A Child with a Difficult Airway: What Do I Do Next?

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Why is the pediatric airway different from the adult airway?

The challenge inherent to the care of infants and children is the basic principle that their development is a dynamic process. This is an important consideration when caring for a pediatric patient with a difficult airway. This is compounded by the fact that growth and change has extra metabolic demands such that the smaller the patient, the higher their relative metabolism. This increases oxygen consumption and in the cases of respiratory compromise hastens the effects of apnea. It is for these reasons that the difficult pediatric airway is particularly demanding of special attention.

Anatomical Differences that Affect Visualization

The head and occiput of infants and young children is disproportionately large relative to the size of the torso. Therefore, the usual placement of a cushion under the head may or not be necessary to aid in the alignment of the axes of the mouth, pharynx and glottic opening. Also, the use of a small shoulder roll may or may not be helpful and positioning should be individualized to each patient. Some patients with craniofacial anomalies may not tolerate the supine position and may require induction of anesthesia and airway management in the elevated or lateral position.

The larynx is a more superior structure at the level of the third or fourth cervical vertebrae rather than the inferior location in adults. During laryngoscopy, this superior position of the glottis will make the airway appear to be more “anterior” from the oral point of view and it may be more difficult to align the three axes of the airway especially in a child with a difficult airway. The epiglottis is also larger relative to the size of the glottic opening and may obstruct the view of the vocal cords and passage of the endotracheal tube. The tongue is bigger relative to the size of the oropharynx that can make laryngoscopy more difficult. The absence of teeth in small children and infants does at least provide more room in the mouth for a laryngoscope or other airway device.

Physiologic Differences of the Respiratory System

Functional Residual Capacity (FRC) is determined by the balance of the tendency of the chest wall to expand and the lungs to collapse. The size of the FRC of infants and children is directly related to age, weight and height. The smaller FRC is due to the fact that the chest wall is not fully formed into bone from cartilage and that the lung us less compliant until the age of five to eight years. Until this time, the connective tissue, elastin is still maturing in the lung. Additionally, the work of breathing is greater as the box-shaped chest of infants is characterized by the ribs at right angles to the vertebral bodies, so that the effects of respiratory distress and/or anesthesia is exacerbated.

Oxygen consumption is inversely related to age as required by the metabolic demand of growth. Apnea under this circumstance requires much more rapid resolution to avoid the complications of hypoxia. Another important consideration is that the great majority of pediatric patients have not reached an emotional/behavioral stage where they can be compliant or cooperative with the health care practitioner and are usually unwilling participants requiring deeper sedation if not general anesthesia for the same interventions performed in adults accomplished with a lighter level of sedation. Depending also on age and co-morbidities such as developmental delay, the pharmacodynamics of anesthetic agents may be unpredictable, exaggerated or may have paradoxical effects. Together, these factors lead to a higher risk of apnea in pediatric patients with less oxygen reserve while a definitive airway is established.
Lastly, the American Society of Anesthesiologists Difficult Airway Algorithm may require some modification for use in pediatric patients especially infants. The techniques available for surgical rescue of the unanticipated airway may be limited when compared to adults. For instance, there are case reports of trans-tracheal jet ventilation in this age group, but as of the writing of this document, none reported emergently. Additionally, in a study of the trachea in infant cadavers it was found that the neonatal cricothyroid membrane is too narrow to accommodate even a 2.0 mm I.D endotracheal tube.

Selected Pediatric Syndromes Associated with a Difficult Airway: Facial/Anatomic Considerations

Apert’s Syndrome
- Craniosynostosis,
- Mid-face hypoplasia
- Symmetrical syndactyly of hands and feet

CHARGE
- (Ocular) Coloboma
- Heart (Defects)
- (Choanal) Atresia (or Stenosis)
- (Growth/Developmental) Retardation
- Ear (abnormalities)
  - Also:
    - Cranial nerve dysfunction
    - Orofacial cleft
    - Tracheoesophageal fistula

Goldenhar
- Hemifacial microsomia
- Auricular anomalies

Klippel-Feil
- Short neck
- Limitation of head and neck movements
- Low posterior hairline

Mucopolysaccharidoses
- Accumulation of mucopolysaccharides in connective tissues including the head, neck and airways
- Narrowed Nasal Airway
- Large Tongue
- Short and Immobile Neck
- Thickened Glottis and Tracheobronchial Tree

Nager
- Bilateral Mandibular Hypoplasia
- Malar Hypoplasia
- Downward Sloping of Palpebral Fissures
- High-Arched hard Palate
- Absent Soft Palate
- External Auditory and Middle Ear Abnormalities
- Bilateral Hand Deformities

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Pierre Robin Sequence\textsuperscript{12}
- Micrognathia
- Cleft Palate
- Glossoptosis

