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REVIEW ARTICLE

Nipah Virus in India and Malaysia: A Comparative Review of Outbreaks, Transmission, and Public Health Response

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Abstract

This review article, Nipah virus (NiV) is a recently emerging a disease-causing germ that can spread from animals to humans, which is part of the Henipavirus genus, which is a health concern due to high transmission rate and ability to infect both animals and humans case deadly pathogen is particularly dangerous due to its high fatality rate and ability to spread between humans.This review gives an overview of the epidemiology, transmission dynamics, clinical features, diagnostic methods, therapeutic approaches, and preventive measures applicable to NiV infections. The virus is acquired primarily from Pteropus fruit bats, and this dangerous pathogen spreads through multiple routes: direct contact with infected animals, consumption of contaminated food, or transmission between humans. Outbreaks have occurred in Malaysia, India, Bangladesh, and the Philippines, with different case fatality rates ranging from 40% to 75%. Respiratory distress, encephalitis, and multi-organ failure are the clinical features of NiV infection, which in survivors result in long-term neurological sequelae. The current diagnostic methods primarily use real-time polymerase chain reaction (RT-PCR) and serological methods, while experimental vaccine candidates and monoclonal antibody treatment are under investigation. Public health interventions, such as surveillance, quarantine, and community education programs, are imperative to contain outbreaks. Despite the current research activities, there is no available antiviral treatment at present, and this highlights the necessity of continued efforts in vaccine development and outbreak preparedness. This review consolidates existing information about NiV, highlights the gaps in current research, and discusses future research directions in the management and prevention of Further cases.

Keywords: Nipah Virus, Zoonotic Disease, Transmission, Diagnosis, Treatment, Prevention, Malaysia ,India.

INTRODUCTION

Nipah virus (NiV) is a highly zoonotic paramyxovirus belonging to the Henipavirus genus of the Paramyxoviridae family[1][2]. It is ranked as a priority pathogen by the World Health Organization (WHO) because it has a high mortality rate, can be transmitted from human to human, and there are no approved vaccines or antiviral drugs [2]. The virus was first detected in 1998-1999 in Malaysia and has since then produced several outbreaks, especially in South and Southeast Asia[3]

NiV virus is a viral infection transmitted from bats, where its natural host is fruit bats belonging to the genus Pteropus. Its transmission occurs along different routes such as:Transmission directly from bats (via saliva, urine, feces, or food carriers like date palm sap).Transstadial animal-to-human (as reported from Malaysia, when pigs served as amplifying hosts).Human-to-human (transmitted in India and Bangladesh mostly by direct exposure to body secretions).Infected patients can develop mild febrile illness or advance to severe encephalitis and respiratory distress, usually leading to death. Due to the lack of specific therapies, early detection and containment are essential [4].

