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Enigmatic Nipah: Understanding the Threat and Insight into a Lethal Pathogen

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Review Article

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Abstract:

The zoonotic paramyxovirus known as Nipah virus (NiV) belongs to the Henipavirus genus and was initially discovered in Malaysia in 1998. Nipa viruses have been isolated from fruit bats found in Oceania, Asia, and Africa, and they have bat reservoir hosts. Although there have been reports of other intermediary hosts, bat-to-human transmission is believed to be the main way that virus infection spreads to humans. Encephalitis is a recognized side effect, and severe respiratory distress can be deadly. The virus arises and spreads due to a number of circumstances. Numerous tactics have been developed to address and improve awareness and monitoring throughout the affected area, with a focus on personal cleanliness. This study covers the current Nipah virus epidemics, their modes of transmission, the preventive and control measures put in place, and any potential causes.

Key Words: Pathogen; Nipah virus; Transmission; Date sap; Saliva.

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INTRODUCTION

The Nipah virus (NiV) is a zoonotic virus that belongs to the Henipavirus genus within the Paramyxoviridae family. It has a high case fatality rate [1]. There have been recent reports of human fatal encephalitis caused by the bat-borne infection Nipah virus (NiV) from Malaysia, Bangladesh, Singapore, and India [2, 3]. Human Nipah virus infections can manifest clinically as a variety of illnesses, including asymptomatic illness, acute respiratory syndrome, and deadly encephalitis. The Nipah virus may also infect pigs and other household animals with illness. As of late, no vaccination has been developed for either people or animals. In human situations, strict supportive care is the most important course of therapy. The World Health Organization has identified ten priority illnesses as possible candidates for the next significant epidemic, and the Nipah virus is at "top of the list" among them [4-6].

The effect of several variables, such as human-to-human contact and animal interaction with severe environmental changes, can lead to outbreaks of different zoonotic viruses [7-9]. The current zoonotic epidemics of NiV may be mostly caused by ecological, environmental, and human factors [10]. Fever lasting up to 14 days, meningitis and/or encephalitis, together with a rapid decrease in brain function that progressed to coma in 24 to 48 hours, were the hallmarks of human illnesses [11, 12]. Subsequent epidemics beyond the Malay peninsula have demonstrated distinct transmission dynamics and clinical manifestations, such as the emergence of severe respiratory symptoms alongside neurological complications. Human infection has been linked to the consumption of horse meat, close contact with other afflicted individuals, and ingestion of raw date palm sap tainted with bat bodily fluids [13, 14]. Viral illnesses have emerged as a result of anthropogenic influences that have drastically disrupted the environment and ecology. Significant contributing variables include deforestation, changes in natural topography, farming, industrialization, and climate change. Effective disease control necessitates a One Health strategy that considers people, domestic and peri-domestic animals, and the environment.

NIPAH VIRUS

This virus is an enveloped pleomorphic virus that is a member of the Paramyxoviridae family's genus Henipavirus [15]. The virus's genome is made up of an approximately 18.2 kb long non-segmented negative sense single-stranded RNA that codes for six structural proteins: RNA polymerase (L), nucleocapsid (N), phosphoprotein (P), matrix protein (M), fusion protein (F), glycoprotein (G), and fusion protein (F) [16]. The ribonucleoprotein complex, which is made up of the N, P, and L and the viral RNA, is an essential complex that controls transcription and the production of viral RNA, (Figure 1). The G protein facilitates the attachment of the virus and attaches to the host's cells Ephrin-B2 and -B3 receptors, whereas the F protein causes the viral cell membrane to fuse, which makes the virion easier to enter [17].

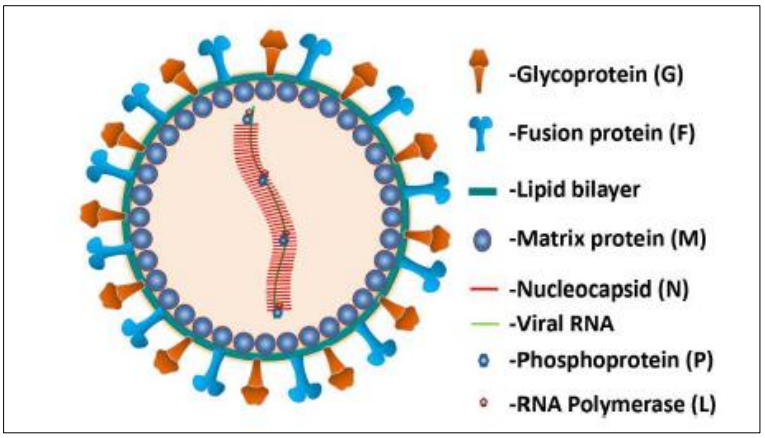

Figure 1: Nipah virus structure, copyright from Vinod *et al*., 2020 [18]

