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REVIEW ARTICLE

Pneumonia Unveiled: A Comprehensive Exploration of Causes, Symptoms, and Prevention

Rashmi Wani[1,*], Sunny Roy[2], Darsh Jain[2], Shreya Menon[2]

[1] *Assistant Professor, Department of Pharmaceutical Chemistry, Vivekanand Education Society's College of Pharmacy, Affiliated to University of Mumbai, Chembur, Mumbai, 400074, Maharashtra, India*
[2] *Student of Final Year B Pharm, Vivekanand Education Society's College of Pharmacy, Affiliated to University of Mumbai, Chembur, Mumbai, 400074, Maharashtra, India*

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[*] *Corresponding author.*
Rashmi Wani
rashmi.wani@ves.ac.in

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ABSTRACT

A major contributor to atypical community-acquired pneumonia, *Mycoplasma pneumoniae* poses a special challenge in the clinical and scientific arenas because of its unique features, which include its tiny genome size, absence of a cell wall, and capacity to elude host immune responses. The many aspects of *Mycoplasma pneumoniae* infections, including epidemiology, etiology, clinical symptoms, and diagnostic methods, are thoroughly reviewed in this study. A critical examination of existing treatment techniques and emerging therapeutic options is presented, coupled with an exploration of the changing terrain of antibiotic resistance in strains of *Mycoplasma pneumoniae*. Comprehensive knowledge of this sneaky pathogen is aided by insights into immune evasion mechanisms, host-pathogen interactions, and the function of *Mycoplasma pneumoniae* in chronic respiratory infections. This review is a useful resource for physicians, researchers, and other healthcare professionals by combining current scientific findings with clinical viewpoints.
Keywords: *Mycoplasma pneumoniae;* Respiratory illness; COVID-19; Epidemics

INTRODUCTION

One of the biggest concerns for world health remains to be pneumonia, a common and potentially dangerous respiratory illness. Numerous infections, such as bacteria, viruses, and fungus, can cause pneumonia. Among the frequent offenders are *Streptococcus pneumoniae, Haemophilus influenzae*, and the influenza virus. Now that we have covered the general terrain of pneumonia, it is necessary to investigate certain causative agents that are involved in the development of this respiratory disease. A pathogen that requires further investigation is *Mycoplasma pneumoniae.*

Mycoplasma pneumoniae, a distinct bacterium belonging to the Mollicutes class, is distinguished by its absence of a cell wall. This unusual bacterium is a well-known causative agent of community-acquired pneumonia, a major cause of respiratory infections worldwide. Despite having a little genome, *Mycoplasma pneumoniae* can withstand the host's immune system and cause long-lasting infections in the respiratory system. *Mycoplasma pneumoniae* can cause a wide range of clinical symptoms, especially in younger age groups. These symptoms can range from moderate upper respiratory tract symptoms to severe pneumonia.

Mycoplasma pneumoniae is resistant to traditional antibiotics that target cell wall formation because it lacks a solid cell wall. This resistance creates therapeutic issues and may contribute to the persistence of the infection in some populations. The fact that this bacterium has also been linked to extrapulmonary symptoms emphasizes how complexly harmful it is. A thorough analysis of the most recent research findings is becoming more and more necessary as our knowledge of the complex interactions between *Mycoplasma pneumoniae*, and the host immune system develops. This review sought to evaluate the Epidemiology, how it affects the humans, investigate new avenues for diagnosis and treatment, current situation of disease and its infection history.

KRUPANIDHI COLLEGE OF PHARMACY

INFECTION OF MYCOPLASMA PNEUMONIAE

Pathophysiology

One obligatory parasite is *Mycoplasma pneumoniae*. *Mycoplasma pneumoniae* has adhesion proteins that can bind to epithelial membranes, particularly those in the respiratory tract. The bacterium produces hydrogen peroxide and superoxide upon adhesion, causing harm to epithelial cells and their cilia. Antibodies produced in response to *M. pneumoniae* may act as autoantibodies by interacting with human brain and red blood cells. Inflammatory cytokines are released during the growth of *Mycoplasma pneumoniae*.

