Dysphagia and Chronic Pulmonary Aspiration in Children

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Practice Gaps

Dysphagia and the accompanying pulmonary aspiration are frequently unrecognized by pediatricians and caregivers as a cause of chronic respiratory symptoms such as recurrent wheezing, recurrent pneumonias, chronic cough, stridor, and brief resolved unexplained events (formerly known as acute life-threatening events). In addition, clinicians may be unfamiliar with the proper evaluation or treatment of patients with dysphagia and chronic aspiration.

Objectives After completing this article, readers should be able to:

1. Recognize the signs and symptoms associated with dysphagia and chronic pulmonary aspiration.
2. Know the conditions predisposing to dysphagia and aspiration in children.
3. Understand the tests that should be used to diagnose dysphagia and chronic pulmonary aspiration.
4. Know when and to what subspecialist(s) to refer the patient who has dysphagia and chronic aspiration.
5. Know the methods available to treat dysphagia and chronic aspiration.
6. Know how to recognize and treat aspiration pneumonia in infants and children.

INTRODUCTION

"Dysphagia, defined as difficult or improper swallowing of oral solids, liquids, or both, can lead to aspiration, the inhalation of foreign material into the lower airway. This can produce significant respiratory morbidity and mortality in children." (1) Dysphagia is described as being oropharyngeal when transfer of the food bolus from the mouth to the esophagus is impaired. The striated muscles of the mouth, pharynx, and upper esophageal sphincter are affected in oropharyngeal dysphagia. Esophageal dysphagia occurs if there is difficulty transporting the food bolus down the esophagus to the stomach. (2)

Aspiration may occur in children who have problems with dysphagia. Aspiration can be either acute or chronic and recurrent. Aspiration can lead to

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ABBREVIATIONS

FEES	fiberoptic endoscopic evaluation of swallowing
FEESST	fiberoptic endoscopic evaluation of swallowing with sensory testing
GER	gastroesophageal reflux
VFSS	videofluoroscopic swallow study

pulmonary problems such as recurrent wheezing, recurrent pneumonias, and the development of severe impairment of lung function and irreversible pulmonary scarring and bronchiectasis. Primary care physicians and other caregivers may not think of dysphagia and chronic pulmonary aspiration as a cause of these respiratory problems in infants and children. (1)

In this article, the following topics concerning dysphagia and pulmonary aspiration are explored: 1) the sequence of normal swallowing; 2) the airway protective reflexes to prevent aspiration; 3) the pathophysiology of aspiration; 4) clinical signs, symptoms, and physical findings of dysphagia and pulmonary aspiration; 5) diagnostic tests; 6) therapeutic options; and 7) evaluation and treatment of aspiration pneumonia in infants and children.

PHYSIOLOGY OF SWALLOWING

The anatomical structures involved in swallowing include the oral, pharyngeal, and nasal cavities and the larynx. (3) A fetus first begins to swallow amniotic fluid as early as 12 weeks of gestation. Nutritive sucking of oral liquids can occur at approximately 34 weeks of gestation. At birth, the larynx is positioned high in the neck adjacent to cervical vertebrae C1-C3. The infant larynx is approximately one-third as large as the adult larynx. The small size and shape of the oral cavity relative to the tongue facilitates early sucking, and the buccal fat pads provide lateral stability for efficient tongue motion. Over time, in the infant, the oral cavity increases in size, and the relative size of the tongue decreases. The pharynx elongates and, beginning at age 4 to 5 months and ending at approximately age 3 years, there is maturational descent of the larynx from C3 to C6. Sucking is the primary way to obtain nutrition during the first 3 to 4 months after birth. Head control and stability as well as differentiation of tongue movements occur by 7 to 9 months of age. Pureed foods and other food textures can progressively be introduced. The development of tongue lateralization and rotary chewing allows table foods to be introduced by age 1 year. By age 2 years feeding has gradually evolved from a reflexive behavior in the infant to a cortically regulated behavior. (4)

