THE DIFFICULT PEDIATRIC AIRWAY

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Learning Objectives

At the conclusion of this activity, the participants should be able to:

1. Describe what makes a pediatric airway different
2. Describe risk factors for difficult airway in pediatrics
3. Describe the American Society of Anesthesiology Difficult airway algorithm
4. Describe ventilation techniques
5. Describe intubation techniques

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The Pediatric Airway

1. Anatomy
2. Physiology
3. Airway evaluation
4. Management of normal vs. abnormal airway
5. Difficult airway

"5" Differences between the Pediatric and Adult Airway

1. More rostral larynx
2. Relatively larger tongue
3. Angled vocal cords
4. Differently shaped epiglottis
5. Funneled shaped larynx-narrowest part of pediatric airway is cricoid cartilage

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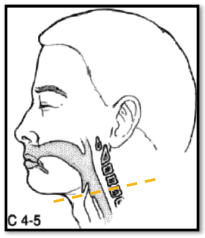
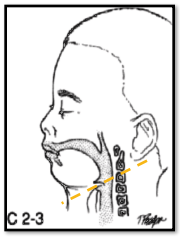
Differences

- Infant's larynx is higher in neck (C2-3) compared to adult's (C4-5)



Larynx C4-5



Larynx C2-3

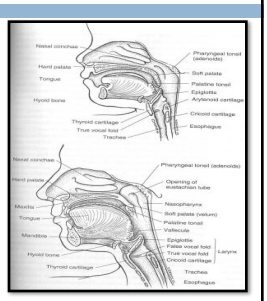
Differences

Larger Tongue

1. Obstructs airway
2. Obligate nasal breathers
3. Difficult to visualize larynx

Angled Vocal Cords

1. Infant's vocal cords have more angled attachment to trachea, whereas adult vocal cords are more perpendicular
2. Difficulty in nasal intubations where blindly placed ETT may easily lodge in anterior commissure rather than in trachea



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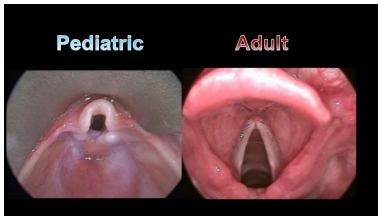
Differences

- Adult epiglottis broader, axis parallel to trachea
- Infant epiglottis omega (Ω) shaped and angled away from axis of trachea
- More difficult to lift an infant's epiglottis with laryngoscope blade



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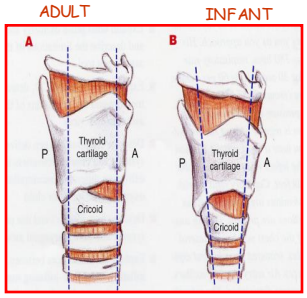
Differences



Funneled shape larynx

1. Narrowest part of infant's larynx is the undeveloped cricoid cartilage, whereas in the adult it is the glottis opening (vocal cord)
2. Tight fitting ETT may cause edema and trouble upon extubation
3. Uncuffed vs. cuffed ETT
4. Fully developed cricoid cartilage occurs at 10-12 years of age

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Potential Airway Issues

- Apnea
- Asthma / Reactive airway disease / Upper respiratory infection
- Obesity (BMI)
- Tonsillar / adenoid hypertrophy
- Swallowing problems
- Severe reflux
- Syndromes (Down, Pierre Robin, Marfan's, Mucopolysaccharidosis)
- Tracheal / laryngomalacia
- Prior tracheostomy
- Vascular ring
- Cerebral palsy/other conditions of muscle weakness

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Signs of Impending Respiratory Failure

- Increased work of breathing
- Tachypnea / tachycardia
- Nasal flaring
- Drooling
- Grunting
- Wheezing
- Stridor
- Head bobbing
- Use of accessory muscles / retraction of muscles
- Cyanosis despite O_2
- Irregular breathing / apnea
- Altered consciousness / agitation
- Inability to lie down
- Diaphoresis

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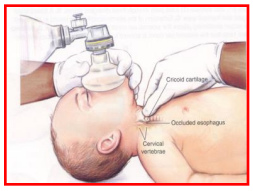
Bag-Mask Ventilation



- Clear, plastic mask with inflatable rim provides atraumatic seal
- Proper area for mask application- bridge of nose extend to chin
- Maintain airway pressures <20 cm H2O

- Place fingers on mandible to avoid compressing pharyngeal space
- Continuous positive pressure when needed to maintain airway patency