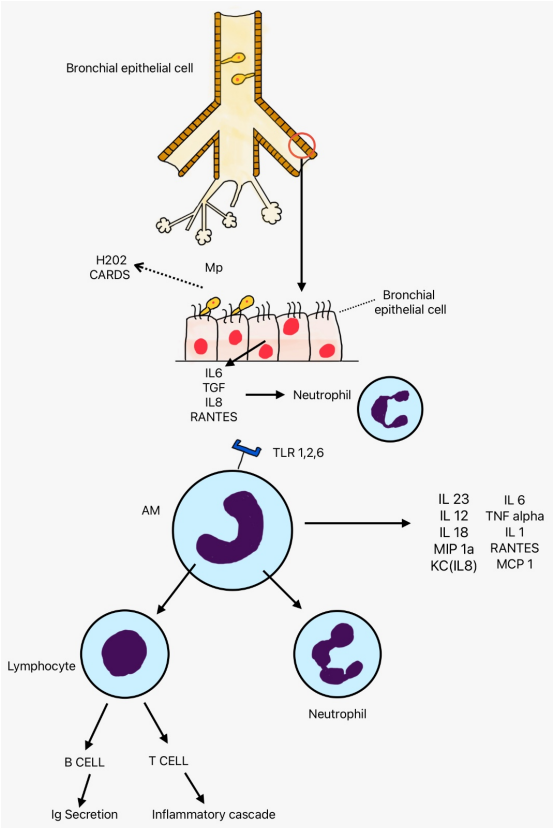

Fig. 1: Unveiling the Intricate Mechanisms Underlying Bacterial-Induced Pulmonary Infections

Mycoplasma pneumoniae possesses a gliding motility and specialized tip organelles that aid in burrowing between cilia in respiratory epithelial cells, resulting in sloughing. The persistent refractory cough is thought to be caused by ciliary movement inhibition.

Epidemiology

M. pneumoniae is a bacterium that can cause infections of the upper and lower respiratory tract and is both endemic and pandemic worldwide. Despite tracheobronchitis having a more common clinical manifestation, pneumonia is the most clinically important disease associated with *M. pneumoniae* infections. During times of endemicity, four to eight percent of community-acquired bacterial pneumonias[1] may be caused by *M. pneumoniae*. Nevertheless, this organism can contribute up to 20–40% of CABP in the general population and up to 70% in closed groups during epidemics. Usually take place in the early to late fall and summer. The extended duration of *M. pneumoniae* infection epidemics may be explained by the lengthy incubation time, comparatively low transmission rate, and organisms' varied persistence in the respiratory tract after infections. There have been several documented cases of *M. pneumoniae* respiratory infections among the public as well as in closed or semi-closed environments including schools, hospitals, schools for the mentally or developmentally handicapped, military posts, and religious groups. Long-term morbidity is uncommon, but acute illnesses can cause significant disruptions and expensive medical bills.

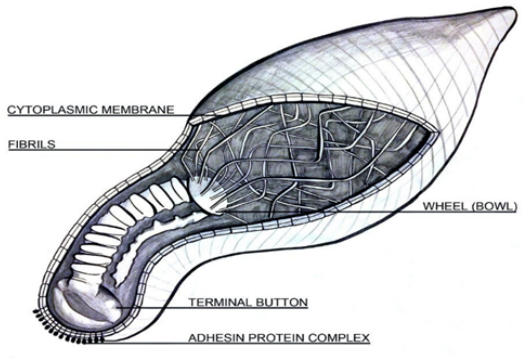

Fig. 2: Structure of *Mycobacterium pneumoniae*

Treatment

Patients, family members, and other people who might get infected should be alerted about the danger of infection. The use of prophylactic antibiotics is debatable. There are studies that advocate usage only in exceptional cases, such as for high-risk populations, and that only drugs with great effectiveness should be utilized. Azithromycin and clarithromycin are primarily used for *M. pneumoniae* respiratory infections and have also been successfully used for *M. pneumoniae* CNS infections, despite the poor CNS penetration of macrolides. Due to its effect on teeth, tetracycline should only be administered to children who are seven years of age or older. Thus, in children, macrolides constitute the first-line therapy.

Erythromycin was the most prescribed medication for the paediatric age group, but new macrolides are now being used due to their higher intracellular concentration, easier posology, decreased incidence of adverse gastrointestinal effects, and decreased potential for drug interactions. There

is currently no agreement on how long macrolide therapy should last, and treatment plans ranging from one to three weeks have been reported. The two most used are clarithromycin, Azithromycin, 10 mg/kg/day, a daily dosage not to exceed 500 mg/dose for five days, and 15 mg/kg/day, split into two doses, not to exceed 500 mg/dose for ten to fifteen days.

History of Mycoplasma pneumoniae Infection Globally

M. pneumoniae is endemic globally and may be found in a broad range of climates. Although they can happen at any time of the year, infections are often more frequent in the summer or early fall. According to study from Japan, there is a direct link between rising temperatures and a rise in *M. pneumoniae* infections. This finding might perhaps account for the higher incidence of infections that may happen during the warmer months. Since 2010, the number of *M. pneumoniae* infections has grown in different European nations, especially in the north[2]. During the same timeframe, there have been reports of other epidemics in Brazil, Chile, Israel, Japan, South Korea, and China.