The 3 phases of swallowing are oral (to include both oral preparatory and oral transit phases),) pharyngeal, and esophageal. The 3 phases operate in sequence to properly direct a bolus of salivary secretions or ingested food into the esophagus and not into the air passages. (5) Feeding and swallowing is controlled neurologically by cortical influences, peripheral afferent signals, nerve networks, and efferent responses driven by motor nerves. Branches of cranial nerves V, VII, IX, X, XI, and XII and branches of the upper cervical nerves innervate the oral, nasal, pharyngeal, and laryngeal structures. Afferent input for swallowing is primarily located in the nucleus tractus solitarius: efferent control is localized in the nucleus ambiguous and the dorsal motor nucleus of cranial nerve X. (4)

AIRWAY PROTECTIVE REFLEXES

There are aspiration protective reflexes in the upper airway consisting of mechanoreceptors and chemoreceptors concentrated over the surface of the pharynx, epiglottis, arytenoid cartilages, and vocal cords. (6)(7) The chemoreceptors respond to contact by water, salts, sugars, and acids. (8)(9) Failure of any of these protective reflexes results in aspiration of swallowed or refluxed materials.

The protective reflex response varies depending on the age of the individual and whether the pharynx or larynx is stimulated. Stimulation of the mechanoreceptors in the pharynx results in swallowing at any age. In young infants, contact of the larynx with acid, water, or milk can lead to prolonged apnea instead of coughing and swallowing. (10) This difference in response, due to age, is probably due to central respiratory inhibition. (10) Viral respiratory infections, such as respiratory syncytial virus, can exacerbate the apneas in these infants due to reversion of the adult response (coughing and swallowing) to the immature response (apnea). (11) Also, infants with respiratory syncytial virus bronchiolitis have copious upper airway and nasal secretions. This could cause prolonged stimulation of the laryngeal chemoreflex, leading to apneas, unless the infant swallows these secretions. (12)(13) Some researchers feel that this may help explain why prone infants with respiratory syncytial virus bronchiolitis have an increased incidence of prolonged apneas and sudden infant death syndrome. (12)(13)(14)

Due to a change in the processing centrally of sensory stimuli in the upper airway over time, the laryngeal cough reflex matures, leading to an increase in coughing and a decrease in both swallowing and apnea in infants after stimulation of the laryngeal mechanoreceptors or chemoreceptors by acid, water, or milk. (15) In both newborns and adults, the laryngeal chemoreflex is the primary source of airway protection against aspiration of liquids. (15)

PATHOPHYSIOLOGY OF ASPIRATION

The acidity and the volume of material aspirated determines, to some extent, the severity of damage done to the lungs. In a landmark study in 1952, Teabeaut (16) demonstrated that as the pH of aspirated material becomes more acidic, lung injury increases, with maximal lung injury occurring at a pH of 1.5. Greenfield and his co-authors, in 1969, demonstrated in dogs that if a volume of 1 mL/kg body weight of gastric acid is aspirated only mild effects occur in the lungs, whereas aspiration of 2 mL/kg body weight or more of gastric acid causes serious effects, even death. (17) Thus, it is presumed that in infants and

small children, the volume of material aspirated does not have to be large to cause significant damage to the lungs.

Pathologic changes in the lungs due to aspiration injury follow a pattern and include degeneration of bronchiolar epithelium, pulmonary edema and hemorrhage, focal atelectasis, exudation of fibrin, and acute inflammatory cell infiltrate. Later, regeneration of bronchiolar epithelium, proliferation of fibroblasts, and fibrosis occur. (1)(18) The acute effects on the lung of an aspiration event occur quickly. Aspirated gastric contents appear on the lung surface contacting the epithelium within 12 to 18 seconds. Extensive atelectasis develops within 3 minutes. Changes of acute pneumonia occur within hours, and granulomatous changes develop within 48 hours. (1)(19)(20) Chronic pulmonary aspiration can lead to recurrent wheezing, recurrent pneumonias with the development of pulmonary scarring, empyema, bronchiectasis, bronchiolitis obliterans, and severe impairment of pulmonary function.

