shoulders
- 6mo-5yo: may not need anything
- >5yo: more likely to need roll under head

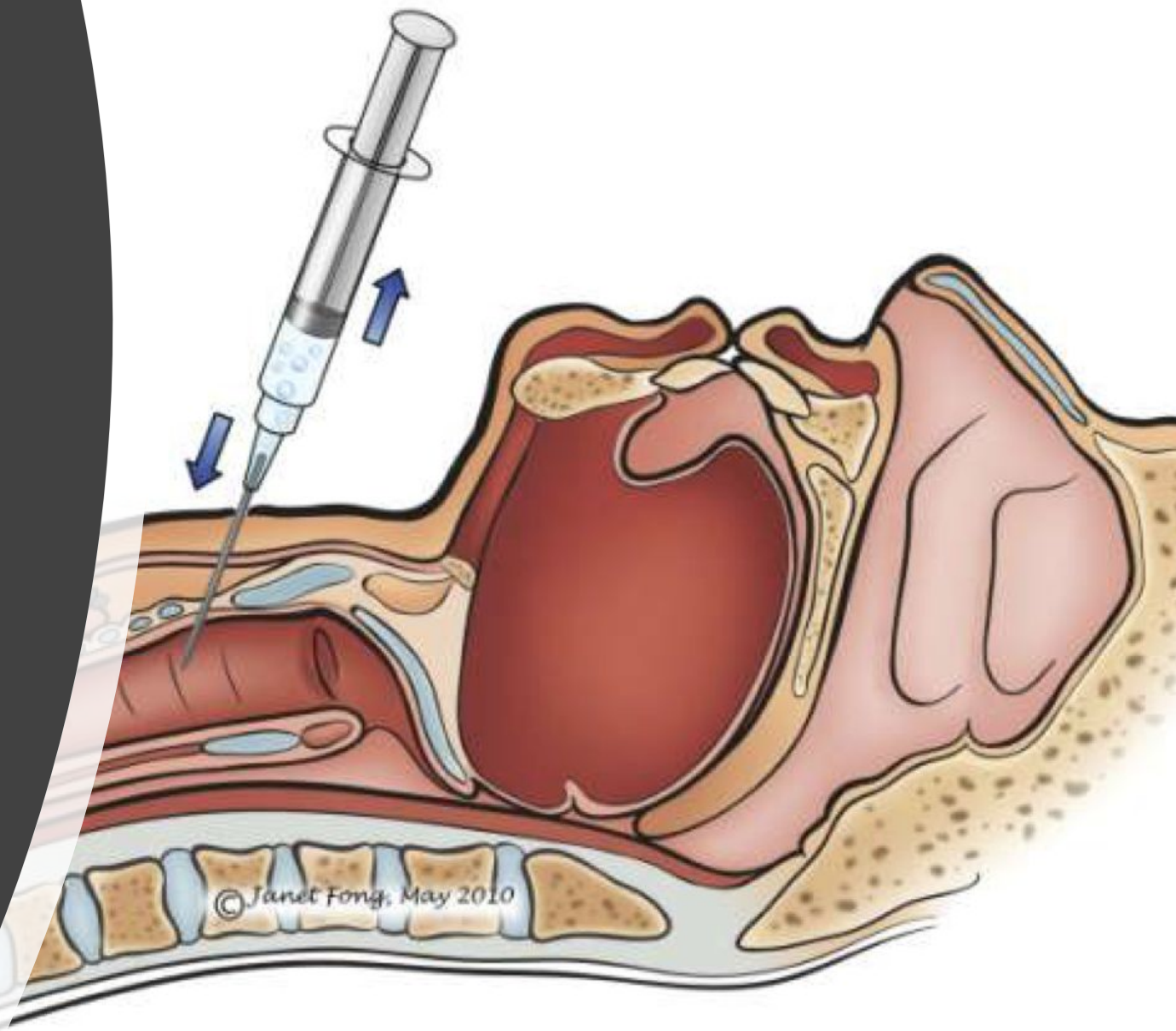
Sniffing Position or "Ear to Sternal Notch"



Nemours. Alfred I. duPont Hospital for Children

Anatomical Differences in Pediatric Airway

- Small cricothyroid membrane: Risk of transecting trachea with standard cricothyrotomy
- Needle cricothyrotomy
- More to come!