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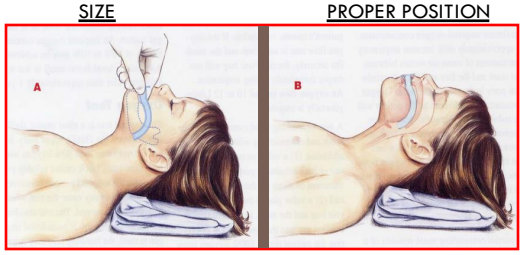
Oropharyngeal Airway

SIZE

PROPER POSITION



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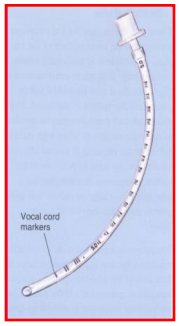
Endotracheal Tube



Uncuffed ETT: (age in years/4) + 4
Cuffed ETT: (age in years/4) +3
ETT depth (lip): ETT size x 3

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Abnormal Pediatric Airway

1. **Congenital Neck Masses**
   - Dermoid cysts, cystic teratomas, cystic hygroma, lymphangiomas, neurofibroma, lymphoma, hemangioma
2. **Congenital Anomalies**
   - Choanal atresia, tracheoesophageal fistula, tracheomalacia, laryngomalacia, laryngeal stenosis, laryngeal web, vascular ring, tracheal stenosis
3. **Congenital Syndromes**
   - Pierre Robin Syndrome, Treacher Collins, Turner's, Down's, Goldenhars, Apert, Achondroplasia, Crouzon

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Abnormal Pediatric Airway

4. **Inflammatory**
   - Epiglottitis, acute tonsillitis, peritonsillar abscess,retropharyngeal abscess, laryngotracheobronchitis,bacterial tracheitis,adenoidal hypertrophy,nasal congestion, juvenile rheumatoid arthritis
5. **Traumatic / Foreign Body**
   - Burn, laceration, lymphatic / venous obstruction, fractures / dislocation, inhalational injury, post-intubation croup (edema), swelling of uvula
6. **Metabolic**
   - Congenital hypothyroidism, mucopolysaccharidosis, Beckwith-Wiedemann Syndrome, glycogen storage disease, hypocalcemia laryngospasm

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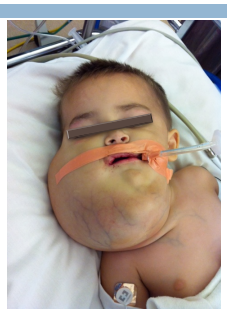
Congenital Neck Masses



Cystic Hygroma

Rigid Bronchoscopy

Choanal Atresia

- Complete nasal obstruction
- Occurs in 0.82 / 10,000 births
- During inspiration, tongue pulled to palate, obstructs oral airway
- Unilateral nare (right>left)
- **Bilateral choanal atresia is airway emergency**
- Death by asphyxia
- Associated with other congenital defects

Pierre-Robin Sequence

- Occurs in 1/8500 births
- Autosomal recessive
- Mandibular hypoplasia, micrognathia, cleft palate, retraction of inferior dental arch, glossptosis
- Severe respiratory and feeding difficulties
- Associated with OSA, otitis media, hearing loss, speech defect, ocular anomalies, cardiac defects, musculoskeletal (syndactyly, club feet, CNS delay, GU defects)

Treacher Collins Syndrome

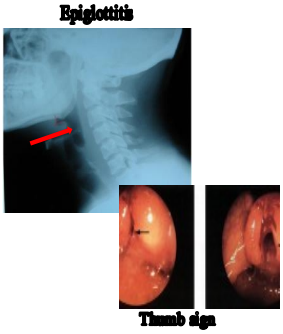
- Mandibulofacial dysostosis
- Occurs in 1/10,000 births
- Cheek bone and jaw bone underdeveloped
- External ear anomalies, drooping lower eyelid, unilateral absent thumb
- Respiratory difficulties
- Underdeveloped jaw causes tongue to be positioned further back in throat (smaller airway)
- Associated with OSA, hearing loss, dry eyes

Down Syndrome

- Trisomy 21
- Occurs in 1/660 births
- Short neck, small mouth with large protruding tongue, flattened nose
- Associated with congenital heart disease, subglottic stenosis, tracheo-esophageal fistula, duodenal atresia, chronic pulmonary infection, seizures, and acute lymphocytic leukemia
- Atlanto-occipital dislocation can occur during intubation due to congenital laxity of ligaments

Inflammatory

Epiglottitis



Thumb sign

- Etiology: Haemophilus influenzae type-B
- Occurs in children ages 2-6 years
- Progresses rapidly from a sore throat to dysphagia and complete airway obstruction (within hours)
- Signs of obstruction: stridor, drooling, hoarseness, tachypnea, chest retraction, preference for upright position
- OR intubation / ENT present for emergency surgical airway
- Do NOT instrument airway before induction of anesthesia to avoid laryngospasm

