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Airway Infectious Disease Emergencies in Children

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Abstract: ***Upper and lower respiratory infections are commonly encountered in the emergency department (ED). Visits for respiratory disease account for 10% of pediatric emergency department visits and 20% of all pediatric hospital admissions [1]. The causes of upper airway infections include croup, epiglottitis, and retropharyngeal abscess-cellulitis (pharyngitis and peritonsillar abscess are described separately). Lower airway infections arise from bacterial and viral infections and cause illnesses such as pneumonia and bronchiolitis. Signs and symptoms overlap with upper and lower airway infections but differentiation is important for the appropriate treatment of these conditions. This article reviews the various clinical characteristics of upper and lower airway infections.***

Keywords: Upper and lower respiratory infections, children

1. Introduction

Upper airway infections Upper airway infections in children include a variety of common and uncommon conditions that can pose significant diagnostic and therapeutic challenges. These difficulties tend to be augmented by the potential for rapid airway compromise and limited evaluations in smaller, apprehensive children [1]. As with many infections, the primary challenge in these conditions lies in identifying the causative pathogen and determining the extent of disease progression. In this discussion, upper airway infections are grouped into the three categories of pharyngotonsillar, laryngotracheobronchial, and deep neck space infections, with an emphasis on recent advances in diagnostic and management strategies.

Pharyngotonsillar infections

Pharyngotonsillar infections are a group of commonly encountered upper airway problems that include pharyngitis, tonsillitis, and peritonsillar infections. Pharyngitis refers to infections of the pharynx and may also include tonsillitis, in which case the complex is referred to as pharyngotonsillitis. The varied causes but overlapping clinical presentations of these infections have made them the focus of several recent practice guidelines that promote selective and targeted antibacterial therapy in an attempt to reduce the number of unnecessary antibiotic prescriptions [2]. Viruses are the most common cause of pharyngitis and tonsillitis in all age groups. Common viral pathogens include respiratory viruses such as influenza virus, parainfluenza virus, adenovirus, and rhinoviruses as well as others, such as coxsackievirus, echoviruses, and Epstein-Barr virus. Group A streptococci (GAS) is the most common bacterial cause of pharyngitis, but a number of other bacteria such as Mycoplasma pneumoniae, Chlamydia pneumoniae, Neisseria gonorrhea, and Arcanobacterium haemolyticum are also implicated, although less commonly [3]. GAS pharyngitis is the only commonly occurring form of bacterial pharyngitis that definitely requires antibiotic therapy [4]. The significance of GAS infection is related to its association with both suppurative complications such as otitis media, sinusitis, peritonsillar and retropharyngeal abscesses and nonsuppurative sequelae, including acute rheumatic fever and acute glomerulonephritis. In light of this, the primary challenge in the diagnosis of pharyngitis lies in distinguishing between streptococcal and nonstreptococcal infections. Clinical symptoms suggestive of GAS infection include the acute onset of sore throat, fever, headache, pain on swallowing, abdominal pain, nausea, vomiting, scarletiniform rash, and enlarged tender anterior cervical lymph nodes [5]. Symptoms more suggestive of nonstreptococcal pharyngitis include concurrent viral respiratory or gastrointestinal infection and associated cough, coryza, conjunctivitis, and diarrhea [6]. A number of decision rules have been proposed to assist with the clinical diagnosis of GAS pharyngitis. Of these rules, the Centor criteria, which include tonsillar exudates, swollen and tender anterior cervical lymph nodes, lack of cough, and a history of fever, are used most commonly. However, despite their value in stratifying the risk of GAS infection, the sensitivity and specificity of these criteria are too low to forgo the use of diagnostic tests.

Laryngotracheobronchial infections

Laryngotracheobronchial infections include a spectrum of common seasonal upper respiratory infections that result from varying degrees of subglottal airway inflammation and obstruction. Laryngotracheobronchitis or croup is most commonly encountered in the second year of life but is also seen frequently in children from the age of 6 months to 6 years. The overall incidence of croup is estimated at 1.5% to 6% and is noted in boys 1.4 to 2 times more commonly than in girls. Admission rates for croup have ranged from 1.5% to 31% and vary greatly with differing practice patterns [7]. Parainfluenza virus types 1 and 3 are associated most commonly with croup across all age groups. Other important but less common pathogens include respiratory syncytial virus (RSV), which is noted more commonly in children less than 5 years of age, influenza virus, and M pneumoniae, which is more prominent in children older than 5 to 6 years of age. Corresponding to the seasonal prevalence of these pathogens, croup is most predominant in late fall and early winter. Characteristic clinical findings of croup include a hoarse voice, inspiratory stridor, and a barking cough, which tends to be worse at night [8]. The severity of these symptoms is related to the degree of narrowing of the larynx and trachea as a result of infection-induced mucosal inflammation and edema. Children with mild croup tend to have inflammation limited to the larynx and present frequently with symptoms of hoarseness, intermittent barky cough, and inspiratory stridor that may be noticeable only with agitation. More severe cases of croup are associated

