Pediatric Airway Emergencies

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ASA Task Force on Management of the Difficult Airway - Definitions:

- **difficult airway** = the clinical situation in which a conventionally trained anesthesiologist experiences difficulty with mask ventilation, difficulty with tracheal intubation, or both.

- **difficult mask ventilation** = (1) inability of unassisted anesthesiologist to maintain SpO2 > 90% using 100% oxygen and positive pressure mask ventilation in a patient whose SpO2 was 90% before anesthetic intervention; or (2) inability of the unassisted anesthesiologist to prevent or reverse signs of inadequate ventilation during positive pressure mask ventilation.

- **difficult laryngoscopy** = not being able to see any part of the vocal cords with conventional laryngoscopy

- **difficult intubation** = proper insertion with conventional laryngoscopy requires either (1) more than three attempts or (2) more than ten minutes
Pediatric PeriOperative Cardiac Arrest (POCA) Registry

- Collects data from 63 large institutions to correlate perioperative pediatric deaths and anesthesia
- The majority are medication related cardiac deaths
- 1998-2003: Respiratory events increased from 20 percent to 27 percent.
- The most common event leading to cardiac arrest in this category was laryngospasm, followed by airway obstruction, inadequate oxygenation, inadvertent extubation, difficult intubation and bronchospasm.
Pediatric Airway Emergencies

- Infrequently encountered
- Stridor
- History and Physical Examination
- Multiple Etiologies
  - Congenital
  - Inflammatory
  - Iatrogenic
  - Neoplastic
  - Traumatic
Urgency

- Must assess the urgency of the situation
- Full and frank discussion of the risks with the parents (and child if appropriate) including tracheostomy and failure to secure the airway
Anatomy

- Infant larynx:
  - More superior in neck
  - Epiglottis shorter, angled more over glottis
  - Vocal cords slanted: anterior commissure more inferior
    - Vocal process 50% of length
    - Larynx cone-shaped: narrowest at subglottic cricoid ring
    - Softer, more pliable: may be gently flexed or rotated anteriorly
- Infant tongue is larger
- Head is naturally flexed
History

- Assess the urgency of the situation
- Simultaneous History and Physical
  - Choking
  - Aggravating factors
    - Feeding, sleeping, positioning
  - Throat or neck pain
  - Birth history
    - Prenatal
Signs of impending respiratory failure

- Increased respiratory rate
- Nasal flaring
- Use of accessory muscles
- Cyanosis
Physical Examination

Stridor

- **Stertor**
  - Bulky oropharyngeal noise
  - Inspiratory, expiratory, or both

- **Supraglottic**
  - Inspiratory

- **Glottic**
  - Inspiratory progressing to biphasic

- **Subglottic**
  - Inspiratory progressing to biphasic

- **Tracheal**
  - Expiratory
Flexible Laryngoscopy:

- Proper Equipment
- Assess nares/choanae
- Assess adenoid and lingual tonsil
- Assess TVC mobility
- Assess laryngeal structures
Radiology:

- **Plain films:**
  - Chest and airway AP and lateral
  - Expiratory films
Airway Fluoroscopy

- Quick, noninvasive, and dynamic study
  - Supraglottic: 33%
  - Glottic: 17%
  - Subglottic: 80%
  - Tracheal: 73%
  - Bronchial: 80%
- Far superior to plain films
- Disadv: radiation exposure
  - 10 rads (0.1 Gy) per 1 minute

- Supraglottic: 33%
- Glottic: 17%
- Subglottic: 80%
- Tracheal: 73%
- Bronchial: 80%
MRI/CT

- Usually not useful in an acute setting
- More reliable for evaluating neck masses and congenital anomalies of the lower airway and vascular system
Treatment Options

- Heliox
- Oral Airways
- Intubation
  - Endotracheal
  - Laryngeal Mask
- Tracheostomy
- EXIT procedure
Heliox

