https://doi.org/10.46344/JBINO.2026.v15i03.02

NIPAH VIRUS (NIV): A HIGHLY FATAL ZOONOTIC PATHOGEN – A COMPREHENSIVE REVIEW

Dhoragolla Ashwith Kumar., B Naveen Kumar., Ramesh Alluri., G Shravani & K.Ramanjaneyulu

Department of pharmacology Assistant professor .,Vishnu institute of pharmaceutical education and Research (VIPER).

Principal Department of pharmacology Vishnu institute of pharmaceutical education and research (VIPER).

Assistant professor Department of Pharmaceutical chemistry VIPER

Associate professor &Hod,Department of Pharmaceutical chemistry ,VIPER

Corresponding Author : Dhoragolla Ashwith Kumar

ABSTRACT

Nipah virus (NiV) is one of the emerging zoonotic viruses and a member of the family Henipavirus, which is known for having a mortality rate between 40%-80%. This virus was first identified during an epidemic in Malaysia in 1998. Nipah virus continues to threaten human beings as there have been multiple episodes recorded in South and Southeast Asia. Fruit bats (genus Pteropus) act as the natural host to the virus, which may infect humans through contact with contaminated food products (such as date palm sap and fruits), either directly or indirectly, following contact with intermediary hosts such as pigs. Human-to-human transmission has also been reported.In terms of its clinical presentation, NiV infection is characterized by a wide range of manifestations, from mild febrile illness to fatal outcomes like ARDS and encephalitis. In most instances, the duration of the incubation period varies between 4 to 14 days; however, in some cases, it can even extend to 45 days. Pathogenesis involves a variety of vasculitis and neuronopathy coupled with a high level of inflammatory response through the production of cytokines like TNF-a and IL-1.Diagnosis primarily relies on laboratory techniques such as real-time polymerase chain reaction (RT-PCR) and enzyme-linked immunosorbent assay (ELISA). Currently, there is no approved antiviral treatment or licensed vaccine available for NiV infection, and clinical management is largely limited to supportive care, including intensive monitoring and symptomatic treatment.Due to the high case fatality rate, risk of human-to-human spread, and lack of any specific treatment modality, NiV has been categorized as a priority organism by various health organizations around the world. As far as preventive aspects are concerned, measures such as proper infection control practices, educating the masses about NiV, and avoiding exposure to high-risk situations play an important role in managing outbreaks. Research is still ongoing to develop an appropriate vaccine and drug against this deadly virus. The present review is designed to discuss all aspects of Nipah virus infection.

Key words : Nipah virus; zoonosis; Pteropus bats; transmission; encephalitis; ARDS; RT-PCR; ELISA; supportive care; outbreak control; emerging infections; One Health

1. Introduction

Nipah virus (NiV) is an emerging zoonotic virus that has recently become known for its high mortality and case fatality rate that has the potential to cause outbreaks with epidemic characteristics. The discovery of Nipah virus was made back in 1998 when the virus caused a fatal outbreak in Malaysia among the pig farmers and there was a huge loss of livestock through culling. The virus later emerged from time to time in countries like Bangladesh and India.

NiV is categorized under the genus Henipavirus of the family Paramyxoviridae and is similar to another zoonotic agent known as Hendra virus. The most worrying aspect of NiV is that it has a wide host range, it infects several species, and it can transmit directly from human to human. As compared to other viral diseases, one of the distinguishing characteristics of NiV infection is its tendency to cause rapid encephalitis and eventually death.

Fruit bats belonging to the genus Pteropus serve as natural reservoirs for the Nipah virus and do not show any signs of disease when infected. Outbreaks arise following exposure to a food item that may have been contaminated, including raw date palm juice and fruits that were partially chewed by the infected fruit bats. In some instances, domestic animals have acted as secondary amplifiers before causing infection in humans.

Yet another vital issue that arises here is the lack of an effective antiviral drug or vaccination that can be used in clinical practice. High fatality rates and the ability to spread from person to person have resulted in the classification of NiV by international health authorities as one of the pathogens whose study is needed immediately.

In view of all this information, Nipah virus poses a great and persistent threat to public health in countries where there is extensive contact between humans and animals.

2. Virology and Mode of Spread

- **2.1 Etiology**

Nipah virus (NiV) is an enveloped, negative-sense, single-stranded RNA virus classified under the family Paramyxoviridae and belongs to the genus Henipavirus. The genome of the virus codes for the necessary proteins both structural and non-structural, which are vital in the replication process. Among the key glycoproteins found on the surface of Nipah include the G and F proteins responsible for facilitating binding to host receptor sites and subsequent membrane fusion.