with the extension of inflammation to the trachea and bronchi and present with inspiratory stridor that is audible at rest and is associated with signs of respiratory distress, including nasal flaring and intercostal retractions [9]. Although, croup is diagnosed primarily on clinical grounds, the finding of the classical ''steeple sign'' in the subglottal area on anteroposterior neck radiographs may be used to confirm the diagnosis.

Epiglottitis

Epiglottitis, also known as supraglottitis, is an inflammatory condition of the epiglottis and its adjacent structures that can progress rapidly to life-threatening airway obstruction. Compared with adult epiglottitis, the now rare childhood form of this condition presents with several distinctive clinical features that further add to the diagnostic and management challenges of this potentially fatal condition [10]. Historically, epiglottitis has been closely associated with invasive Haemophilus influenzae type b (Hib) infection. Before the initiation of childhood vaccination programs with Hib-conjugated vaccines in 1998, epiglottitis was second only to meningitis as the most common presentation of Hib disease. Since the early 1990s, a dramatic decline in the number of cases of childhood epiglottitis has been noted [11]. By contrast and for uncertain reasons, during this same period, the incidence of epiglottitis in adults has risen significantly. In the post-vaccine era, most cases of childhood epiglottitis are caused by pathogens other than H influenzae. Among these, Streptococci and Staphylococci organisms and Candida albicans are the most common bacteria, although the relative frequency of epiglottis caused by these pathogens has not increased. Despite the widespread use of Hib vaccination, a number of cases of Hib-related epiglottitis still have been reported in both immunized and nonimmunized children [12]. For these reasons, an up to date immunization history should not exclude the possibility of epiglottitis in a child with a clinically consistent presentation.

Deep neck space infections

Peritonsillar, retropharyngeal, and parapharyngeal infections are among a group of potentially life-threatening deep neck infections in children that share common clinical features and can present significant diagnostic challenges.

Prompt diagnosis and management of these conditions are essential to ensure successful recovery and prevention of complications [13]. Approaches to the diagnosis and management of these infections are evolving and are the focus of this discussion. Parapharyngeal and retropharyngeal infections Parapharyngeal or lateral pharyngeal infections develop in a funnel-shaped space lateral to the pharynx that posteriorly contains the carotid sheath and cranial nerves. In children, these infections may be related to complications of pharyngotonsillar, dental, or adjacent deep neck space infections. Retropharyngeal infections develop in the potential space located between the posterior pharyngeal wall and the prevertebral fascia and may be medical (45%), traumatic (27%), or idiopathic in origin. Infections secondary to traumatic injuries can be seen in children and adults and may be associated with accidental trauma, foreign body ingestion, or complication of medical procedures [14]. Retropharyngeal infections of medical causes are noted most commonly in children younger than 6 years old, with a peak incidence at 3 years of age. These infections are generally secondary to contiguous spreading along a lymphatic chain that originates from the nasopharynx, adenoids, and paranasal sinuses and extends to the adjacent pharyngeal tissues. Accordingly, retropharyngeal infections in children tend to be preceded by upper respiratory tract infection such as pharyngitis, tonsillitis, sinusitis, and cervical lymphadenitis. The reduced incidence of retropharyngeal infections in older children has been attributed to the atrophy of these lymphatic structures with age [15]. Offending pathogens in these infections tend to vary with the source of origin and frequently include multiple aerobic and anaerobic organisms. Common isolates include S viridans and pyogenes, Staph aureus and epidermidis, as well as Bacteroides, Peptostreptococcus, Fusobacterium, Haemophilus, and Klebsiella organisms. The extent of tissue involvement can range from cellulitis to frank abscess formation and frequently contributes to the varying clinical presentation.

