World Journal of Pharmaceutical Science and Research
www.wjpsronline.com
Review Article
ISSN: 2583-6579
SJIF Impact Factor: 5.111
Year - 2025
Volume: 4; Issue: 3
Page: 903-916

HUMAN METAPNEUMOVIRUS: A COMPREHENSIVE REVIEW OF AN EMERGING RESPIRATORY PATHOGEN

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Article Received: 01 May 2025 // Article Revised: 23 May 2025 // Article Accepted: 13 June 2025

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DOI: https://doi.org/10.5281/zenodo.15773608

How to cite this Article: Pohor Noatia, Nandani Chaturvedi, Nidhi Chaudhary, Ashok Kumar, Dr. Amandeep Singh (2025) HUMAN METAPNEUMOVIRUS: A COMPREHENSIVE REVIEW OF AN EMERGING RESPIRATORY PATHOGEN. World Journal of Pharmaceutical Science and Research, 4(3), 903-916. https://doi.org/10.5281/zenodo.15773608

ABSTRACT

Human metapneumovirus (hMPV) is a respiratory virus that primarily causes infections in the lungs and airways, particularly affecting young children, elderly individuals, and those with weakened immune systems. Discovered in 2001, hMPV has since been recognized as a long-circulating pathogen. It spreads through respiratory droplets via coughing, sneezing, or close contact with an infected person. The virus typically produces cold- or flu-like symptoms, such as cough, fever, runny nose, and shortness of breath. However, in more severe cases, it can lead to bronchitis or pneumonia, especially in individuals with pre-existing health conditions. hMPV belongs to the *Paramyxoviridae* family, which includes other respiratory viruses like Respiratory Syncytial Virus (RSV). It possesses a single-stranded RNA genome and is classified into two major types—type A and type B—each further divided into two subtypes. These variants may differ slightly in clinical presentation and tend to circulate seasonally, with peaks in winter or early spring. While most infections are self-limiting and treated with supportive care, hMPV can exacerbate chronic conditions like asthma or COPD in vulnerable individuals. Currently, there is no specific antiviral treatment or approved vaccine for hMPV, though research is ongoing. Enhancing understanding of the virus's transmission and impact is crucial for developing preventive strategies and protecting high-risk populations.

KEYWORDS: Human Metapneumovirus, hMPV respiratory virus, bronchiolitis, pneumonia, RNA virus, Paramyxoviridae.

INTRODUCTION

Human Metapneumovirus (HMPV) is a significant cause of respiratory infections, particularly in young children, elderly adults, and individuals with compromised immune systems. Since its discovery in 2001, HMPV has been recognized globally as a major contributor to acute respiratory illness now it has been circulating in humans for many decades.[31,32,33]

HMPV is one of the leading causes of colds, bronchitis, pneumonia, and other breathing problems. It is often confused with other respiratory viruses like Respiratory Syncytial Virus (RSV) and influenza because the symptoms can be very similar—fever, cough, nasal congestion, and difficulty breathing.[1,34]

Acute respiratory tract infection (ARI) is a leading cause of morbidity and mortality worldwide. Globally, ARIs were responsible for about 20% of total deaths in children less than 5 years of age in 2000 alone; moreover, about 70% of these deaths occurred in Sub-Saharan Africa and the southern regions of Asia.[35,36,37] Human metapneumovirus (hMPV) was first discovered in 2001 in the Netherlands, when the virus was isolated from a paediatric patient who had symptoms similar to those of hRSV infection. Since then, hMPV has been detected in 4–16% of patients with ARIs. The incidence of hMPV may vary from year to year in the same area. hMPV causes disease primarily in children, but can infect adults and immunocompromised individuals as well. The clinical features of the illness caused by hMPV infection range from a mild upper respiratory tract infection to life-threatening severe bronchiolitis and pneumonia.

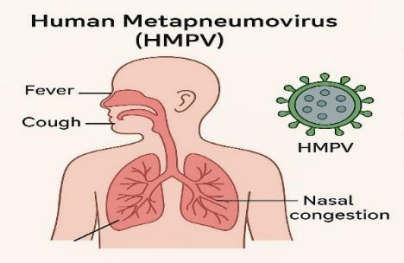

Figure 1: Human Metapneumovirus.