2.2 Natural Reservoir

The natural reservoirs for NiV are the Pteropus fruit bats, which are popularly referred to as flying foxes. Flying foxes are commonly found in South and Southeast Asia and act as asymptomatic carriers of the virus. Flying foxes shed the virus via their saliva, urine, and feces and therefore contribute to the contamination of their environment, including food products. This includes how these bats interact within their environment based on their behavior and feeding habits

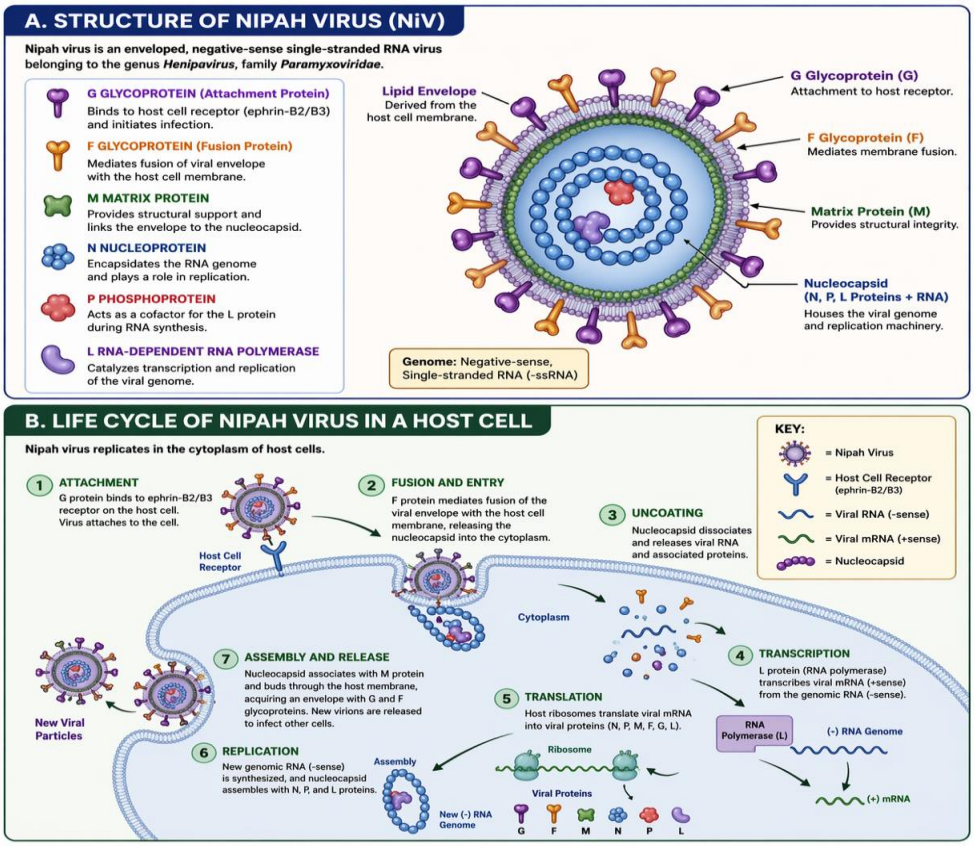
2.3 Methods of Transmission

The spread of NiV involves several routes, hence making it an intricate form of zoonotic disease:

- Zoonotic Transmission: Infection can occur when people consume fresh date palm sap or fruits that have been contaminated by excretory matter from bats. This form of transmission is common in areas where endemicity occurs and where food consumption practices involve the use of contaminated material.
- Animal to Human Transmission: Domesticated animals can be used as amplifying hosts to facilitate the transmission of the virus. For instance, pigs are known to play a critical role in amplifying the disease and can infect human beings through contact with contaminated body fluid or excretory matter.
- Human to Human Transmission: NiV can be transmitted directly from one person to another through physical contact with an infected individual. The transmission process usually involves direct contact with contaminated material or respiratory droplets.

