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

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

Differences

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

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
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

Funneled shape larynx

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

Potential Airway Issues

- Apnea
- Asthma / Reactive airway disease / Upper respiratory infection
- Obesity (BMI)
- Tonsil / adenoid hypertrophy
- Swallowing problems
- Severe reflux
- Syndromes (Down, Pierre Robin, Marfan’s, Mucopolysaccharidoses)
- Tracheal / laryngomalacia
- Prior tracheostomy
- Vascular ring
- Cerebral palsy / other conditions of muscle weakness
- Prior tracheostomy
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 O₂
- Irregular breathing / apnea
- Altered consciousness / agitation
- Inability to lie down
- Diaphoresis

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

Oropharyngeal Airway

SIZE

PROPER POSITION
Endotracheal Tube

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

Abnormal Pediatric Airway

1. Congenital Neck Masses
   - Dermoid cysts, cystic teratomas, cystic hygroma, lymphangiomas, neurofibromas, lymphomas, hemangiomas

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, Goldenhar’s, Apert, Adrenal hypoplasia, Crouzon

4. Inflammatory
   - Epiglottitis, acute tonsillitis, peritonsillar abscess, supraglottic abscess, laryngotracheobronchitis, bacterial tracheitis, adenoidal hypertrophy, and tonsillar congestion, juvenile rheumatoid arthritis

5. Traumatic / Foreign Body
   - Burn, laceration, lymphpathic/vascular obstruction, fracture/dislocation, inhalational injury, post-intubation group (edema), swelling of uvula

6. Metabolic
   - Congenital hypothyroidism, mucopolysaccharidosis, Beckwith-Wiedemann syndrome, glycogen storage disease, hypercalcemia, laryngospasm
**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, obstruction of 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, glossoptosis
- Severe respiratory and feeding difficulties
- Associated with OSA, otitis media, hearing loss, speech defect, palmar 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-oesophageal fistula, duodenal stenosis, diastolic pulmonary infection, seizures, and acute lymphocytic leukemia
- Atlanto-occipital dislocation can occur during intubation due to congenital laxity of ligaments

Inflammatory

- 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, rash, retching, 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% O₂ with tightly fitting mask)
- Employ the “Laryngospasm Maneuver”
- If laryngospasm persists and hypoxia develops, administer Succinylcholine (0.25 - 1 mg/kg)

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 process and induces laryngeal relaxation.

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

Definition

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

Predictors

- **Difficult Ventilation**
  484 children
  1. 0-8 yo
  2. 8.5% incidence
  3. Younger age
  4. ENT surgery
  5. Neuromuscular blockade

- **Difficult Intubation**
  11,200 patients
  1. Neonate to adolescent
  2. 1.35% incidence

Mallampati Score
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 vs. initial approach to intubation
   - Preservation vs. ablation of spontaneous ventilation
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

Non-Emergency Pathway

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

Laryngoscopy
Laryngoscopy

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

Fiberoptic Bronchoscopy

Air-Q LMA
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

Shikani Scope

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

LMA and Fiberoptic Scope

**Case series**
- 5 neonates
- 2.8-3.5 kg
- Awake LMA insertion
- Fiberoptic scope through LMA
- GA after ETT
LMA and Fiberoptic Scopy

Glidescope

Pediatric Glidescope
Emergency Pathway

Can NOT Intubate & Can NOT Ventilate

- Supraglottic (non-invasive)
  - LMA
  - i-gel
  - King
  - Rigid
- Subglottic (invasive)
  - Cricothyrotomy, Tracheostomy
  - Tracheotomy
- Consider ECMO?

Take Home Message

- Planning is everything
- Don’t burn your bridges
- Always proceed with caution
- Always call for more help!
Thank you very much for the opportunity to share with you today!

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