On the other hand, the youngest children had the highest frequency of M. pneumonia, according to Gadsby and colleagues' analysis of 1,232 PCR-positive laboratory samples from Scotland that were gathered between 2008 and 2011. About 29% of the PCR-positive samples included four-year-olds, with the remaining 18% consisting of kids between the ages of five and nine. The global Asian Network for Surveillance of Resistant Pathogens[3] discovered that *Chlamydia pneumoniae* caused 13% of CABP in eight Asian nations and *M. pneumoniae* caused 11% of CABP in 955 individuals based on serological testing. The most frequent bacterium found in the investigation was *Streptococcus pneumoniae*, which was found in 29% of patients. In a 2004–2005 Australian research, Serology revealed that among the 885 adult patients with pneumonia who were recruited from emergency departments, *S. pneumoniae* was the most frequently detected pathogen[4] followed by *M. pneumoniae*[5]. In almost half the cases, no pathogen was found. A prospective study of urban individuals hospitalized with pneumonia between 2004 and 2005 was carried out in Hong Kong.

Current Status of Mycoplasma pneumoniae Infection in China

China is currently dealing with a resurgence of health problems following the COVID-19 epidemic. There have been reports of clusters of pneumonia and an upsurge in respiratory illnesses in China.

On November 13, 2023, representatives of the National Health Commission in China announced a press conference revealing an increase in the nation's incidence of respiratory ailments. The removal of COVID-19 restrictions and the spread of known pathogens like influenza, respiratory syncytial virus[6], *Mycoplasma pneumoniae*[7], and SARS-CoV-2[8] were blamed by Chinese authorities for the increase.[9]

Facilitated by the National Health Commission and the National Administration of Disease Control and Prevention, WHO conducted a teleconference with Chinese health officials from the Beijing Children's Hospital and the Chinese Centre for Disease Control and Prevention on November 23. The necessary data was provided during the meeting, showing an increase in hospital admissions and outpatient consultations for children with RSV, adenovirus, influenza virus, and *Mycoplasma pneumoniae* since October.[10] According to Chinese authorities, since mid-October, there has been heightened outpatient and inpatient surveillance for respiratory illnesses caused by a range of bacteria and viruses, including *Mycoplasma pneumoniae* for the first time. This improves the current respiratory surveillance systems and may have contributed to the observed increase in the detection and reporting of respiratory diseases in children.[11]

The World Health Organisation advises Chinese nationals to take precautions against respiratory illnesses based on current understanding. It is advised that you get the recommended vaccinations, avoid sick people, stay at home when you are sick, get tested and seek medical attention, when necessary, wear masks when appropriate, make sure there is enough ventilation, and wash your hands frequently to avoid catching influenza, COVID-19, and other respiratory infections.[11]

NEW DETAILS RELATING TO IMMUNOLOGICAL COMPLICATIONS AND CLINICAL MANIFESTATIONS

Presentation of Clinical Data

Clinical manifestations of an *M. pneumoniae* infection might be diverse. Tracheobronchitis is the most common symptom, and it usually presents as a dry cough or one that produces mucus or mucopurulent sputum. Many people may have nebulous symptoms such otitis media, headache, sore throat, and coryza, that are indicative of an upper respiratory infection. Experimental infection has demonstrated that those lacking prior antibodies had more severe post-infection symptoms. Correct microbiological diagnosis requires further, highly expensive laboratory tests, as several viruses and bacteria can cause lower respiratory infections with identical clinical signs. Over 12,000 hospitalized children were examined by researchers in China for respiratory infections; however, they were not able to identify individuals who were proof against *M. pneumoniae* infection based on any symptom pattern or test result. To help with patient care and antibiotic therapy, the Japanese Respiratory Society[12] has created a set of

clinical criteria to identify individuals who have pneumonia caused by *Mycoplasma pneumoniae*. The sensitivity of the JRS scoring system was 83% when these criteria were applied to a recent study of patients whose mycoplasma infection was verified by serology and/or culture.[13] This illness takes around 23 days to incubate and can spread slowly through families. Younger children often have lesser symptoms, while older children, typically between the ages of 5 and 14, are the first to fall sick. According to a research, older children and adolescents who contract *M. pneumoniae* frequently experience a persistent cough that lasts for three to four weeks, and for an average of 54 days in adults. 10 out of 42 children with postinfectious bronchiolitis obliterans had *M. pneumoniae* IgM antibody, which is the second most common antibody associated with this illness after adenovirus.

Both younger people in otherwise good health and elderly people with underlying medical conditions have passed away. According to two investigations, individuals with more serious illnesses necessitating hospitalization had a higher *M. pneumoniae* bacterial load in their OP specimens compared to individuals with less severe illnesses who could get outpatient treatment. There have been fatal cases associated with disseminated intravascular coagulation, adult respiratory distress syndrome, diffuse pneumonia, and vascular thrombosis, often resulting in multiorgan failure.