Table: Summary of Nipah Virus Characteristics

Category	**Details**
Virus Type	Enveloped, negative-sense ssRNA virus
Genus/Family	*Henipavirus* / *Paramyxoviridae*
Natural Reservoir	*Pteropus* fruit bats
Transmission Routes	Zoonotic, animal-to-human, human-to-human
Incubation Period	4–14 days (up to 45 days)
Initial Symptoms	Fever, headache, myalgia, vomiting
Severe Symptoms	ARDS, encephalitis, seizures, coma
Mortality Rate	40–80%
Diagnosis	RT-PCR, ELISA
Treatment	Supportive care only
Prevention	Avoid contaminated food, PPE, hygiene
Vaccine Status	Under development (no approved vaccine)



3. Clinical Features and Pathology

3.1 Incubation Period

The incubation period for Nipah virus infection is normally 4-14 days, although in some cases, it can be as long as 45 days. The variable incubation period poses difficulties in identifying and diagnosing NiV infections, which further poses challenges in controlling its transmission.

3.2 Initial (Prodromal) Symptoms

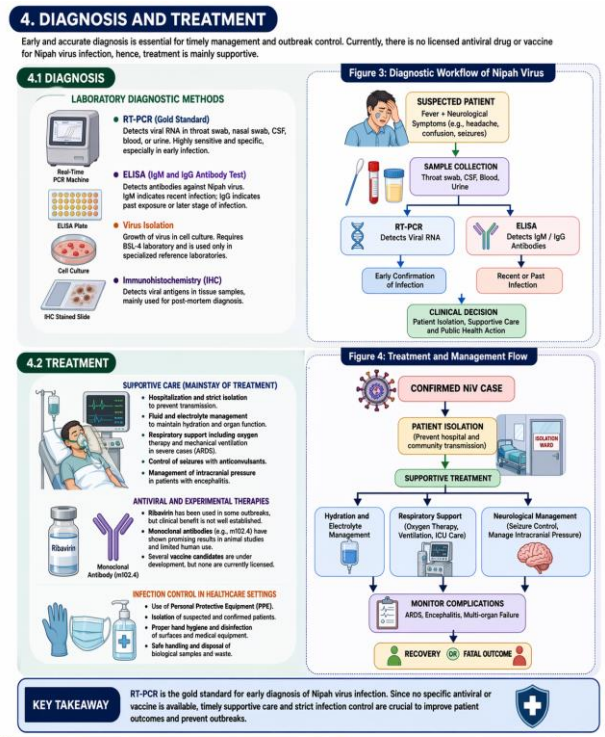
NiV infection often begins with non-specific, influenza-like symptoms, which may delay early diagnosis. Common early manifestations include:

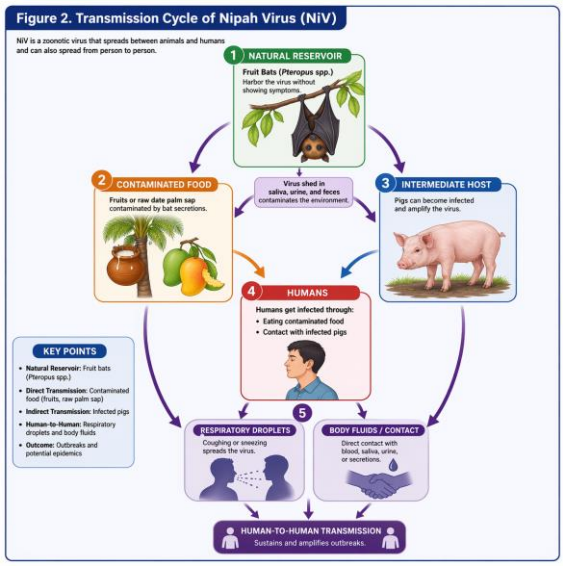
- Fever (often high-grade)
- Headache
- Myalgia (muscle pain)
- Fatigue and malaise
- Sore throat
- Nausea and vomiting

These symptoms reflect systemic viral infection and are typically observed during the initial phase of viremia.

3.3 Severe Clinical Manifestations

As the disease progresses, patients may develop severe and life-threatening complications affecting both the respiratory and central nervous systems:





3.5 Pathogenesis

Pathogenesis of NiV infection is multi-faceted and includes extensive systemic effects:

- Viral Tropism:

It mainly infects endothelial cells of blood vessels and neurons within the central nervous system (CNS)

- Vasculitis:

There is vasculitis caused by infection, leading to destruction of endothelium, increased permeability of blood vessels, and necrosis of tissues.

- @Damage to Central Nervous System:

The virus passes through the blood-brain barrier, infecting neurons and causing encephalitis.