Symptoms

There symptoms are similar to those of the common cold and flu and may include- Cough, Fever, Runny or stuffy nose, Sore throat, Shortness of breath, Wheezing (in severe cases).More infection are mild but in some cases hMPV can lead to more serious conditions like bronchitis or pneumonia.[2,38,39]

History and discovery

For many years, doctors and scientists noticed that people—especially children—were getting respiratory infections that couldn't be explained by the usual viruses like RSV (Respiratory Syncytial Virus) or influenza. There were missing pieces in the puzzle. Then, in 2001, a group of researchers in the Netherlands made a major discovery. HMPV was first identified by Dutch It was isolated from children with symptoms of acute respiratory tract infections. Retrospective analysis revealed that the virus had likely been circulating in human populations for decades before its discovery.[40,41,42] Since its discovery, HMPV has been found all over the world. It's now considered one of the most important respiratory viruses, especially in children under 5 years old, older adults, and people with weakened immune systems. Thanks to improved diagnostic tools like PCR testing, scientists and doctors are much better at detecting and studying the virus today.

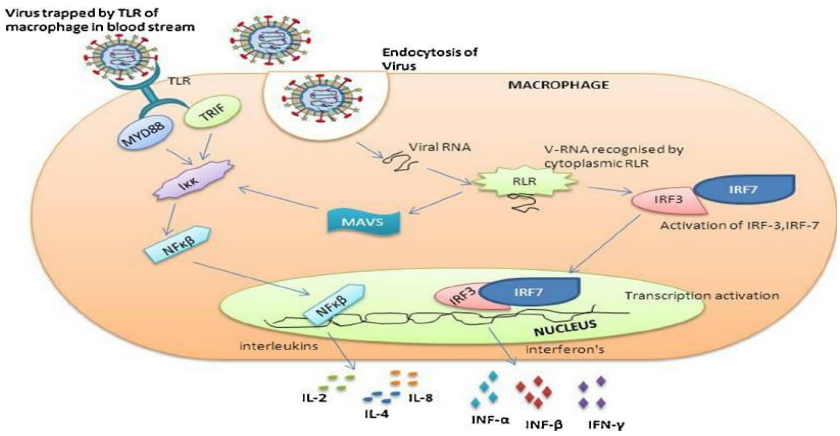

Figure 2: Timeline of HMPV discovery and milestone.

Classification and structure

Human Metapneumovirus (HMPV) is part of a family of viruses called Pneumoviridae. Within this family, it belongs to a group known as Metapneumovirus. It's closely related to another common virus called Respiratory Syncytial Virus (RSV), which also causes lung infections.[3]

HMPV is a virus made up of RNA, which is its genetic material. This RNA is single-stranded and negative-sense, meaning it needs to be converted inside the host's cells before it can start making more virus copies. The entire virus is surrounded by a protective layer called an envelope.[43,44,45]

There are several important proteins on and inside the virus that help it function:

- F protein (Fusion protein): Helps the virus enter human cells by merging with the cell membrane.
- G protein (Attachment protein): Helps the virus stick to the cells in our respiratory tract.
- N protein (Nucleoprotein): Protects and organizes the virus's genetic material.
- M protein (Matrix protein): Gives the virus its shape and structure.
- L protein (Large polymerase): Helps copy the virus's RNA.
- P protein (Phosphoprotein): Supports the L protein during replication.[4]

HMPV is divided into two major groups, A and B, and each group has subtypes. These different strains may cause similar illness, but sometimes one group is more dominant in a given season.

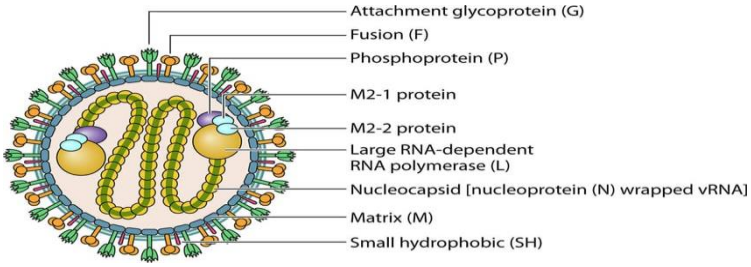

Figure 3: Schematic structure of HMPV particle.

