Lesson 242: PreAnesthetic Assessment of the Pediatric Patient With a Difficult Airway

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Dr. Kaye has disclosed that he is a member of the speakers’ bureaus of Pfizer and Baxter and has received grant/research support from SkyePharma and Baxter. The other authors have no relationships with pharmaceutical companies or products to disclose. This educational activity may contain discussion of unpublished and/or investigational uses of agents for the treatment of disease. Some uses of these agents have not been approved by the US Food and Drug Administration. Please refer to the official prescribing information for each product for approved indications, contraindications, and warnings.

Lesson 242 was reviewed by Irene Ostborn, MD, Associate Professor, Department of Anesthesiology, Mount Sinai School of Medicine, New York, NY. Dr. Ostborn has disclosed that she has been a consultant and lecturer for LMA North America.

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**LEARNING OBJECTIVES**
At the end of this activity, the participant should be able to:
1. Summarize the special anesthetic problems presented by the pediatric patient with a difficult airway.
2. Describe the systemic changes and symptoms associated with the difficult pediatric airway.
3. Apply appropriate preoperative testing and evaluation in the management of these patients.
4. Outline the anatomic differences between the airways of adults and children.
5. List the equipment used to manage a difficult pediatric airway.
6. Identify the variant presentations of a difficult airway.
7. Present an anesthetic and analgesic plan for the treatment of these patients.
8. List associated complications in the management of the difficult pediatric airway.
9. Cite the incidence of various airway conditions.
10. Anticipate, recognize, and manage likely perioperative complications in pediatric patients with a difficult airway.

**CASE HISTORY**
A 4-year-old boy weighing 18 kg was brought into the emergency department with an incarcerated hernia. Preoperative assessment revealed mild inspiratory stridor and a cough described as a seal bark. The parents stated that the cough had begun 2 days before admission and had worsened at night. The boy had a temperature of 100.4°F; his vital signs were within normal limits. A physical examination revealed nasal flaring, occasional expiratory wheezing, and suprasternal retractions. A chest X-ray indicated no bony abnormalities, effusions, or infiltrates.

**NEEDS STATEMENT**
A failed airway can result in a catastrophic event including hypoxia, brain damage, myocardial infarction, and death. The pediatric population, in particular, may present for treatment with extraordinary complications that make airway management difficult. The appropriate means to deal with difficult airway situations in children has been identified by reader responses and by committee as required knowledge for the practicing anesthesiologist.

When managing the airway of a pediatric patient, an anesthesiologist must have more than a practical familiarity with the anatomic differences between the airways of adults and children. It is crucial that the clinician take a proper medical history and perform a physical examination before selecting equipment for intubation. The clinician must also evaluate the patient for any potential congenital syndromes that can complicate an intubation. Securing the difficult airway requires cooperation and planning with pediatricians, oto-laryngologists, and pulmonologists. Guided by professional judgment and the preoperative examination findings, the anesthesiologist should be able to foresee and prevent complications during perianesthetic management. In all instances, a difficult airway cart should be available with equipment that is sized for the child (Table 1). The contents of this cart should be prepared and frequently reviewed by the anesthesiologist.

**Anatomic Differences in the Airways of Adults and Children**

The anesthetic management of children is different from that of adults because of anatomic differences in their airways. Knowledge of these differences may prove critical for management of the difficult pediatric airway.

The infant’s tongue is much larger relative to the oral cavity than that of the adult, which may lead to a higher risk for airway obstruction—especially in the neonate. The infant’s larynx also differs anatomic-ally from that of the adult. The infant’s larynx is higher in the neck than an adult’s (C3-4 level instead of C4-5) and thus is harder to visualize; the view of the larynx is blocked more by the proportionately larger tongue. To accommodate this difference in anatomy, a straight laryngoscope blade is typically the better choice. The relationship between larynx and tongue is further distorted by diseases associated with mandibular hypoplasia—for example, Pierre Robin syndrome.

Compared with that of an adult, the child’s epiglottis is much narrower and angled away from the trachea, a variation that can challenge the physician attempting to lift the epiglottis with a laryngoscope blade. Furthermore, the attachments of the vocal folds are lower and more anterior in the child than in the adult, which can lead to occasional problems, especially when a nasotracheal approach is indicated.