Laboratory testing usually does not identify the presence of *M. pneumoniae* infection in mildly unwell persons with normal complete blood counts, electrolytes, hepatic function, and renal function. A slightly increased C-reactive protein[14] is possible. About 50% of patients test positive for cold agglutinins in more severe cases, such as primary atypical pneumonia, where inflammatory indicators such as CRP and erythrocyte sedimentation rate may be significantly high.

The COVID-19 Pneumonia's Effects

Numerous pneumonia cases with noticeable lung abnormalities on CT scans have been linked to COVID-19. It is unknown how COVID-19 pneumonia may affect survivors' lung function and general quality of life. Past coronavirus outbreaks, such as SARS in 2003, have been associated with a detrimental long-term effect on HRQoL and pulmonary function. As previously mentioned, individuals with COVID-19 pneumonia should have respiratory follow-up; however, there are currently little available data. In Chinese research, limited diffusion ability was seen 30 days after discharge in approximately half of the non-critical COVID-19 pneumonia patients.

In addition to the physical side effects, mental health problems such as anxiety and/or depression may arise after hospitalization due to a COVID-19 infection. Evaluating HRQoL may facilitate the application of specific therapies and contribute to our comprehension of the effects of COVID-19 pneumonia. Evaluating HRQoL may facilitate the application of specific therapies and contribute to our comprehension of the effects of COVID-19 pneumonia.

Patients diagnosed with non-critical COVID-19 pneumonia, as confirmed by RT-PCR, and released from Amphia Hospital[15] between March 16 and April 15, 2020, were the subjects of a prospective longitudinal study.[16] Those with severe pneumonia who needed non-invasive ventilation or ICU hospitalisation were excluded.

Six weeks after being released from the hospital, the individuals were evaluated physically, interviewed, and had their pulmonary function tested[17] in accordance with ERS guidelines using a body plethysmograph and a Ventura Master screen PFT pro. Patients answered questionnaires measuring symptoms of anxiety and sadness[18], subjective dyspnea[19], and HRQoL[20]. The Dutch Medical Research Ethics Committees United accepted the project.

Six weeks after the trial began, most COVID-19 pneumonia survivors displayed decreased diffusion skills. 25% of individuals had a severe limitation after discharge[21], and 71.7% of patients had a significant impairment in DLCO[22]. For 59% of patients, using the lower boundary of normal provided by DLCO had an impact. With a mean KCOc of 89.0% in the moderate group and 83.8% in the patients with a severe pneumonia, there were fewer KCO abnormalities. This is consistent with observations made after COVID-19 survivors were released from the hospital.[23] KCOc measurement may be normal even while DLCO is decreased in situations where alveolar volume is small, indicating loss of complete acini with alveoli and accompanying blood vessels. Neder, J.A. TLC was less than LLN in 21.8% of patients, which is in line with a reduced alveolar volume. Even when TLC is within normal ranges, alveolar volume may still be decreased due to inhomogeneous ventilation and perfusion because the single breath approach of evaluating alveolar volume only samples the better ventilated and perfused portions of the lungs.

Screening for anxiety and depression in this COVID-19 cohort showed that 16% of patients reported symptoms of sadness and 12% of patients had anxiety issues. These results are in line with a Chinese population study that discovered patients who were thought to be infected with COVID-19 had a higher chance of developing depression.

CONCLUSION

This article concludes by the important role that *Mycoplasma pneumoniae* plays in causing community-acquired pneumonia and some of its distinctive characteristics, including its small genome size, lack of a cell wall, and capacity to elude host immune responses. The bacterium's clinical significance is highlighted by its involvement in respiratory infections, which can range in severity from mild upper respiratory symptoms to severe pneumonia. The pathophysiology section provides information about the adhesion

proteins of *Mycoplasma pneumoniae*, the chemicals that are produced following attachment, and the pathogen's capacity to impede ciliary movement, hence causing a chronic cough. The epidemiological findings demonstrate its worldwide occurrence, with seasonal and climate-related variations in infection rates.

New information about immunological problems and clinical symptoms is included; this is especially helpful given the COVID-19 context. The article offers a comprehensive overview of the consequences of *Mycoplasma pneumoniae* infections by discussing the possible long-term implications on mental health and lung function. All things considered, this review combines clinical perspectives with up-to-date scientific results to provide doctors, researchers, and other healthcare professionals with a thorough resource. Considering the constantly changing panorama of respiratory disorders, it emphasizes the necessity of ongoing research, surveillance, and the development of efficient treatment techniques to meet the problems provided by *Mycoplasma pneumoniae* infections.

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