- Cytokine Storm:

Due to a robust immune response, there is production of pro-inflammatory cytokines like tumor necrosis factor-alpha (TNF-a) and interleukin-1 (IL-1), adding to the damage to tissues and severity of disease.

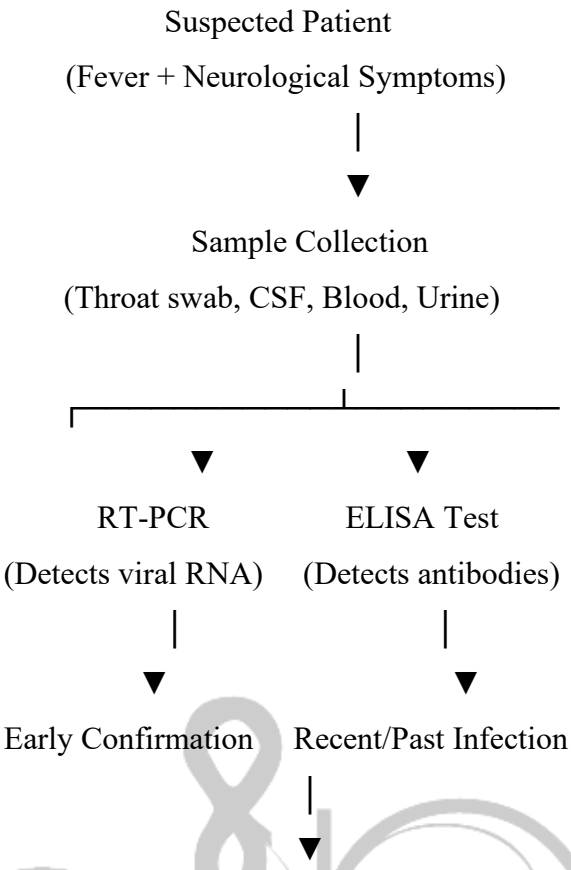
- @Effects on Multiple Organs:

In some cases, the infection can lead to organ dysfunction in lungs, brain, and kidneys, among other organs.

3.6 Case Fatality Rate and Prognosis

The case fatality rate of Nipah virus infection is quite high, with values between 40% to 80%. Factors contributing to poor prognosis include severe neurologic complications, delayed diagnosis, and inadequate supportive management.

Diagram 3: Diagnostic Workflow of Nipah Virus



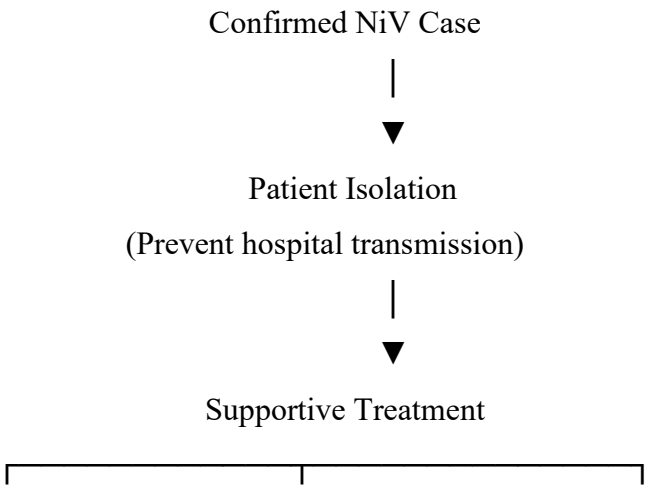
Explanation (for paper):