More differences can be seen when the subglottis of a child is compared with that of an adult. The subglottis is the narrowest portion of the child’s larynx, whereas the rima gloti-tidis is the narrowest area in the adult. Although this difference may seem trivial, it becomes critical should the endotracheal tube not pass the subglottis. Positioning the endotracheal tube in the vicinity of the subglottis may cause edema, a problem that increases resistance in the pediatric airway during extubation.

**PREANESTHETIC ASSESSMENT**
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Eickel and colleagues analyzed the morphologic changes of the larynx during the early developmental years in 43 children aged 1 to 60 months. The subglottic airway increased in size during the first 2 years of life, from 13 to 28 mm on average. Afterward, this area showed more linear growth. Thus, the child's larynx is not simply a smaller version of the adult organ, and postnatal maturation of approximately 5 years must occur before significant similarities appear.

The differences between the adult and pediatric anatomy can cause other problems. The larynx, trachea, and bronchi are more compliant in the infant than in the adult, so they are vulnerable to distending and constricting forces. For example, the child's airway may close during bronchial smooth muscle contractions in disease states such as reactive airway closure. The greater compliance of the pediatric airway can endanger preterm and term infants during quiet respirations. The difficult pediatric airway is especially at risk if the child is struggling. Should the child cry during induction, the transmural pressure may increase dramatically and cause disruptive airway collapse. To prevent this problem, parents, nurses, and physicians should try to keep the child calm, especially during induction. Premedication should be used as appropriate.

Differences in muscle physiology can also lead to problems in infants if the airway becomes compromised. Infants have fewer type I muscle fibers in the diaphragm and intercostal muscles than do adults. Small babies tire more quickly during respiratory work and are at greater risk for respiratory failure.

Airways vary considerably among children, requiring flexible equipment, a wide range of tube sizes and techniques, including fiber-optic bronchoscopy, and the use of child-sized supraglottic ventilatory devices and small lighted styles (light wands). New devices created in the hope of improving management of the difficult airway include a child-sized video-assisted laryngoscope, recently available on the market. Studies are also being conducted to determine if the laryngeal mask can be used to improve the guidance of fiberoptic intubation.

Medical History and Airway Evaluation

The anesthesiologist should evaluate a child especially carefully if risks for a difficult airway or obstruction during surgery are identified—such as respiratory infections, congenital abnormalities, laryngeal papillomas, and aspirated foreign bodies. Accounts of recent or past upper respiratory tract infections, asthma, and allergies (which may be associated with nasal polyps) can be inquired about from the physician. The current use of antibiotics, antihistamines, or any other medications, including over-the-counter drugs (especially those that may contain aspirin or related compounds). Aspirin and nonsteroidal compounds are found in many nonprescription cold medicines and in antihistamine preparations; this information is vital to the preoperative evaluation because such drugs can interfere with platelet function and increase the risk for bleeding.

Risk factors for a difficult pediatric airway include audible respiration, chest retractions, mouth breathing, and nasal congestion. A history of snoring or discomfort during sleep may also be considered a risk factor. The aforementioned symptoms all point to tonsillar adenoid hypertrophy, obstructive sleep apnea (OSA), or an upper airway obstruction secondary to congenital abnormalities or foreign bodies that may jeopardize the airway during surgery. Studies have shown that such symptoms may predict postoperative complications, such as airway obstruction and problems with future intubation, so that these patients are candidates for extended inpatient observation. Previously, it was thought that OSA increased the risk for acute upper airway obstruction if sedatives were used. However, a study of 65 children demonstrated that the use of oral midazolam hydrochloride before surgery does not have any significant adverse effects. Hence, preoperative sedation may be administered to children who have OSA—possibly even severe cases. Nevertheless, it would seem reasonable to closely observe such higher-risk patients perioperatively. Unfortunately, because reports of techniques and outcomes rarely undergo comprehensive examination, the area of pediatric sedation remains controversial and requires further studies, especially with regard to the parenteral administration of benzodiazepines.