Anatomical Differences in Pediatric Airway

Shorter tracheal length

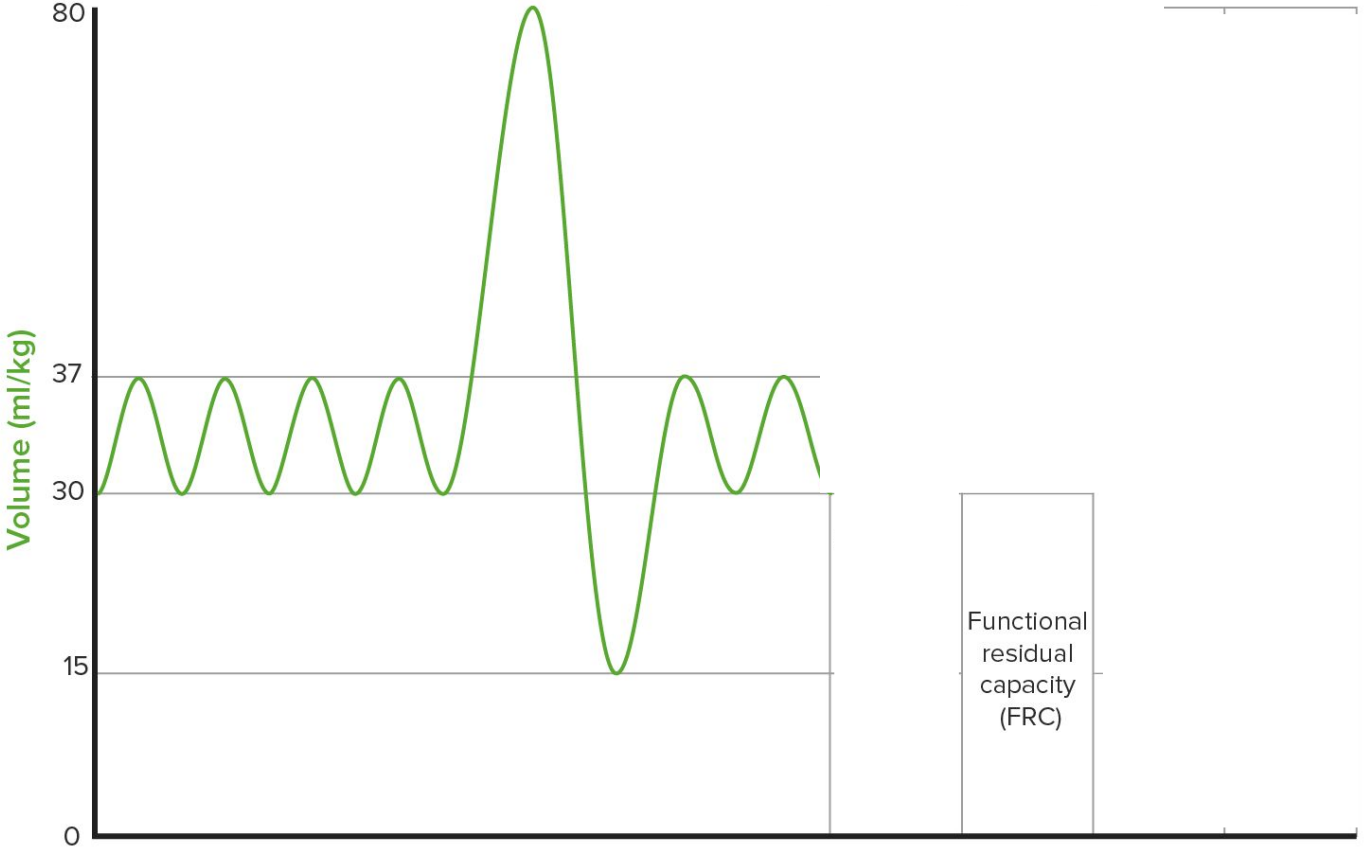
- Caution for right mainstem intubation
- Easy to dislodge tube with neck flexion

Formula for ETT Depth

- ETT size x 3

Physiologic Differences in Pediatric Airway Management

- Lower functional residual capacity (FRC)
  - FRC = volume remaining in lungs after normal exhalation
- Higher metabolic rate
- Results in less time to desaturation



Physiologic Differences in Pediatric Airway Management

- Abdomen rises as diaphragm descends: stomach distention limits tidal volume
- Insufflation of stomach during BVM can affect ventilation →Use OG/NG tube
- Chest wall more compliant: exhalation requires work
- Muscles for ventilation tire easily
- Harder an infant tries to breathe, the less efficient the breaths become

When to Intubate

- Failure to MAINTAIN airway
- Failure to PROTECT airway
- Failure to OXYGENATE
- Failure to VENTILATE
- Potential to DETERIORATE
- Facilitation of TREATMENT or TRANSPORT

The Ps of RSI

- Plan
- Preparation (Drugs, Equipment, People, Place, PPE)
- Protect c-spine
- Positioning
- Pre-oxygenation
- Pre-treatment
- Paralysis and Induction
- Place tube and prove placement
- Post-intubation management

Pros and Cons of RSI

- Pros:
  - Minimize risk of aspiration
  - Improve success rate of intubation
- Cons:
  - Sick patient with inflammation/obstruction may be "stenting" airway with muscle tone --> if paralyzed, results in loss of patent airway
  - Metabolic sick patient requires rapid RR for compensation --> be sure to match RR if taking away respiratory drive
  - In difficult airway, RSI can result in "Can't intubate, can't ventilate" scenario

