Nipah, A Tiny Virus- Big Threat

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***Abstract*—Nipah virus (NiV) is a highly pathogenic, zoonotic virus belonging to the Henipavirus genus of the Paramyxoviridae family, responsible for severe respiratory illness and fatal encephalitis in humans. First identified during outbreaks among pig farmers in Malaysia and Singapore in 1998–1999, Nipah virus has since caused recurrent outbreaks across South and Southeast Asia, including India, Bangladesh, Malaysia, Singapore, and the Philippines. In India, major outbreaks were reported in West Bengal (2001, 2007) and Kerala (2018, 2025), with high case fatality rates.**

Fruit bats (Pteropus species) serve as the natural reservoir, with pigs acting as intermediate hosts. Human infection occurs through contact with infected animals, contaminated food (such as raw date palm sap or fruits), or through person-to-person transmission. The virus demonstrates significant environmental stability under favorable conditions, enhancing its transmission potential. Pathogenesis involves respiratory epithelial invasion, systemic viremia, and neuroinvasion, leading to acute respiratory distress syndrome (ARDS), encephalitis, and multiorgan failure.

Clinical manifestations range from mild febrile illness to severe neurological and respiratory disease. Diagnosis relies on high-containment laboratory testing using RT-PCR, ELISA, immunohistochemistry, and viral isolation. Currently, no specific antiviral therapy or licensed vaccine exists, and management remains primarily supportive. Preventive strategies, including public awareness, infection control measures, and safe food practices, are essential to reduce transmission and mitigate future outbreaks.

***Keywords*— Nipah virus, Zoonotic infection. Encephalitis, Acute respiratory distress syndrome (ARDS) Outbreak prevention**

NIPAH, A tiny Virus: Big threat

- NIPAH is a tiny virus causes broad range of suffering of human responsible for mild fever like sign & fever, headache, sore throat, cough to serious respiratory distress (atypical pneumonia, acute respiratory distress) and life-threatening encephalitis responsible for confusion, seizures coma, and often death, with a high fatality rate.
- Virus is extremely lethal. Killing 4 to 7 people out of 10 who contact it (40% to 75%) [1]. Rate may vary due to epidemiological management and case management.
- Transmission of virus zoontically to humans directly through contact of infected animals (such as bats or pigs), or through body fluid or droplets of infected person and indirectly consuming tainted foods from infected animals
- As a zoonotic virus, Nipah originates in the Pteropodidae family of Fruit bats often called flying foxes,its natural carrier, but can jump to humans.
- No available treatment and vaccine is available for animals and humans.Emphasis given on supportive care.
- In 2018, the WHO included priority diseases with pandemic potential and recommended the need for research and development on Nipah virus.

History of infection:

Recently 2025, July Kerala, India, Nipah virus(NiV) outbreak is reported after the death of 14 years old boy.[2]

First outbreak of Nipah virus reported in Malaysia and Singapore (1998-1999) highlighted animal to human transmission and affecting pig farmers in Singapore.[1] First case recognized in India in 2001.[1] Total human cases identified 749 across five countries: Bangladesh, India, Malaysia, Singapore, and the Philippines.[3]The Name Nipah comes after Sungai Nipah village in Malaysia where pig farmers become infected.[4]

Types of Virus:

- Classification: It is a highly pathogenic, negative-sense single-stranded RNA virus.
- Family/Genus: Classified within the *Paramyxoviridae* family, *Henipavirus* genus.

 Characteristics: It is a zoonotic pathogen closely related to the Hendra virus, sharing similar structure and high virulence. Nipah virus is an enveloped paramyxovirus with negative-stranded polarity and a non-segmented RNA genome, packaged in helical nucleocapsids. NiV differs little from a typical paramyxovirus. It has reticular cytoplasmic inclusions near the endoplasmic reticulum, unlike other paramyxoviruses. NiV is larger than typical paramyxoviruses.[5]
 Host and Disease: It primarily originates in fruit bats (genus *Pteropus*), causes severe respiratory and neurological disease in pigs (as an intermediate host), and leads to acute, often fatal, respiratory infections and encephalitis in humans.
 Pathogenicity: It is a BSL-4 pathogen with a high case fatality rate

In some fruit juices or in mango fruit, Nipah virus remain survive for up to 3 days and for in artificial date palm sap upto 7days(13% sucrose and 0.21% BSA in water, pH 7.0) kept at 22 °C. Half-life of virus is 18 h in the urine of fruit bats and stable in the environment, and remain survive upto 70 °C for 1 h (only the viral concentration will be reduced). It can be completely thermally inactivated at 100 °C for 15 minutes.[6] The viability of the virus vary according to the environment. Soaps, detergents and commercially available disinfectants i.e.sodium hypochlorite can inactivated the virus .[7]

How Virus Causes disease:
The First outbreak of Nipah Virus was in Malaysia initially thought as Japanese Encephalitis. After further investigation, it would confirm as Nipah virus.[8]The second outbreak reported in Taherpur district Bangladesh due to intake of date palm sap contaminated with bat's saliva of and faecal matter and in Siliguri district West Bengal in 2001 with mostly hospital acquired or both direct and indirect touch to infected person and in 2007, However Nadia,West Bengal experienced repeated flare up of this disease.[9] Recently, in 2018 and 2025, Kozhikode district of Kerala drew attention for NiV outbreak. Reported NiV causes due to contact from fruit-eating bats.[9]
Several species of domestic animals, including pigs, horses, dogs and cats may infected by Nipah virus.[10] Main features respiratory infections and, occasionally, neurological signs in pigs.[4] During first attack Malaysia and Singapore in the 1990s, close contact with infected pigs were the main cause. Since then, NiV in humans have occurred through contact with other infected individuals or via exposure to infected bats. Nipah virus infection in humans presents with a range of clinical manifestations, from asymptomatic infection to acute respiratory signs and fatal encephalitis.[4]