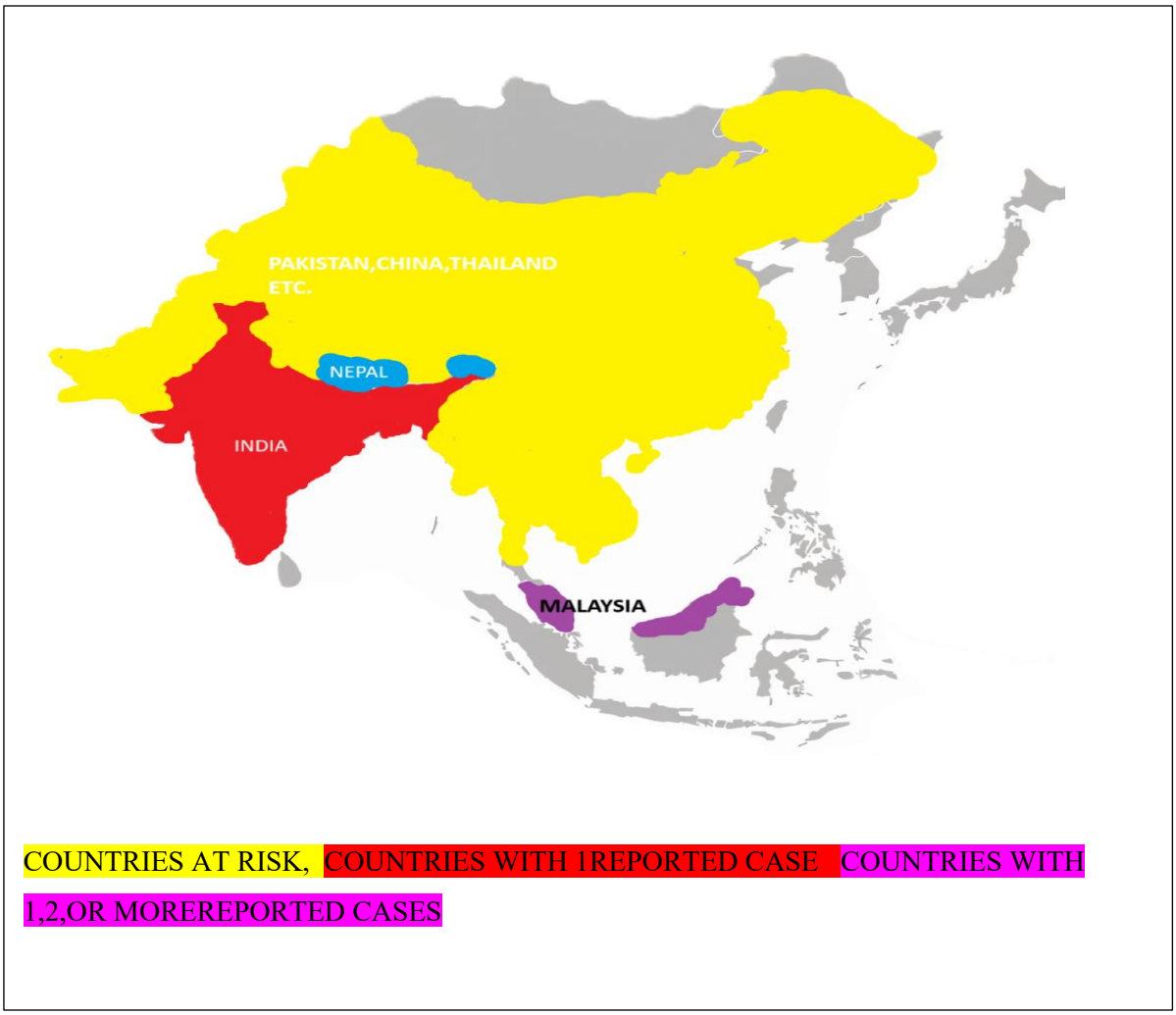

Fig. 1: Global Distribution of Nipah Virus Outbreaks[2][4]

Worldwide Overview of Nipah Virus Outbreaks

While India and Malaysia are the most important areas of interest, Nipah virus outbreaks have also been documented in Bangladesh[5][6], the Philippines, and Cambodia, which points to its wider epidemiological significance:Malaysia (1998-1999): The initial identified NiV outbreak was by pig-to-human transmission, which resulted in more than 265 human cases and 105 fatalities. Sustained rapid containment through mass culling of pigs was able to prevent subsequent outbreaks.Bangladesh (2001-present): There have been nearly yearly outbreaks in the country, with human-to-human transmission dominating. The majority of cases were attributed to consumption of date palm sap contaminated with NiV.India (2001-present): In contrast to Malaysia, Indian outbreaks are associated with direct transmission from bats to humans and onward transmission between humans, resulting in high fatality rates.Philippines (2014): The first confirmed NiV outbreak outside South Asia occurred in Sultan Kudarat due to infected horses.Cambodia (Potential Reservoirs Identified): No human cases have yet been reported in Cambodia, but fruit bats were found to harbor NiV, suggesting a risk of future spillover events.Although the virus is still endemic in some places, enhanced worldwide mobility, woodland clearing, and global warming potentially could lead its spread to more areas, accentuating the justification for international monitoring[6].

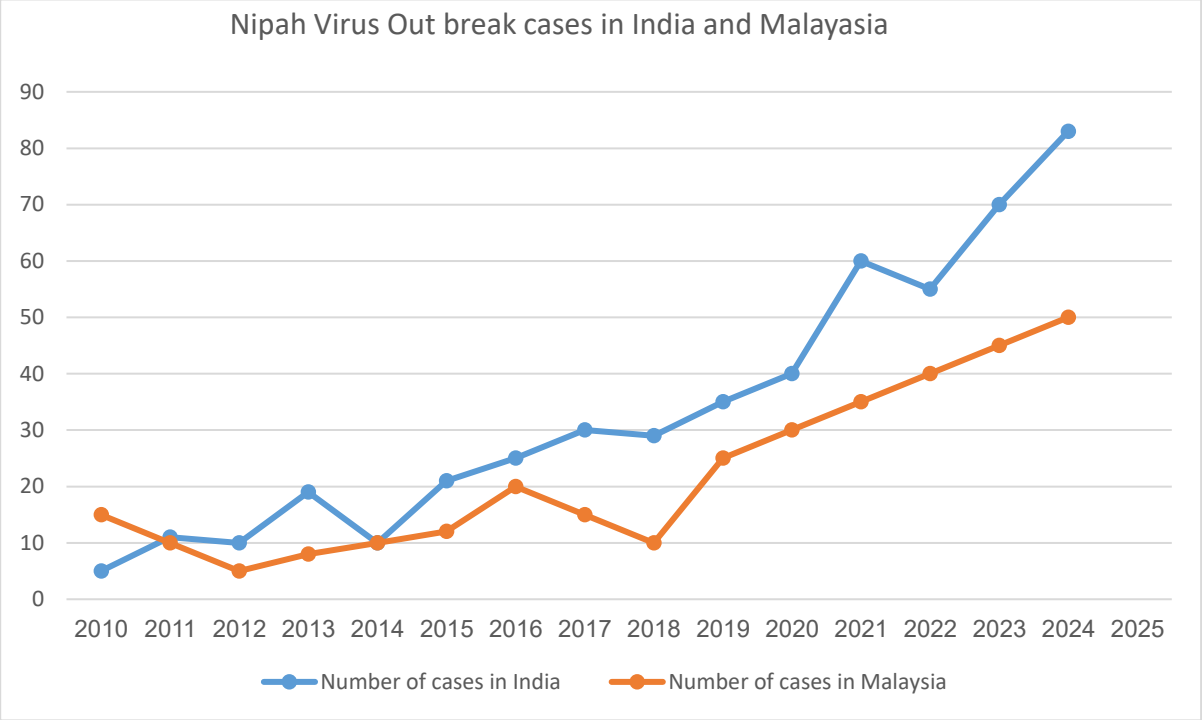

Fig. 2: Nipah Virus Outbreak Cases in India and Malaysia (2010-2024). This graph shows the upward trend of NiV cases over the years[6].

Early Identification and Outbreaks in Malaysia (1998-1999)

The initial Nipah virus outbreak was reported in Malaysia, between September 1998 and May 1999, among pig farmers and abattoir workers in Ipoh (Perak) and Port Dickson (Negeri Sembilan). The disease spread by respiratory droplets from infected pigs to humans, causing severe encephalitis[7].