Plan

The Plan: Airway Script

- Team Timeout: We are going to take a timeout to discuss the airway plan.
- This is an anticipated *non-challenging/difficult /physiologically challenging* airway
- ☑ My plan A is to: ex. Direct laryngoscope with Mac 2, size 5 styletted cuffed ETT
- ☑ My plan B is to: ex. Video laryngoscope with Mac 2, size 4.5 styletted non-cuffed ETT
- ☑ My plan C is to: ex. Switch providers, smaller ETT tube, bougie
- ☑ We will additionally have an appropriately sized LMA
- ⟺ Decision on double set up: neck prepped and landmarked for possible surgical incision

Things to Consider in Plan: Difficult Airway Adjuncts

- BVM
- Bougie
- Position
- Operator change
- LMA
- Video guided
- Surgical "double set-up"

Preparation (People, Place, PPE, SOAP-ME)

SOAP ME

- Suction
- Oxygen
- Airway equipment
- Pre-oxygenate
- Monitors and Medications
- End-Tidal CO2

Equipment: Blade Size

- Premie/Newborn Miller 0
- 1mo-2yo Miller 1
- 3-6yo Miller 2, Mac 1
- 6-12yo Miller 2, Mac 2-3
- >12yo Mac 3

*Please note recommended sizes vary by resource. These are common sizes based on age.

Equipment: ETT Size

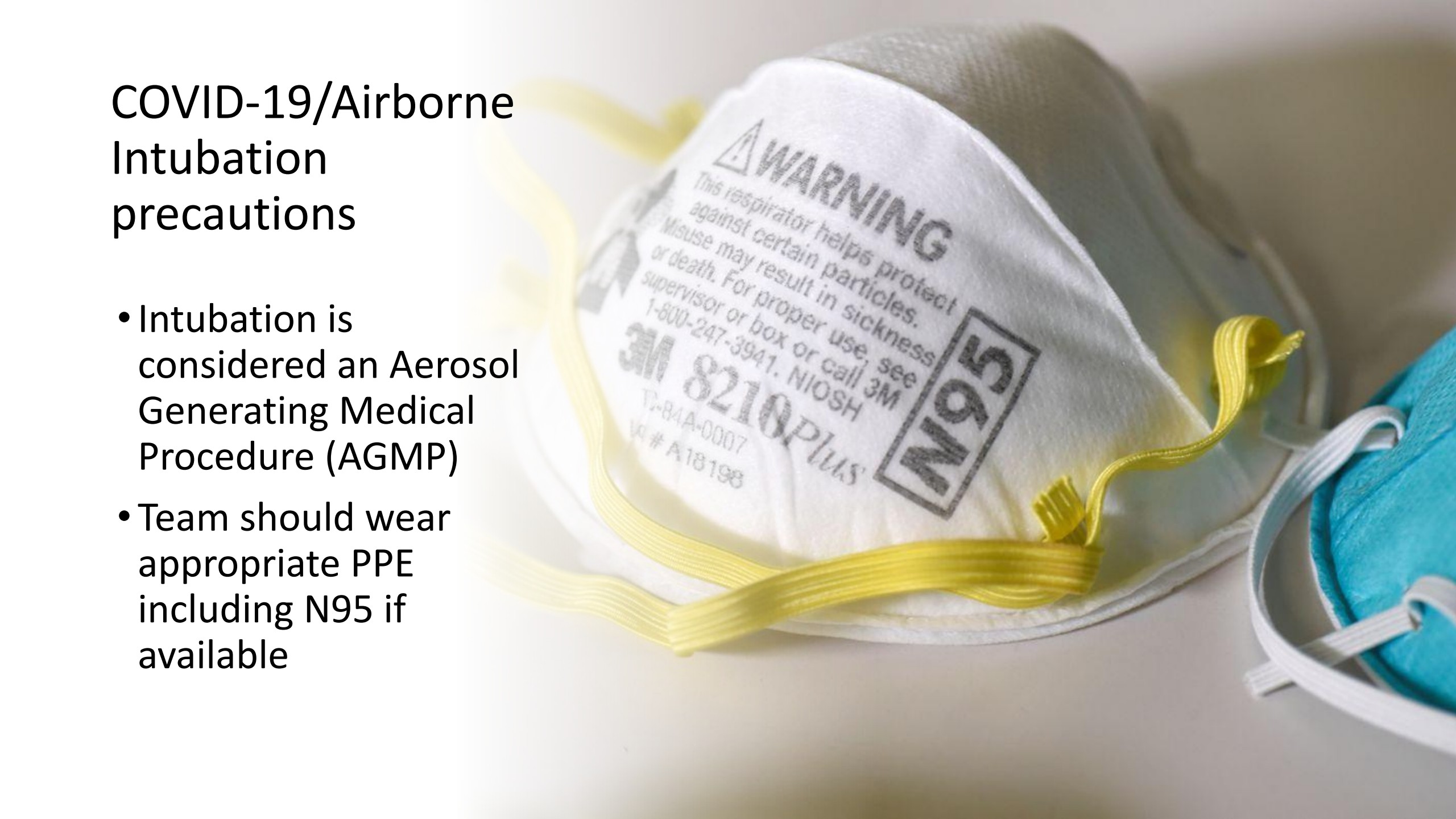
- Broselow tape
- Age/4 + 4, for uncuffed
- Age/4 + 3.5, for cuffed
- Use patient's pinky finger as an estimate
- Newborn size 3 or 3.5

