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Understanding Human Metapneumovirus (HMPV): Transmission, Diagnosis, and Management

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A B S T R A C T

Human Metapneumovirus (HMPV) is a significant respiratory virus that predominantly impacts infants, young children, the elderly, and individuals with compromised immune systems. First identified in 2001, HMPV is closely related to avian metapneumovirus and ranks among the leading causes of respiratory infections globally, particularly during the winter and early spring seasons. In 2024, northern China experienced a surge in HMPV cases, with the first confirmed cases reported in India in early 2025. The virus presents symptoms similar to other respiratory infections, such as COVID-19 and RSV, but can cause severe complications, including pneumonia, bronchiolitis, and respiratory failure in high-risk groups. HMPV possesses a single-stranded, negative-sense RNA genome and displays genetic diversity, classified into two primary subgroups, A and B. Diagnosis is typically confirmed through RT-PCR, and treatment primarily involves supportive care, including oxygen therapy, hydration, and symptom management. This review synthesizes evidence from published articles indexed in Medline, CINAHL, Social Sciences Citation Index, PsychINFO, selected journals since 2001, and reference lists. It aims to provide a comprehensive overview of HMPV, emphasizing the importance of increased awareness and the urgent need for research into preventive and therapeutic measures. The goal is to raise awareness about HMPV in the context of co-circulating respiratory viruses and to emphasize its clinical significance.

Introduction

Human Metapneumovirus (HMPV) is a major contributor to respiratory illnesses, especially in vulnerable populations, underscoring its importance in global public health. Human Metapneumovirus is a respiratory virus that primarily affects the upper and lower respiratory tract, particularly in infants, young children, older adults, and immunocompromised individuals. It is a major contributor to respiratory

infections globally and shares many similarities with the respiratory syncytial virus (RSV) (Febbo *et al.,* 2021). Human Metapneumovirus (HMPV) was first identified in 2001 in the Netherlands (Van den Hoogen *et al.,* 2001). The virus was isolated from children suffering from respiratory tract infections, and genetic analysis revealed that HMPV is closely related to avian metapneumovirus (AMPV), particularly subtype C, suggesting a possible zoonotic origin from birds (Jesse *et al.,* 2022). Molecular studies indicate that HMPV diverged from its closest ancestor (AMPV-C) approximately 200–300 years ago. However, it remained undetected in humans until advances in molecular virology facilitated its discovery (Embarek Mohamed *et al.,* 2014). It contributes significantly to respiratory illnesses, especially in vulnerable groups such as young children, the elderly, and immunocompromised individuals (Kahn, 2006).

According to data from a 2021 article in Lancet Global Health, Human Metapneumovirus (HMPV) is responsible for approximately 1% of acute lower respiratory infection-related deaths in children under the age of five (Wang and Libster, 2021). Currently, no vaccine or specific antiviral treatment exists for HMPV, with management primarily focusing on symptom relief.

Symptoms such as cough, fever, nasal congestion, and shortness of breath often overlap with those of other respiratory illnesses, including COVID-19, RSV, and influenza (Choudhary and Gopichandran, 2021; Choudhary *et al.,* 2022). Accurate differentiation of HMPV from these conditions is critical for effective treatment and infection control.

Surge in HMPV Cases Among Children in Winter 2024–2025

In the winter of 2024–2025, northern China experienced a notable increase in HMPV cases, especially among children under 14years of age. The Chinese Centre for Disease Control and Prevention reported that during the week of December 16 to 22, 2024, HMPV accounted for 6.2% of positive respiratory illness tests and 5.4% of respiratory-related hospitalizations, surpassing the rates for COVID-19, rhinovirus, and adenovirus during the same period (Aljazeera, 2024). In early January 2025, India reported its first confirmed cases of HMPV in Bengaluru, Karnataka. Two infants—a 3-month-old girl and an 8-month-old boy—were diagnosed with the virus at Bengaluru Baptist Hospital. Both children had a history of bronchopneumonia (Times of India, 2025).

Classification, Genome, Structure, and Genetic Diversity of HMPV

Human Metapneumovirus (HMPV) is a member of the family Paramyxoviridae a group of viruses known to cause respiratory illnesses in both humans and animals. It belongs, to the genus Metapneumovirus, which includes closely related viruses like avian metapneumovirus.

HMPV is specific to humans and is recognized as a major contributor to respiratory tract infections. The HMPV genome consists of single-stranded, negative-sense RNA approximately 13.3 kilobases (kb) in length. As a negative-sense RNA virus, its genome requires transcription into a complementary positive-sense strand to facilitate protein synthesis. Structurally, HMPV is an enveloped virus with a lipid bilayer embedded with surface glycoproteins, which play a crucial role in interacting with host cells.