Three physical events can lead to pulmonary aspiration: dysphagia, gastroesophageal reflux (GER) disease, or insufficient management of nasal/oral secretions. (21) "It is clear that chronic aspiration of gastric contents does occur. The risk of aspiration from reflux is increased when there is coexisting swallowing dysfunction, decreased laryngeal sensation, tachypnea, or upper airway obstruction. GER and aspiration may also occur in cases of esophageal dysmotility, compression, or stenosis…" (22)(23)(24)(25) There are many diseases that can predispose children to aspiration lung injury (Table).

Dysphagia can, on occasion, occur in infants and children who are structurally and neurologically normal. Because premature infants have an immature swallowing mechanism, they often require tube feeding until their swallowing mechanism matures. (26) Infants with viral respiratory infections and tachypnea can develop aspiration because they temporarily lose the ability to protect their airways. (27) Oropharyngeal dysphagia can occur in term infants without any detectable risk factors who present with unexplained respiratory problems. This may represent some form of delay in the maturation of the swallowing mechanism. (28)(29)(30)

SYMPTOMS AND SIGNS OF ASPIRATION

The presenting symptoms and signs of children who have dysphagia and pulmonary aspiration are varied and can include wheezing that is poorly responsive to bronchodilators, chronic cough, recurrent pneumonias, atelectasis, bronchiectasis, pulmonary abscess, pulmonary fibrosis, bronchiolitis obliterans, apnea/bradycardia, or brief resolved unexplained events (formerly known as acute life-threatening events). (1)(31)(32)

Infants and children with an absent or ineffective cough, such as those with neuromuscular weakness, have lost their

TABLE. Conditions Predisposing to Aspiration in Children

Anatomical
Choanal stenosis
Cleft lip/palate
Laryngomalacia
Subglottic stenosis
Laryngotracheal cleft
Esophageal atresia
Tracheoesophageal fistula
Craniofacial abnormalities
Vascular ring
Tumors
Cystic hygroma
Syndromes
Pierre-Robin
Beckwith-Wiedemann
Down (sometimes)
Cri-du-chat
Pfeiffer
CHARGE association
Ataxia-telangiectasia
VATER association
Gastrointestinal
Gastroesophageal reflux
Esophageal motility dysfunction
Eosinophilic esophagitis
Neurologic
Perinatal asphyxia
Cranial nerve or recurrent laryngeal nerve injury
Congenital hydrocephalus
Neonatal intraventricular hemorrhage
Familial dysautonomia
Moebius syndrome
Werdnig-Hoffman disease
Cornelia de Lange syndrome
Muscular dystrophy
Myotonic dystrophy

Continued

TABLE. (Continued)

Neurologic
Myasthenia gravis
Guillain-Barre syndrome
Cerebral palsy
Vocal cord paralysis
Arnold-Chiari malformation (sometimes)
Other
Developmental/immaturity of swallowing/prematurity
Viral bronchiolitis
Endotracheal tubes/tracheostomy tubes
Foreign body aspiration
Collagen vascular disease
Obstructive sleep apnea
Cerebral vascular accident
Head trauma
Bottle propping

airway protective reflexes and may have silent aspiration with findings of increased respiratory mucus, congestion, and chronic wheeze or rhonchi, recurrent bronchitis, or recurrent pneumonia. (1)(28)(33) Children with Down syndrome, Prader-Willi syndrome, laryngomalacia, or glossoptosis can have silent aspiration. (34)(35)(36)(37) Also, some premature infants are at high risk for silent aspiration.

PHYSICAL EVALUATION FOR DYSPHAGIA AND ASPIRATION

If at all possible, the clinician should observe the infant or child eating and drinking. There are several signs and symptoms that make dysphagia and pulmonary aspiration in a feeding infant or child highly likely: if crackles, wheezes, "wet" upper airway sounds, and "wet" voice quality appear after feeding; if the child is observed to have difficulty swallowing, sucking, or coughing or chokes during feeding; and if there is drooling, excessive accumulation of secretions in the mouth, or coughing or choking on saliva and nasal secretions. (1)(38)

