Pediatric Airway Management

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KEYWORDS

• Pediatric assessment triangle • Position • Suction
• Oxygen • Delivery • Airway management

Pediatric airway problems are seen commonly in pediatric and general emergency departments; in fact, several studies have shown respiratory distress to be the fourth most common chief complaint in children presenting to the emergency department.[1,2] Furthermore, airway management often is required in children who have other presenting complaints such as trauma and seizures. The peak age of respiratory distress in children is under 2 years of age, an age at which the airway is significantly different from an adult airway.[1,2]

Management of the pediatric airway is often stressful to providers. One reason is that while management of an adult airway is familiar to emergency medicine physicians, management of the pediatric airway is a less frequent but more complex process. The wide variation in equipment sizes and medication doses adds additional steps in airway management. Dose and equipment size calculations are nonautomatic activities that require mental effort.[3] This cognitive activity takes away from the time spent on patient assessment and management decisions.

This article reviews the pediatric airway, highlighting the anatomic and physiologic differences between infant, pediatric and adult airways, and how these differences impact assessment and management of the pediatric airway.

ANATOMIC AND PHYSIOLOGIC DIFFERENCES

Significant differences exist between neonatal and adult airways. As children grow, their airways adopt a form more similar to adults. In general, by the age of 8, the airway is very similar to an adult airway.

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Emerg Med Clin N Am 26 (2008) 961–975
doi:10.1016/j.emc.2008.08.004 **emed.theclinics.com**
0733-8627/08/$ – see front matter

Several of these airway differences make infants and young children susceptible to upper airway obstruction. Infants and young children have a relatively large occiput. When lying supine on a flat surface, this results in neck flexion and potential airway obstruction. The increased soft tissue and the flexible trachea can result in pressure on the tracheal rings and airway obstruction. External pressure such as cricoid pressure can cause tracheal collapse and airway obstruction. Infants and young children also have a proportionally larger tongue within the oral cavity, which is a common cause of airway obstruction.

Other airway differences make infants and young children more susceptible to respiratory failure. Infants have a lower percentage of type 1 or slow-twitch skeletal muscle fibers in their intercostal muscles and diaphragm.[4] Type 1 muscle fibers are less prone to fatigue. Infants also have lower stores of glycogen and fat in their respiratory muscles.[5] These differences predispose infants to respiratory muscle fatigue. Furthermore, young infants preferentially breathe through their noses,[6,7] and during oral breathing, must use soft palate muscles to maintain an open oral airway.[8]

Infants have more horizontal ribs and a flatter diaphragm than adults. They also air trap because of their high respiratory rate. Although this increases their functional residual capacity, it also means that they are less able to increase their tidal volume to compensate for changes in respiratory rate or increased oxygen demand. Because minute ventilation equals respiratory rate multiplied by tidal volume, infants must increase minute ventilation by increasing their respiratory rate. There is a limit, however, to the increase in respiratory rate before tidal volume is compromised. These factors are further reasons infants have less reserve and are more susceptible to respiratory failure.

Awake infants have 40% of the functional residual capacity of adults.[9] This functional residual capacity is achieved, however, because they hold their respiratory muscles in a slightly inspiratory position.[10] Because infants have a compliant chest wall, decreased muscle tone in deep sleep and sedated states lead to a significantly decreased functional residual capacity. During an apneic state, an infant has only 10% of the functional residual capacity of an adult.[9] This decreased functional residual capacity means that infants have less oxygen available in their lungs for gas exchange during exhalation or apnea. Infants have a higher metabolic rate than adults and metabolize at least 6 mL of oxygen per minute, while adults metabolize only 3 mL of oxygen per minute.[9] In addition, term newborn infants have only half of the alveoli seen in an adult.[11] All of these factors cause infants to desaturate much more quickly than adults during periods of apnea.

The child's relatively smaller airway results in increased airway resistance, making infants and children more prone to respiratory failure. Poiseuille's law of resistance demonstrates this. Resistance is inversely proportional to the radius to the power of four ($R \propto 1/r^4$). Therefore, small changes in airway diameter have a large impact on overall airway resistance.