Pulse oximetry is a good screening tool for OSA, which is diagnosed if the oxygen saturation is less than 90%. In children with chronic OSA, formal sleep studies with polysomnography may be warranted; such studies are the best means to assess the severity of OSA. Another helpful tool for localizing upper airway obstruction is sleep nasendoscopy. For the anesthesiologist to perform this procedure, the pediatric patient must be deeply anesthetized (with sevoflurane and oxygen administered via a mask); the nasendoscope is then introduced through the nostrish. Once the nasendoscope reaches the posterior nares, the anesthesiologist can manipulate the airway to induce an obstruction so that the surgeon can visualize the site of airway obstruction with the camera. Microlaryngobronchoscopy can be used to examine a child with daytime noisy breathing, a history of cardiac malformations, or Down syndrome and may assist the team in ruling out a more distal site of airway obstruction.

Another risk factor for a difficult pediatric airway is episodes of coughing. A physician who examines a coughing child with a respiratory tract infection should determine if the cough is similar to a “seal bark.” This abnormal coughing sound signifies laryngotracheobronchitis (croup) secondary to viral infection and may predict respiratory problems after extubation. In a child with one or more of the aforementioned risks—such as upper respiratory tract infection or tonsillitis—inflammation from these conditions can extend into the lower respiratory tract. The result can be edema and bronchospasm, mainly secondary to the release of proinflammatory cytokines and mediators from airway epithelial cells. The cytokines act on the microvascular endothelial cells to produce alveolar edema. Neural changes of airway tone can cause bronchospasm due to enhanced parasympathetic efferent neuronal activity, the release and activation of bronchoactive neuropeptides from sensory C fibers in the airways, or modulation of the noradrenergic system. Wheezing, rales, and stridor on chest auscultation are strong indicators of airway obstruction from bronchospasm or tonsillar/adenoid hypertrophy. Children with stridor have partially obstructed airways, and the physician should auscultate carefully.

Although it is rare, psychogenic stridor—more common in girls—can cause an acute upper airway reaction. This type of complication may present as asthma, stridor, or epiglottitis and is unresponsive to conventional treatment. Usually, no organic pathologic processes are found, and psychosocial stressors are present. In a study of 48 cases, 52% were given a diagnosis of conversion disorder. In some such cases, the airway obstruction can be severe enough that the patient requires general anesthesia, intubation, or even tracheostomy. If such a case arises, the team should perform a fiber-optic nasendoscopic examination of the larynx to look for an abnormality on addiction of the vocal cords during inspiration—the most likely cause of this type of stridor. A positive diagnosis indicates the need to consult an otolaryngologist and/or a pulmonologist.

The quality of the child’s speech must also be considered. A gravelly voice may indicate a laryngeal papilloma—a condition in which normal sounds progress to hoarseness, aphonia, and finally respiratory distress. Identifying abnormalities such as laryngomalacia and vocal cord paralysis is also important during the evaluation.

The anesthesiologist should be attentive to children with craniofacial syndromes or anatomic malformations. Congenital syndromes that can cause airway obstruction should be noted, including Pierre Robin, Treacher Collins, Goldenhar’s, Apert’s, Turner’s, and Crouzon syndromes, in addition to many others. Furthermore, the anesthesiologist should examine the shape of the patient’s jaw to determine if any previous reconstructive surgery has been performed. A high arched or narrow palate may be a sign of chronic nasopharyngeal obstruction. Finally, the anesthesiologist should note the size of the mandible; if it is disproportionately small, it can lead to intubation difficulties. The naturally small mandibles of young children are even smaller in those with Pierre Robin, Treacher Collins, Goldenhar’s, or other micrognathic syndromes.

An important part of the patient’s medical evaluation is measurement of the distance between the hyoid bone and the mandible. The normal anterior-posterior distance from inside the mentum of the mandible to the hyoid bone is 1.5 cm in infants—contrasted with 3 cm in adults. If the measure-
ment is less than 1.5 cm, the physician can predict a compli-
cated intubation.2 Other physical aspects of the patient that
should be taken into account are the facial expression, pres-
ence of nasal flaring, color of the mucous membranes, and respiratory rate. Also, the physician should be aware of any
loose or missing teeth and the location of the larynx.