RADIOGRAPHIC EVALUATION OF ASPIRATION

In infants and children with chronic or recurrent respiratory symptoms, the first study performed often is chest radiography. The chest radiograph in children with recurrent aspiration may be normal, may reveal bronchial wall thickening or hyperinflation, or may reveal diffuse or localized infiltrates. Infiltrates in infants with recurrent aspiration are often localized to dependent areas such as the upper lobes and the posterior areas of the lower lobes due to the effect of gravity when the infants are fed in a semirecumbent position. (1)(18) Chest radiographs are relatively insensitive to early changes from lung injury. (1)(39)

Computed tomography, particularly high-resolution scanning, is more sensitive in the detection of early airway and parenchymal disease in children who aspirate than is chest radiography, but it provides significantly more radiation to the chest than does chest radiography. (1)(40) Findings can include bronchial wall thickening, air-trapping, bronchiectasis, ground-glass opacities, and centrilobular opacities, which look radiologically similar to a "tree in bud." (1)(21)

DIAGNOSIS OF CHRONIC ASPIRATION DUE TO DYSPHAGIA

As in all other pediatric patients, the medical and developmental history should be taken from the parent. In addition, a complete feeding history should be elicited. (1)(40)(41)(42)(43)

If the primary care physician suspects that an infant or child has dysphagia or chronic pulmonary aspiration after watching him or her being fed by the parent, (41)(42)(43) he or she may wish to refer the patient to a pediatric pulmonologist, gastroenterologist, otolaryngologist, speech therapist, or pediatric aerodigestive center to confirm the suspected diagnosis.

Various sophisticated tests can be used by the pediatric subspecialist or speech pathologist to diagnose dysphagia and pulmonary aspiration in infants and children. (1)(44)(45) The most frequent initial tests used are the videofluoroscopic swallow study (VFSS), also known as the modified barium swallow study, or the fiberoptic endoscopic evaluation of swallowing with or without sensory testing (FEES or FEESST). Other diagnostic tests can include sonography, manometry, scintigraphy, and cervical auscultation. (1)(26)(41)(42)(43)(46)(47)(48)(49) VFSS and FEES/FEEST are discussed further herein.

VFSS

"The VFSS is the only instrumental assessment that provides visualization of the anatomy of the oral cavity, pharynx, larynx, and upper esophagus, as well as the function and integration of all four areas during the dynamic process of swallowing. The oral-preparatory, oral, pharyngeal, and esophageal stages of swallowing are all visualized." (1)(26)(41)

VFSS is performed by a pediatric radiologist and a dysphagia-trained pediatric speech and language therapist working together. (26) Test materials of various viscosities are fed to the patient in an age/developmentally appropriate format, and fluoroscopy is performed during swallowing. (42)

The results of the VFSS often allow the speech pathologist to determine the pathophysiologic cause of the dysphagia (aspiration or laryngeal penetration, nasopharyngeal backflow, swallow trigger, or pharyngeal residual). With laryngeal penetration, food or liquid enters the laryngeal vestibule, but unlike aspiration, does not descend below the level of the vocal cords. The speech therapist can then choose the most appropriate treatment strategies to allow the safest and most appropriate intake of calories for the infants and children. (1)(42)(50)(51)

The disadvantages of the VFSS are the need for patient cooperation and the significant amount of radiation exposure to the patient's brain. (26)

The speech therapist will, in a report of the VFSS results, often inform the physician within what period he or she feels that the VFSS should be repeated, if needed. Depending on the severity of the patient's dysphagia and also from the radiation exposure standpoint, if this author does not receive this information from the speech therapist, this author will repeat the VFSS no more frequently than in 3 to 4 months, preferably 6 to 9 months.

FEES/FEESST

FEES enables direct visualization of the hypopharynx and larynx before and after the swallow. A small flexible endoscope is positioned by the endoscopist for optimal visualization of these structures. Then, dyed foods and liquids are observed as they are swallowed by the patient. (1)(52)

The endoscopist can easily determine whether spillover and laryngeal penetration or aspiration occurred during the swallow. If the dyed food and liquid is seen in the trachea, that indicates that aspiration occurred during the swallow. (1)(52)