Equipment: LMA Size

- LMA packaging marked with appropriate weight
- Size 1: up to 5kg
- Size 1.5: 5-10kg
- Size 2: 10-20kg
- Size 2.5: 20-30kg
- Size 3: 30-50kg

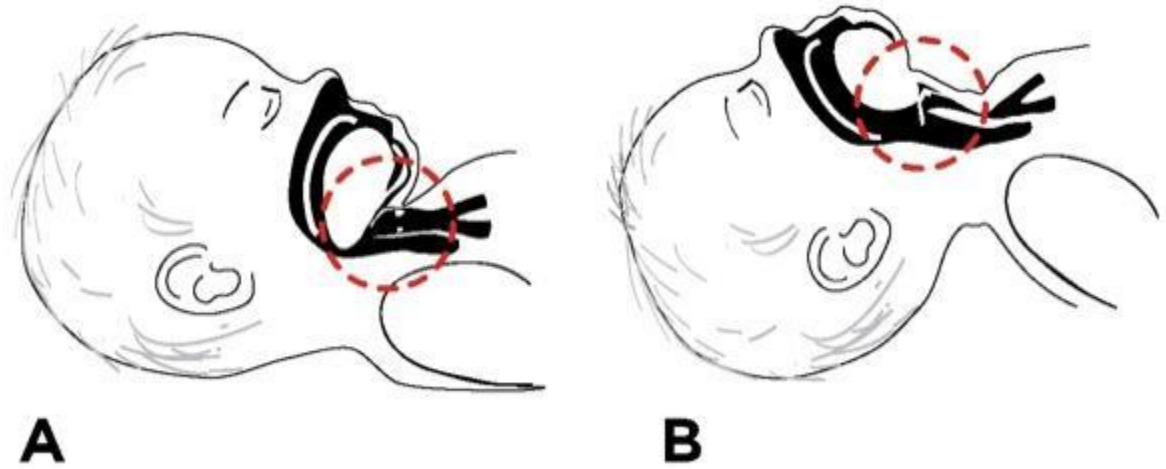
COVID-19/Airborne Intubation precautions

- Intubation is considered an Aerosol Generating Medical Procedure (AGMP)
- Team should wear appropriate PPE including N95 if available