Some pediatric airway differences are especially important to understand to increase likelihood of successful endotracheal intubation. These differences include the relatively large tongue within the oral cavity, the high and anterior airway, and the more acute angle between the tracheal opening and the epiglottis. These differences can make visualization of the airway and manipulation of the endotracheal tube (ETT) tube more difficult in children.

Another difference is that in adults, the narrowest diameter of the airway is at the vocal cords, while in children, the narrowest diameter is at the cricoid ring. This means that an ETT may fit through the vocal cords but be too large to pass through the cricoid ring in a child. In addition, a foreign body can be lodged below the level of the vocal

cords in a child, necessitating either basic life support maneuvers to dislodge it into the oropharynx, or a surgical airway to bypass the obstruction.

ASSESSMENT

Assessing the child for signs respiratory distress or failure can be challenging. One initial approach to assessment is the Pediatric Assessment Triangle (PAT).[12] The PAT is a brief visual and auditory assessment that is performed without touching the child. This initial brief assessment can be extremely helpful, because children often become frightened and agitated when approached by a medical provider and may be difficult to assess. The PAT is an assessment of appearance, work of breathing, and circulation to the skin. The TICLS mnemonic summarizes a brief assessment of overall appearance: tone, interactiveness, consolability, look/gaze and speech/cry. After an assessment of general appearance, the work of breathing should be assessed, focusing on audible airway sounds and visual clues to increased work of breathing. The last component of the PAT is the circulation to the skin, looking for pallor, mottling, and cyanosis. The PAT can be completed in less than 30 seconds and determines if immediate resuscitation is necessary. **Table 1** outlines how abnormalities in the triangle may be used to create a general impression of the physiologic abnormality. This impression then drives immediate management priorities (**Box 1**). Once the PAT is completed, if immediate resuscitation is not required, a more complete assessment can be done (**Fig. 1**).

The complete assessment of the pediatric airway includes visual inspection of the child and assessment of respiratory rate, oxygen saturation and auscultation. The resting posture can provide important clues to level and cause of respiratory distress. A sniffing position is indicative of upper airway obstruction; the child leans forward in an attempt to open the upper airway and improve airflow. Another concerning posture is the tripod position. The child leans forward on outstretched arms to maximize use of accessory muscles of respiration. A child who refuses to lie down may be attempting to maintain a compromised airway. An obviously agitated child may be hypoxic.

Particular attention should be paid to use of accessory muscles of respiration. Retractions are a commonly seen sign of respiratory distress, in which skin and soft tissue are drawn inward during respiration. Retractions can occur in the substernal, intercostal, supraclavicular, and suprasternal areas. Because retractions can occur in any of these areas, it is important to undress the child for a complete assessment. Nasal flaring is another form of accessory muscle use and represents exaggerated

Table 1
Components of the Pediatric Assessment Triangle and the general impression

Stable	Respiratory Distress	Respiratory Failure	Shock	Central Nervous System/Metabolic	Cardio-Pulmonary Failure
Appearance					
Normal	Normal	Abnormal	Normal/ abnormal	Abnormal	Abnormal
Breathing					
Normal	Abnormal	Abnormal	Normal	Normal	Abnormal
Circulation					
Normal	Normal	Normal/ abnormal	Abnormal	Normal	Abnormal

Box 1
Management priorities by general impression

Stable
- Continue assessment
- Specific therapy based on possible etiologies

Respiratory distress
- Position of comfort
- Supplemental oxygen/suction as needed
- Specific therapy based on possible etiologies: (albuterol, diphenhydramine, epinephrine)

Respiratory failure
- Position the head and open the airway
- Provide 100% oxygen
- Initiate bag–mask ventilation as needed
- Initiate foreign body removal as needed
- Advanced airway as needed