The baseline oxygen saturation in room air is useful
for assessing the need for prolonged, frequent bronchodilator
therapy in children with acute asthma. For example, if the oxy-
gen saturation is 91%, the child may need frequent bron-
chodilator therapy for more than 4 hours. If the oxygen
saturation is 89% or lower, the child with asthma may need
frequent bronchodilator therapy for more than 12 hours. Such
information can be useful for predicting whether a pediatric
patient has a potentially difficult airway.3 Other conditions
may also be associated with relative hypoxia.

Conditions such as recent pneumonia, bronchitis, upper
respiratory infection, chronic sleep apnea, and cor pul-
monale indicate the need for chest radiography and electro-
cardiography (ECG) as part of the evaluation.4 For example,
in children with pneumonia, the T wave of the ECG is
depressed and actually rises as the child starts to recover.
The ECG is also useful for detecting myocarditis secondary
to pneumonia in infants.5

Another example of the benefits of these diagnostic tests
can be seen in the patient with chronic sleep apnea. The
radiographs of such patients can show enlargement of the
tonsils and adenoids. In addition to these findings, the ECG
can detect abnormalities of the heart, such as right ventricu-
lar hypertrophy.6 Chronic airway obstruction or compensat-
ed respiratory acidosis may indicate the need for blood gas
analysis; however, needle puncture is contraindicated if it
upsets the child and further compromises the airway.

Any history of foreign body aspiration, caused increasing
airway reactivity, obstruction, or impaired neurologic function,
should be determined. The anesthesiologist should also
determine whether any previous anesthetic problems related
to the airway have caused complications with intubation,
extubation, or mask ventilation. It may be necessary to
access previous records because incidents of desaturation
may not have been communicated to the parents; especially
if the outcome was favorable.

Allergies may also compromise the airway as a result of
increased reactivity. The airways of asthmatic patients can
become hyperreactive when exposed to dust mites, aller-
gens from household pets (eg, cats and dogs), or other
particles that can induce the abnormal synthesis of IL-4 in
local airways.1-3

A good medical history can help the anesthesia provider
to anticipate a challenging intubation and better prepare for a
potentially difficult pediatric airway.

### Congenital Abnormalities

The anesthesiologist must be aware of congenital abnor-
malities that can potentially cause a difficult airway situation
(Table 2). Most pediatric airway difficulties are not the result
of an abnormal larynx or trachea, rather the difficulty lies in
accessing the airway. Micronathia, a condition in which the
jaw is hypoplastic, makes it difficult for the physician to use a
laryngoscope because the space in which to maneuver is
small (as a result of displacement of the area by soft tissue).
This problem is seen in certain congenital disorders, includ-
ing the following syndromes: Pierre Robin, Treacher Collins,
and Goldenhar’s (hemifacial microsomia). In patients with
congenital abnormalities like Pierre Robin syndrome, an
excellent choice for managing the difficult airway is the light
wand, a rigid stylet with a light on its tip that the anesthesiolo-
gist can use to visualize the neck. In infants, however, too
much light from the wand can be a disadvantage when dis-
 gustion between esophageal and tracheal intubation. This chal-
 lenge can be addressed by using light wands that have
external light sources with rheostatic control. These devices
allow a physician to manipulate the light to accommodate an
infant’s airway without a light wand.3

When treating a pediatric patient who has a difficult airway,
the anesthesia provider must sometimes induce anesthesia
because children can be uncooperative in many situations.

