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Anatomic and Physiologic Considerations of the Pediatric Airway:

The complex structures of the human airway vary in anatomy and physiology from birth to adulthood. The infant's larynx and trachea are significantly smaller than the adult's. The vocal cords of the newborn infant are 6-8 mm long and the vocal processes of the arytenoids extend one half of that length. The posterior glottis' transverse length is approximately 4 mm. The subglottis has a diameter of between 5 and 7 mm. The trachea itself is about 4 cm long and as a diameter of 3.6 mm. These dimensions leave little margin for obstruction in the infant, unlike the adult. For example, an infant with one millimeter of glottic edema will experience a 35% obstruction of the airway. In the subglottis, one millimeter of edema leads to a 44% narrowing.

The infant's oral airway differs from the adult's as well. The infant's epiglottis nearly touches the soft palate. Also, the infant's tongue is larger than that of the adult, and generally occupies all of the space in the infant's mouth. These factors contribute to making the infant a preferential nasal breather for 2 to 5 months. Because infants are nasal breathers, nasal obstruction can lead to significant respiratory distress. The act of oral breathing is a reflex that often does not develop at all until several weeks after birth. The nasopharyngeal airway of the infant and child is significantly narrower than that of the adult because of the increased relative size of the child's adenoid pad, lingual and palatine tonsils. The coordination of swallowing is usually well developed in a full term infant. However, before the 34th week of gestation, the pre-term infant generally demonstrates a poorly coordinated suckling response and may be unable to protect the airway.

Initial Assessment of the Child in Respiratory Distress:

The first step in evaluation of the child with airway difficulty is assessment of the urgency of the situation. Immediate history and physical examination should proceed simultaneously until the general status of the patient is known. Signs of reduced level of consciousness or lethargy, quiet shallow breathing indicating respiratory fatigue, or apnea demand immediate intervention. When a neonate presents with complete or severe obstruction, the child is immediately suctioned, and an oral airway is placed and mask ventilation is attempted. If the obstruction persists, a laryngoscope is used to visualize the larynx and a small endotracheal tube is placed. In most cases of suspected airway anomaly leading to respiratory distress, endoscopy by an otolaryngologist is generally preferred before intubation. This can be performed in a controlled fashion discussed below.

Evaluation of Airway Emergencies – History:

Once it is established that the child is not in immediately life-threatening respiratory distress, the examiner should take a thorough medical history. It is very important to ask about the onset of respiratory distress. For instance, sudden onset of choking followed by respiratory distress is strongly indicative of foreign body aspiration. The examiner should always specifically ask about a history of foreign body ingestion or aspiration. Knowledge of the age at onset of symptoms can narrow the diagnostic possibilities, as discussed below. The family should be questioned about noisy breathing, the types and associations of which are discussed below. The family should be asked about aggravating factors, such as feeding or sleeping. Respiratory distress associated with feeding may indicate the presence of aspiration or of nasal airway compromise. The examiner should note previous history of intubation and surgical interventions. Respiratory distress or stridor immediately after extubation may be due to subglottic edema whereas distress that starts after two to three weeks may indicate early subglottic stenosis or vocal cord granuloma. The investigator should ask about throat or neck pain and fever, indicating inflammatory causes of airway obstruction. Birth history should be carefully explored, including history of birth trauma, as vocal cord paralysis due to birth trauma is a common cause of respiratory distress or stridor in infants. History of other congenital anomalies should also be noted.

Evaluation of Airway Emergencies – Physical Examination:

The physical examination should begin with careful inspection of the patient. The patient can remain in the caregiver's arms while the examiner assesses the respiratory rate and the degree of distress. Increased rate of respiration, nasal flaring, use of accessory muscles or presence of respiratory fatigue can indicate serious respiratory distress. Cyanosis is usually a very late sign of respiratory compromise. The above findings, especially if progressive, often indicate a need for immediate airway stabilization (for example, by endoscopy followed by intubation).

