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REVIEW ARTICLE

Pneumonia and Asthma - diagnosing and treatment in pediatric medicine

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ABSTRACT

Pediatric respiratory emergencies, notably asthma and pneumonia, require specialized care due to the distinct anatomical and physiological characteristics of children. Effective management hinges on early and accurate assessment, along with tailored treatment strategies. For pneumonia, the diagnosis involves monitoring respiratory rates and using diagnostic tools like chest radiographs and procalcitonin levels to guide antibiotic use. Vaccination has significantly reduced bacterial pneumonia rates. Asthma management includes rapid assessment and the use of short-acting β-agonists, corticosteroids, and second-line treatments for severe cases. Updated guidelines stress personalized treatment plans, incorporating inhaled corticosteroids and careful monitoring. Avoiding routine antibiotic use unless there's a clear bacterial infection is recommended. By providing healthcare providers with comprehensive knowledge and appropriate tools, outcomes for pediatric patients experiencing these respiratory emergencies can be significantly improved, reducing the risk of long-term complications and hospitalizations. The emphasis on prompt, precise interventions and adherence to updated guidelines ensures that the care delivered to young patients is both effective and efficient, ultimately enhancing their recovery and overall health.

KEY WORDS

asthma, pneumonia, respiratory distress

INTRODUCTION

Pediatric emergencies present unique challenges that demand specialized knowledge and skills from healthcare providers. Unlike adults, children have distinct anatomical and physiological characteristics, which require tailored approaches for effective management. Among the most common emergencies encountered in pediatric patients are respiratory distresses. Respiratory distress is a frequent and critical issue in pediatric medicine, often leading to emergency department and hospital admissions for oxygen therapy and supportive care. These conditions not only necessitate immediate attention but also precise and informed interventions to ensure the best possible outcomes. Respiratory distress often arises from conditions such as asthma exacerbations, infections (both viral and bacterial) leading to pneumonia, allergic reactions, and foreign body aspirations [1-3]. According to Challands et al., main causes of respiratory distress in children include bronchiolitis, asthma, pneumonia, and chronic lung diseases. Bronchiolitis is the most common lower respiratory tract infection in infants, particularly those under one year old [3] According to the studies by Choi J et al the four most prevalent respiratory conditions in children are asthma, croup, bronchiolitis, and pneumonia [4]. Children with respiratory distress may present with many different symptoms such as rapid breathing, wheezing, and difficulty speaking or crying. Although immediate management typically involves oxygen therapy and, in severe cases, the use of respiratory support devices are necessary to stabilize the patient [4]. Early recognition and appropriate management of respiratory distress in pediatric patients are crucial to prevent deterioration and improve outcomes. Understanding and effectively managing common pediatric respiratory emergencies are critical for reducing the risk of long-term complications. This article explores two of many common pediatric respiratory issues that can lead to hospitalization: Pneumonia and Asthma in detail, providing insights into their causes, symptoms, and essential emergency interventions, based on medical literature. By equipping healthcare providers with the knowledge and tools necessary to address these emergencies, we can enhance the quality of care delivered to our youngest and most vulnerable patients.

AIM

The aim of this article is to present and describe two of respiratory emergencies among pediatric patients: Pneumonia and Asthma, their symptoms, and outline treatment strategies.

REVIEW AND DISCUSSION

PNEUMONIA

Pneumonia in children can be viral, bacterial, or mixed. Although it is quite common (14.4 per 10.0000) in all age groups, with viral causes is more common in

those under two years old [3]. Community-acquired pneumonia (CAP) is a prevalent disease in children, presenting significant diagnostic challenges for physicians in both private practice and hospital settings. [5] It ranks among the leading causes of hospitalization in children in developed nations [5, 6].