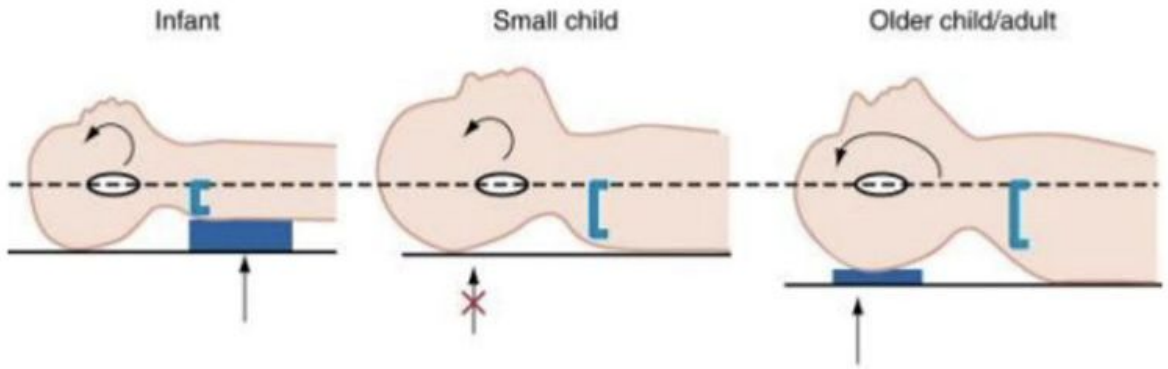


Protect C-Spine

Be careful not to hyperextend/hyperflex neck in infant, can lead to obstruction



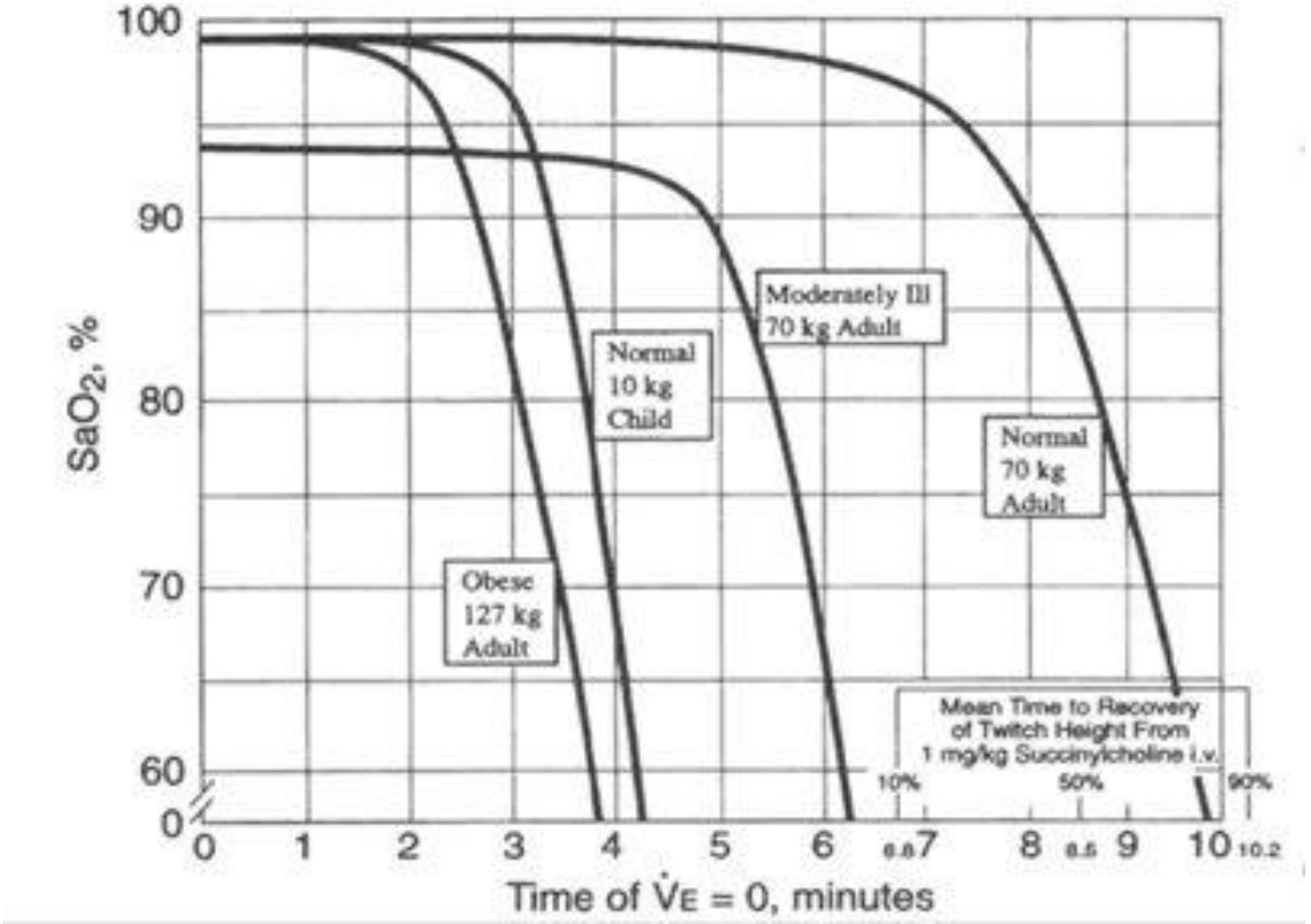
Positioning



Pre-oxygenate

Time to Desaturation

- Healthy adult with 3 minutes pre-oxygenation will desaturate to <90% after 6 minutes
- Healthy child will desaturate after 3 minutes
- Sick child may desaturate **within 1 minute**



Apneic Oxygenation

- High flow nasal cannula during RSI
- Fills hypopharynx
- Diffuses to alveoli
- When using non-rebreather, mask fills with expired gases diluting the oxygen concentration
- Increases duration of oxygenation
- Increases time to desaturation

Pre-treatment

Pre-Treatment

- **Lidocaine and Fentanyl** may be considered in pre-treatment for suspected head injuries/elevated ICP
- Note that in order to be effective, they must be given several minutes prior to the intubation
- Lidocaine 1.5mg/kg, limited data on use in increased ICP in peds
- Fentanyl 1-3 mcg/kg

- **Midazolam** is a helpful adjunct in a highly agitated patient to assist with anxiolysis and amnesia, especially as it can be given IM to help facilitate getting IV access
- It is not used routinely pre-intubation
- Midazolam 0.05-0.1mg/kg

Laryngoscopy = Valsalva

- HR may drop due to vagal stimulation, particularly in less than 2yo
- Evidence now suggests NOT giving Atropine prophylactically routinely
- Atropine 0.02mg/kg, minimum dose 0.1mg and maximum dose 0.5mg

Other possible effects of laryngoscopy:

In older children, may cause increased HR

Increase BP

Increase Intracranial Pressure

Increase Intraocular Pressure

Paralysis and Induction

Succinylcholine

- DEPOLARIZING
- Short acting
- Onset within 45 seconds
- Very low risk for bradycardia, no longer recommendation for routine Atropine