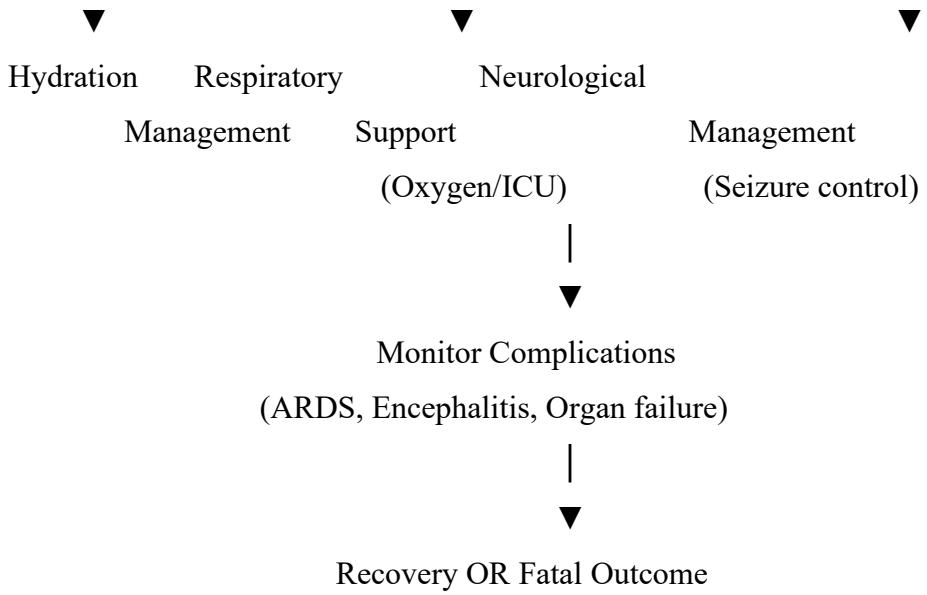
Diagnosis begins with clinical suspicion followed by laboratory confirmation using RT-PCR and ELISA. Early detection is crucial for patient management and outbreak control

4.2 Therapy

At present, there is no definite antiviral therapy available for the treatment of Nipah virus disease. Treatment involves the use of symptomatic and supportive measures to control the disease.

Diagram 2: Treatment and Management Flow





5.Prevention and Control

Prevention and control strategies for NiV infection need to be interdisciplinary due to its zoonotic nature, high mortality rates, and risk of human-to-human spread. The management process involves an integrative strategy that employs the One Health concept, which incorporates human, animal, and ecological interventions as well as public health measures and international cooperation.

5.1One Health Concept:

One Health is crucial in NiV prevention and control, acknowledging the interdependencies between humans, animals, and the environment in disease emergence. Fruit bats belonging to the genus Pteropus act as natural reservoirs, with infection being transferred either directly to humans or indirectly through other animals, like pigs. Coordination of monitoring among the three areas ensures the early identification of viral circulation and minimizes spillover events (1,2).

5.2 Control of Zoonotic Spillover Events:

Limiting exposure between infected animals and people is vital. Biosecurity measures within the livestock industry, especially in the breeding of pigs, reduce viral replication. Physical barriers between animal rearing units and homes and sanitation measures minimize risks of infections (3).

Intervention Strategies:

1. Environmental Interventions

Environmental interventions are vital in minimizing exposure. For instance, the use of bamboo skirts or covers on the pots used in collecting date palm sap protects against contamination from bats. Moreover, reducing deforestation and avoiding human interaction with animal environments helps restore ecological equilibrium, thereby reducing the chances of zoonotic transmission (4).

2. Public Awareness and Behavioral Interventions

Education of communities is fundamental when it comes to preventing infection. Educating people on the risks associated with certain behaviors, such as drinking raw date palm sap or consuming bat-

bitten fruits, is critical. It is vital to boil the sap for not less than 10 minutes to minimize the virus' ability to infect.

3. Surveillance and Detection

Efficient surveillance systems are critical when preparing for any potential outbreaks of Nipah virus. Laboratory methods such as RT-PCR and serological tests can be utilized to detect early signs of the infection.

Quarantine and Contact Tracing:

Tracing the contacts of individuals is essential to disrupt the transmission pathways. The contacts of confirmed cases should be carefully monitored and, where needed, quarantined. Early identification and isolation of potential contacts are highly relevant for outbreaks caused by the more infectious Bangladeshi strains (7).

Laboratory Safety Practices:

The handling of the virus requires the use of BSL-4 laboratories. Adherence to biosafety procedures, appropriate training of personnel, and proper containment are required to reduce risks of accidental transmission and infection (9).

Care Support and Therapy:

There is currently no FDA-approved antiviral agent for treatment of Nipah virus infection. The management strategy relies on providing support through maintaining airways, balancing fluids, and addressing neurological and respiratory symptoms (10).

Vaccines:

Some of the current vaccine candidates include viral vectors (ChAdOx1 NipahB), and RNA based vaccine (mRNA-1215). While preliminary results have been encouraging, there is no approved vaccine as yet. Further work and international cooperation will be required to develop a vaccine against Nipah virus infections (11).

Travel Restrictions and Screening:

In case of outbreaks, travel bans, screening of incoming travelers, and health declaration cards can limit the spread of the disease geographically. Monitoring of travelers from areas affected by Nipah virus helps detect cases early (12).