HMPV encodes several structural proteins critical to its function. The fusion protein (F) facilitates viral entry by merging the viral envelope with the host cell membrane, enabling cell-to-cell spread and triggering membrane fusion upon activation.

The attachment glycoprotein (G) supports initial binding to host cells, though it plays a less critical role than the F protein. The matrix protein (M) provides structural support, maintaining the shape of the viral envelope and aiding in the assembly and budding of viral particles. The nucleoprotein (N) encases the RNA genome, protecting it from degradation and playing a pivotal role in replication and transcription.

Additional proteins include the phosphoprotein (P), which acts as a polymerase cofactor to aid in RNA synthesis, and the large polymerase protein (L), which catalyses RNA replication and transcription. The small hydrophobic protein (SH) may modulate the host immune response, although its precise function remains unclear. The M2 protein regulates transcription and supports replication.

HMPV exhibits genetic diversity, being divided into two main subgroups, A and B. Each subgroup is further subdivided into lineages: A1 and A2 for subgroup A, and B1 and B2 for subgroup B. This genetic variability contributes to differences in virulence and the virus's ability to evade host immune defences (Yang *et al.,* 2009; Kamau *et al.,* 2020).

Risk Factors for Human Metapneumovirus (HMPV)

Infants and toddlers under the age of 2 are especially vulnerable to HMPV due to their underdeveloped immune systems. Similarly, individuals aged 65 and older face an elevated risk because of age-related immune decline. Additionally, underlying conditions such as asthma, chronic obstructive pulmonary disease (COPD), or bronchopulmonary dysplasia further increase susceptibility (Aljazeera, 2024).

Patients with heart conditions are at risk of experiencing more severe outcomes from HMPV infections. Individuals with compromised immune systems—due to conditions such as HIV/AIDS, cancer treatment, organ transplantation, or immunosuppressive medications—are particularly vulnerable. Premature infants face an elevated risk because of underdeveloped lungs and immune systems, while those with cerebral palsy or developmental delays are more prone to severe respiratory complications.

HMPV spreads easily in communal settings like schools, daycare centers, and nursing homes, facilitated by respiratory droplets, which also increase transmission risk in household and healthcare environments. Outbreaks are most common in temperate regions during winter and early spring.

Although pneumonia is less common in HMPV infections outside of the elderly population, the virus remains a significant cause of adult pneumonia, particularly during seasonal surges that typically occur one to two months after the influenza peak. Among adults aged 18 to 49 hospitalized with pneumonia, HMPV infections are more frequent than those caused by *Streptococcus pneumoniae*, Mycoplasma, *Staphylococcus aureus*, or Legionella (Papenburg *et al.,* 2012).

Transmission of HMPV

HMPV spreads in ways similar to the common cold, flu, and other respiratory viruses. The primary mode of transmission is through respiratory droplets released when an infected person coughs or sneezes. The virus enters the body through the nose, mouth, or eyes, typically after inhaling these droplets. Additionally, HMPV can spread through direct contact with infected secretions, such as mucus from the nose or throat, or by touching surfaces contaminated with the virus. Close-contact environments like households, schools, and healthcare settings are common places for transmission due to frequent interactions with infected individuals (Aljazeera, 2024).

Impact of HMPV on the Respiratory System

Upon entering the body, HMPV targets the epithelial cells that line the respiratory tract, including the airways and lungs. These cells serve as a protective barrier for the respiratory system, helping to clear mucus, dust, and other particles. Once the virus invades these cells, it begins to replicate, producing more viral particles. These newly formed viruses then spread to neighbouring cells, further advancing the infection throughout the respiratory lining. In response, the immune system detects the infection and initiates an inflammatory reaction to combat the virus. While this immune response is crucial for clearing the virus, it also contributes to common symptoms like nasal congestion and coughing (Aljazeera, 2024).

Incubation Period of HMPV

The incubation period for HMPV typically ranges from 3 to 6 days, which is the time between exposure to the virus and the onset of symptoms. During this period, individuals may not show any signs of infection but can still spread the virus to others (CDC, 2024).

Signs and symptoms

Human metapneumovirus (HMPV) infections can vary in severity, with symptoms ranging from mild to severe, primarily affecting the respiratory system. In mild cases, the symptoms are usually confined to the upper respiratory tract and may include nasal congestion, sneezing, a sore throat, and a mild cough. Additional general symptoms such as low-grade fever, fatigue, and hoarseness are also commonly observed in these mild infections.

In moderate to severe cases, HMPV can progress to the lower respiratory tract, causing symptoms such as a persistent or worsening cough, shortness of breath (dyspnea), wheezing, and chest pain or discomfort. Severe infections may be accompanied by a high fever, and in some cases, patients may develop hypoxia, leading

to reduced oxygen levels and resulting in cyanosis, a bluish discoloration to the skin and lips. These more serious symptoms are particularly prevalent in high-risk individuals, including infants, the elderly, and those with pre-existing health conditions (Aljazeera, 2024).