EPIDIMOLOGY

Human Metapneumovirus (hMPV) is a globally distributed respiratory virus that primarily affects young children, older adults, and individuals with weakened immune systems. Nearly all children are infected by the age of five. hMPV

infections are seasonal, with peaks in winter and early spring in temperate regions, and during the rainy season in tropical areas. The virus spreads through respiratory droplets and contaminated surfaces. In developed countries, it is a major cause of hospital visits for respiratory illness in children and can trigger outbreaks in nursing homes. In developing countries, its impact may be greater due to limited healthcare access and underreporting. hMPV accounts for approximately 5–15% of pediatric respiratory hospitalizations, and increased surveillance is helping track and manage its spread.[5,46,47]

Transmission and Pathogenesis

Human Metapneumovirus (hMPV) spreads mainly through respiratory droplets when an infected person coughs, sneezes, or talks, and also through contact with contaminated surfaces like doorknobs or toys. It commonly spreads in crowded settings such as schools, hospitals, and nursing homes. Once inhaled, the virus attaches to the epithelial cells of the respiratory tract using its G and F proteins, then enters the cells to replicate. This triggers inflammation, mucus production, and tissue damage, causing symptoms like coughing and breathing difficulty. While infections are usually mild in healthy individuals, they can lead to bronchiolitis or pneumonia in infants, the elderly, and immunocompromised people. Reinfection can occur, but symptoms are typically milder.[6,48,49]

Clinical Manifestation

Clinical manifestations refer to the signs and symptoms a person shows when they are infected with a disease. In the case of Human Metapneumovirus (HMPV), the symptoms can vary from mild to severe, depending on the person's age, immune system strength, and overall health.

For most healthy children and adults, HMPV usually causes symptoms similar to the common cold. These include:[7]
Runny or stuffy nose, Cough, Sneezing, Sore throat, Mild fever, Fatigue, Decreased appetite
These symptoms usually appear 3 to 6 days after a person is exposed to the virus and can last from a few days to a week.[8,50,51]

However, in some people—especially young children, older adults, or those with chronic health problems or weakened immune systems—the virus can travel deeper into the lungs. This can lead to more serious respiratory conditions, such as:

- Bronchiolitis (inflammation of the small airways in the lungs)
- Pneumonia (infection of the lung tissue)
- Wheezing or noisy breathing
- Shortness of breath or difficulty breathing
- Low oxygen levels

In infants, HMPV can cause irritability, poor feeding, and pauses in breathing (apnea), especially if they were born prematurely or have underlying heart or lung disease.[52,53]

In elderly people, HMPV can also worsen existing health conditions such as asthma, COPD (chronic obstructive pulmonary disease), or heart failure.[54,55]

While most people recover without complications, severe cases of HMPV may require hospitalization, oxygen therapy, or even intensive care support.

It's important to remember that the symptoms of HMPV can look very similar to other respiratory infections like RSV (Respiratory Syncytial Virus), influenza, or COVID-19, which is why testing is often needed for a clear diagnosis.[9,56,57]

Diagnosis

Diagnosing HMPV can be tricky because its symptoms—like cough, fever, runny nose, and breathing problems—are similar to many other respiratory illnesses, such as the flu, RSV, or even COVID-19. That's why laboratory tests are often needed to tell HMPV apart from other viruses.

Doctors usually begin by asking about symptoms and medical history. If someone is experiencing signs of a respiratory infection, especially during cold seasons, and they belong to a high-risk group (such as a young child, elderly person, or someone with a weak immune system), testing for HMPV may be considered.[10,58,59]

Here are the main ways HMPV is diagnosed:

1. **PCR (Polymerase Chain Reaction) Test**

This is the most accurate and widely used method. It detects the genetic material of the virus in a sample taken from the nose or throat using a swab. PCR tests are fast and can detect even small amounts of the virus, making them very reliable.[11,60,61]

2. **Antigen Detection Tests**

These tests look for proteins (antigens) from the virus. They are quicker but less sensitive than PCR. Antigen tests are more commonly used for other viruses like RSV or flu but can be used in HMPV studies.[12,62,63]

3. **Viral Culture**

This involves trying to grow the virus in a lab from a sample. It's not used often because it takes a long time (several days) and needs special lab conditions.