Pathophysiology:

Exposure to Nipah virus
↓
Entry through respiratory tract
↓
Infection of epithelial cells (bronchi and pneumocytes)
↓
Viral replication in airway cells
↓
Release of inflammatory cytokines(Interleukins, G-CSF, other mediators)
↓
Excessive immune response
↓
Acute lung injury
↓
Acute Respiratory Distress Syndrome (ARDS)[11]
↓
Viremia (virus enters bloodstream)
↓
Dissemination to organs(lungs → spleen → kidneys → brain)
↓
Crossing of blood–brain barrier
↓
Central nervous system involvement (encephalitis)
↓
Multi-organ dysfunction[5]
↓
Severe disease / death

Clinical features
Disease appear its sign symptoms after infection within 4 days to 2 months in Malaysian outbreak, whereas in Bangladesh it was 10 days,in Kerala within 6–14 days with a median of 9.5 days.[12]
Most typical clinical features are fever with encephalitis and or respiratory involvement.[7]
Non specific sign includes fever (100%), altered sensorium (84.2%), tachycardia (63.1%), hypertension (36.8%), segmental myoclonus (15.7%), segmental sweating (15.7%) and shortness of breath (73.6%) were common features. Mean

duration of illness was 6.4 day[12]. Severe, headache, dizziness, myalgia, vomiting and loose stools is documented in various outbreaks of Nipah. 55% patient reported reduced level of consciousness and prominent brain-stem dysfunction.[05]

Specific sign includes segmental myoclonus,areflexia, hypotonia, hypertension, and tachycardia suggesting the involvement of central and peripheral nervous system upper part of spinal cord.Critical injury to part of central nervous system leading to involuntary action malfunction manifested by doll's eye reflex,vasomotor changes and myoclonic jerks. Nipah encephalitis may present with relapse after months to year after recovery

Psychological and neurological complications are common when one can suffer for weeks or months after initial infection. This post –acute sequelae (PACS) can manifests by depression, personality changes, and deficits in attention, verbal, and or visual memory.

Studies documented that 55% to 66% were diagnosed as ARDS during the Malaysian outbreak. In 2001 Nipah virus outbreak in Siliguri reported significant cases (54%) in later stages were experienced severe respiratory symptoms.[13]

Diagnosis

- Due to high mortality rate associated with the disease early diagnosis and treatment is critical part of the disesse. To facilitate different specimen collected like from nose and throat swab and specimen from , blood, urine and cerebrospinal fluid
- Organs from dead animals such as lung, spleen and kidneys are used to diagone the virus.
- All diagnostic work is done with high security laboratories (BSL 3 or BSL4) because NIV is very dangerous. (BSL 3 BIO Safety Level 3 labs deals life threatening , potentially lethal airborne pathogens (like Mycobacterium tuberculosis, SARS-CoV-2, West Nile virus) with restricted access, negative air pressure, and personal PPE. BSL-4 (Biosafety Level 4) labs are the highest level, working with extremely dangerous, exotic, often fatal agents (like Ebola, Marburg viruses) requiring maximum containment, including full-body positive-pressure suits and separate facilities, building on BSL-3's strict protocols for total decontamination and isolation
- Molecular tests, serological tests, immunohistochemistry, histopathology, virus isolation, and neutralisation tests are used to confirm the test.
- Most sensitive test for diagnosis is RT-PCR which detect the virus gene.It is expensive and reduce efficiency if virus mutates.
- Next-generation sequencing (NGS) another method to identify different viral strains, but it is costly and not routinely used for diagnosis.
- Immunohistochemistry is a safer method as it uses formalin-fixed tissues.
- ELISA is frequently used to identify viral antigens or antibodies in blood and is confirmed by PCR or neutralisation tests.
- Virus isolation is possible using Vero cells (Vero cells are a lineage of cells used in cell cultures. wikipedia), but it is limited to BSL-4 laboratories.

Treatment:

Supportive therapy for Nipah virus (NiV) infection focuses on managing symptoms and complications, as there are no licensed vaccines or specific antiviral treatments currently available for human use

Treatment during past outbreaks involved supportive care measures to address specific symptoms:

- Antivirals: Broad-spectrum antiviral medications like ribavirin and acyclovir were used during earlier outbreaks, primarily as off-label, empirical treatments. One observational study suggested ribavirin might reduce mortality, but its effectiveness has not been definitively proven in controlled trials.
- Complication Management: Patients receive supportive therapies tailored to their condition:
    - Deep vein thrombosis (DVT): Medications or other interventions are provided to prevent blood clots.
    - Seizures: Anticonvulsive medications are administered to manage seizures.
    - Respiratory failure: Mechanical ventilation may be necessary for patients experiencing severe respiratory distress.

Early identification and prompt, aggressive supportive care remain crucial for increasing patient survival rates and managing the severe symptoms of NiV infection.

Prevention and Control:

Areas where Nipah virus infection is reported

People should follow following guidelines

- ✓ Follow handwashing with soap and water
- ✓ Avoid contact with bats are known to roast
- ✓ Avoid eating or drinking products that could be contaminated with raw date palm sap,raw fruit, or fruit that is ground.
- ✓ Avoid contact with body fluid of known cases
- ✓ Raising awareness within people, professionals and following preventive measures .
- ✓ During care of Nipah virus affected person should follow standard infection control procedure, barrier nursing techniques to prevent hospital acquired infection.

CONCLUSIONS

Tiny virus causes a big threat to the global community causing high rate of morbidity and mortality eventually affecting economy of the area, state and country. Preparedness and proper awareness is the key to control the disease. Authorities and Government should control any sporadic outbreak.

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