Conclusion

The diagnosis of the Nipah virus is highly dependent on sophisticated lab tests like RT-PCR and ELISA; there are no drugs that can combat the Nipah virus since it is not curable by any antiviral drugs, thus leaving treatment mainly supportive in nature.

References (1–40)

1. Chua KB. Nipah virus outbreak in Malaysia. *J Clin Virol*. 2003;26(3):265–275.
2. World Health Organization. Nipah virus fact sheet. 2024.
3. Centers for Disease Control and Prevention. Nipah Virus (NiV). 2023.
4. Luby SP, Gurley ES. Transmission of human infection with Nipah virus. *Clin Infect Dis*. 2009;49(11):1743–1748.
5. Ang BSP, Lim TCC. Nipah virus infection. *J Clin Microbiol*. 2018;56(6):e01875-17.
6. Lo MK, Rota PA. Emergence of Nipah virus. *J Clin Virol*. 2008;43(4):396–400.
7. Clayton BA. Nipah virus transmission. *Curr Opin Virol*. 2017;22:97–104.
8. Hossain MJ et al. Clinical presentation in Bangladesh. *Clin Infect Dis*. 2008;46(7):977–984.

9. Chong HT, Tan CT. Relapsing Nipah encephalitis. *Ann Neurol*. 2003;53(4):530–535.
10. Halpin K et al. Pteropid bats as reservoirs. *Emerg Infect Dis*. 2000;6(5):459–461.
11. Epstein JH et al. Nipah ecology. *EcoHealth*. 2006;3(1):69–80.
12. Gurley ES et al. Person-to-person transmission. *Emerg Infect Dis*. 2007;13(7):1031–1037.
13. Rahman MA et al. Date palm sap transmission. *Emerg Infect Dis*. 2012;18(7):1107–1114.
14. Middleton DJ et al. Experimental infection in animals. *J Comp Pathol*. 2002;126(2–3):124–136.
15. Wong KT et al. Neuropathology of Nipah virus. *Acta Neuropathol*. 2002;104(2):145–151.
16. Rockx B et al. Pathogenesis of Nipah virus. *PLoS Pathog*. 2010;6(9):e1001166.
17. Broder CC et al. Henipavirus entry mechanisms. *J Virol*. 2013;87(10):5732–5741.
18. Aguilar HC, Lee B. Henipavirus fusion. *Virology*. 2011;411(2):264–275.
19. Eaton BT et al. Henipavirus overview. *Microbes Infect*. 2006;8(2):354–359.
20. Bossart KN et al. Neutralizing antibodies. *J Virol*. 2005;79(20):12694–12702.
21. Mire CE et al. Antibody therapy studies. *Sci Transl Med*. 2016;8(353):353ra111.
22. Geisbert TW et al. Therapeutic approaches. *J Infect Dis*. 2014;210(3):360–368.
23. Prescott J et al. Vaccine research. *PLoS Negl Trop Dis*. 2015;9(3):e0003499.
24. Weingartl HM et al. Animal model studies. *Emerg Infect Dis*. 2005;11(10):1598–1604.
25. DeBuysscher BL et al. Pathogenesis insights. *J Virol*. 2013;87(11):5975–5983.
26. WHO R&D Blueprint. Priority pathogens list. 2023.
27. CDC. Biosafety guidelines for NiV. 2022.
28. NIH. Nipah virus research updates. 2023.
29. Indian Council of Medical Research (ICMR). NiV outbreak reports.
30. National Institute of Virology. Surveillance data.
31. Kulkarni DD et al. Nipah in India. *Indian J Virol*. 2013;24(3):398–404.
32. Arankalle VA et al. Outbreak investigation. *Indian J Med Res*. 2011;134:678–685.
33. Soman Pillai V et al. Kerala outbreak analysis. *J Infect Public Health*. 2020;13(3):418–426.
34. Kumar AA et al. Epidemiology in India. *VirusDisease*. 2019;30(2):197–203.
35. Field HE. Bats and zoonosis. *Microbiol Aust*. 2009;30(3):132–134.
36. Daszak P et al. Emerging zoonoses. *Science*. 2000;287(5452):443–449.
37. Morse SS et al. Global infectious diseases. *Nature*. 2012;451:990–993.
38. Jones KE et al. Emerging disease hotspots. *Nature*. 2008;451:990–993.
39. Wolfe ND et al. Origins of pandemics. *Nature*. 2007;447:279–283.
40. Karesh WB et al. One Health approach. *Lancet*. 2012;379:1936–1938.
41. Jones KE, Patel NG, Levy MA. Global trends in emerging diseases. *Nature*. 2008;451:990–993.