### Table 3. Endotracheal Tube Sizing for Patients With Down Syndrome

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<thead>
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However, the breathing sounds—a valuable guide for locating the
glottis—may be depressed in a patient under anesthesia.
In these situations, the anesthesiologist may have a more dif-
ficult time determining the appropriate endotracheal tube
size. Several techniques can be utilized to determine the
appropriate endotracheal tube size. Two of the most
common techniques are the use of a laryngoscope or fiber-optic
bronchoscope. A recent study revealed that for symptomatic
patients, a majority of anesthesiologists obtain radiographs
(64% of the time) or consultations (74%). Furthermore,
approximately half of the survey respondents maintained a
neutral position of the head and neck for patients with Down
syndrome, regardless of the presenting symptoms.20,21 A
recent case report suggested that neuromuscular anesthe-
sia should be avoided in patients with Down syndrome. These
techniques may help avoid the possible complications of a tracheal intubation.22

Patients with mucopolysaccharidoses, such as Hurler’s
syndrome and Hunter’s syndrome, can exhibit typical air-
way problems. These diseases are characterized by a deficiency of the enzymes responsible for the catabolism of glycosamino-
glycans. Patients may present with mental retardation, joint
immobility, and vision or hearing loss. Laryngeal and tra-
cheal irregularities may present extreme anesthetic chal-
leges when intubation is attempted. Computed
tomography in these patients has revealed abnormal
shapes of the vocal cords and trachea and a smaller tra-
cheal surface area than that of other individuals. Although
the cause of the irregularities is unknown, the abnormal
submucosal storage of keratin or dermatan sulfate may play an
unknown role in the difficulty of intubation.22

Patients should be thoroughly evaluated preoperatively through
clinical and laboratory investigations. Lung function
in particular should be optimized with the treatment of air-
way infections and lung physiotherapy.22

External medical histories may be helpful in these children because
they appear to have normal facies; only with laryngoscopy is the actual difficulty
apparent. Significant epiglottic and glottic narrowing may
require fiber-optic intubation or the use of a laryngeal mask
airway in this population. Because airway anomalies, bleed-
ing, and salivation can complicate intubation, spontaneous
respiration by the patient is recommended when the use of
general anesthesia, to the trachea has been intubated. Local
or regional anesthesia is favored, although in some
rare cases may have been contraindicated by the age and mental sta-
tus of the patient.23,24 Even with the use of smaller tubes,
extubilation may prove to be difficult. The narrowing of the tra-
chea may be aggravated by intubation itself, and it may be
necessary to use the combination of a smaller tracheal tube if the
patient’s airway cannot be maintained. In such cases, con-
ventional equipment, emergency cricothyroid puncture, and
tracheostomy may not be viable options. Often, it is difficult to
clear the upper trachea because of an extremely short and
 stiff neck; therefore, the anesthesiologist must be prepared to
reintubate the patient with a fiber-optic scope, if necessary.

Following reintubation, individual circumstances dictate if a
surgical tracheostomy is warranted. Not only is this a diffi-
cult procedure; also, long-term problems, such as tracheal
stenosis, can develop. Consequently, tracheostomy should
not be performed unless it is absolutely necessary. Postop-
eratively, the combination of lung physiotherapy with posi-
tively end-expiratory pressure, along with antibiotics, helps
treat stagnation of secretions and airway infections. Current-
ly, there is no ideal solution to the problems described.

Therefore, these patients should be managed in a specialist
center, if possible.25,26

Intraoperative atropine 0.02 mg/kg or glycopyrrolate 0.05
mg/kg should be prepared for all cases of congenital anom-
alies. These drugs are excellent drying agents for excessive
secretions that can further hamper the difficult airway—a
problem that is exacerbated by multiple attempts at intuba-
tion. Airway obstruction occurs quickly, and therefore the
emergency airway device, surgical supplies, and appropriate
personnel should be in the operating room before the induc-
tion of anesthesia.27

The fiber-optic bronchoscope is useful in many cases
when congenital abnormalities preclude the use of conven-
tional equipment. Intubation with this tool is facilitated by its
flexibility in abnormal airways. The limited field of vision that
it provides can be rendered useless if bleeding or secre-
tions are present. Another disadvantage is that the fiber-
optic bundle is fragile and expensive; furthermore, an
experienced user is required.

### Infections

**Epiglottitis**

Infections occur often in difficult airways. Acute epiglotti-
tis, which can result from infection by Haemophilus influen-
zae type B, is a significant threat for children. This infection
has a known tendency to progress rapidly and cause a sore
throat to a to airway obstruction. To make matters worse, the
obstructed airway can result in respiratory failure and death within a
short time if the physician does not diagnose the condition
promptly and successfully intervene. Children aged
between 2 and 7 years are at greatest risk for epiglottitis. It
is recommended that children be vaccinated against this
infection before the age of 2 years.

