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(Review Article)

Human Metapneumovirus (HMPV): An Emerging Public Health Concern

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Abstract

Human metapneumovirus (HMPV) is indeed a significant cause of respiratory infections, particularly in vulnerable populations such as children, the elderly, and those with weakened immune systems. The absence of targeted antiviral treatments or vaccines makes the search for effective inhibitors crucial.

In your study, a computational approach was employed to screen natural compounds for their potential to inhibit the HMPV matrix protein. The results indicated that epigallocatechingallate (EGCG), rutin, and quercetin showed strong binding affinities compared to standard drugs like ribavirin. The binding energies of these compounds, with EGCG having the most favorable binding energy at -9.1 kcal/mol, suggest their potential as effective inhibitors.

The molecular docking studies further confirmed stable interactions, highlighting the significance of hydrogen bonds with specific amino acid residues, which enhances the likelihood of their effectiveness in therapeutic applications. The molecular dynamics simulations supported these findings by demonstrating the stability of the complexes over time, particularly with EGCG showing the lowest root mean square deviation (RMSD), indicating a stable conformation.

Moreover, the Density Functional Theory (DFT) calculations provided insights into the electronic properties of these compounds, with EGCG exhibiting a low band gap and high dipole moment, which suggest strong reactivity and binding potential. The ADMET profiling also indicates that EGCG and quercetin have excellent oral bioavailability, making them suitable candidates for further development.

Overall, the study positions EGCG, rutin, and quercetin as promising candidates for further investigation as potential treatments for HMPV, emphasizing the importance of natural compounds in the search for effective antiviral therapies. This research could pave the way for new therapeutic strategies to combat HMPV infections in at-risk populations.

Keywords: Human metapneumovirus (HMPV), Molecular docking, Molecular dynamics, simulations Density functional theory, Molecular electrostatic potential.

INTRODUCTION

This introduction effectively sets the stage for discussing the challenges posed by human metapneumovirus (HMPV) in the context of global health. It highlights the increasing prevalence of HMPV, especially in densely populated and polluted regions, and emphasizes the significant morbidity and mortality associated with it, particularly among vulnerable groups. The statistics regarding HMPV infections accounting for 5–15% of acute lower respiratory tract infections globally are particularly striking, as they illustrate the virus's impact and the urgent need for better diagnostic capabilities and public awareness. The comparison to respiratory syncytial virus (RSV) underscores the importance of recognizing HMPV as a significant respiratory pathogen. Moreover, the mention of the lack of targeted therapies and vaccines creates a sense of urgency, as it points to a gap in healthcare preparedness that could lead to severe outbreaks. The reference to the COVID-19 pandemic serves as a powerful reminder of the potential consequences of neglecting respiratory viruses.

Advancements in computational drug discovery are presented as a promising solution to these challenges. By utilizing in silico tools to focus on the HMPV matrix protein, the study aims to identify molecules that could effectively disrupt the virus's replication cycle. This approach not only highlights the innovative strategies being employed in the fight against viral diseases but also offers a hopeful path forward in developing effective treatments for HMPV.

Overall, this introduction provides a comprehensive overview of the issue at hand, the current state of

research, and the innovative methods being explored to combat HMPV. It effectively sets the stage for the subsequent discussion on the study's findings and implications. Human Metapneumovirus (HMPV) is indeed a significant respiratory virus that was first identified in the Netherlands in 2001. As a member of the Paramyxoviridae family, it shares this classification with other notable respiratory pathogens, including respiratory syncytial virus (RSV) and parainfluenza virus. HMPV primarily targets the respiratory tract and can result in a wide spectrum of illnesses. These can range from mild, cold-like symptoms to more severe conditions such as pneumonia and bronchitis. While individuals of all age groups can be infected, the virus poses the highest risk to specific populations, particularly young children, older adults, and those with weakened immune systems. Understanding HMPV's transmission and impact is crucial for public health, especially in light of recent outbreaks. Increased awareness and research into effective treatments and preventive measures will be essential in managing the risks associated with HMPV.