Peritonsillar infections Peritonsillar infection, noted most commonly in patients who have chronic or recurrent tonsillitis, represents an extension of infections from the tonsils. Unlike pharyngitis and tonsillitis, which are noted frequently in all age groups, peritonsillar infections are more common in adolescents and adults. The cause of these infections tends to be polymicrobial and frequently includes both aerobic and anaerobic bacteria. Management of these infections is based on their classification into the more common peritonsillar cellulites (PTC) and the less frequent peritonsillar abscesses (PTA) or quinsy. Typical signs and symptoms of peritonsillar infections include fever, trismus, poor oral intake, drooling, and uvular deviation. Among these, uvular deviation combined with trismus can aid in differentiating between PTA and PTC. However, because the clinical presentations of PTC and PTA are very similar, the imaging studies are frequently needed to further delineate the degree and extension of infection. CT with contrast enhancement has been the traditional choice for confirmation of abscess formation in children. However, some authors have advocated ultrasonography of the neck as a highly sensitive, inexpensive, and nonradiating alternative modality for differentiation between PTC and PTA [16].

Lower airway infections

Definition Pneumonia has been defined as pulmonary infiltrates as observed on a chest radiograph or by clinical signs and symptoms. The World Health Organization considers a diagnosis of pneumonia using clinical signs such as tachypnea (respiratory rate >50 breaths/min in infants less than 1 year of age and 40 breaths/min in children more than 1 year of age), retractions, or cyanosis. Tachypnea may also be seen in conditions such as asthma and bronchiolitis. Bronchiolitis is defined as an acute lower respiratory tract infection usually in children less than 2 years of age that results in inflammation and obstruction of the peripheral airways [17].

Pathophysiology

Bacterial pneumonia is seen after the inhalation or aspiration of pathogens. Less commonly, it can also occur after hematogenous spread. An inflammatory reaction follows,

with the release of fluid and polymorphonuclear white blood cells into the alveoli, followed by fibrin and macrophage deposition over days. Viral pneumonia occurs mainly after the inhalation into the lung of infected droplets from upper airway epithelium. RSV, the major cause of bronchiolitis, is transmitted by contact with infected nasal secretions and more unusually by aerosol spread [18]. In both viral pneumonia and bronchiolitis, the resulting inflammatory response causes epithelial cells to slough into airways, thereby causing bronchial obstruction and hyperinflation. Inflammation mostly affects the smaller caliber peripheral airways, essentially sparing the alveoli in bronchiolitis. Lymphocytes infiltrate in the peribronchial and peribronchiolar epithelium, promoting submucosal and adventitial edema in bronchiolitis. Mucous plugs and cellular debris accumulate because of impaired mucociliary clearance, leading to ball-valve obstruction and subsequent hyperinflation. Viral pneumonia may also predispose infected children to bacterial pneumonia because of damage to mucosal barriers. Pneumonia in the neonatal period may occur as a result of infection or colonization of the nasopharynx or conjunctiva by organisms found in the mother's vaginal tract. Lung injury from aspiration or host immunologic factors such as in cystic fibrosis [86] may also predispose the child to pneumonia.

Causes

Many microbiologic agents cause childhood pneumonia, but given the difficulty of establishing the definitive cause, the most likely pathogens are usually inferred from factors such as age, season, and clinical characteristics. Radiographs, blood tests, and cultures are of limited value to the emergency department physician in determining the cause of pneumonia. Depending on the specific laboratory testing used, such as culture, antigen detection, or serology, the microbial cause of pneumonia was found only in 20% to 60% of cases in a European review [19].