4. **Serology (Antibody Testing)[13]**

This checks the blood for antibodies against HMPV. It can help show whether someone was infected recently, but it's more useful in research than in everyday clinical practice.[14,64]

Most of the time, HMPV is not tested for in healthy people with mild symptoms. But in hospitals, especially when patients have severe illness or when it's important to rule out other causes, doctors may request specific tests for HMPV.[14,65]

Early and accurate diagnosis can help doctors make better treatment decisions, avoid unnecessary antibiotics, and take steps to prevent the virus from spreading to others—especially in hospitals and care facilities.[15,66]

Treatment and management

There is currently no specific antiviral medicine to cure Human Metapneumovirus (HMPV). This means that treatment mainly focuses on managing symptoms and helping the body recover on its own. Fortunately, most healthy people who get HMPV experience only mild cold-like symptoms and can recover at home with basic care.[16,67,68]

1. Supportive care

The main approach is supportive care, which means easing the symptoms until the infection goes away. This can include:

- Getting plenty of rest
- Drinking lots of fluids to stay hydrated
- Using a humidifier or breathing in steam to ease congestion
- Taking over-the-counter medicines like acetaminophen or ibuprofen to reduce fever and relieve pain (only if recommended, especially for children)[17,69,70]

2. Medical care for severe cases

In some people—especially infants, older adults, or those with weak immune systems—the infection can be more serious and may require hospital care. In these cases, treatment may include:

- Oxygen therapy if the person is having trouble breathing
- IV fluids to treat dehydration
- Monitoring of breathing and heart rate
- In rare cases, use of ventilators (breathing machines) in intensive care[18,71]

3. Antibiotics are not effective

Since HMPV is caused by a virus (not bacteria), antibiotics do not work against it. However, if a person develops a secondary bacterial infection, such as bacterial pneumonia, doctors may prescribe antibiotics for that separate problem.[19,72]

4. Experimental treatments and research

Researchers are working on potential antiviral drugs and vaccines for HMPV, but none have been officially approved yet. Clinical trials are ongoing to test new treatment options.

5. Infection control in healthcare settings

In hospitals or nursing homes, managing HMPV also includes preventing its spread to others. This may involve:

- Isolating infected patients
- Using face masks and gloves
- Cleaning hands and surfaces regularly.[20,73]

Prevention and Vaccination

Preventive measures focus on good hygiene, isolation of infected individuals, and surveillance. Several vaccine candidates are under investigation, including live-attenuated and subunit vaccines.

Currently, there is no approved vaccine available to prevent Human Metapneumovirus (HMPV) infection. However, scientists around the world are working on developing a vaccine, especially because HMPV can cause serious illness in young children, older adults, and people with weak immune systems.

Even though we don't have a vaccine yet, there are many important steps people can take to reduce the risk of infection and prevent the virus from spreading.[21,74]

Here are the key prevention strategies:

1. **Good hygiene practices**

- Wash your hands often with soap and water for at least 20 seconds.
- Use alcohol-based hand sanitizer when soap is not available.
- Avoid touching your face—especially your eyes, nose, and mouth—with unwashed hands.[22]

2. **Cover your mouth and nose**

- Always cover your mouth and nose with a tissue or your elbow when coughing or sneezing.
- Dispose of used tissues right away and wash your hands afterward.

3. **Avoid close contact with sick people**

- Try to stay away from individuals who have cold or flu-like symptoms.
- If you're sick, stay home and rest to avoid spreading the virus to others.

4. **Clean and disinfect surfaces**

- Regularly clean objects and surfaces that are frequently touched—like door handles, phones, toys, and countertops.[23]

5. **Use of masks in healthcare settings**

- In hospitals or nursing homes, wearing masks and using protective gear can help protect both healthcare workers and vulnerable patients.

6. **Protecting high-risk groups**

- Extra care should be taken to protect infants, older adults, and people with chronic health conditions, as they are more likely to develop severe illness.