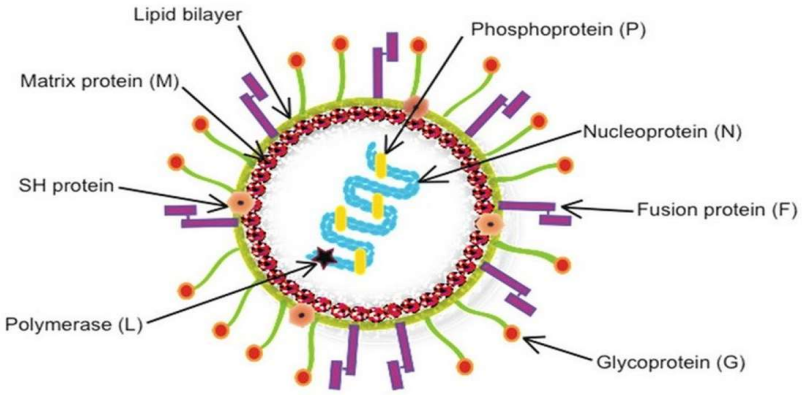

Figure 1: HMPV Virus

The recent outbreak of human metapneumovirus (HMPV) in China has raised significant concerns due to its rapid spread and impact on public health. Starting in late 2024, hospitals in major cities like Beijing and Shanghai began to see a sharp increase in respiratory illnesses. The symptoms reported by patients, including high fever, persistent coughing, and difficulty breathing, initially led to misdiagnoses of influenza or COVID-19.

However, laboratory tests later confirmed that HMPV was the primary cause of these illnesses. This outbreak has become one of the most significant surges of HMPV in recent history, affecting thousands in a very short period. The high population density in urban areas facilitated quick person-to-person transmission, which overwhelmed healthcare systems in several regions.

Particularly vulnerable groups, such as children under 5, the elderly, and individuals with compromised immune systems, have been the most impacted. Severe cases have often necessitated hospitalization, ventilatory support, and lengthy recovery times.

Additionally, with international travel returning to pre-pandemic levels, there is a heightened risk of the virus spreading beyond China. Early reports of HMPV cases in countries like India and neighboring regions underscore the global implications of this outbreak. This situation highlights the need for increased awareness, effective public health measures, and research into potential treatments and vaccines for HMPV.

Diagnosis and Tests for HMPV:

Diagnosing Human Metapneumovirus (HMPV) involves a combination of clinical assessment and laboratory testing due to its similarity to other respiratory illnesses. Here's a breakdown of the diagnostic methods used:

Clinical Evaluation: The first step involves assessing the patient's symptoms and medical history. Healthcare providers look for typical signs of respiratory infection, such as cough, fever, and difficulty breathing. Nasopharyngeal Swabs: This method involves collecting samples from the nose and throat. These swabs are sent to a laboratory for analysis to check for the presence of HMPV. Polymerase Chain Reaction (PCR) Tests: PCR tests are considered the gold standard for diagnosing HMPV. This technique detects HMPV-specific genetic material in the collected samples, allowing for accurate identification of the virus. Serological Tests: These tests identify antibodies against HMPV in the blood. They can help determine if a person has been previously infected with the virus. Early and accurate diagnosis is crucial for effective management of HMPV infections and for preventing potential complications, especially in vulnerable populations.

Prevention from HMPV:

Preventing Human Metapneumovirus (HMPV) is essential since there is currently no specific vaccine

or antiviral treatment available. Implementing effective preventive measures can significantly reduce the risk of infection.

Maintain Good Hygiene: One of the most effective ways to prevent infection is through proper hand hygiene. Wash your hands frequently with soap and water for at least 20 seconds, especially after being in public places or after coughing and sneezing. If soap and water are not available, use hand sanitizers that contain at least 60% alcohol.

Avoid Close Contact: It's important to keep a safe distance from individuals who are exhibiting symptoms of respiratory illnesses, such as coughing or sneezing. Additionally, try to avoid sharing personal items like utensils, towels, or drinks, as these can facilitate the spread of the virus.