Laryngospasm

A forceful, involuntary spasm of laryngeal musculature caused by stimulation of the superior laryngeal nerve

- Occurs more commonly in children
- Occurs at light levels of sedation / analgesia
- Treat with positive pressure ventilation (using 100% O_2 with tightly fitting mask)
- Employ the "Laryngospasm Maneuver"
- If laryngospasm persists and hypoxia develops, administer Succinylcholine (0.25 - 1 mg/kg)

Laryngospasm management must be part of any procedural sedation plan (it is the most common significant complication).

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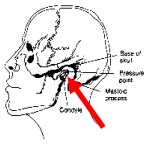
Laryngospasm Maneuver

Apply firm inward pressure bilaterally with both index fingers at the laryngospasm notch (located just behind the earlobe - the posterior aspect of the mandible).
This action exerts pressure on the styloid proc and induces laryngeal relaxation.



Laryngospasm notch

- This hand positioning allows for excellent manual control of the mandible (esp. during invasive procedures threateni or involving the upper airway)
- Avoid the angle of the mandible which places the fingers too low and may threaten the carotids.

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Definition

- Difficult mask ventilation
  - Including difficult Supraglottic Airway placement
- Difficult intubation
- Or both!!

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Airway Exam

- **Difficult Ventilation:**
  1. Facial hair
  2. Small mandible
  3. Airway masses (papillomas, tonsils, mediastinal)
  4. Nasal encephalocele

- **Difficult Intubation:**
  1. Craniofacial anomaly
  2. Small mandible
  3. Decreased mouth opening

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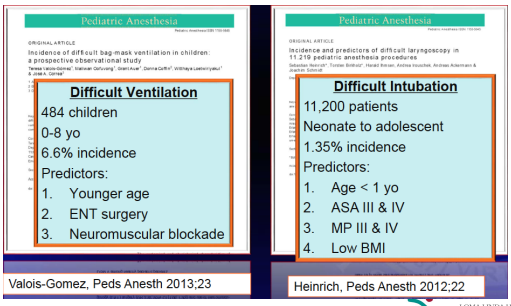
Predictors



Valois-Gomez, Peds Anesth 2013;23

Heinrich, Peds Anesth 2012;22

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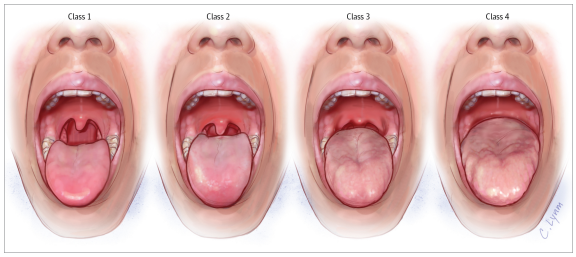
Mallampati Score



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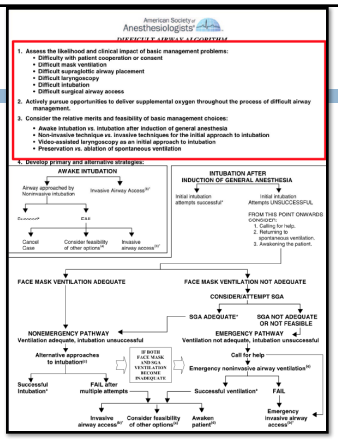

ASA Algorithm Predictors

1. Assess the likelihood and clinical impact of basic management problems:
   - Difficulty with patient cooperation or consent
   - Difficult mask ventilation
   - Difficult supraglottic airway placement
   - Difficult laryngoscopy
   - Difficult intubation
   - Difficult surgical airway access
2. Actively pursue opportunities to deliver supplemental oxygen throughout the process of difficult airway management
3. Consider the relative merits and feasibility of basic management choices:
   - Awake intubation vs. intubation after induction of general anesthesia
   - Non-invasive technique vs. invasive technique for the initial approach to intubation
   - Video-assisted laryngoscopy as an initial approach to intubation
   - Preservation vs. ablation of spontaneous ventilation

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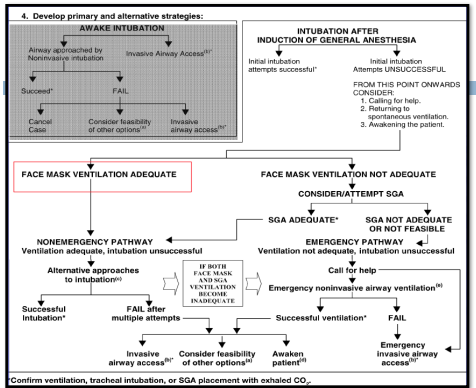