The World Health Organization (WHO) guidelines emphasize measuring respiratory rate as a key initial indicator for suspecting pneumonia. They recommend specific thresholds: a respiratory rate (RR) above 60 in infants under 2 months, above 50 in infants aged 2 to 12 months, above 40 in children aged 1 to 5 years, and above 30 in children older than 5 years. This tool may help detect 50% to 80% of pneumonia cases. It's important to count the respiratory rate for a full minute when the child is calm [4]. Clinically, symptoms and signs of CAP vary widely with age and individual cases. CAP should be suspected in children who exhibit fever and tachypnea, even after fever reduction with antipyretics. In addition to tachypnea, other signs of respiratory distress in children with CAP may include chest indrawing (suprasternal, intercostal, or subcostal), nasal flaring, and grunting. Additional clinical symptoms and signs indicative of CAP are cough, chest or abdominal pain, and focal chest signs. Tachypnea is considered the most crucial clinical sign as it is closely associated with hypoxemia, pulmonary infiltrates on chest radiographs, and the overall severity of CAP [5]. Routine chest radiographs are not required to confirm suspected CAP in patients who are stable enough to be managed as outpatients following assessment in an office, clinic, or emergency department setting. However, posteroanterior and lateral views of chest radiographs should be performed for all patients hospitalized with CAP to confirm the presence, size, and nature of parenchymal infiltrates. This imaging is also essential for identifying complications of pneumonia that might necessitate interventions beyond antimicrobial therapy and supportive medical care [7]. Chest ultrasonography is frequently used to assess local complications such as parapneumonic effusion or empyema and can also detect lung consolidation, offering potential time and cost savings. Studies have shown that both novice and expert physician-sonologists have been able to reduce the use of chest radiography in emergency departments without missing cases of pneumonia or increasing adverse events. While complete blood counts and acute-phase reactants like erythrocyte sedimentation rate and C-reactive protein are not typically used in outpatient settings, they may be useful for decision-making in more severely ill children in hospitals, as recommended by the Infectious Diseases Society of America (IDSA). However, measuring C-reactive protein in general practice for children with nonsevere acute infections has not been shown to reduce antibiotic prescriptions and is not recommended. Procalcitonin can be used alongside other clinical indicators to guide the treatment of pneumonia in children. Levels below 0.25 ng/mL can help identify children who are at a lower risk for bacterial CAP and for whom antibiotics may not be necessary [8].

The introduction of conjugate vaccines targeting Haemophilus influenzae type b and Streptococcus pneumoniae (pneumococcus) has significantly altered the incidence and etiological landscape of community-acquired pneumonia [5]. Recent extensive studies have undertaken comprehensive microbiological analyses to explore the causes of CAP in children with radiological confirmation. These investigations found that 81–99% of the children had viral and/or bacterial pathogens in their upper respiratory tract (URT). Viruses were the predominant pathogens identified, especially in young children, accounting for more than 90% of the cases [3, 5, 6, 9]. In a study of 2,638 U.S. patients under 18 years hospitalized with CAP, viral pathogens were detected more frequently than bacterial pathogens, with viruses present in 66% of cases compared to bacteria in 8%. Additionally, 7% of patients had both viral and bacterial infections, while no pathogens were identified in 19% of the cases [6, 8].

Respiratory syncytial virus (RSV) is the most prevalent pathogen, especially in children under two years old. Other frequently observed respiratory viruses include influenza virus, various coronaviruses (such as SARS-CoV-2, which causes COVID-19), human rhinovirus, human metapneumovirus, and adenovirus [6, 8]. Bradley JS, et al. [7] describe the decision-making framework regarding symptoms that necessitate the hospitalization of a pediatric patient involves assessing several key clinical symptoms and conditions. A children and infants require hospitalization when:

- cannot be adequately monitored at home or are unable to adhere to treatment protocols, or cannot have consistent follow-up care;
- the age is under 3–6 months with suspected bacterial CAP;
- CAP caused by highly virulent pathogens, such as community-associated methicillin-resistant Staphylococcus aureus (CA-MRSA)is suspected or confirmed;
- exhibiting moderate to severe CAP, characterized by factors such as respiratory distress and hypoxemia (with peripheral oxygen saturation [SpO2] below 90% at sea level) [7].

Despite generally good outcomes in high-income countries, pneumonia remains a leading cause of pediatric mortality worldwide [3], thats why it's important to recognize criteria for admitting a child with CAP to an Intensive Care Unit (ICU) or a Unit with Continuous Cardiorespiratory Monitoring. The same group of scientists, Bradley JS, et al. [7] claim that it is necessary when:

- there is a requirement of invasive ventilation through a temporary artificial airway, such as an endotracheal tube;
- there is a requirement of acute noninvasive positive pressure ventilation, such as continuous positive airway pressure (CPAP) or bilevel positive airway pressure (BiPAP);

- there are signs of impending respiratory failure;
- sustained tachycardia or inadequate blood pressure are exibited;
- there is a requirement of pharmacological support to maintain blood pressure or perfusion;
- pulse oximetry reading is below 92% while receiving 50% inspired oxygen;
- an altered mental status due to hypercarbia or hypoxemia resulting from pneumonia is exhibited.

The group also report that Severity of illness scores should not be the only criteria for ICU admission; they need to be considered alongside other clinical, laboratory, and radiologic findings. [7].