In a stable child, the examination can proceed. Auscultation of the noises made by the child on respiration is helpful in determining the level of the obstruction. Patients with nasal obstruction generally have a normal voice or cry, except when the obstruction is severe, when

the voice becomes hyponasal. Nasal flaring and snorting is a frequent finding, with chest retractions noted in severe nasal compromise. Neonates, who are obligate nasal breathers, often experience serious respiratory distress with nasal obstruction. Older children with nasal obstruction characteristically breathe with their mouths open. Most children with nasal obstruction will experience some respiratory distress during feeding. Auscultation of each nare with the cord of a stethoscope is often useful to determine whether there is any airflow through either side individually. Passage of a Rob-Nel catheter through each of the patient's nares is often a difficult test of patency because of difficulty in visualizing the child's oropharynx for presence of the catheter.

Patients with oropharyngeal obstruction usually have a normal voice, though it may be throaty or full. They usually present with inspiratory stridor that is coarse (also known as stertor) and increases during sleep. Sternal and intercostal retractions are common and may increase to total chest retractions. Feeding is often difficult or impossible, and patients may be unable to handle their own saliva. These patients, like those with nasal obstruction, tend to breathe with their mouths open and jaw forward. As with nasal obstruction, cough is usually not a symptom.

Patients with supraglottic laryngeal obstruction often present with a muffled or throaty voice. These patients tend to snore while sleeping and produce coarse inspiratory sounds at rest. Feeding is difficult for these patients and mouth breathing is the norm. Cough is not usually present.

Patients with glottic obstruction are usually hoarse and may even be aphonic. They usually have an inspiratory stridor initially, but will develop biphasic stridor with progression. Chest retractions are common with severe obstruction, but mouth breathing and coughing are not.

Patients with subglottic obstruction may have a hoarse, husky, or even normal voice. These patients generally have an inspiratory stridor that can progress to biphasic. Feeding is normal and nose breathing is the norm. These patients often have a barking cough.

Patients with tracheobronchial obstruction usually have a normal voice and their stridor is generally expiratory with a component of wheezing. Feeding is uncommon, and a brassy cough is usually present.

After observation and auscultation of the patient with respiratory difficulty, the examiner should attempt to reposition the patient to determine the effect on noisy breathing. Noisy breathing caused by laryngomalacia, micrognathia, macroglossia, and innominate artery compression diminishes when the baby lies prone with the neck extended. Respiratory distress caused by unilateral vocal cord paralysis may improve with the baby lying on the affected side.

Flexible laryngoscopy is usually, but not always, required for the complete evaluation of the infant or child with respiratory obstruction. Only uncommonly is indirect laryngoscopy with a mirror successful. For flexible laryngoscopy, the examiner should have suction, oxygen, and bag ventilation kits available, as flexible laryngoscopy in small children may cause apnea by unclear pathways. The exam should begin with bilateral evaluation of the nasal cavities, choanae and nasopharynx. The vocal cords should be visualized and their mobility documented, and pooling of secretions should be noted in the hypopharynx. Findings of laryngopharyngeal reflux

such as posterior glottic edema, hypervascularity, and pseudoculcus should be noted. The flexible laryngoscope is generally not useful for detecting subglottic pathology. If such pathology is suspected, radiography and endoscopy are usually required for its detection.

Evaluation of Airway – Radiography:

Radiographic imaging is very important in evaluation of the pediatric airway. Chest and airway anteroposterior and lateral radiographs can be used to evaluate the large airways, including the nasopharynx and glottic regions. Neck radiographs should be taken with the neck extended and during full inspiration. High kilovoltage films provide the greatest anatomic detail. However, when foreign bodies are suspected, low kilovoltage films are the more sensitive modality. It is important to obtain chest and lower airway films on expiration in order to catch telltale signs of obstruction such as air trapping. In younger children, fluoroscopy is often required to obtain decent inspiratory and expiratory films. Fluoroscopy during sedation-induced sleep can be helpful in complex children with sleep-disordered breathing to visualize anatomic sites that may be responsible for airway obstruction. Fluoroscopy is also useful to detect dynamic causes of airway obstruction.

Magnetic resonance imaging (MRI) with gadolinium or computed tomography (CT) with contrast is useful when the plain film or the clinical history suggests vascular compression or mass lesions of the mediastinum. Computed tomography is the most useful study to detect and delineate choanal atresia or stenosis when it is suspected. The barium esophogram or the modified barium swallow study can be useful when feeding difficulties and aspiration are associated with respiratory distress.