- Succinylcholine 1-2mg/kg
- Neonates use 2mg/kg

Contraindications to Succinylcholine

- Hyperkalemia
  - Burns, over 24 hours old
  - Crush injuries, over 24 hours old
  - Renal failure
  - Spinal cord injury, over 72 hours
  - Rhabdomyolysis
  - Neuromuscular disease ex MD
  - Severe bedridden, over 24 hours
- Malignant hyperthermia, be sure to ask about family history

Rocuronium

- NON-DEPOLARIZING
- Slower onset
- Higher dose has quicker onset

- Rocuronium 0.6-1.2mg/kg

- Reversal agent: Sugammadex 4-16mg/kg
- Very expensive
- Try to optimize with BVM

Ketamine

Pros:

- Hemodynamically stable (except in extreme shock situations)
- Analgesia
- Maintain airway reflex
- Bronchodilator

Cons:

- Increased HR/BP
- Evidence has disproven concern for increased ICP and intraocular pressure

Ketamine 0.5-2mg/kg

Midazolam

Pros:

- Can be given intranasal
- Anti-convulsant

Cons:

- Hypotension
- Apnea
- No analgesia effect

Midazolam 0.05-0.1mg/kg IV

Propofol

Not typically used at pediatric centres, but if it's what you have, you can make it work!

Pros:

- Quick onset, quick offset

Cons:

- Hypotension
- Peds prone to propofol infusion syndrome
- Apnea
- No analgesia

Propofol 0.5-2mg/kg

Etomidate

Pros:

- Hemodynamically stable
- Decreased cerebral blood flow and O2 demand (improves ICP)

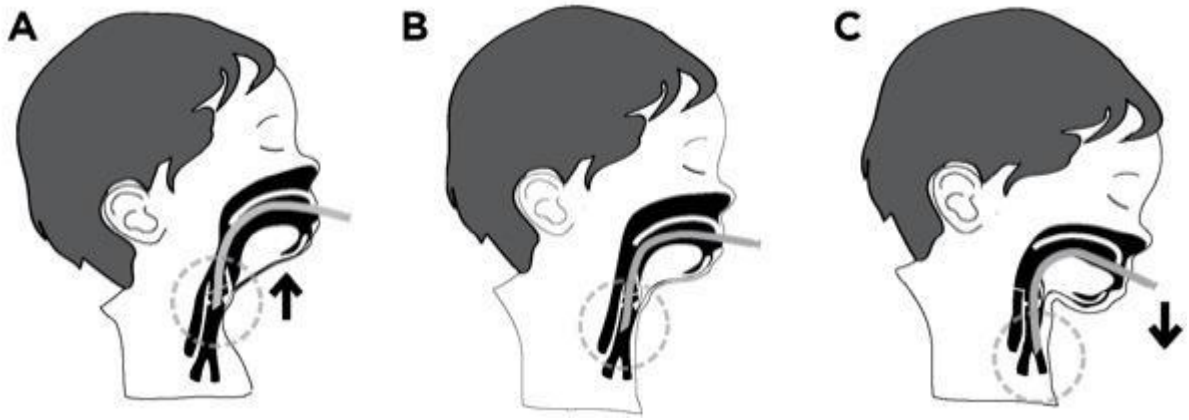
Cons:

- Emesis
- Adrenal suppression, PALS recommends avoiding in sepsis, consider dose of Hydrocortisone if using

Etomidate 0.2-0.3mg/kg

Place tube and prove placement

Careful securing of tube as shorter tracheal length can result in easy accidental extubation with head movement

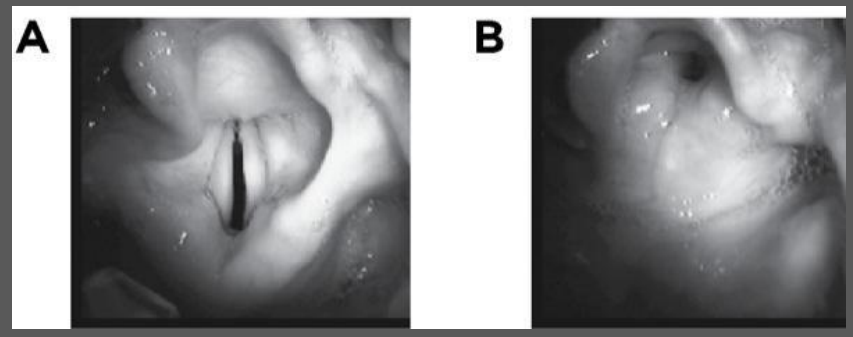


Post-Intubation Management

Medication	Bolus Dosing	Drip	Comments
Lorazepam	0.1 mg/kg		Long acting sedative/amnesic Often used in combination with analgesic
Midazolam	0.1 mg/kg	0.1 mg/kg/h	Short-acting sedative/amnestic Often used in combination with analgesic
Fentanyl	1 to 2 mcg/kg	1 mcg/kg/h	Short-acting analgesia Preserves hemodynamic stability
Morphine	0.1 to 0.2 mg/kg	0.1 mg/kg/hr	Longer-acting analgesic May cause histamine release
Ketamine		0.1 mg/kg/h	Bolus dosing not recommended for prolonged ongoing sedation May be helpful in status asthmaticus
Propofol		50 to 100 mcg/kg/min	No analgesic properties Prolonged infusion in children can lead to profound acidosis and rhabdomyolysis