Airway Management

Ventilation

- Maintain spontaneous ventilation
  - Mask ventilation skills
  - Oral pharyngeal airway (OPA)
  - Nasal pharyngeal airway (NPA)
  - Two handed mask ventilation
  - Laryngeal mask airway (LMA)
  - Laryngoscopy

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Non-Emergency Pathway

Intubation

- Laryngoscopy
- Fiberoptic intubation
- Airtraq
- Shikani
- Rigid bronchoscopy (ENT)
- **LMA & fiberoptic scope**
- **Glidescope**

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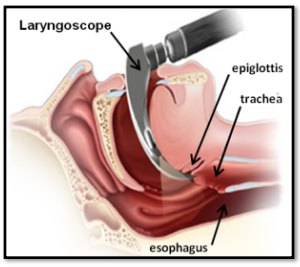
Laryngoscopy



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Laryngoscopy

Case series

- 6 infants with PRS
- Conventional laryngoscopy
  - grade 3-4 view
  - Failed intubation
- Paraglossal / Bougie
  - Successful intubation: 5/6

Anaesthesia, 2008, 63, pages 147–150 doi:10.1111/j.1365-2044.2007.05097.x

Intubation of infants with Pierre Robin syndrome: the use of the paraglossal approach combined with a gum-elastic bougie in six consecutive cases

F. Semjen, M. Bordes and A.-M. Cros

Pediatric Anesthesia Department, Bordeaux University Hospital, Bordeaux, France

Summary

Infants with Pierre Robin syndrome are known to be difficult to intubate. We evaluated the paraglossal approach combined with a gum elastic bougie for intubation of these infants. Whilst under general anaesthesia, a conventional laryngoscopy was performed; if it failed to obtain a laryngoscopic grade I or II view, intubation was attempted using a paraglossal approach and a gum elastic bougie. Six consecutive infants were studied. Conventional laryngoscopy failed in all infants whilst the paraglossal approach combined with a gum elastic bougie was successful in five of the cases. The paraglossal approach combined with a gum elastic bougie made intubation easy in most children with severe Pierre Robin syndrome and difficult laryngoscopy. Therefore we recommend this as the first line for airway management in such children. However, a fibreoptic bronchoscope and an anaesthetist trained in fibreoptic intubation must still be present when dealing with severe Pierre Robin syndrome infants.

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Accepted: 12 March 2007

The Pierre Robin syndrome presents as airway obstruction secondary to micrognathia with retrogenia and glossoptosis (tongue prolapse). An oval or cleft palate is present in 50% of cases [1]. It is usually revealed by acute respiratory distress in the neonate and is a major concern as infants with Pierre Robin syndrome are known to be difficult to intubate. Although many airway management protocols have been described, mostly in case reports and short series, the gold standard for difficult intubation is considered to be fibreoptically assisted intubation [2]. As a fibreoptic bronchoscope is not always available in every institution and a physician trained in paediatric fibreoptic intubation is not always on hand [3], alternative methods need to be assessed. We therefore evaluated the association of a paraglossal approach associated with a gum elastic-bougie in six consecutive infants presenting with severe Pierre Robin syndrome requiring glossopexy.

Methods

Written informed parental consent and institutional Ethics Committee approval were obtained for every child participating in this study. Over a 1-year period, every child scheduled for glossopexy was prospectively included. Children's age, sex, weight, previous history of difficult intubation, grade of laryngoscopic view at conventional laryngoscopy, number of attempts required previously for successful intubation, incidents or adverse effects, and time before successful intubation were collected. No sedative premedication was given prior to the procedure. Anaesthesia was induced using 8% sevoflurane in 100% oxygen and spontaneous breathing was assisted using pressure-support ventilation as required. Standard monitoring was applied prior to induction of anaesthesia; this included ECG, pulse oximetry, capnography, and monitoring of tidal volume and noninvasive arterial pressure. Following induction of anaesthesia, a venous line was inserted and a staff anaesthetist trained in difficult airway management performed conventional laryngoscopy using a number 0 or 1 Miller blade to assess the laryngoscopic view according to the Cormack and Lehane classification. To improve the laryngoscopic view, external manipulation of the larynx was allowed. If the view was grade III or IV following manipulation of the larynx, a paraglossal approach was performed and

