

REVIEW

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Nipah virus strikes Kerala: recent cases and implications

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Abstract

The Nipah virus, a highly pathogenic zoonotic pathogen, has once again surfaced in the state of Kerala, India, with recent cases reported in 2023. This article delves into the epidemiological details of these cases, shedding light on the two fatalities that occurred in September 2023 and August 2023 as well as the suspected cases that have undergone testing. Nipah virus, known for its severe neurological and respiratory disease manifestations, remains a formidable health threat due to the lack of specific treatments or vaccines. The government's response to these recent cases, including mass testing and quarantine measures, is discussed, drawing lessons from past outbreaks in the region. Kerala has experienced multiple Nipah virus outbreaks since 2018, prompting a closer examination of environmental factors, such as deforestation and urbanization, which increase the risk of zoonotic transmission. This article underscores the global implications of Nipah virus resurgence in Kerala and emphasizes the importance of preparedness and vigilance in the face of emerging infectious diseases. The lessons learned from Kerala's experience with Nipah virus outbreaks provide valuable insights for public health professionals and policymakers worldwide.

Keywords Nipah virus, Kerala, Zoonotic transmission, Epidemic preparedness, Public health implications

Introduction

A recently discovered and extremely deadly zoonotic illness called Nipah virus (NiV) infection poses a serious risk to human health and has a high death rate [1]. NiV, a member of the *Henipavirus* genus and family of the Paramyxoviridae family, was first discovered in 1999 during an outbreak that affected humans and pigs in Malaysia and Singapore. It shares genetic similarities with the Hendra virus. The main source of this zoonotic virus is the fruit bat (genus *Pteropus*), also referred to as the flying fox [2]. Humans can contract NiV from animals by intimate contact with infected people, ingestion of contaminated food products, or direct contact with diseased animals or their bodily fluids [3]. After exposure, a person may experience mild to severe symptoms such as fever, headache, coughing, sore throat, breathing difficulties, vomiting, disorientation, drowsiness, confusion, seizures, coma, and encephalitis within 4 to 14 days [4]. Avoiding contact with sick bats and pigs in endemic areas is one way to prevent NiV infection. Another is to avoid

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eating raw date palm sap, which can be contaminated by infected bats [5]. In order to shed light on this new public health concern, this paper offers a thorough examination of NiV infection, covering its epidemiology, transmission dynamics, clinical signs, and preventive measures. Moreover, we stress the urgent necessity of alertness, careful cleanliness, and conscientious actions to fight NiV and safeguard community health [5, 6].

Recent Nipah virus cases in Kerala

Fatality in September 2023

Recent news reports have highlighted two fatalities linked to the Nipah virus in Kozhikode, Kerala, India [7–9]. The first death was recorded on August 30, 2023, followed by the second on September 11, 2023. Nipah virus primarily spreads to humans through direct contact with infected bats, pigs, or other individuals, leading to symptoms such as fever, headache, cough, sore throat, and respiratory distress. Subsequently, some patients may experience encephalitis characterized by drowsiness, disorientation, and mental confusion, which can quickly escalate to coma within 24–48 h. Severe symptoms, including seizures, coma, and brain swelling (encephalitis), may manifest, with death occurring in 40–75% of cases [10]. It is essential to note that no specific vaccine or treatment exists for Nipah virus, emphasizing the critical role of vigilance, stringent hygiene practices, and responsible behaviors in combatting the virus and protecting community well-being [11, 12].

August 2023 fatality

On September 11, a second fatality was reported, and an additional four cases are currently under investigation, with their samples already forwarded to the National Institute of Virology (NIV) for confirmation. The Nipah virus, a zoonotic pathogen originating from animals and transmitted to humans, primarily relies on fruit bats as its carriers. Despite its gradual spread, the virus carries a substantial fatality rate, estimated to be between 40 and 75% [7, 10]. Unfortunately, there is neither a vaccine nor a specific treatment available for this virus. As a result, preventive measures emphasize avoiding contact with infected animals and their secretions, along with rigorous adherence to hygiene protocols [7, 10, 13].