Laryngospasm

- Transient spasm of vocal cords
- Results in sustained closure of cords with partial or complete loss of airway
- On exam:
  - Stridor or absent breath sounds
  - Desaturation
  - Increased work of breathing
  - Difficulty bagging



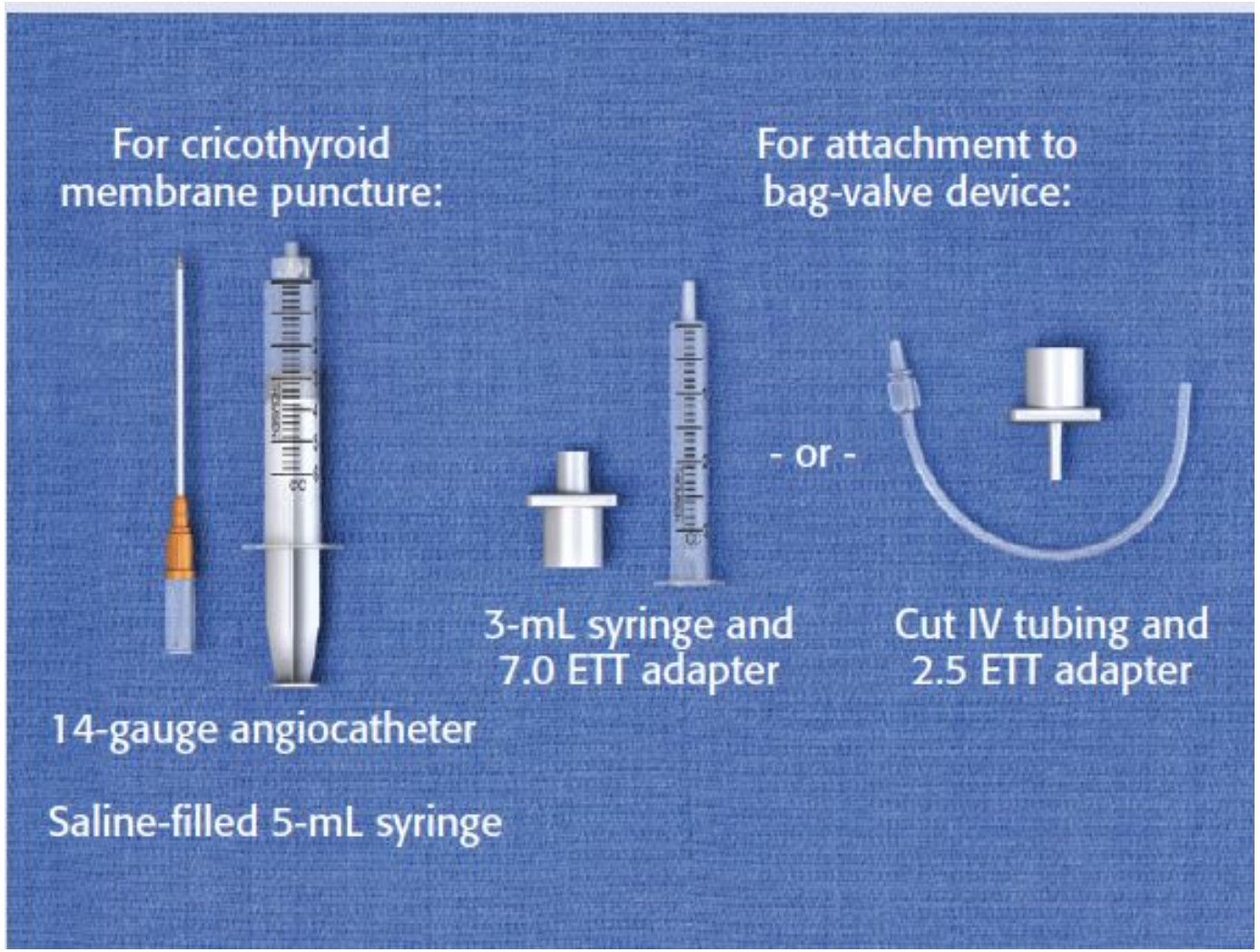
Risk Factors for Laryngospasm

- Insufficient depth of anesthesia
- Induction
- Emergence
- Airway irritation
- Volatile anesthetics
- Mucous/blood
- Manipulation ex. Suctioning
- Airway device ex. LMA
- Asthma
- Young children
- Recent URTI
- Obesity with OSA
- GERD
- Anatomical anomaly or airway surgery