Treacher Collins\textsuperscript{13}
- Bilateral mandibular Hypoplasia
- Zygomatic Hypoplasia
- Downward Sloping of Palpebral Fissures
- External Auditory and Middle Ear Abnormalities

### A Choice in Airway Management

One important similarity in the care of both adults and children is the distinctive management of the airway that is amenable to mask ventilation with difficult intubation from the difficult mask ventilation and difficult intubation in the predicted difficult airway. A pre-induction estimation of the difficulty of mask ventilation may be a guide that anesthetization of the airway should be used along with sedated intubation versus intubation following the induction of general anesthesia. There appear a number of accepted predictors of the difficult airway in adults. Conversely, in infants and children, other than the known syndromes such as those listed previously, an obviously small mouth or airway obstruction, there is little objective evidence on the prediction of a difficult airway. There are few studies in infants and in children (one predicting the airway in Goldenhar/hemifacial microsomia), but no consistent guidelines specifically for pediatric patients.\textsuperscript{6,14} This is compounded by the fact that these patients are often uncooperative with airway examination as stated earlier.

#### Sedated Intubation

For a plan of sedated intubation with a patient spontaneously breathing, topicalization is entirely possible, even in neonates, and will aid in sedated intubation possibly allowing for less intravenous anesthetic medications. If topicalization of the airway is desired, a number of approaches have been described, similar to the use of local anesthetic in adults. Nebulization, atomization and regional anesthesia of the airway can be used.\textsuperscript{15} An important consideration is the limiting of the amount of local anesthetic to avoid toxicity in small patients. If a fiberoptic scope is to be used, sizes 2.8 mm O.D. and above will have a side-port in most circumstances for use in the installation of oxygen and to spray additional local anesthetic on the vocal cords and in the trachea once those structures are visualized. Unfortunately, the 2.5 mm O.D. and smaller scopes do not have side ports due to the size limitations. Both the 2.8 mm O.D. and 2.5 mm O.D. will fit through a 3.0 mm I.D. endotracheal tube, but it will be necessary to remove the endotracheal tube connector before placing the tube on the fiberoptic scope.

A number of medications for use in children have been described in the literature including propofol, opioids, benzodiazepines, ketamine and dexmedetomidine.\textsuperscript{16,17,18}

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<th>Advantages</th>
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<th>Opioid</th>
<th>Benzodiazepine</th>
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<td>Quick Onset/Offset IV Requires</td>
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<th>Disadvantages</th>
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<td>Apnea Hypotension</td>
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<td>Low Potency</td>
<td>Nausea/Vomiting Dysphoria Long Half Life Sialagogue</td>
<td>Bradycardia Long Half Life Low Potency</td>
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Intubation under General Anesthesia

If a general anesthetic with an inhalation induction with an agent such as sevoflurane has been selected for the predicted difficult airway and spontaneous ventilation is maintained, a nasopharyngeal device (endotracheal tube or standard nasopharyngeal airway with an endotracheal tube connector) may be placed and attached to the anesthesia circuit. Inhalation anesthesia can continue along with oxygen as can monitoring of carbon dioxide from the hypopharynx while a definitive airway is established though the other nostril or orally. The advantage is the maintenance of anesthetic depth and oxygenation and continuous monitoring for apnea as opposed to intermittent mask ventilation between intubation attempts.

The unpredicted difficult airway in pediatric patients is especially challenging for the reasons outlined earlier especially due to the decreased reserve in oxygen in the scenario of difficult mask and difficult intubation. A review of 100 pediatric tracheotomies placed between 2004 and 2007 in a single institution found that a Laryngeal mask Airway (LMA) was a useful airway adjunct. Six of their patients were emergency tracheostomies, five of which could not be intubated and all of these were managed with an LMA or a facemask while the tracheostomy was established.

Pediatric Airway Devices

Beyond standard direct laryngoscopes and fiberoptic scopes, a number of supraglottic and intubation devices are now available specifically designed for use in infants and children. There have been two recent reviews of the equipment available at this time in 2009 and 2010 that would be recommended reading for those who care for infants and children. The options are continually being expanded and many are available in both pediatric and adult sizes. One recommendation that might be useful is to get familiarized with the larger sizes before attempting the smaller versions depending on the scope of one’s practice.

Extubation

Extubation of pediatric patients with a known difficult airway may also be fraught with the peril of airway obstruction. A number of reports have been published using various devices in innovative ways as an exchange catheter in preparation for a potential re-intubation (non-FDA approved) such as ureteral stent guidewire and a guidewire sheath adapted to the size needs of a pediatric patient. Also conversion from oral intubation to nasal intubation in children has also been described. Lastly, in a review of 20 intubated children, an airway exchange catheter was a successful bridge to extubation or re-intubation. Re-intubation was accomplished using the airway exchange catheter as a guide to re-pass the endotracheal tube.
References


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