Suspected cases and testing

Two deaths attributed to the Nipah virus have been documented in Kerala's Kozhikode district [7, 13–15], prompting the Kerala health department to issue a high alert for the region. Additionally, four more cases are currently under suspicion [14]. Notably, Kerala experienced a Nipah virus outbreak in 2018, resulting in 17 fatalities, and subsequent outbreaks occurred in the same

state, notably in 2021 [13]. The Nipah virus, a zoonotic pathogen transmitted from animals to humans, can lead to severe illness and fatalities. Symptoms of the virus encompass fever, headache, muscle pain, vomiting, and sore throat [14]. Unfortunately, there is no specific treatment available for this virus [13]. Health authorities are actively implementing preventive measures, including contact tracing and the isolation of suspected cases. It is imperative for individuals to exercise caution and take preventive steps, such as avoiding contact with sick animals and maintaining stringent hygiene practices, to curb the spread of the virus [14] (Table 1).

Nipah virus: characteristics and transmission

The NiV is a zoonotic virus that can infect humans by a variety of means, such as eating infected food, coming into intimate contact with fluids and excretions from other people, or coming into touch with domestic or wild animals like pigs or bats [10]. A variety of disorders, from asymptomatic instances to severe acute respiratory sickness and deadly encephalitis, can be caused by NiV infection. Direct contact with affected animals, their bodily fluids (blood, urine, or saliva), or ingestion of contaminated food products (palm sap or fruit tainted by infected bats) are the main ways that the disease is transmitted to people [2]. Furthermore, contact with bodily fluids from infected people—such as blood, urine, or nasal or respiratory droplets—can spread NiV from one person to another. In Bangladesh and India, reports of NiV transmission from person to person are common, particularly among the relatives and caregivers of infected patients [10]. Figure 1 provides a visual representation of these transmission routes.

Government response and measures

The recent Nipah virus outbreak in Bangladesh has prompted government action to control its spread. Healthcare workers have received directives to adhere to optimal infection prevention and control protocols, including the use of masks and gloves, local case investigation and management, and referral to Dhaka only when necessary. Additionally, the National Guideline for Management has been updated to incorporate the latest virus-related information [11]. Furthermore, in response to the Nipah virus outbreak in Kerala, India, the World Health Organization (WHO) is providing technical support to the government [22]. WHO has recognized NiV infection as a priority for research, emphasizing the importance of raising awareness among relevant authorities [23]. Preventive measures against Nipah virus infection involve avoiding contact with sick pigs and bats in affected areas and refraining

Table 1 Nipah virus outbreak studies overview

S. no	Study	Outbreak period	Location	Number of cases	Mortality rate (%)	Key findings	Reference
1	Clinical Features of Nipah Virus Encephalitis in Malaysia	September 1998–June 1999	Malaysia	94	32%	-Direct viral transmission from pigs to humans’ short incubation period -Prominent brain-stem dysfunction 76% tested positive for Hendra virus antibodies	[16]
2	Nipah Virus Encephalitis Reemergence in Bangladesh	2001 and 2003	Meherpur and Naogaon, Bangladesh	25 (13 confirmed)	Not confirmed	-Transmission likely through close contact or common source -Antibodies found in <i>Pteropus</i> bats	[17]
3	Nipah Virus-Associated Encephalitis Outbreak in Siliguri, India	January–February 2001	Siliguri, West Bengal, India	18	Not confirmed	-Retrospective analysis detected NiV-specific antibodies and RNA -Close relatedness to Bangladesh NiV isolates	[18]
4	Foodborne Transmission of Nipah Virus in Bangladesh	December 15, 2004–January 31, 2005	Tangail District, Bangladesh	12	92%	-Drinking fresh date palm sap implicated in transmission -Bats (<i>Pteropus giganteus</i>) associated with sap collection	[19]
5	Nipah Virus Infection in Kozhikode, Kerala, India	May 2018	Kozhikode, Kerala, India	18	88.8%	-Person-to-person transmission -Primary case served as a source for 15 other cases -Mean incubation period of 9 days -Contained within 3 weeks	[20]
6	Nipah Virus Disease: A Rare and Intractable Disease	Multiple outbreaks	Indo-Bangladesh regions	Not confirmed	Not confirmed	-Outbreaks primarily in Indo-Bangladesh regions consumption of raw date palm sap linked to outbreaks -Limited treatment options, supportive care -Importance of infection prevention and control measures	[21]

from consuming raw date palm sap, which may be contaminated by infected bats [24].