Epidemiological Impact:265 laboratory-confirmed human cases and 105 fatalities (CFR: ~40%).The outbreak extended to Singapore, infecting 11 abattoir workers, one of whom died.

Containment Measures: The culling of more than one million pigs successfully eradicated the virus.Tight biosecurity measures were enforced, and no further outbreaks occurred.

Malaysia's rapid response guaranteed no follow-up outbreaks, making it a successful case study in zoonotic disease control through agricultural intervention.[8]

Repeated Outbreaks in India (2001-Present): India has seen repeated NiV outbreaks, with Kerala being a hot spot for repeated occurrences since 2018. In contrast to Malaysia, where pig culling terminated the outbreak, India's routes of bat-to-human and human-to-human transmission make containment difficult.

Significant outbreaks are as follows:

- 2001 (Siliguri, West Bengal): 66 cases, 45 fatalities (CFR: ~68%).
- 2007 (Nadia, West Bengal): Five cases, all fatal (CFR: 100%).
- 2018 (Kerala - Kozhikode & Malappuram): 19 cases, 17 fatalities (CFR: 89%).
- 2019 (Kerala - Ernakulam): One case confirmed, no fatalities.
- 2021 (Kerala - Kozhikode): One case confirmed, one fatality.
- 2023 (Kerala - Kozhikode): Six cases confirmed, two fatalities.

In contrast to Malaysia, where the outbreak was contained by managing livestock, India uses medical surveillance, quarantine, and genome sequencing to monitor and contain outbreaks. Kerala's model of response has been commended for its swift containment measures, even in the face of human-to-human transmission[9].

Why India and Malaysia Are Key Regions of Focus:India and Malaysia offer two contrasting case studies of NiV outbreaks, providing useful insights into zoonotic spillover, transmission dynamics, and public health responses:

Alternative Transmission Routes:

- Malaysia (1998-1999): Pig-to-human transmission (controlled by animal culling).
- India (2001-present): Direct bat-to-human and human-to-human transmission (demanding complex containment measures).

Public Health Responses: Malaysia's response was agriculture-based, with mass pig culling and farm closures.India's reaction is dependent on clinical measures such as contact tracing, quarantine, virology analysis, and WHO collaboration.

Recurrence & Risk Factors: Since 1999, Malaysia has been free from any outbreaks, but India has ongoing outbreaks at intervals in Kerala.The prevalence of Pteropus bats in both countries implies continued re-emergence risk.

Global Implications: As a zoonotic virus of pandemic potential, NiV calls for enhanced surveillance, vaccine development, and inter-country collaborations to ensure future outbreak prevention.One Health strategy, through the convergence of veterinary, medical, and environmental research, plays a pivotal role in the containment of Nipah and emerging zoonoses[10].

Comparative Analysis Need:

Compared to the successful eradication in Malaysia against India's on-going containment debacle, this work seeks to:Compare outbreak patterns and transmission modalities in Malaysia and India.Assess effectiveness of public health interventions (agrarian vs. medical strategies).Determine loopholes in surveillance and preparedness to prevent on-going outbreaks.Offer suggestions for an international strategy for managing Nipah virus and other emerging diseases.Knowledge about these factors is critical to building pandemic preparedness, particularly because human-wildlife contact grows with deforestation, urbanization, and global warming[11].

Epidemiology and Transmission: Knowledge of the epidemiology and dynamics of transmission of the Nipah virus (NiV) is essential to the successful implementation of containment policies. The virus has shown unique patterns of outbreaks in Malaysia and India, determined by primary host species, modes of transmission, and response from governments. This section offers a comparative overview of outbreaks in Malaysia and India.