Shock
- Provide oxygen as needed
- Obtain vascular access
- Begin fluid resuscitation
- Specific therapy based on possible etiologies

Central nervous system/metabolic
- Provide oxygen as needed
- Obtain rapid glucose as needed
- Specific therapy based on possible etiologies

Cardiopulmonary failure/arrest
- Position the head and open the airway
- Initiate bag–mask ventilation with 100% oxygen
- Begin chest compressions as needed
- Specific therapy as based on possible etiologies (defibrillation, epinephrine, amiodarone)

nostril opening during respiratory distress. Nasal flaring is an attempt to decrease airway resistance. Another form of accessory muscle use seen in infants who have severe respiratory distress is head bobbing. In head bobbing, the neck muscles are used to increase inspiratory pressure. The neck is extended during inhalation and relaxed during exhalation.

Abdominal breathing can be normal in young infants but may become exaggerated during respiratory distress. Paradoxical breathing or chest collapse during inspiration can be seen in infants. This occurs because, as high negative intrathoracic pressure is generated, the compliant chest wall is pulled inward. An ominous sign of impending respiratory failure is seesaw breathing. Seesaw breathing is a combination of

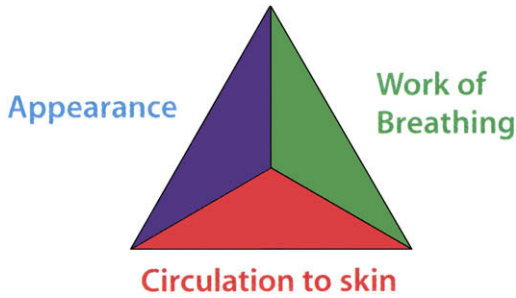

Fig. 1. The Pediatric Assessment Triangle components: appearance, work of breathing, and circulation to skin. (*From* Dieckmann RA. Pediatric assessment. In: Gausche-Hill M, Fuchs S, Yamamoto L, editors. APLS: the pediatric emergency medicine resource. 4th edition. Sudbury (MA): Jones and Bartlett; 2004. p. 25; with permission.)

paradoxical respiration and abdominal breathing. The chest retracts during inspiration and the abdomen bulges out; the converse happens during exhalation. Seesaw breathing is an ineffective form of breathing, and the infant is likely to fatigue quickly.

Resting respiratory rate should be assessed before disturbing the child (**Box 2**). Infants frequently have periodic breathing, so it is important to count respirations over a full minute and frequently reassess respiratory rate.[13] Oxygen saturation also should be measured.

Both audible and auscultated respiratory sounds can provide clues as to cause of respiratory distress. Expiratory wheezing is a very common sign of respiratory distress. This high-pitched sound is made during attempts at exhalation against an intrathoracic airway obstruction. The obstruction can be intrinsic such as airway constriction caused by asthma, extrinsic such as a mass or vascular structure compressing the airway, or caused by a foreign object within the airway. Wheezing can occur in both inspiratory and expiratory phases with severe obstruction. Wheezing generally is heard only with a stethoscope, but in severe cases, it may audible without a stethoscope.

Inspiratory stridor is a high-pitched sound that is caused by turbulent air flow across an extrathoracic airway obstruction. Causes of stridor include laryngotracheobronchitis (croup), retropharyngeal abscesses, and upper airway foreign bodies. Changes in the quality of voice or cry can be another clue to the cause of respiratory distress.

Box 2
Normal respiratory rates in infants and children

Neonates—24 to 50 breaths per minute

1 month to 1 year—24 to 38 breaths per minute

1 to 3 years—22 to 30 breaths per minute

4 to 6 years—20 to 24 breaths per minute

7 to 9 years—18 to 24 breaths per minute

10 to 14 years—16 to 22 breaths per minute

14 to 18 years—14 to 20 breaths per minute

Data from Loughlin CE. Pulmonology. In: Robertson J, Silkofski N, editors. The Harriet Lane handbook. 17th edition. Philadelphia: Elsevier; 2005. p. 613–30.