Pharyngolaryngeal reflux is an occasional cause for respiratory distress in children. Detection of extraesophageal reflux is not well standardized, but the 24-hour pH probe allows detection of lower or upper esophageal reflux.

Evaluation of Airway – Endoscopy:

Flexible Laryngoscopy:

Flexible fiberoptic laryngoscopy is a crucial step in most cases of the evaluation of suspected airway obstruction. This modality, combined with airway radiography is usually sufficient to diagnose the site of most glottic and supraglottic airway obstruction. However, flexible or rigid endoscopy and bronchoscopy are often required to diagnose esophageal lesions or subglottic lesions leading to respiratory obstruction. These modalities also allow for rapid diagnosis followed by intubation of the patient with a critical airway. Rigid endoscopy allows for closer control of the airway and intervention (e.g. removal of a foreign body) if necessary.

Flexible Bronchoscopy:

Flexible bronchoscopy is unique from the rigid modality because general anesthesia is not required. Fiberoptic bronchoscope does, however, require the presence of a nurse trained in monitoring endoscopy patients and in intravenous access, conscious sedation and pediatric

advanced life support. Infants generally require only local anesthetic, whereas older children may require conscious sedation for the procedure. Obviously, the flexible bronchoscope cannot be used for definitive surgical procedures but it can be used for diagnostic purposes, for suctioning secretions from the airway, and for intubation.

Direct Laryngoscopy and Rigid Bronchoscopy:

Rigid bronchoscopy is indicated in children in whom airway obstruction is severe and progressive requiring airway stabilization; in children in whom subglottic pathology is suspected; in cases where the flexible laryngoscopy and radiographic studies have not shed light on the cause of airway obstruction; or in situations that require surgical intervention on the upper airway. The advantages of rigid endoscopy over flexible endoscopy include the allowance of better airway control, stereoscopic imaging, and surgical intervention.

The steps in pediatric bronchoscopy are first to perform laryngoscopy, followed by bronchoscopy, and then esophagoscopy, if necessary. Before beginning the procedure, the endoscopist should carefully check all of the endoscopic equipment to ensure that all needed equipment is available and functioning. Operating room personnel should be familiar with this equipment as well. After intravenous access is obtained, anesthesia is generally induced via mask with halothane. During the procedure, spontaneous ventilation is maintained as much as possible to maximize the ability to assess complete airway dynamics. The child is carefully positioned with the neck extended and the occiput slightly elevated. A small handheld laryngoscope for initial visualization of the larynx is inserted. The types most often used include the Jackson side slide, Parson, or an anesthesia-type handle with a Phillips blade. This visualization is followed by insertion of a hands-free laryngoscope. To maintain anesthesia an insufflation technique can be used either through the side port of the laryngoscope or through the nasopharynx by insufflating high flow oxygen and halothane into the pharynx. Venturi jet ventilation can also be used to allow unimpeded view of the larynx. If adequate spontaneous ventilation cannot be achieved with the insufflation technique, the airway can be stabilized using an endotracheal tube and paralysis. Microlaryngoscopy can be performed using the hands-free laryngoscope and an operating microscope with a 400 mm objective lens or using a Hopkins rod telescope. The goal of direct laryngoscopy is to examine the base of tongue, pharynx, epiglottis, piriform fossae, larynx (including the appearance and movement of the vocal cords), the subglottic region, and the trachea.

After laryngoscopy, a ventilating bronchoscope should be introduced to allow visualization of the subglottis, trachea, and bronchi. The ventilating bronchoscope has made bronchoscopy in children and babies a very practicable procedure. Its features include a closed gas system allowing connection to an anesthetic circuit with the bronchoscope acting as the endotracheal tube; a rigid telescope to allow magnified, illuminated distal visualization, and a side channel for the passage of suction catheters or flexible forceps. The bronchoscope is inserted either directly by the experienced endoscopist, or under direct visualization using a slotted laryngoscope or an anesthetic laryngoscope. The bronchoscope should be passed gently to the carina, and by rotating the patient's head it can be introduced into each main bronchus and even distally in smaller children. Complications of rigid airway endoscopy include loss of airway control; injury to the subglottis (which can lead to edema and need for post-procedure

intubation); damage to the teeth or gums, airway bleeding, pneumothorax, and failure to recognize the abnormality in the airway, leading to a need for further interventions.