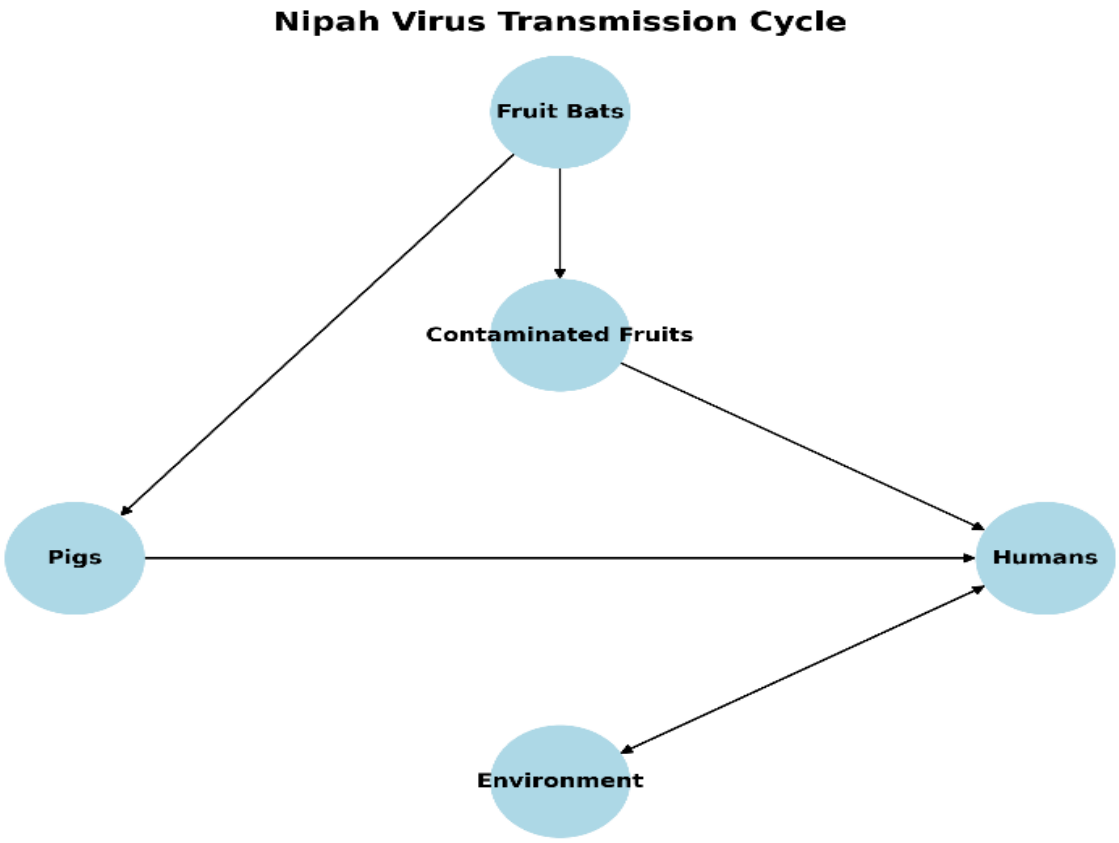

Fig. 3: Nipah Virus Transmission Cycle[9][10][11]

Nipah Virus in Malaysia

The initial outbreak of Nipah virus was reported in Malaysia in 1998-1999 among pig farmers in Ipoh and Negeri Sembilan. The source of the outbreak was traced to:Infected pig-to-pig transmission: Amplification of the virus took place in commercial pig farms, where infected pigs showed respiratory complications and neurological signs[12].Bat-to-pig spillover: Fruit bats (Pteropus species) were found to be the natural reservoir, which infected pig enclosures through saliva, urine, and partially consumed fruits[13].Restricted human-to-human transmission: In contrast to subsequent outbreaks in India, the transmission in Malaysia was predominantly zoonotic (animal-to-man) and very few cases of person-to-person spread were reported[14].

Containment Measures: Mass slaughtering of infected pigs (~1.1 million pigs were killed).Closure of farms and prohibition of the transportation of pigs to stop the spread.Tight biosecurity measures were implemented, and further outbreaks in Malaysia ceased after 1999.

Nipah Virus in India (Kerala): Unlike Malaysia, India has seen several Nipah virus epidemics since 2001, but with a distinct pattern of transmission. Its most severe epdemic breaks happened in:West Bengal (2001, 2007) and Kerala (2018, 2019, 2021, 2023).

Key Factors in Transmission of NiV in India: Transmission between humans: Contrary to Malaysia, in India, NiV has been associated with continuing person-to-person spread, which mainly occurred between caregivers and within healthcare facilities.Direct bat-to-human spillover: Outbreaks were attributed to the ingestion of date palm sap with fruit bat contamination, especially in West Bengal[14].High mortality rates: The Indian case fatality rate (CFR) is 65-90%, much higher compared to Malaysia[15].

Indian Containment Measures: Stringent isolation and quarantine of affected patients.

- Surveillance and contact tracing for monitoring possible spread.
- Early detection through genome sequencing and virology tests.

Table 1: Comparison of Nipah Virus Transmission Patterns in Malaysia and India[16]

Factor	**Malaysia (1998-1999)**	**India (2001–Present)**
Primary Transmission	Pig-to-human	Human-to-human & bat-to-human
Reservoir Host	Fruit bats (Pteropus)	Fruit bats (Pteropus)
Amplifying Host	Pigs	None
Human Fatality Rate	~40%	65-90%
Key Containment Strategy	Pig culling & farm closures	Quarantine, contact tracing, and hospital infection control

Perspective on the World Beyond India and Malaysia, other countries have reported sporadic Nipah virus cases:Bat-contaminated date palm sap has caused frequent outbreaks in Bangladesh from 2001 to the present.[17][18] The Philippines (2014): A small outbreak linked to horse exposure.In Thailand and Cambodia, there is serological evidence of NiV in bats but no human cases have been recorded. The epidemiology of Nipah virus differs significantly between Malaysia and India, with Malaysia's outbreak being more zoonotic (pig-related) and India experiencing direct bat-to-human and human-to-human transmission. Understanding these variations is crucial for tailoring public health responses in different regions.

Clinical Manifestations and Diagnosis: Nipah virus (NiV) infection has a wide range of clinical manifestations from mild, self-limiting febrile illness to severe, life-threatening encephalitis and acute respiratory distress syndrome (ARDS)[19][20].Knowledge of the clinical course of NiV in infected individuals and the diagnostic methods employed to identify the virus is important for early treatment and control.