Complications of HMPV

Complications from Human Metapneumovirus (HMPV) can be severe, especially in high-risk groups such as infants, the elderly, and individuals with underlying health conditions. While many cases are mild, serious complications may include secondary bacterial infections like otitis media and bacterial pneumonia. Respiratory issues such as bronchiolitis and pneumonia can also develop, with symptoms like wheezing, coughing, and difficulty breathing, potentially leading to respiratory distress that requires hospitalization. HMPV can exacerbate conditions such as asthma and COPD, and may cause hypoxia, resulting in cyanosis. In immunocompromised individuals, HMPV can lead to prolonged illness, severe pneumonia, and potentially life-threatening respiratory failure (Mazzoncini *et al.,* 2008; Cleveland Clinic, 2023).

Diagnosis of HMPV

The diagnosis of Human Metapneumovirus (HMPV) is primarily based on clinical presentation and confirmed through laboratory tests, as its symptoms often overlap with other respiratory viruses like influenza or respiratory syncytial virus (RSV). A detailed medical history and physical examination help assess symptoms such as fever, cough, wheezing, and respiratory distress. The virus is commonly suspected in cases with sudden onset of respiratory symptoms, particularly in high-risk groups such as young children, the elderly, and immunocompromised individuals. Laboratory confirmation typically involves RT-PCR, the gold standard for detecting the virus's RNA, which is highly sensitive and specific. Infection with HMPV can be confirmed usually by direct detection of viral genome by nucleic acid amplification test (NAAT), and direct detection of viral antigens in respiratory secretions using immunofluorescence or enzyme immunoassay. Other diagnostic methods include viral culture, and serology, although these are less sensitive or more time-consuming. Imaging, such as chest X-rays, may be used to identify pneumonia or respiratory complications in severe cases, but these findings are not specific to HMPV (Aljazeera, 2024; CDC, 2024).

Management of HMPV

The management of Human Metapneumovirus (HMPV) primarily focuses on supportive care, as there are no specific antiviral treatments available. The aim is to alleviate symptoms and prevent complications, particularly in high-risk individuals. Supportive care includes oxygen therapy for patients with hypoxia or respiratory distress, maintaining hydration to avoid dehydration, and mechanical ventilation for severe cases of respiratory failure. Medications such as antipyretics (acetaminophen or ibuprofen) are used to manage fever, while bronchodilators may be prescribed to relieve wheezing and breathing difficulties. Although ribavirin has been studied for its potential antiviral effect in severe or immunocompromised patients, its effectiveness remains uncertain and it is not routinely used. Symptomatic treatments to address cough, sore throat, and congestion are also important for managing milder cases (Aljazeera, 2024; CDC, 2024; Cleveland Clinic, 2023).

Prevention of HMPV

Prevention of Human Metapneumovirus (HMPV) centers on minimizing transmission, particularly among high-risk groups. Key preventive measures include regular hand hygiene, achieved through thorough washing with soap and water or using alcohol-based sanitizers, to reduce the spread of respiratory viruses. Infected individuals should avoid close contact with others, especially vulnerable populations such as infants, the elderly, and those with weakened immune systems. Practicing proper respiratory etiquette—covering the mouth and nose when coughing or sneezing—helps prevent the spread of respiratory droplets. Disinfecting frequently touched surfaces, like doorknobs and cell phones, is crucial, as the virus can survive on surfaces for a period of time. Infected individuals should also isolate themselves, particularly during the contagious phase, to prevent infecting others. While no licensed vaccine is currently available for HMPV, ongoing research into vaccine development provides hope for future preventive solutions (Aljazeera, 2024; CDC, 2024; Cleveland Clinic, 2023).

Human Metapneumovirus (HMPV) is a significant cause of respiratory illness, particularly in vulnerable populations such as infants, the elderly, and immunocompromised individuals. Its transmission through respiratory droplets and close contact highlights the importance of preventive measures, including hand

hygiene, respiratory etiquette, and isolation of infected individuals. Despite the absence of specific antiviral treatments or a licensed vaccine, supportive care remains the cornerstone of management, with oxygen therapy, hydration, and symptomatic relief being vital. Continued research into HMPV's genetic diversity, transmission dynamics, and vaccine development is essential to improve prevention and treatment strategies. Awareness and vigilance are key in mitigating the impact of this virus, especially during peak seasons and in high-risk settings.

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Conceptualization of article, and writing original draft preparaton: Dr R Shyamala, Dr S.K. Mohansundari; writing—review and editing by Dr Mamta Choudhary. All authors have read and agreed to the published version of the manuscript.

Data Availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethical Approval Not applicable.

Consent to Participate Not applicable.

Consent to Publish Not applicable.

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