A muffled or hot potato voice might indicate a retropharyngeal or peritonsillar abscess. Laryngotracheobronchitis usually causes a hoarse voice and cry. Snoring noises may be a clue to partial airway obstruction from the tongue falling back into the posterior oropharynx as may be seen in seizing patients. Gurgling sounds can be an indication of blood or secretions in the airway.

Another sign of respiratory distress is grunting. Grunting is the sound produced when an infant exhales against a partially closed glottis and serves to increase end–expiratory pressure. It is seen frequently in alveolar diseases such as pneumonia and pulmonary edema and in diseases of the small airways such as bronchiolitis.[10]

Once a child in severe respiratory distress fatigues, many of these signs of respiratory distress diminish. Disappearance of retractions or slowing of respiratory rate in a child previously noted to be in severe respiratory distress can be an ominous sign of fatigue and impending respiratory arrest.

MANAGEMENT OF THE PEDIATRIC AIRWAY

Airway management should proceed in an orderly, stepwise fashion. Timely basic airway maneuvers may prevent the need for intubation and mechanical ventilation. Even when intubation is required, the early steps of airway management remain important. Successful intubation is difficult or impossible if the early steps of proper positioning and suctioning are omitted.

Airway Positioning

The first step in airway positioning is to place the head in a midline sniffing position with the neck extended and chin lifted. This can be accomplished with a head lift and chin tilt in medical patients. If there is any concern about cervical spine injury, a jaw thrust is preferred. The prominent occiput of young children impacts ideal head positioning. To counteract the natural neck flexion seen in children, a towel roll should be placed under the shoulders of the child (**Figs. 2** and **3**). Proper positioning opens the airway and improves ventilation. In some patients, proper positioning is all that is needed to correct respiratory distress. If intubation is required, proper positioning can improve visualization of the vocal cords.

Supplemental Oxygen

Supplemental oxygen should be provided to children in respiratory distress. Choice of oxygen delivery device depends on the situation and degree of respiratory distress. In a child who has mild hypoxia, a simple nasal cannula may be sufficient. A child who is fighting the oxygen delivery device vigorously can increase his or her oxygen demand. In an awake, agitated child, blow-by oxygen sometimes is tolerated better and might be a better choice. In cases of moderate hypoxia, a simple facemask might be more appropriate. In moderate-to-severe hypoxia, or if preoxygenation for intubation is desired, a nonrebreather mask is preferred.

Suction

Because infants preferentially breathe through their noses, obstruction of the nares with secretions can lead to severe respiratory distress. Suctioning the nose can improve the respiratory status of a young infant with bronchiolitis or an upper respiratory infection dramatically.

Excessive secretions can pool in the posterior oropharynx and cause airway obstruction. This is especially true in cases of oral or nasal bleeding, bronchiolitis,

Fig. 2. Infant with neck in flexed position and partial airway obstruction.

or seizures. Suctioning is important to decrease obstruction and to improve visualization during laryngoscopy.

Airway Adjuncts

As discussed previously, infants and young children have a proportionally larger tongue than adults. This large tongue is a common cause of airway obstruction, especially in children who are seizing, postictal, or obtunded. Placement of a nasal or oral airway can reverse this obstruction. Oral airways should be used only in comatose patients without a gag reflex. The appropriate size of oral airway can be determined by holding the airway along the side of the child's face. The flange should be placed at the corner of the mouth, and the tip should reach the angle of the mandible (**Fig. 4**). Nasal airways can be placed in awake or semiconscious patients, but they cannot be used if there is possible basilar skull fracture, cerebrospinal fluid (CSF) leak, or coagulopathy. Nasal airways should be placed cautiously in young infants, because the large

Fig. 3. Infant positioned with roll under shoulders to maintain a patent airway.