TRANSMISSION

Pigs contract the virus from bats when they consume fruits that have been partially chewed or contaminated by Nipah-infected bats. Human-to-human infection may occur by direct touch, aerosols, or fomites, while viral transmission from pigs to humans happens through direct contact with sick pigs [19]. A few affected individuals in Bangladesh were found to have swallowed raw palm sap around 30 days before the sickness manifested itself, indicating that the palm sap may have been contaminated with bat secretions carrying the NiV virus [20]. The underlying cause of epidemics is sometimes attributed to direct contact with unsanitary pigs, other infected animals, contaminated fruits (half-eaten fruits dropped by fruit bats), or even direct contact with ill people, (Figure 2).

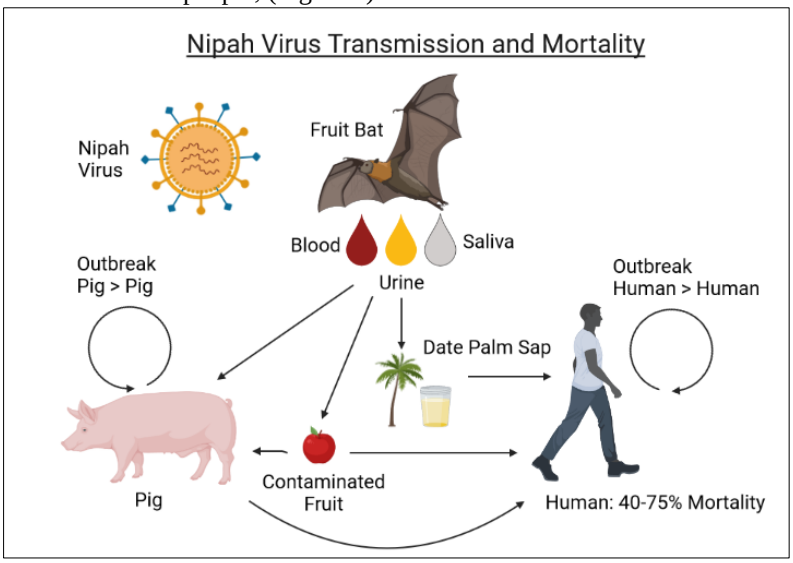

Figure 2: Transmission cycle in human, source: jenner.ac.uk

CLINICAL SIGNS AND SYMPTOMS

The virus can incubate for four to twenty-one days. NiV is extremely deadly and mostly causes acute encephalitis and respiratory illnesses. A tiny portion of those with the infection have no symptoms [21]. Within a week, encephalitis manifests itself. Areflexia, hypotonia, segmental myoclonus, altered mental status, gaze palsy, and limb weakness are the most typical symptoms. Patients progressively worsen and within a few days, they pass away in a coma.

Twenty percent of survivors experience residual neurological abnormalities, which might include sadness, tiredness, and localized neurological problems [22]. There have been reports of late-onset or relapse NiV encephalitis patients [23]. The clinical characteristics of the Indian and Malaysian epidemics differ in a few ways. India and Bangladesh have reported greater death rates (70%) than Malaysia (40%). In Bangladesh and India, respiratory illnesses affect 70% of patients [24]. Patients with Nipah cases who have respiratory issues are more prone to spread the virus than people who do not. People who exhibit symptoms may have the sickness in the midst of an epidemic outbreak [25]. Myalgia, drowsiness, epilepsy, fatigue, fainting, nausea, convulsions, lethargy, vomiting, fever, coughing, headache, stomach pain, respiratory sickness, encephalitis, disorientation, mental confusion, coma, and maybe even death are among the common symptoms.