FEEST, similar to FEES, allows the endoscopist to observe swallowing dysfunction but also allows information about airway protection to be obtained. The laryngeal adductor reflex, one of the main airway protective reflexes, is elicited by providing air pulses of increasing pressures to the aryepiglottic folds of the larynx through the flexible endoscope. The laryngeal adductor reflex, when elicited, helps prevent aspiration into the lower respiratory tract by closing the glottis and causing coughing and swallowing. The normal reflex requires less than 4 mm Hg of air pulse pressure; any more pressure indicates that the reflex is abnormal and airway protection is suboptimal, thereby allowing aspiration into the airway to occur during eating. (1)(53)(54)(55)(56)(57)

SALIVAGRAM

Some children, even if adequately treated for dysphagia of oral foods and liquids, may have both sialorrhea, an increased production of saliva, and dysphagia with resultant aspiration of saliva. The radionuclide salivagram is used at several pediatric academic hospitals because it is a relatively easy test to perform to try to detect salivary aspiration. A radiotracer with the consistency of saliva is placed in the mouth, and serial images are taken until the tracer is swallowed. The test is positive if there is the presence of radioactivity in the trachea or bronchi, indicating that aspiration has occurred. However, the salivagram is a poorly sensitive test for salivary aspiration, with only 26% to 28% prevalence of positive salivagrams in children suspected of aspiration. (1)(58)(59)(60) The results of the salivagram also correlate poorly with the results of other tests of aspiration, such as VFSS and milk scans. (61) Thus, the diagnosis of sialorrhea with aspiration is often made clinically by the pediatric subspecialist.

TREATMENT OF DYSPHAGIA

The goals for treatment of dysphagia are to ensure safe swallowing with adequate oral intake of calories with minimal or no pulmonary aspiration. Feedings may be given orally with compensatory strategies to decrease dysphagia and pulmonary aspiration or by feeding through a temporary/permanent feeding tube. (1)(41)(43)

Compensatory strategies used by the speech pathologist for infants and children with dysphagia during oral feedings may include changes in positioning, changes/modification to bottle/nipple systems, thickening of oral liquids, and improving swallowing function through various exercises and maneuvers. (1)(41)(42)(43)(44)(62) The parents are taught these techniques by the speech/language pathologist. Use of commercial thickening agents is not recommended with premature infants who have dysphagia due to the risk of development of necrotizing enterocolitis. (63)(64)

Management strategies for feeding a child with dysphagia include adjusting the child's environment, proper positioning, appropriate sensory stimulation, and using adaptive equipment. The environment should be calming and soothing to help the child relax and should have reduction of external stimuli that interfere with the child's concentration and effective swallowing pattern. The optimal body position is an upright 90° sitting position. The child's head should be midline of the body with the chin slightly flexed. Hyperextension of the head and neck makes swallowing more difficult and increases the risk of aspiration. (65) Sensory stimulation includes modification of foods and liquids regarding texture, volume, temperature, and taste, and direct stimulation of the lips and oral cavity with a gloved finger, a finger stimulator, or a flexible, introductory toothbrush. (66) For a child who has a problem protecting the airway or has a delayed pharyngeal swallowing phase, thickened food or liquid should be used. Change in food temperatures may reduce the problem of a delayed pharyngeal swallowing phase. (67) Some of the adaptive equipment that may be used include 1-way slit valve nipples to control flow of thin liquids, a nosey cup or a flexible, plastic cup

with 1 side cut out to avoid neck extension when in use, and a spoon made of hard smooth plastic with a shallow bowl that permits food to slide off easily. This type of spoon is used with children who have difficulty with lip closure, oral hypersensitivity, tonic bite, or tongue thrust problems. (67)

NONORAL FEEDING

Children with dysphagia and chronic aspiration who continue to have recurrent respiratory symptoms despite using compensatory feeding strategies may need placement of a temporary or permanent nasogastric or nasojejunal feeding tube to provide adequate calories in a nonoral manner. (1)

