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Review Article

A comprehensive review on Nipah virus infection control measures

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ABSTRACT

Nipah virus (NiV) has emerged as a deadly zoonotic pathogen, causing sporadic outbreaks with high mortality rates. The patient typically exhibits thrombocytopenia, leukopenia, and transaminitis along with fever, encephalitis, and/or respiratory involvement. This comprehensive review delves into the multifaceted realm of Nipah virus infection control measures. We explore the latest research, strategies, and practices aimed at preventing, containing, and mitigating the impact of NiV outbreaks. From surveillance and diagnosis to treatment and public health interventions, this review offers a holistic perspective on the ongoing efforts to combat this deadly virus.

Key words: Nipah virus, Zoonotic transmission, Diagnosis, Prevention, Treatment

INTRODUCTION

Nipah virus infection control is a pressing global health concern, given its potential for rapid transmission and high fatality rates. This in-depth review article explores the various facets of Nipah virus infection control measures. We discussed the latest research findings and strategies aimed at preventing, diagnosing, and treating NiV infections. Additionally, we delve into the critical role of surveillance in early detection and containment, examine the zoonotic nature of the virus, and explore public health interventions that play a pivotal role in curbing outbreaks. Stay informed about the evolving landscape of Nipah virus infection control by reading this comprehensive review. The Nipah virus is a highly infectious zoonotic pathogen primarily transmitted from Pteropus bats to humans, causing sporadic outbreaks with high mortality rates. In response to this grave public health threat, extensive efforts have been made to establish effective infection control measures and outbreak prevention strategies.

NIPAH VIRUS

Nipah virus belongs to the Paramyxoviridae family and is responsible for severe respiratory and neurological diseases in humans. It has a well-documented history of outbreaks in South and Southeast Asia.

The Nipah virus is characterized as an enveloped virus with a variable pleomorphic shape ranging from 40 to 1900 nanometers. Its genetic material consists of a single-stranded negative-sense RNA genome (Knipe *et al.,* 2013). When observed under an electron microscope, NiV displays a morphological structure similar to other members of the Paramyxoviridae family. Like its counterparts in the Paramyxovirus group, NiV possesses a set of six genes responsible for encoding specific proteins: fusion protein (F), glycoprotein (G), matrix protein (M), nucleocapsid (N), phosphoprotein (P), and polymerase protein (L) (Figure 1). The phosphoprotein (P) gene serves a critical function in generating various accessory proteins, namely C, V, and W. Among these, the C protein plays a pivotal role in regulating viral RNA synthesis and contributing to the virus's virulence. On the other hand, the V and W proteins are essential for enhancing virulence, as they actively inhibit the activation of an interferon-inducible promoter, as elucidated (Harcourt *et al.,* 2005).

Pathogenesis of Nipha virus

NiV gains entry into human and other animal hosts through the oropharynx, where it infects respiratory epithelial cells. In the body, high levels of viral antigen are present in lymphoid and respiratory tissues (Clayton *et al.,* 2016). The virus initially spreads throughout the body during the early viremia phase, with subsequent replication occurring primarily in endothelial cells. The initiation of infection hinges on the interaction between the viral G protein and cellular receptors known as ephrin-B2 and -B3 (Xu *et al.,* 2008). These receptors, which are highly conserved, facilitate the virus's rapid dissemination to various organs within the first week, accounting for its broad tissue tropism.

Additionally, although NiV's replication in immune cells is not efficient, it can still infiltrate the central nervous system through immune cells like immature dendritic cells and monocytic cells (Tiong *et al.,* 2018). Infected immune cells can breach the blood-brain barrier, selectively infecting vulnerable cells, a process akin to neuronal infection. This leads to the development of focal brain lesions in infected patients (Liu *et al.,* 2109).

Infection control

Infection control measures encompass a range of practices aimed at preventing the transmission of Nipah virus within healthcare settings and communities. These measures include strict isolation protocols, the use of personal protective equipment (PPE), and adherence to rigorous hygiene standards.

Outbreak prevention

Preventing Nipah virus outbreaks involves a combination of strategies, such as restricting the consumption of fruits potentially contaminated by bats, implementing animal surveillance programs, and educating communities about the risks associated with bat exposure.

Zoonotic transmission

Nipah virus has a zoonotic origin, with fruit bats, particularly Pteropus bats, serving as natural reservoirs (Figure 2). Understanding the dynamics of zoonotic transmission is crucial for developing effective prevention strategies (Hughes *et al.,* 2009; Nikolay *et al.,* 2019; Rahman *et al.,* 2020).

Symptoms

Nipah virus infection can manifest with a broad spectrum of clinical symptoms, ranging in severity from mild to severe. Extensive sero-surveillance studies have revealed a notable occurrence of asymptomatic Nipah infections. The primary hallmark of NiV infection is the development of an encephalitic condition characterized by fever and neurological manifestations, such as headaches. The commonly observed fever is often accompanied by symptoms like vomiting, dizziness, abnormalities related to the brainstem, and weakened or absent reflexes. Respiratory symptoms like cough, nasal congestion, and shortness of breath are also frequently encountered. Additionally, individuals with NiV infection may experience gastrointestinal issues such as constipation, gastritis, diarrhea, and abdominal pain. It is important to note that the intensity and prevalence of these symptoms can vary in different outbreaks and geographical regions, as observed in various studies, including one (Sharma *et al.,* 2019).