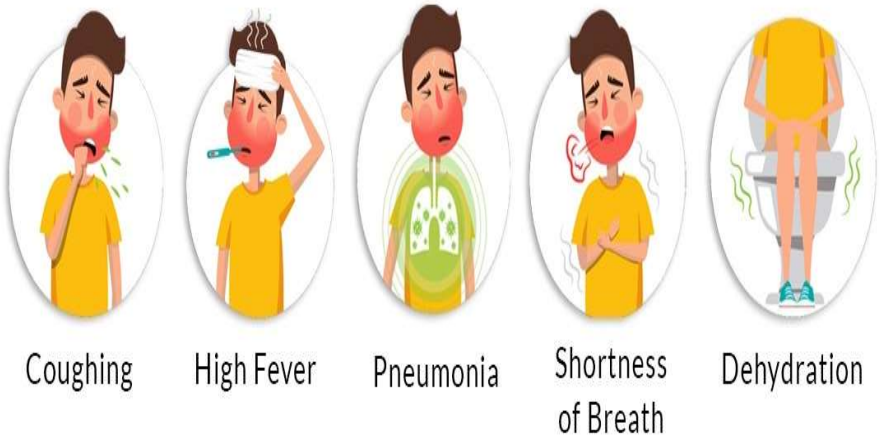

Figure 2: Symptoms of HMPV

Disinfect Surfaces: Regular cleaning of high-touch surfaces is crucial. Common areas such as doorknobs, light switches, phones, and countertops should be disinfected frequently to reduce the likelihood of virus transmission.

Wear Masks: In crowded or enclosed spaces, wearing masks can help minimize the risk of inhaling respiratory droplets that may contain the virus. This is particularly important in settings where social distancing is challenging.

Boost Immunity: A strong immune system can help fend off infections. To support your immune health, focus on eating a balanced diet rich in fruits and vegetables, engaging in regular physical activity, and ensuring you get adequate sleep. These lifestyle choices can contribute to overall well-being and immune resilience. By following these preventive strategies, individuals can help protect themselves and others from HMPV and other respiratory infections.

Risk of Severe HMPY Infection:

Human Metapneumovirus (HMPV) can affect anyone, but certain groups are more vulnerable to experiencing severe complications. Recognizing these high-risk groups is essential for preventing severe outcomes and ensuring timely medical intervention.

Children Under Five Years Old: Young children, particularly infants, are at greater risk due to their developing immune systems and smaller airways. When infected, they may have difficulty breathing, which can lead to severe conditions such as bronchiolitis and pneumonia.

Older Adults (65 and above): Older adults are more susceptible to severe infections because of the natural decline in immune function that comes with aging. Additionally, many older adults have chronic health conditions, such as heart disease, diabetes, or chronic obstructive pulmonary disease (COPD), which can complicate recovery from respiratory infections like HMPV.

Immunocompromised Individuals: Those with weakened immune systems, including individuals with cancer, HIV/AIDS, or organ transplant recipients, are at a higher risk for severe infections. Their bodies may struggle to fight off viruses, making them more prone to complications from HMPV.

Individuals with Chronic Respiratory Conditions: People suffering from conditions like asthma, COPD, or chronic bronchitis may find it harder for their lungs to cope with respiratory infections. This increases their risk of experiencing severe illness when infected with HMPV.

Pregnant Women: Pregnancy can lead to a slight suppression of the immune system, making women more susceptible to infections such as HMPV. Additionally, the respiratory demands during pregnancy can exacerbate symptoms of respiratory viruses.

People with Heart Disease or Other Chronic Conditions: Individuals with heart disease or other chronic health issues may find it challenging to manage the additional stress on their bodies caused by respiratory infections, which can lead to severe complications.

People in Crowded or Remote Places: Living in overcrowded environments or areas with limited access to healthcare raises the risk of both contracting HMPV and experiencing severe outcomes. High transmission rates and the lack of proper care can significantly impact these populations.
Understanding these risk factors is crucial for taking preventive measures and seeking timely medical attention when necessary.

CONCLUSION

In conclusion, raising awareness about Human Metapneumovirus (HMPV) is essential, particularly in relation to the high-risk groups that are more susceptible to severe complications. Understanding that young children, older adults, immunocompromised individuals, those with chronic respiratory conditions, pregnant women, and people living in crowded or remote areas are at greater risk is vital for effective public health strategies.
The implications of HMPV extend beyond just individual health; they affect families and communities as well. Increased awareness can empower individuals and families to recognize the symptoms associated with HMPV, which may include respiratory distress, fever, and cough. This knowledge can lead to earlier diagnosis and treatment, thereby reducing the risk of severe illness and hospitalization.
Furthermore, public health campaigns that educate communities about the importance of hygiene practices, such as handwashing and avoiding close contact with infected individuals, can significantly reduce transmission rates. Promoting vaccination and other preventive measures is crucial in protecting those who are most vulnerable.
In addition to awareness and prevention, there is an urgent need for effective treatment options for HMPV. Currently, there are no specific antiviral therapies approved for HMPV, which underscores the importance of research and development in this area. Investment in treatment options can significantly improve outcomes for those infected, particularly for high-risk individuals.
Additionally, fostering a culture of awareness can help reduce stigma associated with respiratory illnesses, encouraging individuals to seek medical help without hesitation. By prioritizing education and awareness around HMPV and advocating for treatment advancements, we can create a more informed society capable of acting swiftly and effectively in response to respiratory viruses. Ultimately, this collective effort can lead to better health outcomes, safeguard our communities, and protect those who are most at risk from the impacts of HMPV.