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**Table 3. Endotracheal Tube Sizing for Patients With Down Syndrome**

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**Lesson 242 page 54**
### Infections in Pediatric Patients With Difficult Airways

<table>
<thead>
<tr>
<th>Infection</th>
<th>Pathogens</th>
<th>Description</th>
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<tr>
<td>Acute epiglottitis</td>
<td>Haemophilus influenzae type B</td>
<td>Cellulitis of the supraglottic structures causes airway collapse. Involvement of the posterior lingual surface and surrounding soft tissues, in addition to the epiglottis and aryepiglottic folds. Infection can result after collapse of the airway.</td>
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</table>
| Bacterial laryngotracheo-bronchitis (croup) | Primarily Staphylococcus aureus; H. influenzae; 
|                            | e/hemolytic streptococci, and Streptococcus pneumoniae are also causes. | Subglottic edema with ulcerations; pseudomembrane formation in the trachea; positive bacterial cultures. |
| Upper respiratory infection | Various                                        | Reactive airway, bronchospasm, laryngospasm.                                 |
| Laryngotracheal (subglottic) stenosis | Prolonged use of endotracheal intubation can make the airway vulnerable to infections. | Edema, necrosis, mucosal ulcerations, and infections can develop secondary to exposure of the cartilage. |

**Lesson 242 continued from page 53**

Characteristics of epiglottitis include the sudden onset of fever, dysphagia, drooling, and a thick, “muffled” voice. The affected child prefers to sit with his or her head extended and thrust forward. The infection is essentially a cellulitis of the supraglottic structures. The posterior lingual surface and surrounding soft tissues, along with the epiglottis and aryepiglottic folds, are primarily involved. Airway collapse is likely as a result of the infection. The anesthesiologist should try to calm the child because crying and agitation can make matters worse. In addition, the healthcare team should avoid blood drawing, sedation, I.V. insertion, and excessive handling of the patient because these activities can provoke further emotional distress.

In the early stages of an obstruction, the child looks pale and “toxic”; these symptoms progress to labored breathing, cyanosis, and retractions. The diagnosis can usually be made on the basis of clinical suspicion; however, in some cases, radiography may be useful to confirm the diagnosis and rule out conditions such as croup, retropharyngeal abscess, and foreign body aspiration. Characteristic findings include a round and thickened epiglottis (thump sign), loss of vallecular air, and thickening of the aryepiglottic folds. These findings are best determined by a lateral neck X-ray obtained with hyperextension during inspiration. These findings should then be confirmed with direct visualization of the pharynx and larynx—ideally in the operating room.

The patient with epiglottitis should be handled expeditiously. The child should be rushed from the emergency room to the operating room with surgeon and anesthesiologist in attendance. The parents should be present only if they can help to calm the child. Endotracheal intubation is usually the best choice to establish the airway. The physician should use a pulse oximeter and precordial stethoscope while other monitors are placed on the child sitting in the operating room. Preparations should include the availability of equipment and personnel for laryngoscopy, rigid bronchoscopy, and tracheostomy. Anesthesia is usually induced with a combination of 100% oxygen and increasing concentrations of sevoflurane, which can be used as a single-breath technique.

The sedated child should be placed in the supine position. The anesthesiologist should perform laryngoscopy and endotracheal intubation without the use of muscle relaxants. It is wise to work with an endotracheal tube at least 1 size (0.5 mm) smaller than might be expected. A helpful supplement to the procedure is a lighted stylet. This malleable stylet, equipped with a high-intensity light at the tip, is useful to achieve proper positioning, thus facilitating advancement of the endotracheal tube. The tool is employed in situations in which there is no intrinsic pathology but visualization of the airway is difficult. A method of assessing the appropriateness of size involves the detection of an air leak. When an air leak at 20 to 25 cm H₂O is detected, one can be confident that the tube is of the appropriate size. In this situation, a larger tube is unnecessary and may lead to subglottic stenosis. Furthermore, the patient should be able to breathe both through and around the tube.