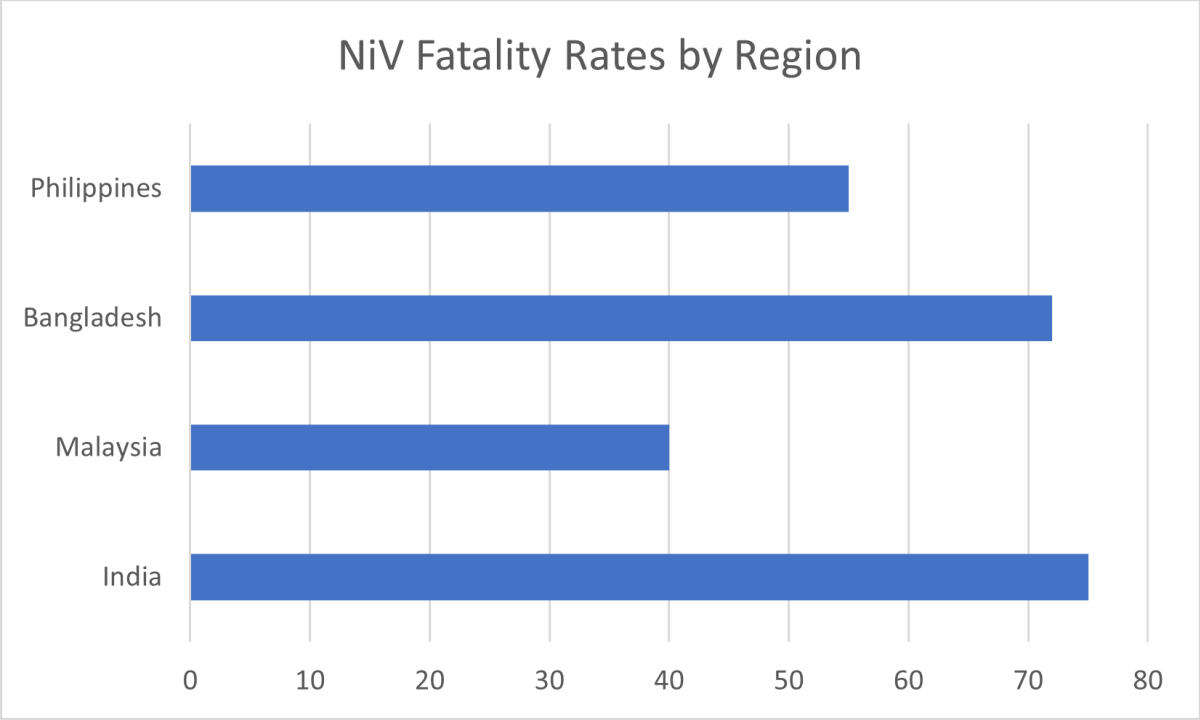

Fig. 4: NiV Fatality Rates by Region [21][22][23]24]

Clinical Manifestations of Nipah Virus Infection

NiV infection can be divided into three principal clinical presentations:Asymptomatic or Mild Infection – Some patients can be infected but are asymptomatic or have mild flu-like illness, which makes surveillance difficult. Acute Febrile Illness – The majority of symptomatic cases initially manifest with[25][26].

- High fever
- Severe headache
- Myalgia (muscle pain)
- Sore throat
- Nausea and vomiting

Severe Disease (Neurological and Respiratory Symptoms) – In advanced cases, patients develop[27][28]:Acute encephalitis (inflammation of the brain) → confusion, dizziness, altered consciousness,Seizures and coma (within 24–48 hours in severe cases)Respiratory distress and pneumonia (more common in Bangladesh and India)[29].

Comparative Clinical Manifestations: Malaysia vs. India

The clinical presentation of NiV varies between Malaysia and India because of differences in modes of transmission:

Table 2, Comparative Clinical Manifestations: Malaysia vs India[30][27]

Clinical Feature	**Malaysia (1998-1999)**	**India (2001-Present)**
Primary Symptoms	Fever, headache, encephalitis	Fever, encephalitis, pneumonia
Human-to-Human Transmission	Rare	Common (hospital outbreaks)
Neurological Complications	Encephalitis in most cases[	Severe encephalitis & coma
Respiratory Symptoms	Less frequent	More common (ARDS, pneumonia)
Case Fatality Rate (CFR)	~40%	65-90%

The 1998-1999 Malaysian outbreak elicited mainly neurological symptoms (encephalitis) but with less respiratory involvement. Indian outbreaks (particularly in Kerala) exhibit greater pneumonia and respiratory distress rates, tending to cause human-to-human transmission in hospitals[31].

Risk of misdiagnosis: Symptoms of NiV are similar to Japanese encephalitis, malaria, and dengue, resulting in delayed intervention[32].