Surgical gastrostomy or jejunostomy tubes may be placed by the pediatric surgeon as an open procedure or by laparoscopy. Alternately, they can be placed percutaneously or endoscopically by the pediatric gastroenterologist. (1)(39) Enteral access through the jejunum is indicated when patients cannot tolerate oral intake or gastric feeding. (68) Feeding through a gastrostomy tube may initiate or worsen GER. (36)(39) Thus, 5% to 34% of children will require anti-GER surgery, such as fundoplication, to control symptomatic GER. (39)(69)(70)(71)(72)(73)(74)(75)(76)(77)(78)(79)(80) In a study comparing gastrostomy and jejunostomy tubes, gastrostomy tubes were more likely to become dislodged or occluded and require a repeated intervention than jejunostomy tubes. Jejunostomy tubes were more likely to leak at the insertion site, but patients with jejunostomy tubes were more likely to meet their enteral feeding goals than patients with gastrostomy tubes. (68)

Placing a feeding tube can lead to future problems with the development of further feeding skills. (1)(42)(43)44)

Children who receive tube feedings have significantly more dental problems than children who do not receive feedings in this manner. This is felt to be due to an increase in the amount of oral flora present in the patient's mouth. (1)(81)(82) Frequent brushing of teeth, flossing, and visits to dentists are recommended for children who receive tube feedings. (1)(81)(82)

MANAGEMENT OF SALIVARY ASPIRATION

There are several methods used to treat sialorrhea and salivary aspiration. (26) Glycopyrrolate or scopolamine patches have been used to treat sialorrhea. These medications are used to try to decrease salivation. However, in some patients their effect is erratic and does not decrease salivation adequately. (26) These anticholinergic agents have adverse effects such as behavioral changes, constipation, flushing, nasal congestion, vomiting, diarrhea, and tachycardia. Mucous plugging and respiratory distress can be troublesome in patients who have tracheostomy tubes and who are administered oral anticholinergics. Treatment has to be stopped in up to one-third of patients due to ineffectiveness of the drug or the development of significant adverse effects. (1)(26)(39)(83)(84)(85)(86)

Injections of botulinum toxin A into the salivary glands under sonographic guidance by an otorhinolaryngologist have been effective in controlling sialorrhea in children. (87)(88)(89)(90)(91) Injection of the toxin into the salivary glands causes reversible reduction in acetylcholine release from presynaptic nerve terminals. Downregulation of acetylcholine, theoretically, leads to reduction in the production of saliva. (92) Repeated injections are given at 6- to 28-week intervals. (90) Development of antibodies to botulinum toxin type B can result in the injected toxin having no clinical response, presumably due to cross-reactivity of the antibodies with botulinum type A. (93)

Surgical bilateral submandibular salivary gland and parotid duct ligation or submandibular salivary gland excision with parotid duct ligation may be necessary to decrease drooling, sialorrhea, and salivary aspiration. Results have varied in children. (94)(95)(96)(97)(98)

"Children who continue to aspirate and have recurrent pneumonias despite other medical/surgical therapies may need the placement of a tracheostomy, particularly one using a cuffed tracheostomy tube, for pulmonary toilet. Despite this, there is a lessened but still present risk of continued aspiration." (1)

For very resistant cases, the definitive treatment for the elimination of chronic pulmonary aspiration is surgical laryngotracheal separation or diversion. The procedure eliminates all continuity between the respiratory and digestive tracts. The ability to speak is lost, and the patient is left with a permanent tracheostomy. (1)(39)(99)(100)(101)

ASPIRATION PNEUMONIA

Dysphagia resulting in acute or chronic pulmonary aspiration can lead to the development of pneumonia in some cases. In a report in 2007, in a group of 150 children with VFSS-proven dysphagia, the odds ratio for pneumonia was significantly increased in children with postswallow residue or aspiration of thin fluids but not thick fluids or purees. After multiple logistic regression, pneumonia was associated with the diagnosis of asthma, Down syndrome, GER disease, history of lower respiratory tract infection, moist cough, or oxygen supplementation. (102)

In neonates, dysphagia can lead to aspiration, which, in turn, can lead to physical obstruction of the airway manifested as atelectasis or consolidation and can predispose to infection. The infant may develop cyanosis, apnea, or gasping. Crepitation and rhonchi may be heard on auscultation of the chest and back. A new area of consolidation or infiltrate on a chest radiograph, particularly in the upper lobes and the posterior areas of the lower lobes, is suggestive of aspiration. After an episode of aspiration, the airways should be cleared, and an infant with

aspiration pneumonia may require supplementary oxygen or even ventilator support. Broad spectrum antimicrobial drug coverage should be given, such as flucloxacillin and an aminoglycoside for at least 5 days. (18)(103)