Specific Etiologies of Airway Emergencies:

Inflammatory:

Laryngotracheobronchitis:

Infectious agents are frequent causes of airway emergencies in children. Viral laryngotracheobronchitis, known as “croup,” is the most common infectious cause of stridor with a peak incidence in the second year of life. Parainfluenza type 1 is the most common culprit. Croup usually develops from an upper respiratory infection (URI) to a “barking” cough and high-pitched inspiratory stridor associated with varying amounts of respiratory distress. Although radiography is not required in the presence of these classic symptoms, neck films often show the “steeple sign,” – symmetric narrowing of the subglottic space. Severe cases of viral laryngotracheobronchitis require hospitalization and use of corticosteroids with or without racemic epinephrine. Children rarely require intubation for the disorder, and those who fail extubation or require repeated hospitalizations should undergo direct laryngoscopy and bronchoscopy to check for subglottic stenosis.

Bacterial Tracheitis:

Membranous, or bacterial tracheitis is thought to be a complication of viral laryngotracheobronchitis. The most common causative agent is *Staphylococcus aureus*. Children with the disorder present after a URI that progresses rapidly to harsh biphasic stridor with high fever and respiratory distress. Treatment is by endoscopy (flexible or rigid) with suctioning of the bacterial membranes on the trachea, placement of an endotracheal tube and antibiotics directed against the most common etiologic agents.

Acute supraglottitis:

Acute supraglottitis is a disease that is caused by infection of the epiglottis and surrounding structures. The disease used to be caused frequently by *Haemophilus influenzae* type B in children 1 to 5 years of age. However, since conjugate vaccines for this bacteria were introduced in 1987, the disease’s incidence has declined greatly, the age of occurrence has increased, and other pathogens such as *Candida albicans*, *Haemophilus parainfluenzae*, and staphylococcus have become more common culprits. The child with the disorder typically presents with a mild URI that progresses over the course of hours to severe throat pain, drooling, fever and respiratory distress. The diagnosis is generally made by history with a very limited physical exam to avoid compromising the airway. Radiography is not generally necessary, but it will show epiglottic swelling, the “thumbprint sign.” Management is by halothane and oxygen induction of anesthesia, placement of an intravenous line, and direct laryngoscopy with blood and epiglottis cultures, followed by endotracheal intubation. Extubation is carried out when leak around the endotracheal tube occurs with less than 20 cm H₂O of pressure. Antibiotic therapy with ampicillin and chloramphenicol are initiated and modified to culture results.

Congenital:

Nasal obstruction:

Nasal obstruction is typically an airway emergency only in the neonate, since newborns are obligate nasal breathers. Causes of nasal obstruction in neonates and infants are varied. Choanal atresia should be suspected in an infant whose nasal airways are shown to be occluded by methodologies suggested above. These infants often have severe respiratory distress alleviated somewhat by crying. Computed tomography confirms the diagnosis. Choanal atresia usually presents as an airway emergency only when it is bilateral. Choanal atresia occurs in 1 in 8000 births with twice as high an incidence in female as males. It is believed to be caused by a failure of the breakdown of the bucopharyngeal membrane or persistence of epithelial rest cells in the nasal cavities during embryonic development. The atresia usually has mixed bony and membranous components. Choanal atresia can present as part of the CHARGE association, consisting of colobomas, heart abnormalities, renal anomalies, genital defects and ear (external, middle and inner) anomalies. Diagnosis of choanal atresia should prompt a search for those associated anomalies. Bilateral choanal atresia is managed urgently with a taped-in neonatal oropharyngeal airway or a McGovern nipple and nasogastric feeding. Definitive surgery is usually carried out soon after diagnosis, though it can be delayed in the presence of other pathology. The two main surgical approaches for bilateral choanal atresia are the transpalatal or transnasal route. The transnasal route is generally preferred for first-line procedures and involves the perforation the atretic plate with a urethral sound under direct visualization and enlargement of the defect and removal of the posterior vomer using either a cutting burr or a microdebrider. Alternatively, the carbon dioxide or YAG laser may be used to remove the atretic plate. The transpalatal approach involves the removal of the posterior hard palate and posterior vomer with preservation of mucosal flaps for reconstruction. There is some controversy about an increased risk of maldevelopment of the upper dental arch with crossbite deformity using the transpalatal technique in children under the age of five. After removal of the stenosis, silastic choanal stents are placed for six weeks to decrease the risk of restenosis. Serial dilations of restenotic areas are sometimes required for years after the procedure.