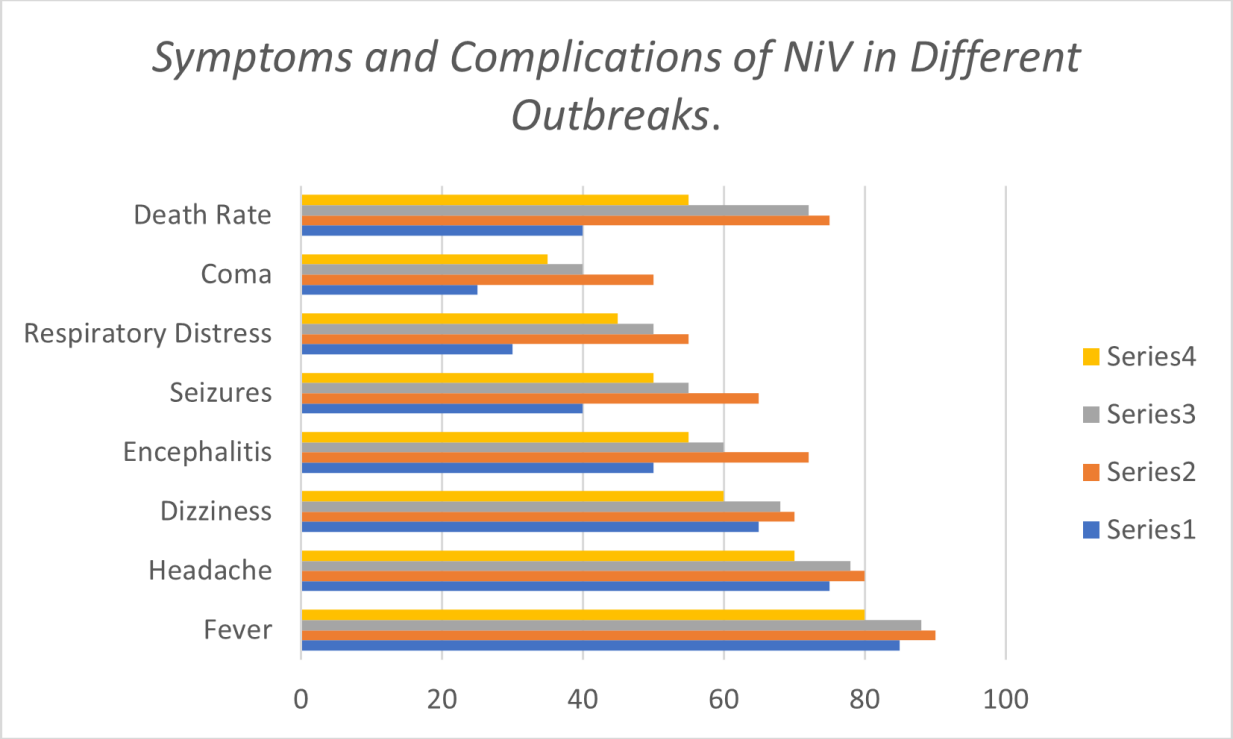

Fig. 5: Symptoms and Complications of NiV in Different Outbreaks[33][30][31]

Strategies for Prevention and Control for Public Health

To prevent secondary transmission, rapid and coordinated public health measures are required to control Nipah virus (NiV) outbreaks[34].Due to differences in transmission patterns, outbreak recurrence, and healthcare facilities, response strategies in Malaysia and Kerala, India, are quite distinct. The major public health interventions in both countries are described and evaluated in this section.

Malaysia's Public Health Response to the 1998-99 Outbreak

Agriculture-based rather than medical interventions were used to successfully contain Malaysia's 1998-1999 reported Nipah virus outbreak. The outbreak was eradicated by slaughtering infected livestock because the primary mode of transmission was between humans and infected pigs.

Major Methods of Containment: Large-scale pig slaughter:

To get rid of the infection, more than one million pigs were killed. Restrictions on livestock movement and farm closures: Infected farms were closed, and livestock movement was restricted. Biosecurity regulations

– Farm management and hygiene instruction were provided to farmers.

• There was no strict requirement for quarantine because human-to-human transmission was uncommon.

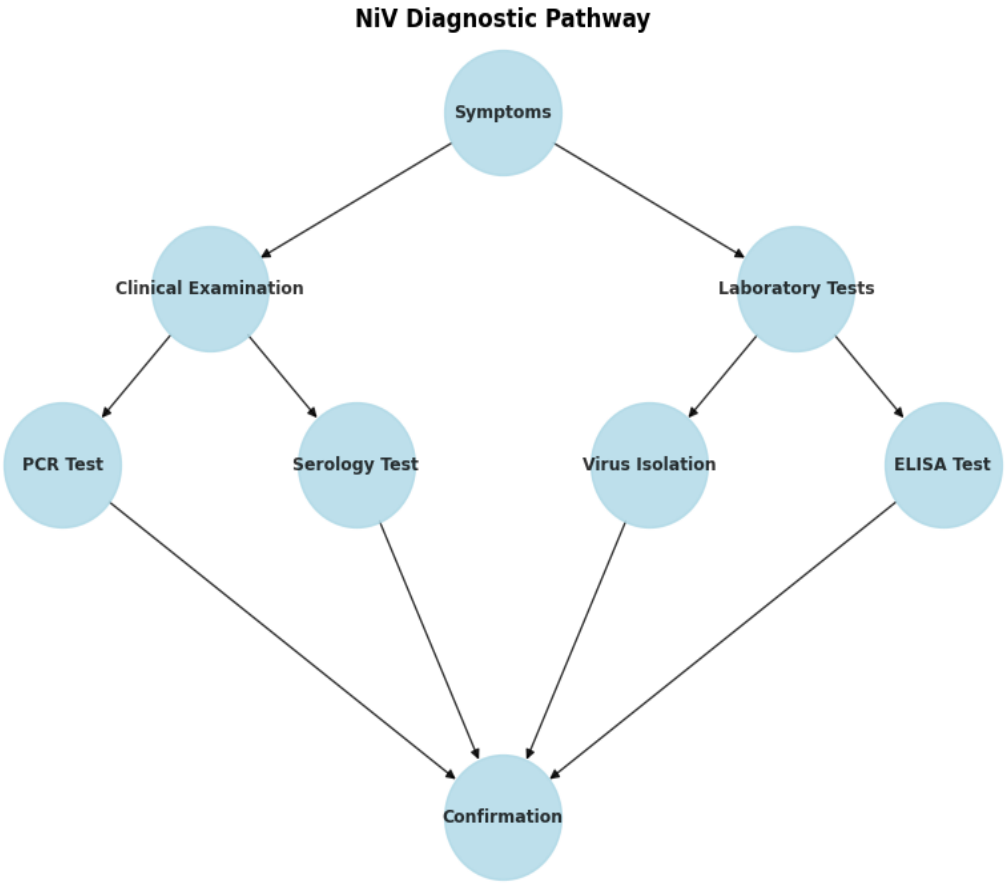

Fig. 6: NiV Diagnostic Pathway[35][32]

The Efficacy of Malaysia's Response: Rapid containment:

The outbreak was contained within a year, and no human cases were reported after that. Low human-to-human transmission: Instead of medical quarantine, containment efforts focused on livestock intervention[36].