 147

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Fiberoptic Bronchoscopy

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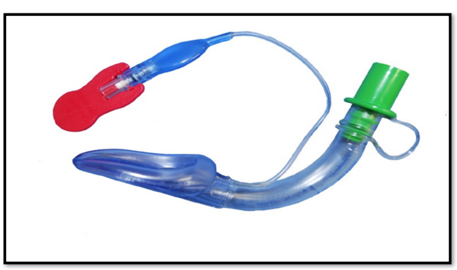
Air-Q LMA



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AirTraq Optical Laryngoscope

Optical laryngoscope

- 5 mo, 4.8 kg PRS
- Lap nissen
- Miller 1
  - Cormack-Lehane grade 3 view
- Airtraq 0
  - Cormack-Lehane grade 1 view

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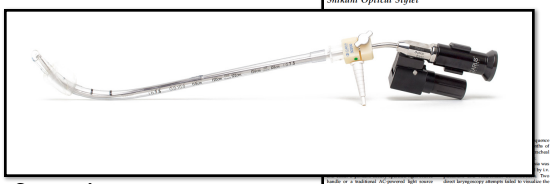
Shikani Scope



Case report
Management of the difficult pediatric airway with Shikani Optical Stylet™

Case series

- 4 patients
- 19 m/o with Pierre-Robin Sequence
- Grade 4 view
- Intubated in 35 seconds with Shikani

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LMA and Fiberoptic Scope

Case report
Awake tracheal intubation through the laryngeal mask in neonates with upper airway obstruction

Case series

- 5 neonates
- 2.8-3.5 kg
- Awake LMA insertion
- Fiberoptic scope through LMA
- GA after ETT

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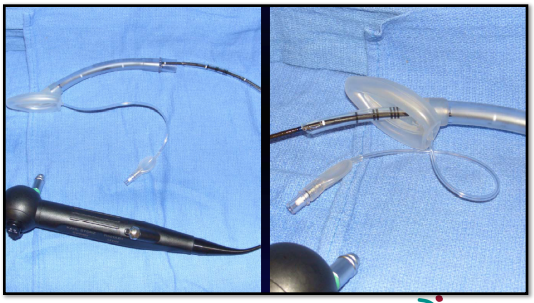
LMA and Fiberoptic Scopy



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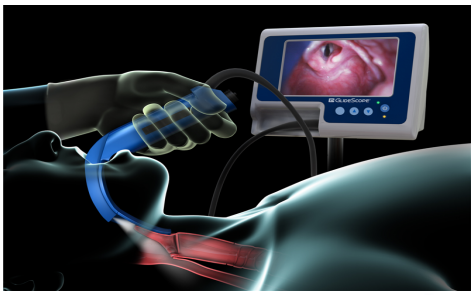
Glidescope



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Pediatric Glidescope

A

GVL 0	Preterm, <1.5 kg
GVL 1	Full term, 1.5-3.6 kg
GVL 2	Toddler, 1.8-11 kg
GVL 2.5	Sm child, 11-28 kg
GVL 3	Avg adult, 11kg-adult wgt

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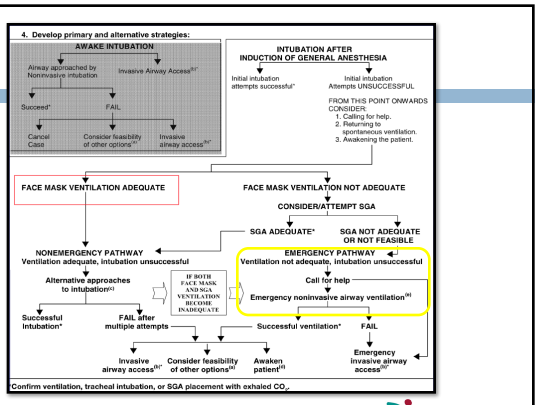

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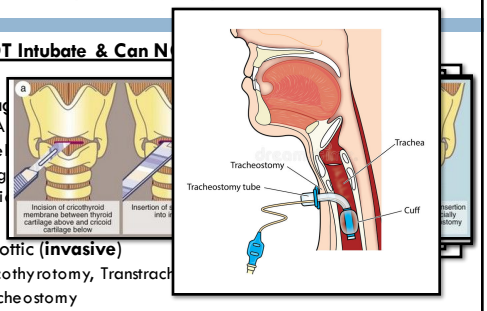
Emergency Pathway

Can NOT Intubate & Can N

- Supra
  - LMA
  - *i*-ge
  - King
  - Rigi
- Subglottic (**invasive**)
  - Cricothyrotomy, Transtrach
  - Tracheostomy
- **Consider ECMO?**



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Take Home Message

- Planning is everything
- Don't burn your bridges
- Always proceed with caution
- **Always call for more help!**

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Thank you very much for the opportunity to share with you today!

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