7. **Research on vaccines**

- Several types of vaccines are being studied, including live-attenuated vaccines (weakened virus), protein-based vaccines, and mRNA vaccines.[24]

Similarities with Other Viruses

- HMPV, like RSV and influenza, spreads through respiratory droplets and by touching contaminated surfaces.
- It often causes mild cold-like symptoms but can lead to serious illness in high-risk individuals.
- It follows a seasonal pattern, especially in colder months.[25]

Differences

- Unlike influenza and COVID-19, there is no vaccine for HMPV yet.
- While influenza tends to cause high fever and body aches, HMPV more commonly causes wheezing and breathing difficulties in young children.
- HMPV and RSV are very similar in how they affect infants but differ slightly in genetic structure and how the body responds to them.[26]

Public health Implication: Human Metapneumovirus (HMPV) is a growing public health concern, especially because it can cause serious respiratory illness in infants, older adults, and people with weak immune systems. While it may not be as widely known as other viruses like flu or COVID-19, HMPV has significant implications for public health systems around the world.[27]

1. High Risk for Vulnerable Groups

HMPV can lead to hospitalization, especially in children under five, elderly adults, and people with chronic lung or heart conditions. These groups may develop pneumonia or severe breathing problems, increasing the burden on hospitals and long-term care facilities during respiratory virus seasons.

2. Seasonal Outbreaks Strain Healthcare Systems

Like influenza and RSV, HMPV usually causes outbreaks in the winter and early spring. During these months, hospitals often see an increase in respiratory illnesses. Since HMPV symptoms are similar to other viruses, it adds to the diagnostic and treatment workload for healthcare workers.

3. Lack of Vaccine and Targeted Treatment

The absence of an approved vaccine or specific antiviral medication means that prevention and treatment rely mainly on supportive care and infection control. This puts more pressure on hospitals, especially in resource-limited areas, to manage severe cases and prevent the spread.

4. Diagnostic Challenges

Because HMPV symptoms are similar to many other respiratory illnesses, and testing is not always done, cases may be underreported. This can lead to missed opportunities for controlling outbreaks and protecting vulnerable people, especially in community or institutional settings.

5. Economic and Social Impact

Severe HMPV infections may lead to missed school and work, hospital stays, and the use of costly healthcare resources. For families with young children or elderly relatives, this can cause emotional stress and financial strain. For healthcare systems, the cost of managing seasonal surges in respiratory illness adds to annual budgets.

6. Need for Surveillance and Awareness[28]

Many people, including healthcare providers, are still not fully aware of HMPV. Increasing awareness, improving testing availability, and including HMPV in routine respiratory virus surveillance can help identify outbreaks earlier and guide better responses.

7. Opportunities for Prevention

Basic public health strategies—like good hand hygiene, respiratory etiquette (covering coughs and sneezes), staying home when sick, and isolating infected patients in hospitals—remain key tools for preventing the spread of HMPV.[29,30]

CONCLUSION

- Human Metapneumovirus (HMPV) is an important and often under-recognized respiratory virus that can cause illness in people of all ages, but especially in infants, the elderly, and those with weakened immune systems. Since its discovery in 2001, research has shown that HMPV is a common cause of respiratory tract infections worldwide and plays a major role in seasonal outbreaks, often alongside viruses like RSV and influenza.
- Although most HMPV infections are mild, severe cases can lead to hospitalization and even death in vulnerable populations. Because symptoms of HMPV are very similar to other respiratory viruses, proper diagnosis through laboratory tests is essential. While there is currently no specific treatment or vaccine for HMPV, supportive care remains effective in most cases, and ongoing research is actively exploring new therapies and preventive options.
- Public health strategies such as hand hygiene, respiratory etiquette, early detection, and surveillance play a key role in limiting the spread of the virus. At the same time, scientific advances—especially those driven by lessons from the COVID-19 pandemic—are helping to accelerate vaccine development and diagnostic tools for HMPV.
- HMPV is a globally prevalent respiratory pathogen with substantial clinical and public health impact. Ongoing research and development efforts are vital to reduce its burden. Understanding its virology, epidemiology, and clinical aspects is essential for healthcare professionals

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