Outpatient care for CAP is suitable for patients who do not exhibit respiratory distress and are able to take oral antibiotics effectively. Empiric outpatient treatment based on IDSA Guidelines depends on the age of a patient and the cause of pneumonia. Initial antibiotic treatment is generally not recommended for preschool-aged children with pneumonia since viral infections are the primary cause in this age group. The IDSA suggests using macrolide antibiotics for treating atypical pneumonia in children, though evidence is mixed, and the potential for increased resistance in S. pneumoniae and M. pneumoniae must be considered [8].

According to IDSA Guidelines [7, 8, 10], (outpatient treatment) children under 5 years old:

- with presumed bacterial cause should be treaten in the first-line with amoxicillin, alternatively amoxicillin/ clavulanate
- with presumed atypical cause in the first-line with azithromycin, alternatively clarithromycin
- with presumed influenza pneumonia- Oseltamivir

According to IDSA Guidelines [7, 8, 10] (outpatient treatment) children who are 5 years old or more:

- with presumed bacterial cause - first-line with amoxicillin alternatively amoxicillin/ clavulanate
- with presumed atypical cause - in the first-line they should be treated with azithromycin alternatively clarithromycin or erythromycin. Doxycycline can also be considered for children older than 7 years
- with presumed influenza pneumonia - oseltamivir or zanamivir is recomended.

Children who do not show improvement within 48 to 72 hours of starting therapy should undergo a clinical reevaluation the severity of their illness and to decide on the appropriate level of care. Empiric parenteral antibiotic therapy should be tailored based on the patient's vaccination history against S. pneumoniae and H. influenzae type b. When bacterial pathogens are identified in blood or pleural fluid cultures, antibiotic treatment should be guided by the sensitivity of the pathogens [8].

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- with presumed influenza pneumonia- oseltamivir or zanamivir is recomended.

ASTHMA

Asthma affects a significant number of children and is a leading cause of pediatric emergency admissions. It involves variable airflow obstruction and airway hyper-reactivity, often triggered by viral infections or allergens [3].

According to American Lung Association, Epidemiology and Statistics Unit asthma is a prevalent condition, particularly among children aged 5 to 17 years. In 2008, approximately 7.0 million children in this age group in the United States were affected by asthma. In 2006, asthma accounted for 1.7 million emergency department visits, with children under 15 years old representing 33% of these visits, despite this age group constituting only 20% of the overall population. It is the leading condition that limits activity in children, resulting in 14.4 million missed school days annually. The financial impact of asthma is significant, with annual costs amounting to $20.7 billion - $15.6 billion in direct healthcare expenses and $5.1 billion in indirect costs and lost productivity.

Research through epidemiology [12] has pinpointed several risk factors linked to the onset of asthma. These include sensitization to airborne allergens, maternal diet during pregnancy and lactation, exposure to pollutants (especially environmental tobacco smoke), microbes and their by-products, and psychosocial factors. However, there is insufficient evidence supporting preventive measures to avoid asthma in many of these cases.

Atopic sensitization to common aeroallergens, particularly perennial inhalant allergens, is a significant risk factor for asthma. Early life sensitization to local allergens, especially when associated with frequent lower respiratory illnesses, increases the risk of developing asthma. Several aeroallergens play a crucial role in this process:

- House Dust Mites: A Cochrane review questioned the effectiveness of avoiding house dust mites for treating established asthma, and there is no evidence that such measures prevent asthma onset;
- Companion Animal Allergens: The relationship between exposure to pet allergens and sensitization is unclear, making it difficult to recommend for or against having pets unless the child is sensitized;

- Cockroaches: Exposure to cockroach allergens is linked to sensitization and a higher risk of developing asthma.
- Fungi: Sensitization to Alternaria is a major risk factor for both asthma development and severity. This fungus, typically an outdoor aeroallergen, can have similar concentrations indoors and outdoors [12].

Current data do not support a protective effect of any dietary interventions during pregnancy or lactation against asthma or atopic disease. Although breastfeeding reduces early childhood wheezing associated with respiratory infections, it has not been shown to prevent persistent asthma. Maternal smoking during pregnancy and early life exposure to tobacco smoke increase the risk of childhood wheezing and reduced lung function. Biomass fuel use is linked to higher asthma risk and severity. Traffic-related outdoor air pollution can trigger early-life wheezing. Early childhood wheezing is often associated with viral infections such as rhinovirus and RSV. The "hygiene hypothesis" suggests that early exposure to farming environments and their microbial components may reduce asthma and allergy risks. Probiotics have not shown an impact on asthma development, though they benefit atopic dermatitis prevention. The use of antibiotics, particularly broad-spectrum ones, should be cautious in young children due to their controversial impact on asthma development. A child's social environment, including caregiver stress during the first year of life, is associated with an atopic profile, wheezing, and asthma. Prolonged maternal distress may also contribute to childhood asthma development [12].

