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Human Metapneumovirus in India (HMPV) : Unveiling the Silent Respiratory Threat and Forging a Path to Resilient Healthcare Solutions

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Abstract: Human Metapneumovirus (HMPV), a respiratory virus first identified in 2001, has gained significant attention globally and in India due to its increasing prevalence and impact on public health. Recent cases reported across India, particularly in pediatric and elderly populations, underscore its growing significance as a cause of acute respiratory infections. This review comprehensively examines HMPV's epidemiology, seasonal patterns, clinical manifestations, and transmission dynamics, with a focus on its implications within the Indian healthcare context. It explores the proactive measures adopted by the Indian government and state health departments, such as enhanced surveillance, public advisories, and the establishment of specialized healthcare facilities. Furthermore, the article highlights scientific advancements, including genomic studies identifying new viral lineages and promising vaccine development efforts targeting HMPV and Respiratory Syncytial Virus (RSV). By addressing diagnostic challenges, healthcare capacity, and public awareness, this review provides a detailed roadmap for managing HMPV and mitigating its impact on India's healthcare system.

Keywords: Human Metapneumovirus, HMPV, respiratory infections, India, public health, vaccine development, epidemiology.

INTRODUCTION

Human Metapneumovirus (HMPV), a member of the Pneumoviridae family, was first identified in 2001 by Dutch researchers examining samples from children with respiratory infections. Despite its global presence, HMPV remains relatively under-recognized compared to other respiratory pathogens like Influenza and Respiratory Syncytial Virus (RSV). [1-3] In India, HMPV has been circulating since at least 2016, with sporadic detections over the years. Recent reports of confirmed cases, particularly among infants and the elderly, have heightened its public health relevance. This review consolidates the latest data on HMPV in India, critically examines the current situation, evaluates responses from authorities, and identifies future research needs. By contextualizing these findings within global trends, this article aims to inform policymakers, researchers, and healthcare professionals about the challenges and opportunities in managing HMPV infections.

Epidemiology of HMPV

Globally, HMPV is recognized as a significant contributor to respiratory tract infections, accounting for approximately 5-15% of cases. It predominantly affects young children, older adults, and individuals with weakened immune systems. The clinical spectrum ranges from mild upper respiratory tract infections to severe lower respiratory tract diseases, including bronchiolitis and pneumonia. In India, studies have estimated the prevalence of HMPV among acute respiratory tract infections (ARTIs) to be between 4% and 12%, underscoring its substantial role in the nation's respiratory illness burden. The virus exhibits marked seasonality, with increased activity during the colder months of November to May [4-7]. Recent outbreaks in states such as Karnataka, Gujarat, Tamil Nadu, and Maharashtra have highlighted the need for heightened surveillance and targeted interventions to mitigate the impact of HMPV on public health. [8-11]

Seasonality and Current Situation in India

HMPV infections in India display a distinct seasonal pattern, with peak incidence typically occurring in December and January. This trend aligns with global observations, reflecting increased susceptibility to respiratory illnesses during colder periods. As of January 2025, multiple confirmed cases of HMPV have been reported across various Indian states. Notably, two cases were identified in Bengaluru, Karnataka; three in Gujarat, involving both pediatric and geriatric patients; and two cases in Tamil Nadu, one each in Chennai and Salem. Additionally, two suspected cases in Nagpur, Maharashtra, were later ruled out by the Indian Council of Medical Research (ICMR). The geographical dispersion of these cases, though currently limited in number, indicates the virus's potential for broader outbreaks, particularly in densely populated regions. The Indian health ministry has stated that there is "no unusual surge" in cases of severe acute respiratory or influenza-like illnesses, suggesting that the current situation remains under control. [9-14]

Clinical Manifestations and Risk Factors

Human Metapneumovirus (HMPV) infections present a wide range of clinical symptoms that vary in severity, from mild upper respiratory tract illnesses to severe lower respiratory tract infections. The common symptoms include a persistent cough, fever, nasal congestion, and general fatigue, often resembling other respiratory illnesses such as influenza. In more severe cases, particularly among vulnerable groups, patients may experience wheezing, difficulty in breathing, and hypoxemia, which can lead to hospitalization. Complications such as secondary bacterial infections, exacerbation of chronic respiratory diseases like asthma or COPD, and acute respiratory distress syndrome (ARDS) are not uncommon in severe cases. [12,13,15,16]

Specific populations are at a heightened risk of developing severe HMPV infections. These include young children under three years of age, who often lack prior exposure to the virus and have underdeveloped immune responses; older adults, particularly those with pre-existing conditions like cardiovascular or pulmonary diseases; individuals with weakened immune systems, such as those undergoing chemotherapy or living with HIV/AIDS; and preterm infants with low birth weights who often have immature lung development. Recognizing these high-risk groups is critical for clinicians to prioritize diagnostic testing and management. Early intervention and supportive care can significantly improve outcomes in severe cases. [10,14,17,18]

