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THE CLINICAL AND IMAGING ASPECTS OF LUNG INFECTIONS CAUSED BY PATHOGENIC MICROORGANISMS

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ABSTRACT

Pathogenic microorganisms can enter the respiratory tract and cause infection in the lungs. Microorganisms can be divided into viruses, bacteria, and mycoplasmas, which can all cause pneumonia. Mycoplasma, a bacterium that does not have a cell wall, can also cause an atypical pneumonia that may present with mild symptoms. Viral lung infections affect the lung alveoli and are very common in childhood. Diverse viruses are involved in this pathology and the most common are adenoviruses, enteroviruses, influenza viruses, parainfluenza viruses, syncytial viruses, cytomegaloviruses, and herpes viruses. Bacterial lung infection is usually caused by *Streptococcus pneumoniae*, *Staphylococcus aureus*, *Haemophilus influenzae*, and some Gram-negative bacteria. The severity of lung infection depends on the virulence and the type of pathogen. Viruses can induce pneumonia and cause serious breathing difficulties. In addition, pneumonia in children is often caused by mycoplasma. *Mycoplasma pneumoniae* can cause an atypical pneumonia that is milder than other forms and can be treated with specific medications. X-ray imaging is utilized for the diagnosis and during therapy of pneumonia.

KEYWORDS: *Lung infection, microorganism, pneumonia, imaging, clinical, bacteria, virus*

INTRODUCTION

Viruses, bacteria, and *Mycoplasma pneumoniae* are pathogens that can cause lower respiratory tract infections. Each type of infection affects the lungs differently, with varying symptoms, severity, and treatment options (1). *M. pneumoniae* causes approximately 30% of pneumonia in infancy and school age, while it is rare under 3 years of age (2).

Viruses are the most common cause of upper and lower respiratory tract infections in infancy and childhood, accounting for 65% of childhood pneumonia and 90% of pneumonia in children under 2 years of age (3). Viral lung infections are among the most common causes of respiratory tract diseases. They typically affect both the upper and lower respiratory tracts and can range from mild to severe (Table I). Bacterial infections of the lungs often result in pneumonia, which can be more severe than viral infections (4). These infections usually affect the alveoli in the lungs, leading to the accumulation of fluid or pus.

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Table I. *Viruses that typically cause respiratory tract infections.*

Upper respiratory tract infections	
Adenovirus	Causes pharyngitis, conjunctivitis, and sometimes pneumonia.
Respiratory syncytial virus (RSV)	Can also progress to lower respiratory infections.
Parainfluenza virus	Causes croup (laryngotracheobronchitis).
Influenza virus	Causes seasonal flu, which can lead to complications.
Coronavirus (SARS-CoV-2)	Can cause mild to severe respiratory illnesses.
Rhinovirus	The most common cause of the common cold.
Lower respiratory tract infections	
Adenovirus	Can cause severe pneumonia, particularly in immunocompromised children.
Respiratory syncytial virus (RSV)	The leading cause of bronchiolitis and pneumonia in infants.
Parainfluenza virus	Causes croup and sometimes bronchitis or pneumonia.
Influenza virus	Can cause viral pneumonia or predispose to bacterial superinfection.
Coronavirus (SARS-CoV-2)	Can cause respiratory distress in some infants and children.
Human metapneumovirus (hMPV)	Affects young children and can lead to bronchiolitis.

M. pneumoniae is a type of bacteria that lacks a cell wall, making it unique compared to other bacteria (5). It causes atypical pneumonia, often referred to as walking pneumonia because the symptoms are milder, and patients can often remain ambulatory (6).

DISCUSSION

The most common viruses which cause pneumonia are adenoviruses, enteroviruses, influenza viruses, parainfluenza viruses, syncytial viruses, cytomegalovirus, and herpes virus (7). The most common bacteria that cause lung infections are *Streptococcus pneumoniae*, *Staphylococcus aureus*, *Haemophilus influenzae*, Gram-negative bacteria, *Escherichia coli*, *Klebsiella*, and *Proteus*. Inhalation-aspiration of microorganisms or aspiration of infected gastric secretions are the most frequent mechanisms of spreading airway and lung infections (8).

The evolution and severity of lung infection is strictly connected to the virulence and the inoculated quantity of pathogenic antigens, and the immune response of the subject. The clinical picture is related to the severity of acute infection, with fever, pharyngitis, headache, chest and abdominal pain, and increased heart rate and respiratory rate (9). Subsequently, respiratory symptoms appear such as cough and respiratory noises.