According to Birgham, et al., although the initial diagnosis of asthma relies on a healthcare provider's suspicion and evaluation of symptoms, several objective tests are available to confirm airway obstruction and its variability. Current recommendations for these tests are detailed in the Global Initiative for Asthma (GINA) Guidelines and the National Institute for Health and Care Excellence (NICE) Quality Standard [13]. In 2024 GINA updated the diagnostic flowchart for adults, adolescents, and children aged 6 to 11 with chronic or recurrent respiratory symptoms. The flowchart includes guidance on using peak expiratory flow (PEF) for asthma diagnosis, considering many healthcare providers lack access to spirometry. GINA recommends using the best of three PEF measurements each time and the same meter for follow-ups, as different meters can vary by up to 20%. They also emphasize documenting evidence of asthma before starting inhaled corticosteroid (ICS) treatment [14]. Peak expiratory flow (PEF) is an objective measure for assessing airway obstruction severity. However, obtaining reliable PEF measurements in children under 6 years is challenging, and even in cooperative children, these measurements may not be dependable during an acute exacerbation. Suggested PEF categories are: mild (PEF >80% of predicted), moderate (PEF 60–80% of predicted), and severe (PEF <60% of predicted). These values can vary across different guidelines [4].

In childhood asthma, key predictors of remission include fewer and milder symptoms, improving lung function, and reduced airway hyper-responsiveness. Persistent asthma in children is associated with factors like atopy, parental asthma or allergies, later symptom onset, wheezing without a cold, and exposure to tobacco smoke. For adults with severe asthma, remission with biologic therapy is predicted by better short-term symptom control, improved lung function, fewer comorbidities, earlier onset, and minimal use of oral corticosteroids. Factors indicating persistent asthma in adults off treatment include moderate-to-severe airway hyperresponsiveness and nasal polyps [14].

According to Choi, et al. children experiencing acute asthma exacerbations should be quickly evaluated and placed in an area where they can be frequently reassessed by medical and nursing staff. Monitoring oxygen saturation is crucial, as hypoxemia can develop rapidly in children, especially infants. Oxygen should be administered to maintain saturation above 92-94%. First line treatment includes Short-acting β-agonist (SABA), Levosalbutamol [(R)-salbutamol, also known as levalbuterol], Systemic corticosteroids (SCS), Ipratropium bromide. Second line treatment, when there is severe or life- threating asthma is based on medicines such as magnesium sulfate, oral leukotriene receptor antagonists (LTRA) such as montelukast, heliox - a blend of helium and oxygen. The scientists claim that Routine use of antibiotics, mucolytics and sedatives is not advised unless there is a suspicion of pneumonia, indicated by symptoms such as fever and purulent sputum, or bacterial sinusitis [4].

The updated in 2024 GINA initial asthma treatment recommendations for children aged 6 to 11 years align symptom levels and lung function criteria with those for adults and adolescents. GINA provides detailed study results for this age group. For children with well-controlled symptoms on low-dose ICS or those using SABA alone with symptoms less than twice a week, GINA recommends using ICS whenever SABA is taken. Infrequent symptoms (1-2 days per week or less) should be treated with low-dose ICS whenever SABA is taken. For symptoms 2-5 days per week, use low-dose ICS plus as-needed SABA. Daily symptoms, night awakenings, and low lung function warrant medium-dose ICS-LABA plus as-needed SABA, or low-dose ICS-formoterol MART. For acute exacerbations, treat the exacerbation (possibly including a short course of OCS for severe cases) and arrange follow-up [14].

CONCLUSSIONS

Asthma and pneumonia, demand prompt and specialized care due to children's unique physiological traits. Early and accurate assessment, along with tailored treatment strategies, are crucial for effective management.

Proper diagnosis of Pneumonia involves monitoring respiratory rates and using diagnostic tools like chest radiographs. Vaccines have reduced bacterial pneumonia

rates, and procalcitonin levels can guide antibiotic use. Effective management with asthmatic patients includes rapid assessment, use of β-agonists, corticosteroids, and second-line treatments for severe cases. Updated guidelines recommend personalized treatment plans, emphasizing the use of inhaled corticosteroids and careful monitoring. Providing healthcare providers with the necessary knowledge and tools ensures improved outcomes for pediatric patients experiencing these respiratory emergencies.

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CONFLICT OF INTEREST

The Author declares no conflict of interest.

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