Occasionally upper respiratory infection can cause nasal obstruction and respiratory distress in infants. In these infants structural narrowing such as piriform aperture stenosis (seen on endoscopy as a shelf-like projection of maxillary bone into the posterior vestibule) should be sought. Rare causes of obstruction include congenital dacryocystoceles (nasolacrimal duct cysts), which can be treated by intranasal marsupialization. Midline nasal masses include the encephalocele, glioma, dermoid cyst, and rarely the teratoma. CT scan assesses intracranial communication of the lesion, and a combined procedure may be needed with neurosurgery for their removal. In neonates, all of these conditions are managed by obtaining an adequate oral airway until definitive surgery can be performed.

Laryngomalacia:

Laryngomalacia is the most common congenital laryngeal anomaly. The incidence among males is twice that among females. The symptoms often do not present for days to weeks after birth, but then peek at around two weeks after birth and resolve by 12 to 18 months. The disorder is associated with a low pitched stridor that has a fluttering quality and is more noticeable when the child is agitated or in the supine position. The stridor is relieved by placing the patient prone and extending the neck. On endoscopy, laryngomalacia is characterized by several anatomic abnormalities including shortened aryepiglottic folds and a curled epiglottis (“omega shaped epiglottis”). Shortened aryepiglottic folds can draw the cuneiform and

corniculate cartilages forward over the laryngeal inlet, causing the larynx to prolapse during inspiration. Most theories about the cause of laryngomalacia center on the immaturity of the cartilaginous supraglottis and on immature laryngeal neuromuscular control. Surgical intervention usually is not necessary. However, for symptoms of obstructive apnea, failure to thrive, or cor pulmonale, supraglottoplasty is performed during direct laryngoscopy. This procedure is individualized to the infant's anatomy contributing to the airway collapse. It can include trimming of the epiglottis, excision of redundant mucosa and cartilage in the cuneiform and corniculate cartilages, or removing a wedge of tissue from the aryepiglottic folds.

Vocal cord paralysis:

Vocal cord paralysis is the second most common congenital laryngeal anomaly. When bilateral, it is generally due to a central nervous system abnormality. When unilateral, it is often due to neuropraxic injury from birth trauma. While unilateral paralysis is generally well tolerated and often unnoticed (mild stridor, occasionally aspiration), bilateral paralysis presents as an airway emergency with a normal cry and a high pitched inspiratory stridor. In cases of bilateral vocal cord paralysis, direct laryngoscopy is performed if feasible, followed by intubation and tracheostomy. Direct laryngoscopy and bronchoscopy are also performed on children with unilateral vocal cord paralysis present for more than 2 weeks. Such unilateral paralysis should also prompt a search for pathology along the recurrent laryngeal nerve by chest radiography. Bilateral vocal cord paralysis should prompt head ultrasound or MRI to detect central pathology. Other possible causes detected by direct laryngoscopy include cricoarytenoid joint fixation, posterior glottic web or stenosis, and infiltrative lesions. Definitive operative management for bilateral vocal cord paralysis involves procedures to widen the glottis and are deferred until at least the age of 2 years.

Congenital subglottic stenosis

Congenital subglottic stenosis is the third most common laryngeal anomaly. It is defined as a diameter of less than 4 mm of the cricoid region in a full-term infant, and less than 3 mm in a premature infant. Congenital stenosis is believed to be caused by failure of the laryngeal lumen to recanalize after obliteration during the eighth week of gestation, or by the presence of redundant subglottic mucosa. Recurrent episodes of croup may point to mild subglottic stenosis. Severe subglottic stenosis results in biphasic stridor, dyspnea and accessory muscle use. Radiographs help establish the location of the lesion and flexible laryngoscopy rules out supraglottic pathology. Rigid endoscopy establishes the diagnosis. Most patients will improve with age, but some will require tracheostomy followed by laryngotracheal reconstruction.