- Graham’s Law: flow rate is inversely proportional to the square root of its density
- Helium 7x less dense than Nitrogen
- Shown to be effective in upper airway obstruction, viral croup, postextubation stridor
Heliox

- Gosz et al:
  - Immediate positive response in 73% of patients
  - Average duration of treatment 15min to 384 hours (overall mean of 29.1hrs)
  - Laryngotracheobronchitis were more likely to respond than other causes. (other causes were upper airway obstruction, postextubation stridor, congenital heart disease)
Endotracheal Intubation

- Multicenter study
- 156 out of 1288 total ED intubations
  - Rapid Sequence Intubation (81%)
  - Without medications (16%)
  - Sedation without neuromuscular blockade (6%)
- Overall successful intubations
  - RSI 99%
  - Non RSI 97%
- Only 1 out of 156 required surgical intervention
Rapid Sequence Intubation

- Recommended for every emergency intubation involving a child with intact upper airway reflexes by the Pediatric Emergency Medicine Committee of the American College of Emergency Physicians

- Simultaneous administration of a neuromuscular blockade agent and a sedative
Intubation

Rule of 4’s: Age+4/4 = ETT size

- Mucosal injury at 25cm of pressure. Therefore, always check for leak.

- Spontaneous ventilation:
  - allows for a limited examination of the dynamics of vocal cord motion.

- Apneic technique:
  - Turn to FiO2 100% prior to extubation.
  - 6L O2/min flow via laryngoscope
  - General rule to work apneic in a proportional amount of time as reoxygenation.
Laryngeal Mask Airway
Tracheotomy

- Cricothyroidotomy is difficult b/c of small membrane and flexibility
- Early complications
  - Pneumothorax, bleeding, decannulation, obstruction, infections
- Late complications
  - Granuloma, decannulation, SGS, tracheocutaneous fistula
EXIT Procedure
(ex utero intrapartum treatment)

- Prenatal diagnosis is crucial
  - Flattened diaphragms, polyhydramnios
- The head, neck, thorax, and one arm are delivered.
- Uteroplacental circulation can be maintained for 45-60 minutes
Specific Etiologies of Airway Emergencies

- Congenital Neck Masses
- Congenital anomalies
- Syndromic patients
- Inflammatory
- Foreign Bodies
Congenital Neck Masses

- Dermoid cysts
  - Mesoderm/ectoderm

- Teratoid cysts and teratomas
  - All 3 layers
  - 20% incidence of maternal polyhydramnios
Congenital Neck Masses

- Lymphangiomas
- Capillary, cavernous, cystic types
- More airway obstructive when found in the anterior triangle
CHAOS
(congenital high airway obstruction syndrome)

- Emergent airway management at the time of delivery is key for survival

- Prenatally
  - Flattened diaphragms, polyhydramnios, cervical mass

- TEAM Members
  - Maternal-fetal specialist
  - Neonatallogist
  - Anesthesiologist
  - Otolaryngologist
  - Patient
Laryngotracheobronchitis (Croup)

- Parainfluenza type 1
- Generalized mucosal edema of the larynx, trachea, bronchi
Laryngotracheobronchitis

Treatment

- **Humidification**
  - No scientific data to support
  - May worsen the situation

- **Racemic Epinephrine**
  - Reduces mucosal edema/bronchial relaxation

- **Steroids**
  - Systemic vs. Inhaled

- **Intubation**
Bacterial Tracheitis

- Complication of viral laryngotracheobronchitis
- Fever, white count, respiratory distress following a complicated course of croup
- Staphylococcus aureus
- Endoscopy and intubation
Acute Supraglottitis

- Mild URI that progresses over a few hours to severe throat pain, drooling, and fever
- H. influenza, parainfluenza
- Treatment
  - Intubation
  - Empiric Abx
Congenital Syndromes

- Close embryological development of the airways and the craniofacial structures
- Early complications are usually more profound
- Late complications may be more subtle
Congenital Syndromes and Airway Emergencies

