

Curbing Future Nipah Outbreaks in India with a Sustainable "One Health Approach"

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ABSTRACT

Nipah virus is deadly RNA virus that spread from bats to humans with high case fatality rate. India witnessed the 6th outbreak in the month of September 2023, while it was the 4th outbreak in the state of Kerala. The man coming into contact with bat secretions like urine or saliva increased the risk of transmission of disease. As the population increases and animal-human interaction or human-environment interaction increases, we need to take a holistic approach to the solution. One Health approach promotes collaborative efforts of many experts working across human, animal, and environmental health to improve the health of people and animals. The important preventive measures undertaking the One Health Approach like strengthening public health system, maintaining environmental health and animal health, health education and ongoing research will help to curb the occurrence and control of outbreaks to greater extent.

KEY WORDS: Animal, Environment, Human, Nipah, One Health, Outbreak.

Introduction

The Nipah virus was recognized in 1999 and the name of the virus and disease is from the village of "Sungai Nipah" in Malaysia where an outbreak occurred among pig farmers^[1]. The first outbreak of Nipah virus occurred in Malaysia in 1999 among pig farmers and affected 265 people, resulting in 105 deaths and a case fatality rate of 39.6%. Spillover events were seen in Singapore, affecting 11 people and resulting in one death. Further, outbreaks occurred in Bangladesh, India, and the Philippines, which were linked to fruit bats^[2]. The spread of infection from Bangladesh to India may be linked to the presence of a reservoir for Nipah virus in Southeast Asian countries and could be a spillover

infection in neighbouring countries^[3].

The RNA virus known as the Nipah virus is very lethal and is transmitted from bats to humans. Kerala witnessed four outbreaks in the years 2018, 2019, 2021, and 2023. There is neither a specific treatment nor a vaccine available for the infection. Thus, it is the disease that most concerns public health^[4]. The public health system needs new and better ideas to be developed that address root causes and create long-term, sustainable solutions. 'One Health' is an integrated approach that aims to sustainably balance and optimise the health of people, animals, and ecosystems^[5]. The study aims to review the historical background of outbreaks in Kerala and other parts of India, as well as the virulence, epidemiology, clinical features, and preventive measures reported in the past. The study aims to highlight the scope of the 'One Health' approach in designing preventive strategies that the nation can implement to curb future infections and prepare for future epidemics.

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Nipah Outbreaks in India

India witnessed the 6th outbreak in the month of September 2023 (Figure 1), while it was the 4th outbreak in the state of Kerala. In 2001 and 2007, the Nipah outbreak occurred in the eastern state of India, with encephalitis being the common clinical scenario in both outbreaks^[6]. Due to a lack of functional laboratories, screening was not carried out in the first outbreak, and the case fatality rate was high. In the second outbreak, the case fatality rate was 100%, which alarmed the public health department. The infection was contracted by the ingestion of the contaminated sap with bat urine, and man-to-man transmission was responsible for the spread of the disease^[2]. The identified strain was NiV-B (Bangladesh), which is less infectious but highly fatal^[6]. The bat also known as flying fox is the natural reservoir of the nipah disease. *Pisastur gigantus*, a bat species commonly found in Bangladesh, can fly between India and Bangladesh, which is responsible for the contamination of palm sap. The spread of nipah in eastern India and Bangladesh can be understood by taking account of the similar cultural practices in rural communities of both countries that collect palm sap and consume it unprocessed^[4,7].

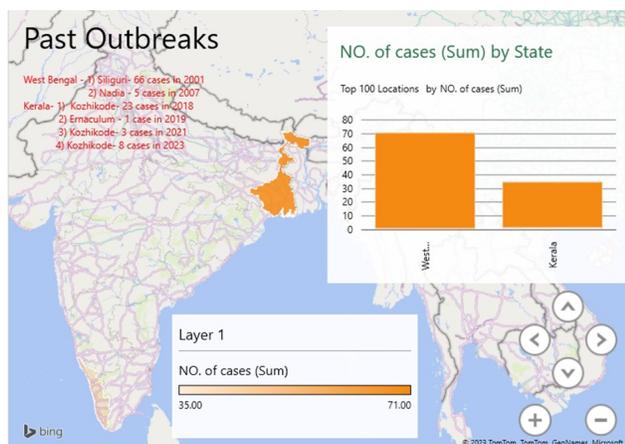


Figure 1: Past outbreaks of Nipah virus in India^[2,6]