Economic losses: The policy of mass culling resulted in significant losses for the pig farming industry.

Approaches to Public Health in India (Kerala, 2018–Present)

In contrast to Malaysia, outbreaks in India—particularly in Kerala—have been sporadic, necessitating a multifaceted public health response to control both direct bat-to-human transmission and human-to-human transmission [37].

Public awareness campaigns

Instruction in prevention for avoiding fruits that have bats living in them (particularly date palm sap). Advising people about early symptoms to encourage them to go to the hospital sooner. Global collaboration The World Health Organization (WHO) and the National Institute of Virology (NIV), Pune, offer technical assistance for outbreak management [38].

Table 5,Comparative Analysis of Malaysia and India's Containment Strategies[39][36]

Factor	**Malaysia (1998-1999)**	**India (Kerala, 2018-Present)**
Transmission Route	Pig-to-human	Bat-to-human & human-to-human
Main Containment Strategy	Mass pig culling	Human quarantine & contact tracing

Healthcare Response	Limited hospital cases	Dedicated NiV isolation wards
Testing Infrastructure	Basic diagnostic tests	Advanced RT-PCR, ELISA, and genome sequencing
Public Education Focus	Farm biosecurity	Hygiene, bat avoidance, and early reporting
Outcome	No further outbreaks	Recurring outbreaks in Kerala

Nipah Virus Containment Challenges: Even with enhanced public health response, there are still some challenges [37]:Delayed Case Detection: With non-specific initial symptoms, NiV cases tend to be diagnosed too late, raising mortality rates.Exposure of Healthcare Workers: NiV is easily transmitted in healthcare facilities, infecting doctors, nurses, and caregivers.Frequent Outbreaks in India: In contrast to Malaysia, India has frequent outbreaks, indicating ongoing spillover from bats.Limited Vaccine Availability: No approved vaccine, with prevention depending strongly on public health interventions.

Future Directions for Nipah Virus Preparedness

Vaccine Development: Various vaccine candidates (mRNA-based & vector-based) under preclinical and clinical trials [40][41].

- Early Detection Tools: Portable rapid NiV test development for use in remote rural settings.
- One Health Approach: Enhancing intersectoral collaboration between human, animal, and environmental health.
- Community Engagement: Raising education programs in bat-endemic areas to reduce human exposure.

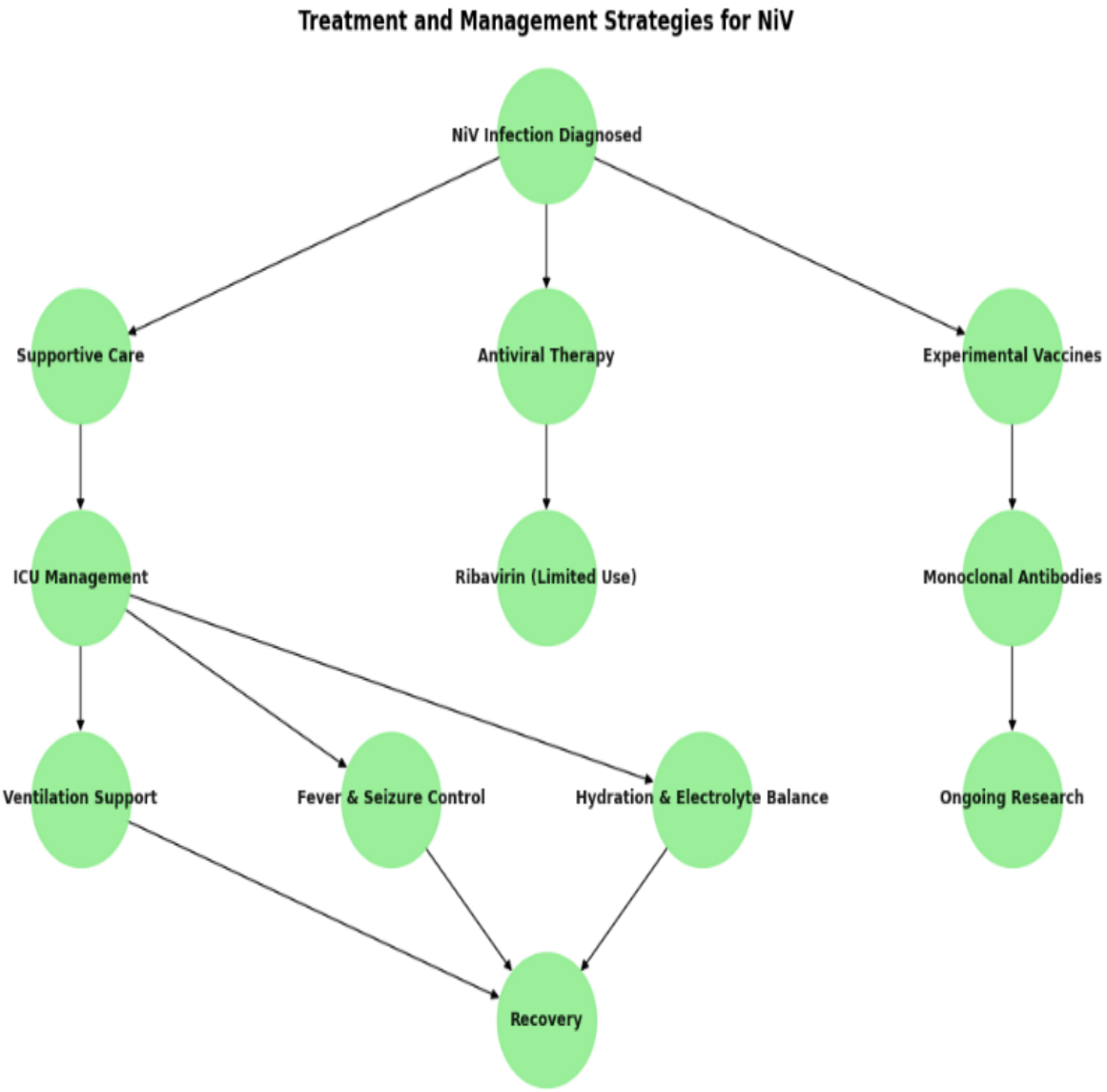

Fig. 7,Treatment and Management Strategies for NiV[42][39][40]