- Syndromes of facial anomalies
  - Pierre Robin Sequence
  - Treacher Collins
  - Goldenhar/Hemifacial microsomia

- Deformities of skull shape
  - Crouzon’s/Apert’s
  - Pfieffer
Pierre Robin Sequence

- Micrognathia, relative macroglossia with or without cleft palate
- Intubation via the lateral tongue approach
- Tracheotomy
- Glossopexy
- Subperiosteal release of mandible
Treacher Collins

- Hypoplastic cheeks, zygomatic arches, and mandible;
- Microtia with possible hearing loss;
- High arched or cleft palate;
- Macrostomia (abnormally large mouth);
- Colobomas;
- Increased anterior facial height;
- Malocclusion (anterior open bite);
- Small oral cavity and airway with a normal-sized tongue;
Goldenhar & Hemifacial Microsomia

- Oculoauricular dysplasia
- Limited atlanto-occipital extension
Klippel-Feil

- Congenital fusion of any 2 of the 7 cervical vertebrae
- Short, immobile neck
Crouzon’s/ Apert’s

Abnormal closure of the cranial sutures

- Nasal cavity
- Nasopharyngeal stenosis - leads to OSA

- Associated anomalies
  - SGS
  - Tracheal sleeves

- Treatment
  - Nasal decongestants/stents
  - Selective adenoid/tonsillectomy
  - Tracheostomy
  - Midface advancement
Mucopolysaccharidoses

- Hunter’s, Hurler’s, Marateaux-Lamy
- Progressive infiltration of MPS within the airway structures

Treatment
- Tracheostomy
- Death by age 10-15
Down’s Syndrome

- Midface hypoplasia, macroglossia, narrow nasopharynx, and shortened palate.
- Immature immune system
- Tendency towards obesity
- GERD is very prominent
- Equals a very difficult patient to sedate and still maintain an airway
- Longer lifespan of these patients leads to an increase in the incidence of CHF and pulmonary hypertension secondary to OSA
Down’s Syndrome

- Mitchell et al.
- 23 Downs Patients
  - 48% OSA
  - 43% Laryngomalacia
- Systemic comorbidities
  - 61% GERD
- Cause of Upper airway obstruction is age related
  - <2yrs old: laryngomalacia is most common cause
    - Age dependent progression to OSA
  - >2yrs old: OSA is most common cause
    - Delay in diagnosis is common because symptoms overlap
Down’s Syndrome

- Jacobs et al.
- 55 of 71 patients underwent upper airway surgery (all had DL/B at the same time)
  - 44 T&A with pillar plication, 4 UPPP

- Overall:
  - 76% had significant or complete relief
  - 24% had moderate or severe residual symptoms

- Failures:
  - Greater number of obstructive sites
    - Laryngotracheal stenosis (23% of failures)
    - Tongue base
  - More severe UAO

- Recommendations:
  - Comprehensive preoperative airway evaluation
  - Tailor the surgical procedure for the site of obstruction
  - Close follow up for failures
Choanal Atresia

- Failure of the breakdown of the buccopharyngeal membrane
- McGovern Nipple and nasogastric feeding
- CHARGE association
  - Colobomas
  - Heart abnormalities
  - Renal anomalies
  - Genital abnormalities
  - Ear abnormalities
Foreign Bodies

- 2-4 year olds
- Acute episode of choking/gagging
- Triad of acute wheeze, cough and unilateral diminished sounds only in 50%
- 5-40% of patients manifest no obvious signs
Foreign Bodies

- Severity is determined by complete vs partial obstruction
- Peanuts are most common
- Right mainstem
  - Larger diameter
  - More airflow than left
  - Narrow angle of divergence
  - Carina sits on the left side
Foreign Bodies
Foreign Bodies

- **Plain radiography:**
  - 25% of bronchial lesions and >50% of tracheal lesions do not show up

- **Airway Flouroscopy:**
  - Above the carina: 32-40%
  - Below the carina: 80-90%

- **DL/B:**
  - Gold Standard
Airway Foreign Bodies