Laryngeal Saccular Cyst and Laryngocele:

Congenital saccular cyst of the larynx is an uncommon lesion that may present with respiratory obstruction. The lesion is thought to arise in the saccule of the ventricle of the larynx. It is a fluid filled cyst that may either extend posteriorly and medially from the saccule (anterior cyst) or extend posterosuperiorly from it (posterior cyst). Laryngoceles are rare dilatations or herniations of the laryngeal saccules filled with air and can be internal, external or mixed. Diagnosis is made by direct laryngoscopy with repair by marsupialization of the roof of the cyst.

Subglottic Hemangioma:

Subglottic hemangiomas are benign congenital vascular tumors characterized by cellular hyperplasia of endothelial cells, mast cells, fibroblasts, and macrophages. Subglottic

hemangiomas grow rapidly, but growth generally slows in the first year of life and the hemangiomas generally resolve by the age of five. Their incidence is two times as common among females as males. Infants become symptomatic usually between the age of 3 to 6 months with inspiratory or biphasic stridor, barking cough and occasionally hoarseness. Only rarely does the disorder present as an airway emergency. Asymmetric subglottic narrowing is seen on anteroposterior neck films. MRI or CT demonstrate the extent of the lesion, including extension into the neck or mediastinum. Diagnosis by endoscopy is possible without the need for biopsy because the lesion has a characteristic appearance of a compressible asymmetric submucosal mass, occasionally with a bluish or reddish discoloration and in the posterior lateral subglottis. Choices for therapy are many and include tracheotomy (avoided if possible), systemic or intralesional steroids, the CO₂ laser for partial excision, open surgical excision, and interferon alfa-2a therapy.

Laryngeal Web and Atresia:

Laryngeal webs and atresias are caused by failure of recanalization of the larynx during prenatal development. Most of these disorders occur in the glottic area and have an extension into the subglottic larynx. Congenital webs rarely occur in the supraglottic larynx. Webs of the larynx only rarely present with airway emergency. Instead, they most commonly present with hoarseness in the cry or aphonia or stridor. Complete laryngeal atresia presents as a respiratory emergency that leads to death unless emergent tracheotomy is performed. Minor webbing with no airway symptoms can be observed, but more severe webs require tracheotomy, incision of the web with keel placement, and possible laryngeal reconstruction.

Tracheoesophageal Fistula and Laryngeal Cleft:

Tracheoesophageal fistula takes many different forms and can present as respiratory distress, particularly in cases in which esophageal atresia is present, where children present with aspiration and cough. Laryngeal clefts are rare anomalies in which, like with tracheoesophageal fistula, the lumen between the larynx and esophagus fails to completely develop. Treatment for mild laryngeal clefting may include observation, but more severe forms, and all forms of tracheoesophageal fistula require operative repair.

Vascular Anomaly:

Vascular anomalies may lead to significant respiratory distress in the neonate because of the proximity of the great vessels to the airway. These disorders are best diagnosed by MRI or CT with contrast when suspected. An aberrant right subclavian artery sometimes arises from the left descending aorta, passes behind the esophagus and trachea and then follows its normal course on the right side. This produces aspiration and respiratory distress, and is strongly suggested by compression on a barium esophagram. The double aortic arch malformation is characterized by duplicate aortic arches that meet posterior to the esophagus and trachea and lead to formation of a complete vascular ring. Treatment is by division of one of the arches. Inominate artery compression of the trachea can lead to apneic episodes and respiratory distress when the artery arises more to the midline than usual.