Surveillance

Surveillance systems play a pivotal role in early detection and response to Nipah virus outbreaks. Monitoring bat populations, conducting serosurveys in human and animal populations, and establishing sentinel surveillance in healthcare facilities are essential components.

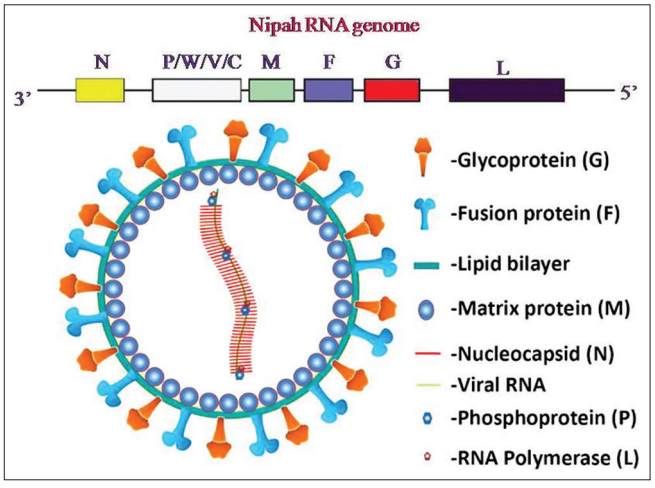

Figure 1: Representation of Nipah virus (NiV) structure (Pillai *et al.,* 2020).

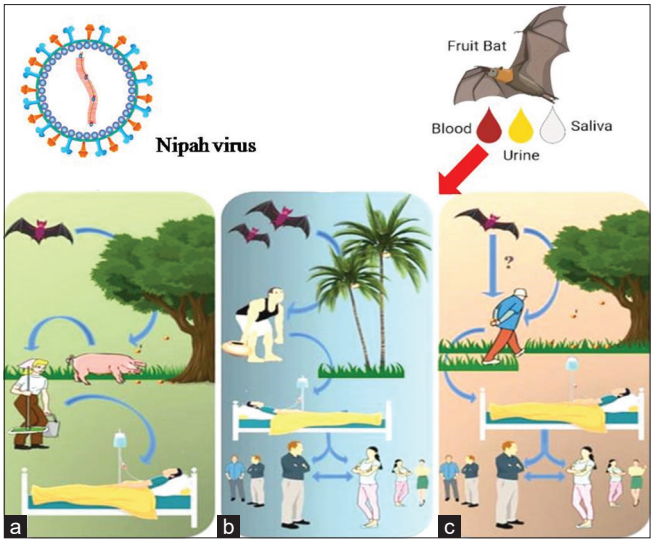

Figure 2: (a-c) Routes of NiV transmission (Pillai *et al.,* 2020).

Diagnosis

Timely and accurate diagnosis of Nipah virus infections is critical for patient management and outbreak containment. Diagnostic methods include PCR-based assays, serological tests, and virus isolation from clinical samples.

Treatment strategies

While there is no specific antiviral treatment for Nipah virus, supportive care remains the mainstay of management. Experimental therapies and vaccines are being developed, with some showing promise in preclinical studies.

Public health interventions

Public health interventions encompass a wide range of activities, including risk communication, contact tracing, quarantine measures, and vaccination campaigns. These

interventions are essential for breaking the chain of transmission during outbreaks.

Epidemiology

Epidemiological studies provide insights into the patterns and determinants of Nipah virus transmission. Epidemiological data help inform public health responses and guide containment efforts.

Pteropus bats

Pteropus bats, also known as fruit bats or flying foxes, are the primary reservoirs of Nipah virus. Understanding the ecology and behavior of these bats is crucial for mitigating the risk of spillover events (Yob *et al.,* 2001; Islam *et al.,* 2016).

Nipah virus outbreaks worldwide

Nipah virus is a zoonotic pathogen that primarily emerges in South and Southeast Asia. These outbreaks are sporadic but have been associated with significant morbidity and mortality. Here are some notable outbreaks: Malaysia 1998-1999: The first recognized outbreak of Nipah virus occurred in Malaysia in 1998-1999. This outbreak was linked to pigs, which were amplifying the virus. It resulted in human cases with a high mortality rate (Chua, 2003). Bangladesh: Bangladesh has experienced multiple Nipah virus outbreaks since the early 2000s. These outbreaks are often associated with the consumption of date palm sap contaminated with urine or saliva from infected fruit bats (*Pteropus spp.*).

Nipah virus outbreaks in India

India has also faced Nipah virus outbreaks, with notable occurrences in the state of Kerala:-Kerala 2018: The Nipah virus outbreak in Kerala in 2018 gained widespread attention. It resulted in several fatalities and raised concerns due to the virus's high mortality rate. Strict control measures were implemented, including contact tracing, quarantine, and public awareness campaigns (WHO, 2018a, b). Kerala 2019: In June 2019, another Nipah virus outbreak was reported in Kerala. Quick action by health authorities, informed by lessons learned from the 2018 outbreak, helped contain the virus's spread. The outbreak was relatively smaller in scale compared to 2018. Kerala 2021: In September 2021, a Nipah virus outbreak was reported in Kerala's Kozhikode district. Authorities swiftly enacted response measures, including contact tracing and isolating cases, to prevent further transmission. Nipah virus has a fatality rate between 40% and 75% depending on the strain (Conroy, 2023). Nipah virus outbreaks in India are often associated with fruit bats, which serve as natural reservoirs for the virus. Efforts have been made to educate the public about preventive measures, such as avoiding the consumption of raw date palm sap and practicing good hygiene.

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