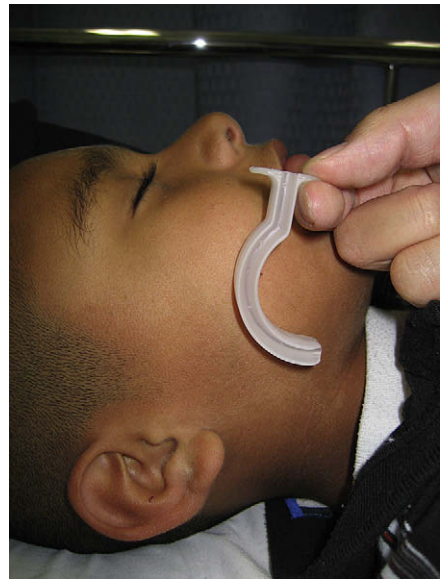

Fig. 4. Measuring correct length of oral airway.

adenoids and tonsils can be traumatized during insertion, resulting in bleeding. The nasal airway should be inserted with the bevel pointed away from the nasal septum to minimize risk of bleeding. Correct length can be determined by placing the airway along the side of the face extending from the nostril to the tragus of the ear, and the width of the nasopharyngeal airway should be less than that of the nostril (**Figs. 5** and **6**).

Bag–Mask Ventilation

Care must be taken to avoid compression of the soft tissues of the neck in young children during bag–mask ventilation (BMV). The provider should hold the jaw and avoid compressing the submental soft tissues. In young children, the airway can be compressed easily, or the tongue can be pushed up into the airway, causing an obstruction. One technique of BMV taught is the E-C clamp[14] (**Fig. 7**). In this technique the thumb and index fingers of the left hand form a C that holds the mask on the child's face. The other three fingers form an E and are placed on the angle of the jaw to lift the jaw into the mask. The right hand is free to squeeze the ventilation bag to deliver respirations.

Care must also be taken not to overventilate young children. The bag should be squeezed only until chest rise is seen. Normal tidal volume is 6 to 8 mL/kg, but with dead space of the device, one can estimate the volume needed to initiate chest rise as 10 mL/kg. Using this estimate, a 10 kg 1- year-old child requires only 80 to 100 mL per breath. This is equivalent to 6 tablespoons of air. Overventilation can lead to gastric distention and emesis or difficulty ventilating because of an elevated hemi-diaphragm. Time allowed for passive exhalation should be longer than inspiratory time. One method that is taught to prevent the likelihood of overexpansion of the chest and allow adequate exhalation time during BMV ventilation is to say ''squeeze-release-release'' while bagging. The ventilation bag is squeezed only until chest rise is initiated, while the provider

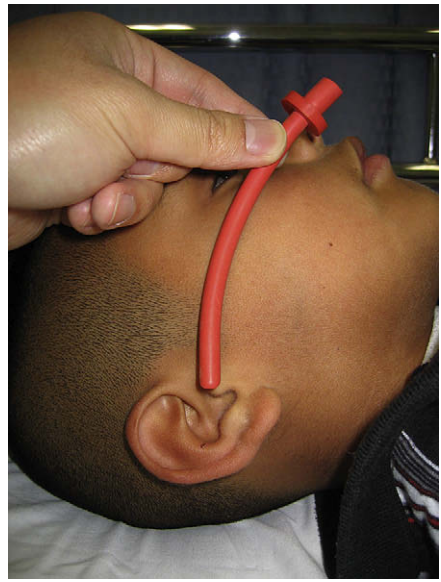

Fig. 5. Measuring correct length of nasal airway.

says "squeeze," and then the provider's hand relaxes to allow for the bag to re-expand during exhalation as the provider says "release, release."[14]

During rapid sequence intubation, gentle cricoid pressure should be maintained from the time of chemical paralysis until endotracheal intubation is confirmed. Children have flexible tracheal rings that can be collapsed if excessive pressure is applied