Acquired:

Subglottic Stenosis:

Subglottic stenosis, vocal cord paralysis, and laryngeal cysts can also be acquired after birth. Acquired subglottic stenosis is different from the congenital form because it is usually more severe, requiring a variety of corrective laryngotracheal reconstruction surgeries for its repair. It is most often caused by endotracheal tube injury and can present weeks to years after intubation. Laryngopharyngeal reflux has also been implicated in its etiology. It is treated initially by tracheostomy for severe cases, followed by a reconstruction procedure. Acquired vocal cord paralysis and laryngeal cysts are separate acquired causes of airway obstruction that can be treated in a similar fashion to the neonatal form.

Recurrent Respiratory Papillomatosis:

Recurrent respiratory papillomatosis (RRP) is the most common benign neoplastic lesion of the pediatric airway. It is a disease of viral etiology, caused by human papilloma virus (HPV) types 6 and 11. These types are the most commonly implicated agents of genital papilloma as well; and the link between maternal and childhood infection is well established. The disease is most commonly diagnosed between 2 and 4 years of age, on average 1 year after the onset of symptoms. Its incidence is about 4.3 per 100,000. The disease is characterized by formation of pedunculated or sessile masses of nonkeratinized stratified squamous epithelium located at anatomic sites of the respiratory system where ciliated and squamous epithelium are juxtaposed. The most common sites for RRP are the nasopharyngeal surface of the soft palate, the midline of the laryngeal surface of the epiglottis, the upper and lower margins of the ventricle, the undersurface of the vocal folds, the carina, and at bronchial spurs. It is also noted to flourish in areas of epithelial trauma such as in areas affected by gastro-esophageal reflux disease or at tracheostomy sites. While the usual presenting symptom of the disease is dysphonia and/or stridor, RRP can occasionally present as respiratory distress from lesions obstructing the airway. The diagnosis is confirmed by flexible laryngoscopy. Treatment of the lesion is by microlaryngoscopy with removal of papilloma by cup forceps, microdebrider, CO2 laser, KTP/ND:YAG laser, and flash scan lasers. None of these modalities is effective in eliminating disease. Therefore, it is most prudent to accept the presence of some residual papillomata in order to preserve normal tissue when performing these procedures. Adjuvant agents are often used in patients who require frequent procedures, have multisite spread of the disease, or show rapid regrowth of papillomata with respiratory compromise. A commonly used agent is alpha interferon, which is injected subcutaneously daily for six months, followed by checking of the response. Other therapies include photodynamic therapy (in which a photo-sensitive drug, dihematoporphyrin, which tends to concentrate in papillomas, is injected followed by photoactivation with argon pump dye laser), cidofovir (intralesionally injected form shows promise in some small trials), acyclovir, ribavirin, retinoic acid, and methotrexate. None of these measures has been shown to drastically and conclusively decrease the growth of papillomata.

Airway Foreign Bodies:

Airway foreign bodies are common causes of respiratory distress in children. The problem includes foreign-body aspiration, in which the object is lodged in the laryngotracheobronchial axis, and foreign-body ingestion, in which the object is found in the esophagus. The most common age group affected is children between 2 and 4 years of age, with a male to female ratio of 2:1. Most often, children have an acute episode of choking and gagging, though if this episode is not witnessed, diagnosis by history may be difficult. Patients may present with nonspecific pulmonary complaints such as intermittent coughing or wheezing;

or they may present with severe respiratory distress. The most common culprits are food products, such as nuts, raisins, or seeds. Some objects, such as seeds, will swell and lead to complete bronchial obstruction. Plastic can be nonradiopaque and undetectable on plain films. Expiratory chest film is most useful in evaluation of foreign-bodies. Fluoroscopy may be necessary in younger children to obtain good expiratory views. On expiration, mediastinal shift and air trapping is seen. Bronchoscopy should be performed in the presence of suspicious history even in patients with negative films because of the risk of false negative films in up to 25% of patients. Rigid bronchoscopy allows removal of the foreign body and should be followed by careful examination of the airway for distant lesions. Post-instrumentation edema may necessitate intravenous steroids and inhaled bronchodilators. Esophageal foreign bodies may present with respiratory distress due to compression of the posterior tracheal airway, especially in smaller children. This occurs most commonly when the foreign body lodges at the level of cricopharyngeal muscle. Esophageal foreign bodies should be treated as airway emergencies because of the risk of conversion of an upper esophageal foreign body into an airway foreign body.

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