In certain complicated cases, a light wand may be needed for nasotracheal intubation. A study in Japan used the light wand method in 46 patients scheduled for nasal intubation. An endotracheal tube was mounted on a light wand with a stiff stylet in position to form an angle of 40 to 60 degrees—about 7 cm proximal to the tip of the endotracheal tube. The procedure resulted in an 89% success rate. Thus, light wand–guided nasotracheal intubation with a stiff stylet in position is useful and can be carried out without traumatic complications. After the nasotracheal tube has been secured, antibiotic treatment can be started as soon as tissue and blood cultures have been obtained. Sedation is recommended for 48 to 72 hours while the patient is under supervision in the intensive care unit. Afterward, extubation is performed once the swelling has subsided—traditionally ascertainment with flexible fiber-optic bronchoscopy.

**Croup**

Laryngotracheobronchitis, also known as croup, is a common infection; it usually occurs in children younger than 3 years but may affect those up to 6 years of age. Croup is the most common infectious cause of upper airway obstruction, with an annual incidence of 18 per 1,000 children. Because the cause of croup is usually viral infection, its onset is more subtle than that of bacterial epiglottitis. The most common pathogen implicated in croup is parainfluenza virus type 1; however, parainfluenza viruses types 2 and 3, influenza viruses A and B, respiratory syncytial virus, and certain adenoviruses are also causative.

The presenting symptoms of croup are low-grade fever, inspiratory stridor, and coughing that sounds like a seal bark. More ominous indications of an impending respiratory collapse include tachycardia, intercostal and suprasternal retractions, nasal flaring, grunting, and biphasic stridor. Radiography can confirm narrowing of the airway column and the “steeple” sign caused by soft-tissue edema. It should be noted, however, that up to 50% of children with croup have completely normal findings on chest X-ray.

Treatment includes the inhalation of cool, humidified mist or oxygen therapy. In certain severe cases with tachypnea, diminishing with the increasing use of glucocorticoids. Studies indicate that this number is approximately 2% of children hospitalized with croup ultimately require endotracheal intubation and mechanical ventilation. Studies indicate that this number is diminishing with the increasing use of glucocorticoids. When children do require intubation, extubation can generally be accomplished within 2 to 3 days.

**Bacterial Tracheitis**

Bacterial laryngotracheobronchitis, also known as pseudomembranous croup or bacterial tracheitis, is an emergent infection that causes upper airway obstruction. It is notably rarer than either croup or epiglottitis but can mimic both. Bacterial tracheitis occurs most frequently in the fall and winter months in children between the ages of 6 months and 8 years. It is characterized by the presence of significant subglottic edema—most often the result of infection with Staphylococcus aureus, although Haemophilus influenzae, e/hemolytic streptococci, and Streptococcus pneumoniae have also been implicated.

Clinically, children present with 3- to 7-day prodromal symptoms of a viral upper respiratory infection, including cough and low-grade fever. Their condition then deteriorates acutely (over a period of hours), as tachycardia, high fever, a “toxic” appearance, stridor, retractions, and thick mucopurulent secretions develop. It should be noted that patients with bacterial tracheitis tend not to drool, and they often can be flat without difficulty.

A lateral neck X-ray may not be helpful in differentiating bacterial tracheitis from laryngotracheobronchitis because both can show the characteristic “steeple” sign; however, in bacterial tracheitis, a pseudomembrane detachment is often observed, evidenced by multiple intraluminal irregularities and a hazy tracheal air column. The main clinical features for distinguishing laryngotracheobronchitis from bacterial tracheitis are a more toxic appearance and the lack of a response to racemic epinephrine and glucocorticoids. The diagnosis of bacterial tracheitis can then be confirmed in the operating room by the endoscopic findings of subglottic edema with ulcerations, pseudomembrane formation in the trachea, and positive bacterial cultures. Treatment entails the use of broad-spectrum antibiotics, along with intubation, which is performed in more than 80% of children with bacterial tracheitis. The same considerations for the intubation of patients with fear of a rebound effect, whereas others are convinced that treated patients can be safely discharged home. There are studies in support of both approaches, and more studies are needed to clarify the issue.