Transmission and Pathogenesis

HMPV spreads primarily through respiratory droplets expelled during coughing, sneezing, or even talking, making close contact with infected individuals a significant risk factor for transmission. The virus can also be indirectly transmitted by touching surfaces or objects contaminated with infectious droplets and subsequently touching the nose, mouth, or eyes. Its high transmissibility in crowded environments, such as schools, daycare centers, and hospitals, increases its potential for outbreaks in these settings. [4,12]

The virus has an incubation period of three to five days, during which it begins replicating in the respiratory epithelium. HMPV targets the epithelial cells lining the upper and lower respiratory tracts, causing cell damage, inflammation, and mucosal edema. This inflammatory response can impair gas exchange in severe cases, leading to wheezing and respiratory distress. In some patients, particularly those with compromised immunity, the viral infection may facilitate secondary bacterial colonization, exacerbating disease severity. [19,20]

Effective preventive strategies are vital to control HMPV transmission. These include practicing good respiratory hygiene, such as covering one's mouth and nose when sneezing or coughing, frequent handwashing with soap and water, and disinfecting commonly touched surfaces. Public education on these preventive measures is essential, especially during seasonal peaks of respiratory infections. [21,22]

Responses from the Indian Government

The Indian government has adopted a comprehensive and multi-layered strategy to address the emerging threat posed by HMPV. At the national level, the Indian Council of Medical Research (ICMR) and the National Centre for Disease Control (NCDC) have intensified surveillance mechanisms to track HMPV circulation and monitor trends in Influenza-Like Illness (ILI) and Severe Acute Respiratory Infections

(SARI). Surveillance has been enhanced through integration with the country's existing respiratory disease monitoring systems.[9,23,24]

The Union Health Ministry has issued detailed advisories to all states, urging them to strengthen their healthcare infrastructure to manage potential HMPV outbreaks. States have been advised to increase testing for HMPV in patients presenting with unexplained respiratory symptoms and to ensure the availability of isolation wards in tertiary care hospitals. The Ministry has also launched public awareness campaigns to educate citizens about respiratory hygiene, emphasizing handwashing, mask-wearing, and avoiding close contact with symptomatic individuals. These campaigns aim to reassure the public about the generally mild nature of most HMPV infections while preventing unnecessary panic.[25-28]

Collaboration with international health agencies such as the World Health Organization (WHO) has been a key component of the government's response. Through this partnership, India is staying updated on global developments, including diagnostic advancements, treatment protocols, and vaccine research. This collaboration ensures that India remains equipped with the latest strategies to address HMPV effectively. [1,29,30,31]

At the state level, governments have tailored their responses to local needs. Gujarat, for instance, has established dedicated isolation wards in major hospitals across Ahmedabad, Rajkot, and Gandhinagar to handle suspected HMPV cases. Karnataka has focused on public communication and departmental coordination, ensuring that healthcare facilities are prepared to manage a surge in respiratory cases. Tamil Nadu has emphasized vigilance and public reassurance, highlighting the manageable nature of HMPV with early intervention. Maharashtra has taken a particularly proactive stance by forming a dedicated task force responsible for developing standardized operating procedures for detecting and managing HMPV infections. These state-level interventions demonstrate the government's commitment to a decentralized, locally adapted approach in addressing the virus.[11-15,32-34]
Through coordinated efforts at both the national and state levels, India has demonstrated a robust and adaptive response to HMPV. However, continued efforts in research, vaccine development, and public health education will be essential to mitigate the long-term impact of this virus. These measures underscore the importance of a resilient healthcare system capable of addressing emerging infectious diseases like HMPV.

Research and Scientific Advancements

Recent advancements in the study of Human Metapneumovirus (HMPV) have highlighted its evolving nature and genetic diversity, necessitating continuous research and genomic surveillance. Indian researchers, particularly from the Jawaharlal Institute of Postgraduate Medical Education and Research (JIPMER) in Puducherry, have identified new lineages of HMPV, designated A2.2.1 and A2.2.2. These findings underscore the virus's ability to adapt and mutate, which may influence its transmissibility, clinical severity, and immune evasion. Such discoveries emphasize the importance of ongoing genomic studies to track viral evolution, identify emerging strains, and develop targeted interventions. [35-37]