42. Wolfe ND, Dunavan CP, Diamond J. Origins of major human infectious diseases. *Nature*. 2007;447:279–283.

43. Karesh WB, Dobson A, Lloyd-Smith JO. Ecology of zoonoses. *Lancet*. 2012;379:1936–1938.

44. Eaton BT, Mackenzie JS, Wang LF. Henipaviruses. *Curr Top Microbiol Immunol*. 2007;315:133–159.

45. Wang LF, Anderson DE. Viruses in bats. *Viruses*. 2019;11(1):1–18.

46. Halpin K, Young PL, Field HE. Identification of Nipah virus reservoir. *Emerg Infect Dis*. 2000;6(5):459–461.

47. Epstein JH, Field HE, Luby S. Nipah virus ecology. *EcoHealth*. 2006;3(1):69–80.

48. Gurley ES, Montgomery JM, Hossain MJ. Person-to-person transmission. *Emerg Infect Dis*. 2007;13(7):1031–1037.

49. Rahman MA, Hossain MJ, Sultana S. Risk factors of Nipah infection. *Emerg Infect Dis*. 2012;18(7):1107–1114.

50. Luby SP, Rahman M, Hossain MJ. Foodborne transmission of Nipah virus. *Clin Infect Dis*. 2006;43(7):816–820.

51. Middleton DJ, Westbury HA, Morrissy CJ. Experimental infection studies. *J Comp Pathol*. 2002;126(2–3):124–136.

52. Weingartl HM, Berhane Y, Czub M. Animal models of Nipah virus infection. *Emerg Infect Dis*. 2005;11(10):1598–1604.

53. Rockx B, Bossart KN, Feldmann F. Pathogenesis of Nipah virus. *PLoS Pathog*. 2010;6(9):e1001166.

54. Wong KT, Shieh WJ, Zaki SR. Neuropathology of Nipah virus infection. *Acta Neuropathol*. 2002;104(2):145–151.

55. Chong HT, Tan CT. Clinical features of Nipah encephalitis. *Neurol J Southeast Asia*. 2003;8:43–47.

56. Tan KS, Tan CT, Goh KJ. Relapsing encephalitis due to Nipah virus. *Neurology*. 1999;53(8):1984–1986.

57. Ang BSP, Lim TCC, Wang L. Clinical management of Nipah infection. *J Clin Microbiol*. 2018;56(6):e01875-17.

58. Lo MK, Rota PA. Henipavirus replication. *J Virol*. 2008;43(4):396–400.

59. Broder CC, Xu K, Nikolov DB. Viral entry mechanisms. *J Virol*. 2013;87(10):5732–5741.

60. Aguilar HC, Lee B. Fusion proteins of Henipavirus. *Virology*. 2011;411(2):264–275.

61. Bossart KN, Wang LF, Flora MN. Neutralizing antibodies against Nipah virus. *J Virol*. 2005;79(20):12694–12702.

62. Mire CE, Satterfield BA, Geisbert TW. Antibody therapy for Nipah virus. *Sci Transl Med*. 2016;8(353):353ra111.

63. Geisbert TW, Feldmann H. Experimental therapeutics for Nipah virus. *J Infect Dis*. 2014;210(3):360–368.

64. Prescott J, de Wit E, Feldmann F. Vaccine development for Nipah virus. *PLoS Negl Trop Dis*. 2015;9(3):e0003499.

65. DeBuysscher BL, Scott D, Thomas T. Immunopathogenesis of Nipah virus infection. *J Virol*. 2013;87(11):5975–5983.

66. World Health Organization. WHO R&D Blueprint: Priority diseases list. 2023.

67. Centers for Disease Control and Prevention (CDC). Nipah biosafety guidelines. 2022.

68. National Institutes of Health (NIH). Emerging infectious disease reports. 2023.

69. Indian Council of Medical Research (ICMR). Nipah virus outbreak reports in India.

70. National Institute of Virology (NIV). Surveillance reports.

71. Ministry of Health and Family Welfare, India. Nipah outbreak updates.

72. Kerala Health Department. Nipah virus outbreak management report.