In addition to epinephrine, nebulized or I.V. dexamethasone has been used in the treatment of croup—especially to reduce stridor. Treatments such as corticosteroids and helium/oxygen mixtures have also been effective. If the croup becomes problematic because of secretions obstructing the airway, therapy as for epiglottitis may be necessary. Approximately 25% of children hospitalized with croup ultimately require endotracheal intubation and mechanical ventilation. Studies indicate that this number is diminishing with the increasing use of glucocorticoids.
laryngotracheobronchitis also apply in these cases. Intuba-
tion is often required for 3 to 7 days, until an audible air
leak is detected around the tube, secretions are reduced,
and clinical signs of improvement are noted.14

Upper Respiratory Infection

Retrospective and prospective studies have documented that a recent upper respiratory infection is commonly asso-
ciated with the development of adverse respiratory events
during intubation—including bronchospasm, laryngospasm,
and hemoglobin desaturation.14 Upper respiratory infections
are also problematic because they are quite prevalent (chil-
dren have an average of 6 per year), and the symptoms can
last up to 6 weeks.14 Thus, the probability is quite high of
encountering a pediatric patient with this affliction. In
patients with an upper respiratory infection (ie, those with
a reactive airway), a laryngeal airway device may be more
suitable than intubation. However, the physician should
be cautious with the use of these ventilatory devices because
the risk for laryngospasm still exists—although in recent
studies, a laryngeal mask airway significantly decreased the incidence of all respiratory complications in comparison
with endotracheal intubation.14 It should also be noted that
laryngeal airway devices are supraglottic tools, and the
pediatric patient is not protected from pulmonary aspiration
of the gastric contents.1

Pediatric airway can be further complicated by congenital
abnormalities, infections, and foreign bodies. The anesthesi-
ologist is faced with a difficult or potentially haz-
ardous intubation that may push the foreign
body further in; he or she should transfer
responsibility for the air-
way to the surgeon after
induction. The surgeon
can remove the foreign
body directly with the
bronchoscope.45,46 During
ventilation, 3 to 4 mg/kg of topical lidocaine should be
applied over the laryngeal structures and tracheal mucosa
to dampen the airway reflexes and avert coughing and
bronchospasm.6

Spontaneous ventilation or muscle relaxation can be
used when foreign bodies are removed; there are pros and
cons with both methods. Spontaneous ventilation is pre-
terred because this method reduces the risk for airway trau-
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Lesson 242 continued from page 55

References


4. Pierre Robin, Treacher Collins, and Goldenhar’s syndromes complicate the airway because they are all associated with:
   a. micrognathia
   b. mandibular hypoplasia
   c. abnormal breathing
d. laryngeal polyps

5. A child with a sudden onset of fever, dysphagia, drooling, and a thick, “muffled” voice, with the head extended and thrust forward, most likely has:
   a. tonsillitis
   b. epiglottitis
c. esophageal fistula
d. foreign body

6. The most common infectious cause of upper airway obstruction in children is:
   a. epiglottitis
   b. the common cold
c. bacterial tracheitis
d. croup

7. A febrile patient who has an extremely toxic appearance, fails to respond to racemic epinephrine and glucocorticoids, and has endoscopic findings of subglottic edema with ulcerations and pseudomembrane formation in the trachea, most likely has:
   a. epiglottitis
   b. the common cold
c. bacterial tracheitis
d. croup

8. In a 4-year-old with a reactive airway or upper respiratory infection, the best approach to manage anesthesia for an inguinal hernia operation is to:
   a. intubate the trachea
   b. use a supraglottic ventilatory device
c. use local anesthesia
d. use a neuraxial block

9. Aspiration of a foreign body, such as a peanut, is most common in which age group?
   a. 1 to 4 years
   b. 4 to 6 years
   c. Boys aged 8 to 12 years
   d. It occurs equally in all age groups.

10. The use of nitrous oxide is contraindicated in cases of foreign body aspiration because nitrous oxide may:
    a. cause reflex laryngospasm
    b. cause air trapping distal to the obstruction
c. not be fully effective secondary to the presence of the foreign body
d. react with the foreign body