In 2018, nipah outbreak hit Kerala, the southern state of India first time. Out of four outbreaks to date, three occurred in the district of Kozhikode. In the southern state commonly found fruit bat *Pteropus* distinct strain from NiV-B (Bangladesh) and NiV-M (Malaysia), was found in the fruit bat responsible for the nipah outbreak in Kerala^[8,9]. The persistent infections that remain in bat populations during weakened immunity have been conceptualised as the source of spillover and other events of pathogen shedding^[2]. Sudeep et. al. NiV positivity in *Pteropus*

species of bats revealed that NiV is circulating in many districts of Kerala state which possess threat of future outbreak^[8]. After the 2018 outbreak, the Government of Kerala strengthened the public health department and accelerated the health response, which was reflected in the success story of the 2019 outbreak (limited to the index case with zero mortality)^[2] (Table 1).

Factors increasing the risk of outbreak

There is evidence of Nipah virus infection in domestic animals including dogs, cats, goats, sheep and horses. Unlike Malaysia, intermediate host pigs were not identified as a threat to the transmission of disease in India, as pig farming is uncommon in India^[11]. The transmission in Bangladesh and India is mostly from bat-human and then human-human interaction^[6]. The man coming into contact with bat secretions like urine or saliva increased the risk of transmission of disease. It can be contaminated by palm sap or fruits^[4,6]. The common mechanism of human-to-human transmission is the passage of respiratory secretions contaminated with Nipah virus from a patient to the respiratory tract of an uninfected person following physical contact. The body secretions of an infected person, like urine and saliva, also contain a high load of viruses after the onset of a severe illness^[4,12]. The factors related to the humans which increases the risk of the infections are as follows:

- **Occupation:** Farmers, fruit vendors, workers working in the field of palm or fruit, migratory workers and health workers have a high risk of contracting the infection due to their exposure to pathogens.
- **Low socio-economic status:** A majority of countries in the SEAR are underdeveloped or developing nations, and disease outbreaks agonise the lives of citizens in these nations. Contrary to SEAR, West Bengal and Kerala are among the most literate and socio-economically developed states in India, but transportation, tourism, and high proportions of health care units in both states account for the high rate of nosocomial NiV incidences^[2].
- **Lack of education:** Due to a lack of education, the precautions related to curbing the outbreak remain untouched. Lack of public participation in the prevention drive can be the biggest bottleneck in the process. The control of zoonotic diseases comes from the citizens through public policies of the awareness of food, environmental

Table 1: The details of the past outbreaks of nipah virus in India is given as [2,6,9,10]

Outbreak	1 st outbreak of nipah in India	2 nd outbreak of nipah in India	3 rd outbreak of nipah in India	4 th outbreak of nipah in India	5 th outbreak of nipah in India	6 th outbreak of nipah in India
Year	2001	2007	2018	2019	2021	2023
Region/State	Siliguri, West Bengal	Nadia, West Bengal	Kozhikode, Kerala	Ernakulum, Kerala	Kozhikode, Kerala	Kozhikode, Kerala
Cases	66	5	23	1	3	8
Screening	Failure of laboratory investigation	30	NA	300	NA	387
Case Fatality Rate	68%	100%	91%	0%	33%	25%
NiV strain	NiV-Bangladesh	NiV-Bangladesh	NiV-India	NiV-India	NiV-India	NiV-India
Spread of disease	Nosocomial	Unknown	Nosocomial (later), Contaminated fruits (initially)	The spread was curbed by interventions taken by the government of Kerala.	Nosocomial	Nosocomial
Contracting infection from Bat	Yes (Ingestion of contaminated palm sap with bat urine)	Yes (Ingestion of contaminated palm sap with bat urine)	Yes	Probably yes	Yes	Yes
Clinical Feature	Encephalitis, Respiratory Distress	Encephalitis, Respiratory Distress	fever, myalgia, respiratory difficulties, headache, vomiting, cough	fever, myalgia, respiratory difficulties, headache, vomiting, cough	fever, myalgia, respiratory difficulties, headache, vomiting, cough, altered sensorium	Acute Respiratory Distress Syndrome, Pneumonia

and social education^[13].

- **Unavailability of health services:** Unavailability of health services due to a lack of skilled health staff, poor-equipped laboratories, and geographically hard-to-reach areas are the identified bottlenecks in the health service. A heavy burden on the tertiary care centre can expose the medical faculty, patients, and bystanders to the infection, and nosocomial transmission of disease can be seen^[1].