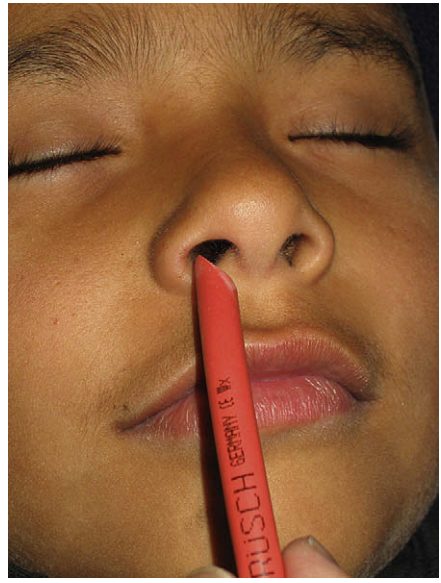

Fig. 6. Measuring correct width of nasal airway.

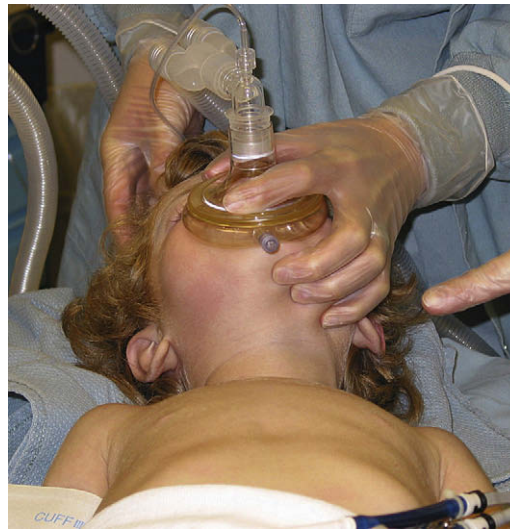

Fig. 7. E-C clamp method of ventilating patient with a bag-valve mask. Notice that the physician is lifting jaw into mask.

during the Sellick maneuver. Care must be taken to avoid obstructing the tracheal lumen or distorting airway landmarks with excessive pressure; if the intubator cannot visualize the airway (only pink mucosa is seen), it may be that excessive cricoid pressure is being used.

Endotracheal Intubation

One challenge in intubating children is determining the appropriate size of equipment. Equipment sizes are listed on length-based resuscitation tapes. If a length-based tape is not available, uncuffed ETT size can be estimated by the equation (age in years/4) + 4. This age-based formula has been shown to be more accurate than methods estimating ETT size based on width of the patient's fifth finger.[15] Cuffed ETT size can be calculated from the equation[16] (age in years/4) + 3 or one half size smaller than the calculated cuffed ETT diameter. Correct depth of insertion is approximately three times the uncuffed ETT size. Determining tube size for premature neonates can be challenging. **Table 2** provides an easy way to remember ETT size and depth of placement for these small infants.

Conventional teaching is that cuffed tubes should not be used in children under the age of 8 because of the risk of ischemic damage to the tracheal mucosa from compression between the cuff and the cricoid ring. This is a potential problem in young children, because the cricoid ring is the narrowest portion of the airway. However, because the design of modern ETTs has improved, it is less of a risk than previously thought.[17] ETT cuffs now are designed to be high-volume and low-pressure and produce a seal at a lower pressure. The use of cuffed tubes in young children is increasing, especially in emergency departments and pediatric ICUs.[17] Several studies have not shown an increase in postextubation stridor or reintubation rates when cuffed tubes were used in controlled settings with frequent cuff pressure monitoring.[16–18] Cuffed tubes also may provide some protection from aspiration.[19] Potential benefits of cuffed ETTs are facilitating ventilation with higher pressures, more consistent ventilation, and decreased need to exchange inappropriately sized ETTs.