Bronchiolitis

Bronchiolitis is a common, usually self-limited, lower respiratory tract infection caused by RSV that is observed in all geographic areas and usually seen between the months of October through April. There are two strains of RSV, A and B, with numerous genotypes and serotypes. The incubation period varies from 2 to 8 days and, after a prodrome of several days, there is an acute illness characterized by rhinorrhea, cough, and low-grade fever. Young children may be restless or lethargic and drink less than normal. The physical examination is marked by tachypnea, accessory muscle use, wheezes, or crackles. Hypoxemia may be seen secondary to ventilation-perfusion mismatch. The complications of apnea and respiratory failure are seen most frequently in young infants and those with underlying conditions such as prematurity, bronchopulmonary dysplasia, chronic lung disease, congenital heart disease, or immunodeficiencies. In typical cases, laboratory testing or chest radiographs are generally not useful but should be considered if the diagnosis is unclear because viral myocarditis, congenital heart disease, and pneumonia may have similar clinical presentations. Because the diagnosis of bronchiolitis is a clinical one, routine RSV antigen testing has little value in management. Respiratory viral antigen testing may be helpful for infection control if patients are admitted to inpatient units Oxygen saturation should be performed routinely because cyanosis is difficult to detect and an oxygen saturation of less than 95% was found to be the single best predictor of severe illness in a study of outpatients who had bronchiolitis. The treatment for bronchiolitis is supportive, including intravenous hydration, supplemental oxygen, nasal suction, and mechanical ventilation for respiratory failure. Although many therapies have been attempted for bronchiolitis, including ribavirin, interferon alfa, vitamin A, montelukast, b agonists, epinephrine, and corticosteroids, the optimal therapy is still controversial. Although some studies, including a meta-analysis and a systematic review, all failed to show significant clinical improvement with b agonists, other studies have reported a positive effect [20]. Racemic epinephrine may be more effective in the treatment of bronchiolitis because of its additional vasoconstrictor effects in reducing microvascular leakage and mucosal edema. Infants with bronchiolitis, who are treated with nebulized racemic epinephrine, showed more improvement than those treated with nebulized albuterol without an increase in side effects. Nebulized ipratropium bromide has not been shown to be of added benefit in treating bronchiolitis. Confounding results have also been seen with corticosteroids. Although the majority of studies have not demonstrated a benefit with oral, nebulized, or parenteral steroid therapy, some studies suggest that steroid therapy may be effective in improving recovery. In actual hospital practice, short-acting b agonists have been shown to be used 53% to 73% in various studies. Steroids are used 8% to 13%. Many physicians will attempt a trial of nebulized albuterol for children with bronchiolitis with mild respiratory distress; if there is moderate or severe distress, then nebulized racemic epinephrine and possibly steroids are used. The mainstay of treatment remains supportive care with oxygen and intravenous fluids as needed [21].

Atypical pneumonia

The term ''atypical pneumonia'' has referred, for the most part, to pneumonia caused by organisms other than the historically common and more easily cultured bacteria, including most often M pneumonia, C pneumoniae, Chlamydia species (eg, burnetti, trachomatis, and psittaci), Legionella pneumophila, Bordetella pertussis, and viral pathogens. M pneumoniae and C pneumoniae have been reported to be the most frequent causes of community-acquired pneumonia in children age 5 years or older. Pneumonia caused by C pneumoniae and M pneumoniae has been reported as relatively mild and rarely resulting in hospitalization; however, Legionella spp, which are the exception and are often classified as the causative organisms in atypical pneumonia, usually cause more acute and severe symptoms. The pneumonias caused by M pneumoniae and C pneumoniae can be further differentiated clinically by wheezing on presentation. Chest radiographic findings are less likely to be lobar for atypical pneumonias than those caused by S pneumoniae. Radiographic abnormalities in M pneumoniae vary, but bilateral, diffuse infiltrates are common. Pleural effusions are also less likely to be seen with M pneumoniae and C pneumoniae. The treatment for atypical pneumonia, covering M pneumoniae and C pneumoniae, includes macrolide agents in any age group and tetracyclines in children older than 8 years of age.

Fluoquinolones (including levofloxacin and oflaxacin but not ciprofloxacin) also are appropriate in children older than 16 years of age [22].

Neonatal pneumonia

Neonatal pneumonia and neonatal sepsis are very different entities than community-acquired pneumonia in older children. These neonates typically present with tachypnea, grunting, and retractions. Nonspecific symptoms such as irritability and poor feeding may also be seen. They may have a fever, or they may present with hypothermia. The most common bacterial agent is group B streptococci, but Listeria monocytogenes and other bacteria that cause pneumonia in older infants can also be seen. Gram-negative enteric bacteria can also cause pneumonia in neonates older than 1 week, usually from nosocomial infection [23]. The treatment is supportive and includes broad-spectrum antibiotic coverage such as parenteral ampicillin and gentamicin or ampicillin and cefotaxime.

2. Conclusion

Upper and lower airway infections are common in pediatrics and are usually diagnosed clinically based on the history, physical examination, and specific epidemiologic characteristics. Changes in pneumococcal resistance and immunization practices with pneumococcal and influenza vaccines will continue to change the incidence rate and causative findings of pneumonia. The treatment of airway infections is always supportive, but specific management strategies for certain pathogens, including the selection of antibiotics, bronchodilators, steroids, and inpatient or outpatient disposition, depend on the disease, the age, and the clinical characteristics of the host.

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