Needle Cricothyrotomy

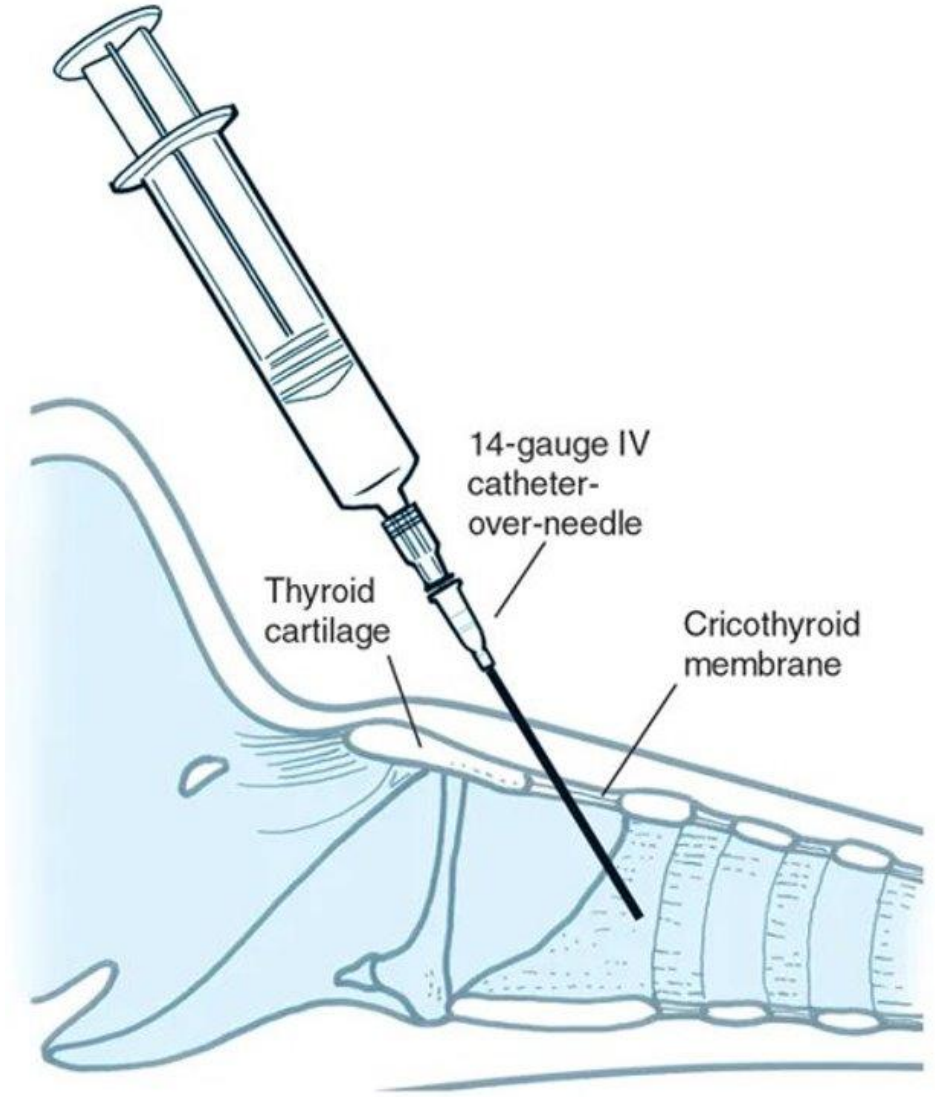
Indications	Contraindications	Complications
• Failed intubation and inability to bag-mask ventilate • Airway obstruction above level of cricothyroid membrane • Age less than 10-12yo	• Laryngeal transection or fracture	• Subcutaneous emphysema • Bleeding • Malposition • Infection • Posterior tracheal wall perforation • Pneumothorax • Barotrauma

Equipment


For cricothyroid membrane puncture:
For attachment to bag-valve device:
- or -
14-gauge angiocatheter
Saline-filled 5-mL syringe
3-mL syringe and 7.0 ETT adapter
Cut IV tubing and 2.5 ETT adapter

Steps

- Emergency consent
- Prepare equipment
- Sterile prep
- Landmark
- Insert 14G angiocath with 5cc syringe partially filled with saline at 15-45 degrees angled caudad
- Advance needle until able to aspirate air
- Advance angiocath and remove needle
- Connect angiocath to 2.5 ETT adapter or 3cc syringe with 7.0 ETT adapter
- Place oral or nasal airway to maintain patency, avoid breath stacking



Source: Goodman DM, Green TP, Unti SM, Powell EC: *Current Procedures: Pediatrics:* www.accesspediatrics.com

References

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- Tintinalli’s 9th Edition, Ch30, Surgical Airway, p198-199
- Rosen's 9th Edition, Ch 161
- Roberts and hedges 6th Edition, Ch 6 Cricothyrotomy, p131
- https://www.youtube.com/watch?v=Wxal2dlyPVI
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