The nosocomial mode of transmission of the disease seen in all outbreaks shows the importance of measures to be taken in the hospital to curb the infection in other patients, medical faculty, workers, or bystanders^[4]. The Nipah virus infection is a zoonotic disease, and its natural reservoir bats pose a threat of repeated NiV spillover in the environment. The threat of NiV spillover is dependent on the following factors^[4]:

- **Deforestation:** Deforestation and biodiversity loss are closely linked to the emergence of zoonotic diseases. Deforestation leads to the loss of bat habitat, which results in the co-existence of animals and humans with bats, ultimately increasing the risk of transmission of disease^[13,14].
- **Dense population:** As the population is increasing, industrialization and urbanisation are taking place at a fast pace and people tend to look for new spaces to live, moving into areas that were previously occupied by forests or other natural habitats. Population density accounts for the high rate of interaction among individuals and between environments. The coexistence of reservoirs like farm animals in dense human inhabitation has a high risk of virus spillover^[2,13].
- **Human activity in bat habitat:** Human activity like agroforestry, camping, and tourism in forests can result in increase in amount of interactions between agents, hosts, and the environment. Intense fruit production in Malaysia was linked to the nipah outbreak in the rural community engaged in the production and fruit handling process^[13,14].
- **Climate change:** The NiV outbreak in Malaysia and Kerala occurred after facing a drought situation due to the El Nino effect. Drought in the regions could reflect a reduced availability of natural fruit, forcing the bats to resort to

fruiting trees in gardens and orchards existing in dense human habitats, which increases the risk of transmission^[2,13,15].

As the population increases and animal-human interaction or human-environment interaction increases, we need to take a holistic approach to the solution.

One Health approach in preventing zoonotic disease outbreak

One health approach recognises that the health of people is closely connected to the health of animals and our shared environment^[16]. An One Health approach promotes collaborative efforts of many experts (like epidemiologists, laboratorians, physicians, and veterinarians) working across human, animal, and environmental health to improve the health of people and animals, including pets, livestock, and wildlife. One health approach can protect the biodiversity, maintain the human and animal health and prevent the emergence of zoonotic diseases^[17]. Chattu et.al. the close link between globalization, urbanization, and the behavior of emerging viruses in the modern era can be addressed well through “One Health.”^[1] (Table 2).

The important preventive measures undertaking the One Health Approach should be focus on:

1. **Maintaining Animal Health:** Measures including restriction of movement of infected animals, regular check-ups of domestic animals, and disinfection of farms can maintain animal health and decrease the spread of infection in animals.
2. **Strengthening the public health system:** Implementation of SOP or government guidelines, a surveillance system, contact tracing, logistic support with well-equipped laboratories, and capacity building with periodic training in service to health staff can enhance the rapid response to any outbreak.
3. **Awareness:** Using the IEC strategy, sessions should be arranged to disseminate information on the Nipah virus, contact-droplet precautions, contaminated food, and updates related to it.
4. **Environment maintenance:** Measures like afforestation or promotion of green zones to maintain the climate and biodiversity are important. Minimising human intervention by adopting existing legislation can also open the way to protect the environment and future outbreaks.

Table 2: The prevention strategies identified so far with One health approach

<ul style="list-style-type: none"> • Prevention strategies targeting animal^[1,13] 	1. Controlling NiV in animals	1) Thorough cleaning and disinfection of pig farms 2) Culling of infected animals 3) Restricting or banning the movement of animals from infected farms to other areas 4) Establishing an animal health surveillance system
	2. Reducing bat/animal to human transmission	1) Keeping bats away from sap collection sites with protective coverings (e.g., bamboo sap skirts) 2) Gloves and other protective clothing should be worn while handling sick animals
<ul style="list-style-type: none"> • Prevention strategies targeting Environment^[1,2,14] 	1. Curbing the spillover of NiV in environment	1) Measures against deforestation and climate change to minimize human-bat interaction 2) Minimal Fruit collection, deforestation and tourism in green zones
	2. Awareness	1) High alerts can be made in affected areas and public meetings, gatherings and the conduct of mass event can be avoided 2) Strict measures against misleading messages 3) Proper observation of the preventive measures with proper awareness
<ul style="list-style-type: none"> • Preventive measures targeting humans^[1,2] 	1. Controlling nosocomial transmission	1) Contact and droplet precautions 2) Healthcare workers safety with the provision of PPE 3) equipped laboratories. 4) Periodic training to health staff
	2. Controlling NiV in humans and reducing human to human spread	1) Isolation of cases 2) Contact tracing and monitoring 3) Strengthening of surveillance system 4) Containment
	3. Prohibition of Procurement and consumption of contaminated raw fruits and products	1) Avoiding bat-bitten fruits consumption 2) Avoiding the consumption of raw date palm sap contaminated with bat excreta; Consumption after boiling the molasses or the sap was advised along with a proper covering of the vessels used for sap collection 3) Proper awareness and observation of hygienic method
	4. Research ^[18]	1) Investment in clinical trial, vaccines trial 2) Epizootic research 3) Stakeholder engagement in locally and globally