In pneumonia forms caused by *Staphylococcus aureus*, a superinfection may occur in particularly debilitated patients, often during hospitalization (10). Pneumonia may be particularly virulent with rapidly evolving pulmonary edema and haemorrhage. After a few days, the evolution may lead to pneumatocele due to necrosis of the bronchiole walls and air infiltration into the interstitium. In a high percentage of these patients, pneumothorax occurs due to rupture of the pneumatocele (11).

Most pneumonia infection in school-age children are caused by mycoplasma, which is rarely the cause in children under three years of age. The disease presents with general malaise, headache, fever, and mild cough. Radiographic signs are often more serious than the patient's clinical conditions (12).

Viral pneumonia mainly affects infants and very young children, causing severe respiratory distress, respiratory noises, tachypnea, cyanosis, dyspnea, and rib indentations (13). Radiographically, signs indicate the presence of viral infection, but specific details are not evident. Chest X-ray examination in pulmonary infections is the investigation that requires the greatest commitment and professionalism of the radiologist (14). In fact, it is necessary to identify the pneumonic focus, its extension, the probable cause, and any other complications that are involved. For this reason, it is essential to know the patient's age, his/her clinical history, the duration and intensity of the symptoms, and the result of laboratory tests, since the clinical conditions can often mimic a pneumonic process in a large number of patients (15). It is also essential to acquire radiograms in the inspiratory phase in high definition with very short exposure times and

minimal respiratory movements in the two posteroanterior (P-A) and lateral (L-L) projections (16). The airways in children are more susceptible to obstruction by secretions in inflammatory processes causing hyper-insufflation with areas of irregular aeration, atelectasis and thickening of the bronchial walls (17).

It's not always possible to differentiate between pneumonia, bronchopneumonia, lobular pneumonia, and interstitial pneumonia through clinical-radiographic correlation. In fact, the forms with initial involvement of the interstitium can progress towards areas of parenchymal consolidation and the forms with initial parenchymal opacities can evolve by subsequently involving the interstitium (18). In bacterial pneumonia, the penetration of the germs into the alveolar lumen causes an exudative edema that rapidly extends to an entire alveolar group, segment, or lobe, creating an area of massive and homogeneous opacity (hepatization) on the radiogram with segmental or lobar extension on which the air bronchogram stands out.

In bronchopneumonia, multiple, patchy nodular opacities are seen on the radiogram, with involvement of the peribronchial interstitium with a predominantly segmental distribution. In the forms caused by *Staphylococcus aureus*, the nodular opacities evolve towards cavitation with a cystic appearance (pneumatocele). In the acute form, the radiographic picture of interstitial pneumonia of viral origin is characterized by areas of faint parenchymal consolidations with a reticulonodular appearance, disseminated throughout the lung fields with thin streaks of opacity that branch radially from the hilar regions to the upper and basal lung regions (19). Therefore, for example, when performing a chest X-ray of an individual with pneumatocele in *Staphylococcus aureus* pneumonia, characteristic air bubbles may be noted in the context of parenchymal opacity. In addition, in bacterial pneumonia, a large area of homogeneous opacity (hepatization) affecting the lung may be highlighted on X-ray imaging. Again, in interstitial pneumonia, the X-ray may show parenchymal consolidations, even small ones, of reticulonodular appearance, with areas of hyperdiaphany in the lung lobes (12). The streaks of opacity intersect each other, delimiting areas of irregular hyperdiaphany, which is often the predominant radiographic sign in children (20)

Bronchiectasis is a chronic respiratory disorder characterized by permanent dilation and damage of the bronchi with accumulation of mucus, recurrent infections, and progressive lung disease. Bronchiectasis is an almost always reversible dilation of a portion of the bronchial tree which is frequently the result of prolonged respiratory tract infections (21). Cough is always present, often accompanied by hemoptysis and dyspnea. Chest X-ray may show dilation and thickening of the bronchial walls surrounding an area empty of parenchyma, while high-resolution chest CT/CT scan allows for a more in-depth evaluation of the involved areas (22). Multidisciplinary therapy includes respiratory physiotherapy with postural drainage, the possible use of mechanical ventilators, and proper use of antibiotics (23). The role of inhaled corticosteroids in the individual is controversial, although aerosolized antibiotics have been shown to be useful in treating certain conditions, such as cystic fibrosis (24).

CONCLUSIONS

Lung infections are caused by diverse bacterial and viral pathogens. Viral lung infections are often mild but can cause serious illnesses such as viral pneumonia, as has happened with COVID-19. Bacterial lung infections tend to be more serious and require antibiotics, especially if they lead to pneumonia. *M. pneumoniae* causes a milder, atypical pneumonia that can be treated with specific medications. Early diagnosis and proper treatment are key to managing respiratory tract infections caused by these pathogens. Vaccinations and preventative measures can also help reduce the risk of infection.

Conflict of interest

The authors declare that they have no conflict of interest.

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