TREATMENT

Many vaccinations have been researched in light of our growing understanding of their molecular biology. Early research on vaccinia virus recombinants expressing either NiV-G or F proteins in mice and hamsters showed the production of neutralizing antibodies and protection from lethal infection [26]. In this case advanced research for drug delivery systems is ongoing to develop newer medicine for this type of infection [27]. The G and F proteins are still the foundation of more current vaccination research. In ferrets exposed to fatal dosages of NiV, a subunit vaccination containing the G glycoprotein of HeV—which has 83% amino acid similarity with the G protein of NiV—appears to be effective in preventing NiV infection. Two of the five ferrets had their viral genomes found, but none of them showed any symptoms of sickness [28].

Infected patients in Malaysia were treated with ribavirin, which is effective against other Paramyxoviruses, including Respiratory Syncytial Virus. During the same epidemic, Chong et al. [29] reported a drop in mortality, whereas Goh et al. [30] observed no decrease. Since then, ribavirin has been examined in animal models and proven to be useless. In Singapore, acyclovir was administered, although it's uncertain whether it was beneficial [31]. Although chloroquine was found to be useful in cell culture, neither by itself nor in conjunction with ribavirin was able to stop hamster deaths in a model.

PATHOGENESIS

Only zoonotic paramyxoviruses, or henipaviruses, exist. Their wide host range and high case fatality rates are extraordinary features as well. The virus particles they possess are spherical to filamentous, pleomorphic, and are composed of helical nucleocapsids enclosed in an envelope, which is a non-segmented negative-stranded RNA genome. Compared to other paramyxoviruses, HeV and NiV both have substantially bigger genomes [32, 33]. Six structural proteins, in the sequence 3′-N-P-M-F-G-L-5′, are encoded by the genome: phosphoprotein (P), matrix protein (M), fusion protein (F), glycoprotein (G), nucleocapsid protein (N), large protein (L), or RNA polymerase. The P gene codes for three non-structural proteins that have been predicted: C, V, and W [34]. The oro-nasal route is the vector by which the virus enters its host and spreads infection. The site of initial replication of the virus is unknown because human tissues studied during the later stages of the disease have high concentrations of antigen, suggesting that lymphoid and respiratory tissues are likely sites of initial replication.

PREVENTIVE MEASURE

By limiting exposure to sick pigs and bats in endemic areas, the illness can be avoided by not drinking uncooked palm sap, or "palm toddy," tainted with bat droppings. It is well known that while drinking toddy, bats may occasionally gather in open containers and urinate in them, contaminating them with viruses [35]. Public health and medical personnel should be made aware of neglected and related illnesses on a regular basis. Government and medical authorities in areas where outbreaks have occurred in the past should also be prepared to contain any future outbreaks. Research aimed at comprehending the bat ecology, its vulnerability to transmitting NiV, and its exact prevalence may be able to mitigate the risk associated with human encroachment into their natural habitat. Monitoring and sero-surveillance for NiV antibodies and NiV using ELISA and PCR techniques in people and bats can assist in preventing the potential for an epidemic in the areas where it is most common [36]. Using infection control techniques including patient isolation, wearing personal protective equipment, and practicing excellent hand hygiene are all part of preventing the spread of disease from person to person. After being located through contact tracing, contacts are tested and monitored until the results are negative [37].

The WHO Asia Region Strategy for Nipah Virus Prevention and Control, 2023–2030 was created to assist Member States in preventing sickness and fatalities caused by NiV, with a focus on senior decision-makers and program managers involved in zoonotic disease control. The Strategy is one of several WHO initiatives in the Region aimed at strengthening systems to prevent and control NiV. Other initiatives include policy briefs to facilitate high-level engagement, a standard operating procedure laboratory manual, a NiV disease profile to support systematic risk assessment, and prevention and control at the national level.

CONCLUSION

Because there are currently no viable treatments or vaccinations for NiV infection, it might be regarded as an emergent illness and a public health concern. This epidemic emphasizes how critical it is to establish a robust surveillance system that is backed by a network of cutting-edge laboratories that are capable of handling and diagnosing novel pathogens. It also emphasizes the significance of patient isolation techniques, the use of private protective equipment, obstacle nursing, and the safe disposal of potentially infected materials in the prevention and control of Nipah virus infection. Future outbreaks might be significantly reduced by listing the contributing elements, conducting surveys and research to better understand the dynamics of the virus within interspecies groups, and implementing preventative measures. Governments and authorities should implement preventative and containment strategies in order to manage any potential periodic outbreaks of a similar kind.

Competing interest: None
Data availability: Not applicable.

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