5. **Research:** Research is the key factor in case of emerging and reemerging diseases to protect the community. The vaccines of NiV is unavailable but it is under trial. The National Institute of Allergy and Infectious Diseases (NIAID), part of the National Institutes of Health, has launched an early-stage clinical trial. The experimental mRNA-1215 Nipah virus vaccine will be tested in a dose-escalation clinical trial to evaluate its safety, tolerability, and ability to generate an immune response in 40 healthy adults aged 18 to 60 years^[19].

The National Centre for Disease Control (MoHFW, India) delivers a range of preventive measures, including periodic risk assessment, community awareness and health education using the IEC strategy, measures to reduce the risk of animal-human transmission (promotion of safety measures while handling animals), measures to reduce the risk

of human-human transmission (social distancing, maintaining hygiene, and raising awareness). The public health system implements control measures in addition to these preventative ones, such as strengthening the surveillance system, identifying cases with regular follow-up, reporting, and concurrent disinfection. Given the threat posed by this newly emerging disease, more targeted interventions with intersectoral collaboration are needed. Therefore, the present article has incorporated the existing as well as proposed preventive and control measures into one health approach^[20].

India has the largest population, contributing to the effects of urbanisation and industrialization, which result in deforestation and loss of biodiversity. The risk of emerging zoonotic diseases has increased, and the burden on health infrastructure has increased. We need to strengthen the public health infrastructure and should encourage research in health to

curtail any outbreak. The low socio-economic status of the community suffers the most. Therefore, they should be linked to public health services, and the most feasible tool of prevention is health education, which should be promoted (Figure 2).

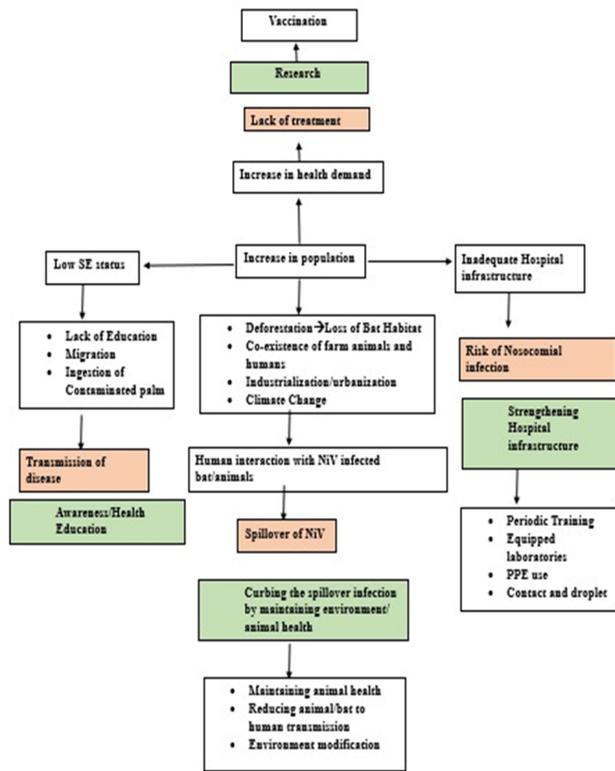


Figure 2: The concept map on factors responsible for the outbreaks and Future strategies to curb the NiV infection

Conclusion

The frequent outbreaks of the Nipah virus had pose a substantial stress to community health & economic stability. Preparedness to contain outbreak, awareness among people about disease control measures, strengthening public health system & maintaining environmental health/ animal health and ongoing research will help to curb the occurrence and control of outbreaks to greater extent.

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