Table 2
Endotrachial tube size and depth for premature newborns

Weight (kg)	Endotrachial size (mm internal diameter)	Depth of placement (cm)
Less than1	2.5	7
1-2	3.0	8
2-3	3.5	9

Care must be taken not to over inflate the cuff of a cuffed ETT.[17] A pressure of 20 mm H_2O is sufficient to provide a seal, but does not compromise mucosal blood flow.[20] Tracheal mucosal blood flow is compromised at 30 cm water pressure, and mucosal blood flow is completely obstructed at pressures of 45 cm water.[21] There is evidence that experienced physicians are unable to accurately estimate cuff pressure by palpating the pilot balloon and routinely inflate ETT cuffs to unsafe pressures in adults.[22,23] In one study of emergency medicine attending physicians, the average inflation pressure was over 90 cm water.[22] Use of an ETT cuff manometer can avoid high cuff pressures.[22–24] The advantages of uncuffed ETTs are that the risk of cuff overinflation with resultant tracheal damage does not exist, and a larger internal diameter ETT can be placed.

Choosing the correct size laryngoscope blade is critical to successful endotracheal intubation (**Table 3**). Macintosh (curved) blades primarily are used in older children and adults. The Macintosh blade is placed in the vallecula, lifting the base of the tongue and indirectly lifting the epiglottis. In infants and young children who have a larger, floppy epiglottis, this often does not provide adequate exposure of the airway. In this age group, Miller (straight) blades are preferred, because they directly lift the epiglottis and improve visualization of the vocal cords. Miller blades generally are used until about the age of 5, although they could be used in any age child. Another straight blade that can be useful in managing the pediatric airway is the Wis-Hipple blade. The Wis-Hipple blade has a widened distal tip that can be useful in controlling a large tongue and epiglottis. It is manufactured in a size 1.5, which is a convenient size for use in toddlers. Miller 0 blades should be used only in premature infants and average-sized newborns. A Miller 1 blade is appropriate for most infants beyond the immediate newborn period.

Because young children have an acute angle between the tracheal opening and epiglottis, correct placement of the laryngoscope blade is more important to ensure adequate visualization of the glottic opening. Exact depth of ETT insertion is more critical in young children than in adults, because the short trachea predisposes to accidental ETT dislodgement or right mainstem intubation. The proper depth of ETT placement is listed on the Broselow-Luten or length-based resuscitation tape.

Table 3
Laryngoscope blade size

Age	Weight (kg)	Laryngoscope Blade Size
Premature/newborn	1–3	Miller 0
1 month to 2 years	3.5–12	Miller 1, Wis–Hipple 1.5
3–6 years	15–20	Miller 2 McIntosh 2 (by age 5 years)
6–12 years	20–35	Miller 2, McIntosh 2 or 3
>12 years	>35	McIntosh 3

Alternatively, proper depth of ETT can be estimated by multiplying the size of the ETT by three; for example a 3.5 mm ETT should be placed at 10.5 cm at the lip.

The keys to successful intubation are following a standard procedure each time, choosing the correct size equipment, initially placing the laryngoscope blade in just to the base of the tongue and lifting upward, and having an assistant pass the suction and the ETT to the laryngoscopist. The assistant also can pull on the right corner of the mouth to allow more room to maneuver the ETT. Caution should be exercised with use of Sellick maneuver in young infants, as too much pressure may result in collapse of airway structures during intubation. When intubating a newly born or small infant, one trick to improve visualization during laryngoscopy is for the intubating physician to use his or her own left fifth finger to provide cricoid pressure. This avoids excessive cricoid pressure and allows the intubating physician to easily manipulate the cricoid ring. This is especially helpful in the premature neonate, because minimal pressure can alter the laryngoscopic view dramatically. A jaw thrust maneuver also may be used to aid in visualizing airway structures during intubation.

Proper ETT placement always should be confirmed by multiple methods, including clinical assessment and the used of end–tidal CO_2 detectors. Clinical assessment begins with listening for breath sounds over the stomach. In infants and small children, however, breath sounds can be transmitted easily. If breath sounds are heard in the stomach, the ETT should not be removed immediately. Breath sounds may be transmitted to the stomach from the lungs. Gurgling sounds indicate esophageal intubation, and the ETT should be removed. Next listen for two breaths over the right hemithorax and then over the left hemithorax. Decreased breath sounds over the left hemithorax may indicate that the ETT is too deep.