Mass testing initiatives

While information regarding mass testing initiatives for the current Nipah virus outbreak is unavailable, it is important to note that accurate and timely diagnosis of

Nipah virus (NiV) is critical for disease control [25]. To address this need, three rapid, cost-effective molecular diagnostic tests for Nipah virus have been assessed, including nucleic acid lateral flow, recombinase polymerase amplification (RPA), and recombinase-aided amplification (RAA) [25]. Furthermore, the World Health Organization (WHO) has designated NiV infection as a

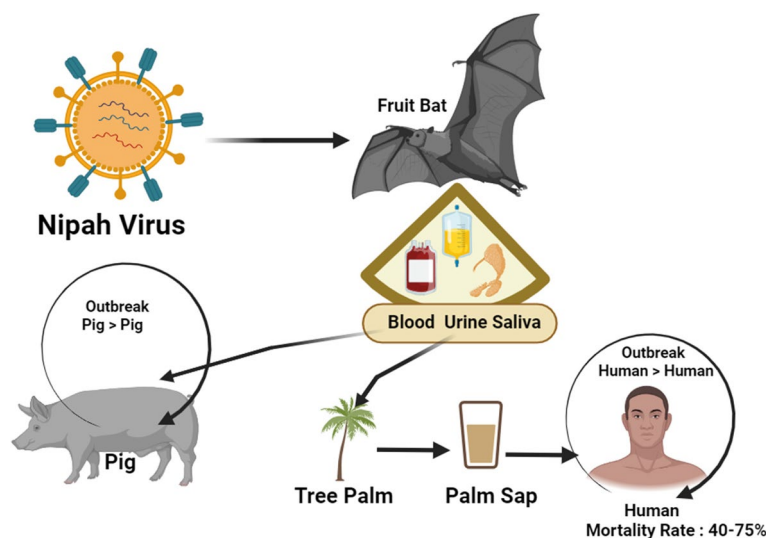


Fig. 1 Schematic representation on Nipah virus transmission

research priority, underscoring the importance of raising awareness among relevant authorities [23].

Quarantine protocols

Quarantine protocols serve as a crucial measure to curtail the spread of Nipah virus. In the event of a suspected outbreak, immediate quarantine of animal premises is imperative [10]. To prevent secondary transmissions, current strategies include active case identification, contact tracing, and the isolation and quarantine of both confirmed cases and their contacts [26]. Implementing the One Health approach is essential for identifying new cases through surveillance and quarantining domestic animals [27]. In the context of enhancing preparedness for urban Nipah virus outbreaks, comprehensive measures should encompass detailed isolation and quarantine procedures, clinical management protocols, and ensuring an adequate supply of personal protective equipment (PPE) [28]. Moreover, standard infection control practices during outbreaks are vital in healthcare settings to mitigate person-to-person transmission [24].

Environmental factors and risk

Nipah virus can cause severe illnesses in animals, with pigs being particularly susceptible, resulting in significant economic hardships for the agricultural sector. The primary risk factors associated with Nipah virus infection involve close contact with animals, exposure to contaminated environments, handling live pigs' urine or feces, and the importation and slaughtering of infected pigs [29, 30]. The emergence of infectious diseases like Nipah virus is closely intertwined with various social and environmental risk factors [31]. It is worth noting

that the likelihood of Nipah virus transmission is notably heightened in regions situated in South and Southeast Asia [27].

Implications for public health

The recent Nipah virus outbreak holds significant implications for public health, as it represents an emerging and re-emerging infectious disease that the World Health Organization views as a major public health concern [27]. Risk factors associated with Nipah virus infection encompass contact with animals, environmental exposure, handling urine or feces from live pigs, and the importation and slaughtering of infected pigs [26, 32]. While the virus exhibits a 100% infection rate in pigs, the mortality rate among infected pigs is relatively low [32]. The risk of Nipah virus transmission is notably high in South and Southeast Asia [27, 33]. Hence, it is imperative to implement preventive measures to curb virus spread, including robust surveillance, early detection, and isolation of infected individuals [34]. Moreover, public health authorities should prioritize educating the public about the risks of Nipah virus infection and effective preventive measures.