Aspiration pneumonia can also occur in children past the neonatal period who have dysphagia. It may be accompanied by fever, coughing, wheezing, and leukocytosis, and infiltrates may be seen radiologically. There are several conditions predisposing to infectious complications of aspiration: gingivitis, decayed teeth, gastric outlet or intestinal obstruction, enteral tube feeding, prolonged hospitalization, endotracheal intubation, prone positioning without elevation of the head, and use of antacids or acid blockers. Multiple bacterial pathogens found in the oropharynx can cause aspiration pneumonia in children with dysphagia. Aerobic and facultative bacteria found include *Streptococcus pneumoniae,* group A *Staphylococcus aureus, Proteus* species, *Pseudomonas aeruginosa, Klebsiella pneumonia, Escherichia coli, Aerobacter* species, *Haemophilus influenza,* and others. Anaerobic organisms in adults with ventilator-associated aspiration pneumonia predominate in the oropharynx with a ratio between 3:1 and 10:1. When aspiration occurs in the hospitalized patient, or in a patient receiving broad spectrum antibiotic drug therapy, nosocomial and facultative organisms predominate. Most commonly these include *E coli, Proteus* species, and *P aeruginosa.* (104) There is a role for flexible bronchoscopy with bronchoalveolar lavage or the use of protected specimen brushes early in the course of aspiration pneumonia to help identify the bacterial organism. If the child with aspiration pneumonia has very limited reserve (pulmonary or immunologic) or a highly infectious aspirate is suspected, early empirical antibiotic drug therapy may be warranted. In the previously healthy individual, in whom anaerobic bacteria are most likely to predominate, initial therapy with penicillin, ampicillin, or clindamycin is recommended. In the treatment of pneumonia in children with underlying chronic lung disease, in institutionalized patients, and in those having received broad spectrum antibiotic drug therapy, a second- or third-generation cephalosporin should be considered. In immunocompromised patients, a combination of an aminoglycoside and a synthetic penicillin or cephalosporin such as ceftazidime might be initiated until culture results are available to guide more specific therapy. Culture results should be used to discontinue or narrow antibiotic drug therapy. Treatment with antibiotics for 7 to 10 days is reasonable for patients who respond promptly. (104)

Summary

- Based on some research evidence and consensus, dysfunction of airway protective reflexes can allow pulmonary aspiration to occur in children with dysphagia. (1)
- Based on some research evidence and consensus, dysphagia and chronic pulmonary aspiration should be in the differential diagnosis of infants and children with chronic cough, recurrent wheezing, recurrent pneumonias, atelectasis, bronchiectasis, pulmonary abscess, pulmonary fibrosis, bronchiolitis obliterans, apnea/bradycardia, acute life-threatening events, (31) failure to thrive, stridor, and laryngitis/hoarseness. (1)(32)
- Based on some research evidence as well as consensus, there are several conditions that can predispose children to aspiration lung injury (Table). Children with Down syndrome, Prader-Willi syndrome, laryngomalacia, and glossoptosis, (34)(35)(36)(37) as well as children with neuromuscular weakness, can have silent aspiration.
- Based on some research evidence as well as consensus, the clinician should observe the infant or child eating and drinking if dysphagia is suspected.
- Based on strong research evidence, the chest radiograph may be normal in up to 14% of children with recurrent aspiration. (18)
- Based on strong research evidence, the VFSS and FEES/FEESST are the most common instrumental assessments used for evaluation of swallowing in children. (26)(41)(42)(43)(47)
- Based on strong research evidence, the salivagram has poor sensitivity to detect salivary aspiration. (58)(59)(60)
- Based on strong research evidence, speech therapists use several compensatory strategies to treat dysphagia in children. (41)(42)(43)(44)(62) Some children with severe dysphagia require placement of feeding tubes. (39)
- Based on strong research evidence, sialorrhea can be treated with anticholinergic agents, (83)(84)(85)(86) botulinum toxin injections into the salivary glands, (87)(88)(89)(90)(91) ligation or resection of the salivary glands, (94)(95)(96)(97)(98) placement of a tracheostomy, or even laryngotracheal separation. (99)(100)(101)
- Based on research evidence as well as consensus, aspiration pneumonia secondary to dysphagia can cause significant morbidity in children of all ages and requires prompt treatment with appropriate antibiotic agents. (102)(103)(104)