REFERENCES

1. Wang X, Li Y, Deloria-Knoll M, Madhi SA, Cohen C, Ali A, et al. Global burden of acute lower respiratory infection associated with human metapneumovirus in children under 5 years in 2018: a systematic review and modelling study. Lancet Glob Health 2021; 9(1): e33 − 43.
2. Howard LM, Edwards KM, Zhu YW, Griffin MR, Weinberg GA, Szilagyi PG, et al. Clinical features of human metapneumovirus infection in ambulatory children aged 5-13 Years. J Pediatric Infect Dis Soc 2018; 7(2):165 − 8. https://doi.org/10.1093/jpids/pix012.
3. van den Hoogen BG, de Jong JC, Groen J, Kuiken T, de Groot R, Fouchier RAM, et al. A newly discovered human pneumovirus isolated from young children with respiratory tract disease. Nat Med 2001; 7(6): 719 − 24. https://doi.org/10.1038/89098.
4. Rima B, Collins P, Easton A, Fouchier R, Kurath G, Lamb RA, et al. ICTV virus taxonomy profile: Pneumoviridae. J Gen Virol 2017; 98(12): 2912 − 3. https://doi.org/10.1099/jgv.0.000959.
5. Yi LN, Zou LR, Peng JJ, Yu JX, Song YC, Liang LJ, et al. Epidemiology, evolution and transmission of human metapneumovirus in Guangzhou China, 2013-2017. Sci Rep 2019; 9(1):14022.
6. Saikusa M, Nao N, Kawakami C, Usuku S, Sasao T, Toyozawa T, et al. A novel 111-nucleotide duplication in the G gene of human metapneumovirus. Microbiol Immunol 2017; 61(11):507 − 12.
7. Piñana M, Vila J, Gimferrer L, Valls M, Andrés C, Codina MG, et al. Novel human metapneumovirus with a 180-nucleotide duplication in the G gene. Future Microbiol 2017; 12(7):565 − 71.
8. Liu ZR, Xie ZB, Sun R, Zhang F, Xu WB, Wang ZG, et al. The A2c111nt-dup variants of human metapneumovirus predominantly circulating in Qingdao, China, during 2018 and 2019. J Med Virol 2022; 94(9):4301 − 8.
9. Agca H, Akalin H, Saglik I, Hacimustafaoglu M, Celebi S, Ener B. Changing epidemiology of influenza and other respiratory viruses in the first year of COVID-19 pandemic. J Infect Public Health 2021; 14 (9): 1186 − 90.
10. Bagul A, Kumar M, Tufail A, Tufail N, Gaikwad D, Dubey A. Synergistic exploration of antimicrobial potency, cytotoxicity, and molecular mechanisms: A tripartite investigation integrating in vitro, in vivo, and in silico approaches for pyrimidine-based metal (II) complexes. Applied Organometallic Chemistry 2024; 38:7521.
11. Daina A, Michielin O, Zoete V. SwissADME: a free web tool to evaluate pharmacokinetics, druglikeness and medicinal chemistry friendliness of small molecules. Scientific reports 2017; 7:42717.
12. Pires DE, Blundell TL, Ascher DB. pkCSM: predicting small-molecule pharmacokinetic and

toxicity properties using graph-based signatures. Journal of medicinal chemistry 2015; 58:4066-72.
13. Banerjee P, Eckert AO, Schrey AK, Preissner R. ProTox-II: a webserver for the prediction of toxicity of chemicals. Nucleic acids research 2018; 46:257-63.
14. Kumar B, Devi J, Dubey A, Kumar M. Biological and Computational Studies of Hydrazone based Transition Metal (II) Complexes. Chemistry & Biodiversity 2024; 21:202401116.
15. Kadyan P, Kumar M, Tufail A, Ragusa A, Kataria SK, Dubey A. Microwave-assisted green synthesis of fluorescent graphene quantum dots (GQDs) using Azadirachta indica leaves: enhanced synergistic action of antioxidant and antimicrobial effects and unveiling computational insights. Materials AdvanceS 2024.