In the domain of vaccine development, significant progress is being made globally, with several promising candidates in various stages of clinical trials. Technologies such as mRNA-based vaccines and Virus-Like Particle (VLP) platforms are being explored for their potential to provide robust and long-lasting immunity. A notable development is Vicebio and AstraZeneca's dual-target vaccine, which aims to protect against both HMPV and Respiratory Syncytial Virus (RSV). Similarly, Moderna has initiated phase I trials of its HMPV-specific vaccine candidate, leveraging its successful mRNA platform used in COVID-19 vaccines. Accelerating vaccine research, through international collaborations and government-supported initiatives, is critical to achieving long-term control of HMPV. Additionally, exploring therapeutic options, including monoclonal antibodies and antiviral drugs, could provide immediate relief for high-risk populations while vaccines are being developed. [33,34,37,38]

Public Health Implications

The increasing prevalence of HMPV cases in India presents a range of challenges for the public health system, highlighting vulnerabilities in existing healthcare infrastructure. A significant hurdle is the limited availability of diagnostic tools, particularly in primary healthcare settings, which hampers early

detection and timely management of cases. This challenge is compounded by the seasonal overlap of HMPV infections with other respiratory viruses such as influenza, placing additional strain on healthcare resources during peak respiratory illness seasons.

Public awareness about HMPV remains alarmingly low, with many people mistaking its symptoms for common colds or seasonal flu. This lack of awareness delays medical intervention and increases the risk of severe outcomes, especially in high-risk groups. Targeted educational campaigns are urgently needed to inform the public about the symptoms, transmission mechanisms, and preventive measures for HMPV. These campaigns should also prepare communities for the eventual availability of vaccines, emphasizing their role in reducing the burden of respiratory infections.

Despite these challenges, the current scenario also presents opportunities to innovate and strengthen India's healthcare delivery systems. Digital health tools, such as mobile applications and real-time surveillance platforms, can play a pivotal role in tracking outbreaks, monitoring case trends, and disseminating public health messages. Strengthening community-based healthcare systems, including training healthcare workers to identify and manage HMPV cases, can enhance early diagnosis and improve patient outcomes. These initiatives must be integrated into India's broader respiratory disease management framework to ensure a cohesive and efficient response.

Future Directions

To effectively manage the impact of HMPV in India, a comprehensive and multi-faceted strategy is essential. Enhanced surveillance systems must be established to monitor the virus's prevalence and genetic diversity continuously. This includes integrating HMPV into existing respiratory disease surveillance frameworks and utilizing advanced genomic tools to identify emerging strains promptly. Expanding diagnostic capacity, particularly in rural and underserved areas, is critical to ensuring early detection and reducing the risk of severe disease outbreaks.

Public health education campaigns should be prioritized to raise awareness about respiratory infections, emphasizing preventive measures such as respiratory hygiene, handwashing, and mask-wearing during peak seasons. These campaigns must also combat misinformation and build public trust in emerging vaccine technologies, ensuring widespread acceptance once vaccines become available. Expanding healthcare capacity, particularly during winter months when respiratory infections surge, is essential to prevent overwhelming the healthcare system.

International collaboration in research and vaccine development should be intensified. Partnerships with global health organizations and research institutions can accelerate the development and accessibility of HMPV vaccines and treatments. India's active participation in global clinical trials and research networks will ensure timely access to breakthroughs and position the country as a leader in managing respiratory viruses.

In addition to vaccines, exploring alternative therapeutic interventions, such as antiviral drugs and monoclonal antibodies, should be a research priority. These treatments could provide immediate protection for vulnerable populations and serve as a bridge until vaccines are widely available. Investments in digital health infrastructure, such as telemedicine platforms and data analytics tools, will also be critical for efficient disease monitoring and management.

The long-term goal must be to create a resilient healthcare system capable of addressing not only HMPV but also other emerging respiratory pathogens. By integrating scientific advancements, public health strategies, and community-level interventions, India can effectively mitigate the impact of HMPV and prepare for future public health challenges.

CONCLUSION

The recent surge in Human Metapneumovirus (HMPV) cases in India highlights the urgent need for sustained vigilance, enhanced preparedness, and a proactive approach to public health management. Although HMPV is not a newly identified virus, its evolving genetic diversity, coupled with its capacity to cause significant respiratory illnesses, necessitates continuous monitoring and research. The coordinated efforts of Indian authorities, including strengthened surveillance systems, public health campaigns, and state-level interventions, have laid a robust foundation for addressing current challenges. Advancements in genomic research, vaccine development,

and therapeutic strategies further bolster the ability to mitigate the virus's impact. However, these efforts must be complemented by investments in healthcare infrastructure, increased diagnostic capacity, and widespread public education to ensure early detection and effective prevention. By integrating these measures into a cohesive strategy, India can not only manage the immediate threat posed by HMPV but also enhance its resilience against future respiratory pathogens, safeguarding public health in the long term.

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