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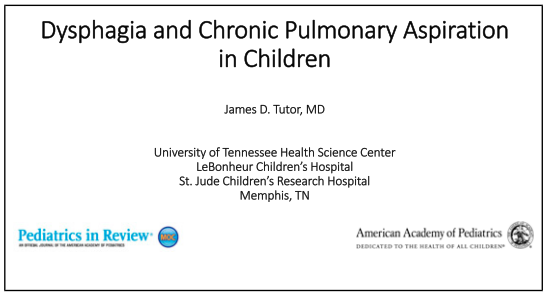

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1. A 4-week-old girl is brought to the clinic with a 2-day history of cough, congestion, and decreased appetite. She usually drinks 4 oz of formula with each feeding but now stops after 2 oz, with coughing and difficulty swallowing. On physical examination she has copious nasal secretions. Respiratory examination shows mild tachypnea with intercostal retractions and coarse breath sounds bilaterally. A test of her nasal secretions is positive for respiratory syncytial virus. This infant is most at increased risk for which of the following conditions?

   A. Apnea.
   B. Aspiration pneumonia.
   C. Empyema.
   D. Failure to thrive.
   E. Pulmonary edema.

2. You are seeing a 2-year-old girl with cognitive and motor impairment. During the past 9 months she has been treated with 3 courses of antibiotic drugs for pneumonia. She is fed pureed foods and a high-protein liquid nutritional supplement. During the past 2 to 3 months, the parents have noticed increased episodes of coughing and choking during feedings. Which of the following is the most appropriate next step in this girl's evaluation?

   A. Computed tomography of the brain.
   B. Esophageal pH monitoring.
   C. Upper gastrointestinal endoscopy.
   D. Upper gastrointestinal tract radiographic series.
   E. Videofluoroscopic swallow study.

3. An 18-month-old girl with dysphagia, gastroesophageal reflux, and chronic aspiration is brought to the clinic for follow-up. Her last visit was 6 months ago when she was referred to a speech pathologist who recommended thickening of oral liquids and foods as well as exercises to improve swallowing function. Despite these changes the patient continues to experience problems with swallowing, spitting up, failure to thrive, and recurrent respiratory symptoms, including 2 episodes of aspiration pneumonia. Given her multiple problems, which of the following is the most appropriate next step in the management of this patient?

   A. Change the temperature of her food.
   B. Nasojejunal feeding tube placement.
   C. Surgical gastrostomy tube placement.
   D. Surgical jejunostomy tube placement.
   E. Switch her feeding to an elemental formula.

4. You are seeing a 3-year-old boy with cerebral palsy. He has excessive production of saliva, which has resulted in dysphagia and several episodes of aspiration pneumonia. A salivagram showed findings consistent with aspiration pneumonia. You decide to treat the sialorrhea with glycopyrrolate. Which of the following is the most likely adverse effect of this medication?

   A. Bradycardia.
   B. Constipation.
   C. Fatigue.
   D. Increased sweating.
   E. Rhinorrhea.

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5. A 2-year-old boy with Down syndrome and a history of dysphagia is brought to the clinic for evaluation. He has been seen by a speech pathologist, who recommended thickening feeds, but the family has been noncompliant with this recommendation. He presents today with fever, coughing, and decreased oral intake. He has no known drug allergies. Physical examination is significant for diffuse wheezing and rhonchi in the right lower lung field. A chest radiograph reveals a new infiltrate in the right lower lobe. Which of the following is the most appropriate treatment regimen in this patient?

   A. Azithromycin.
   B. Cefixime.
   C. Ceftazidime and gentamicin.
   D. Clindamycin.
   E. Flucloxacillin and gentamicin.

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