The comparison of Malaysia's and India's actions serves to point out the role of outbreak-specific measures in control. Malaysia managed to eradicate NiV with animal intervention, but India is tasked with having to constantly deal with human-to-human transmission via preparedness of hospitals and monitoring. As the disease reoccurs in Kerala, the reinforcement of diagnostic capacities, vaccine production, and education within communities will prove vital in cutting down future cases[43][44].

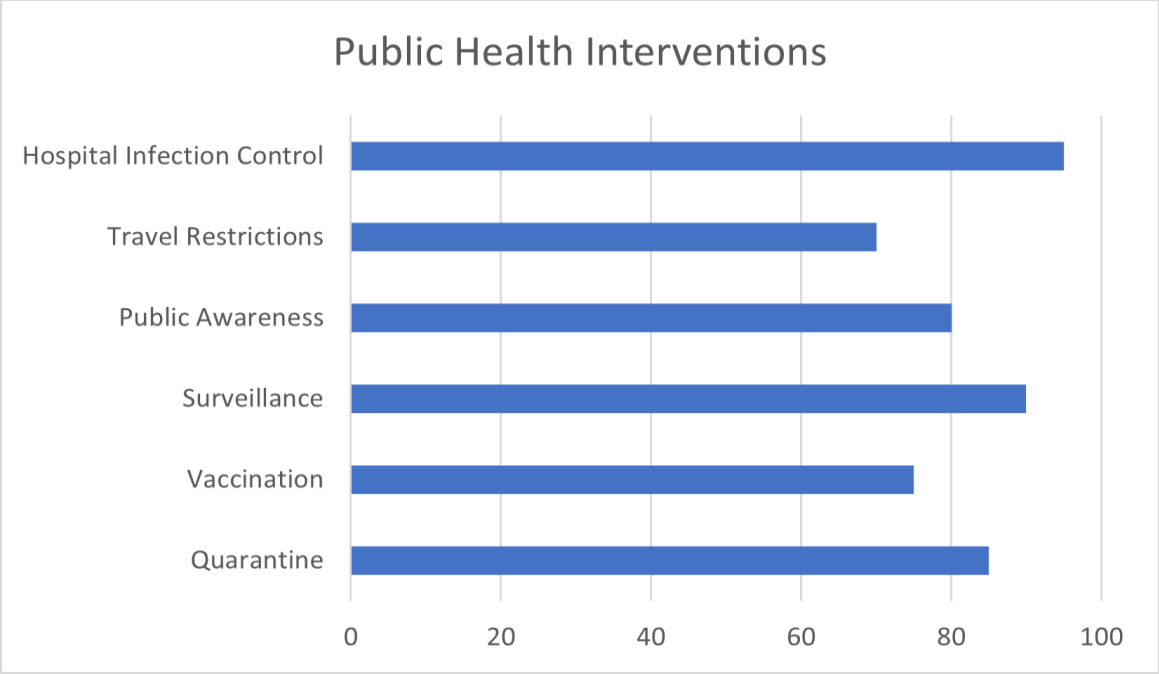

Fig. 8, Effectiveness of Public Health Interventions Against NiV[45][43][44]

Table 6, Regional Public Health Strategies for NiV Control[46] [42][43][44]

Region	**Quarantine Measures**	**Vaccination Campaigns**	**Surveillance Strategies**
India	Strict isolation and testing	Experimental vaccines	Contact tracing & testing
Malaysia	Targeted lockdowns	Pilot immunization trials	Thermal screening & alerts
Bangladesh	Home-based quarantine	Limited vaccine distribution	Enhanced hospital monitoring
Philippines	Airport screening & isolation	Ongoing vaccine research	Travel restrictions & surveillance

Limited Awareness and Risk Perception

- Risk groups (farmers, fruit pickers) are not necessarily aware of transmission risks of NiV.
- Raw date palm sap consumption persists in vast sections of India and Bangladesh, raising the risk of spillover.
- Religious and cultural beliefs tend to hinder isolation and quarantine measures.

Conclusion

Nipah virus (NiV) continues to be a significant public health concern, especially in South Asia and Southeast Asia, since frequent outbreaks in India and Bangladesh highlight its transmission capabilities in humans and high mortality rates. Although Malaysia eradicated the virus with livestock intervention, India continues to experience recurrent spillover episodes from fruit bats.This review has brought to the fore the epidemiology, transmission, clinical presentation, diagnostic difficulty, public health responses, and global preparedness for NiV. Comparative between in Malaysia, India, Bangladesh, and the Philippines, with different case fatality rates ranging from 40% to 75%. Respiratory distress, encephalitis, multi-organ failure and long-term neurological sequelae. In the future, a multidisciplinary solution encompassing vaccination, early diagnosis, outbreak prediction models, and international cooperation is required to prevent future outbreaks.

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