In addition to these clinical indicators, an end–tidal CO_2 detector should be used to confirm proper ETT placement. Pediatric end–tidal CO_2 detectors are indicated for children weighing 2 to 15 kg. Standard adult end–tidal CO_2 detectors are indicated for children weighing over 15 kg. Adult end–tidal CO_2 detectors can be used in smaller children, but cannot be left in-line, because they cause excessive dead space.[25] Pediatric end–tidal CO_2 detectors can be used in larger children in adults but should not be left in-line, because they increase resistance in the circuit. The validity of end–tidal CO_2 detectors has not been studied in infants under 2 kg. End–tidal CO_2 detectors do not detect tracheal tube placement reliably in cases of low pulmonary blood flow such as cardiac arrest and massive pulmonary embolism.[25,26] Oxygen saturation must be monitored, but an initial drop in oxygen saturation sometimes is seen immediately following intubation. If all other indicators confirm endotracheal placement of the ETT, the ETT should be left in place and ventilation continued for several breaths. Because of decreased functional residual capacity, children can take longer than adults to recover after the lack of oxygenation during laryngoscopy.

Just as in adults, close monitoring of the patient must continue after successful intubation. If an intubated patient develops problems with oxygenation or ventilation, a useful reminder of potential problems is the DOPE mnemonic: dislodgement, obstruction, pneumothorax, and equipment. Dislodgement may be more common in young children because of the short tracheal length. ETTs with a small internal diameter are more prone to obstruction than the larger tubes used in adults. The first step in troubleshooting oxygenation or ventilation problems is to remove the patient from the ventilator and hand ventilate with 100% oxygen. This serves to rule out ventilator malfunction as a cause of the problem. Auscultation over the stomach and bilateral thoraces may reveal tube dislodgement. An end–tidal CO_2 should be checked to confirm ETT position. During hand ventilation, difficulty bagging may be

a clue to kinking of the ETT or obstruction with secretions. A suction catheter should pass easily down the ETT, and any secretions should be suctioned. If equipment failure, dislodgement, and obstruction are ruled out, pneumothorax must be considered. Because breath sounds can be transmitted, the presence of a pneumothorax may be more difficult to clinically diagnose in children. Poor perfusion may be the only sign of a tension pneumothorax in young children. If the child is in extremis, a needle thoracostomy can be performed. If the side of pneumothorax cannot be determined, the right side should be needled first, because the right lung is subjected to higher pressures and more likely to develop a pneumothorax from barotrauma. If the patient is not in extremis, and the cause of the problem is not obvious, a radiograph of the chest should be obtained to check for pneumothoraces or right mainstem intubation not appreciated on clinical examination.

Length-Based Resuscitation Tape

A length-based resuscitation tape should be used to determine appropriate sizes for equipment used in resuscitations. Length-based determination of ETT size has been determined to be at least as accurate as age-based calculations in normal and pathologically short children.[27]

Length-based resuscitation tapes and other resuscitation aids have other advantages over use of memory and formulas in choosing appropriate equipment and medication doses in resuscitations. Calculation of equipment sizes and medication doses and volumes is error prone, especially in a high-stress situation. The use of a length-based resuscitation aid avoids memorization of formulas and need for calculations. The other advantage is that use of resuscitation aids decreases mental effort required and allows the practitioner to focus mental effort on patient evaluation and management decisions.[3]

SUMMARY

Successful management of the pediatric airway depends on careful preparation and development of a routine that becomes automatic to the physician. The assessment and management of the airway always should proceed in a logical, orderly fashion. Knowledge of the airway differences between young children and adults will help the physician anticipate and troubleshoot difficulties that may occur. When intubation of the infant or young child is necessary, taking the time to properly position the patient, select the appropriate-sized equipment, and instruct assistants in their role will increase the likelihood of success of intubation and decrease the likelihood of potential complications. A length-based resuscitation tape will help the physician quickly select the appropriate equipment for the young child.

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