Lessons learned from past outbreaks

In the battle against the Nipah virus, the critical importance of surveillance and early detection cannot be overstated [32, 34]. Swiftly identifying infected individuals is paramount to controlling the virus's spread. Equally crucial are effective preventive measures, such as isolating infected individuals, to halt the virus in its tracks [35]. It is imperative to comprehend the risk factors associated with Nipah virus infection [32, 36], which encompass various

modes of transmission, including contact with animals, environmental exposure, and handling urine or feces from live pigs. Importation and slaughter of infected pigs also constitute significant risk factors. Nipah virus infection is characterized by severe clinical symptoms, including acute or delayed-onset encephalitis, disorientation, coma, viral bronchopneumonia, acute respiratory illness, and fatal encephalitis [37]. The mortality rate of Nipah virus infection can vary significantly depending on the outbreak's circumstances. For instance, the 2018 NiV outbreak in Kerala exhibited a considerably higher mortality rate compared to the outbreak in Siliguri [34]. Geographically, the risk of Nipah virus transmission is notably elevated in South and Southeast Asia, underscoring the necessity for vigilant monitoring and proactive preventive measures [34].

Global concerns and preparedness

The recent NiV outbreak in India has elicited global concerns regarding its potential to escalate into a worldwide problem akin to COVID-19. The risk of Nipah virus transmission is notably elevated in South and Southeast Asia [27]. As a result, imperative preventive measures, including robust surveillance, early detection, and isolation of infected individuals, are essential to curbing the virus's spread [34, 38]. Public health officials also have a responsibility to inform the public about the dangers of Nipah virus infection and practical prevention measures. Because the Nipah virus yearly spreads from animal reservoirs into human populations, the World Health Organization has designated it as a "virus of concern" for upcoming epidemics. Depending on the outbreak, the death rate from Nipah virus infection might vary and can approach 70% [34]. Contact with animals, exposure to the environment, handling the urine or feces of live pigs, and the importation and killing of diseased pigs are risk factors linked to Nipah virus infection [32, 38]. By utilizing the knowledge gained from past outbreaks, public health experts can create efficient plans for stopping and managing Nipah virus outbreaks in the future [33].

Serological significance: key diagnostic strategies for Nipah virus outbreak

The importance of serology in diagnosis is highlighted in light of the current NiV outbreak in India in order to effectively identify and manage the infection. Important diagnostic procedures, such as enzyme-linked immunosorbent assay (ELISA) for IgM and IgG antibodies and real-time polymerase chain reaction (RT-PCR), are essential, especially in the acute phase when early detection is necessary for better survival and outbreak response. The need of laboratory testing for suspected cases and high-risk contacts is emphasized by the World Health Organization (WHO), as is hospital preparedness

for complete case care, infection prevention and control, and community involvement [39–41]. The challenging early diagnosis due to non-specific symptoms is highlighted, emphasizing the crucial role of serological diagnosis and laboratory testing in early detection and management [41]. The global impact of Nipah virus, exacerbated in low-income countries with challenging symptom management, contributes to its endemic nature in these regions [42]. The clinical management protocol in response to the outbreak involves diagnostic strategies using RT-PCR and ELISA, with a focus on supportive care and intensified measures for severe cases in the absence of licensed treatments [43–45]. Prevention and control efforts encompass avoiding contact with sick bats or pigs, regular handwashing, and refraining from consuming potentially contaminated products, complemented by comprehensive measures such as laboratory testing, hospital readiness, infection prevention, control, risk communication, and community engagement [39, 43]. Monitoring and surveillance include a 21-day quarantine for high-risk contacts, early outbreak detection, ensuring adequate supplies of personal protective equipment, research investment, and awareness campaigns [39, 46]. Guidelines and protocols, accessible in various countries including India and Bangladesh, provide recommendations for clinical management covering surveillance, diagnosis, case management, prevention, and control of Nipah virus encephalitis [47, 48].

Conclusion and future prospective

In 2023, Kerala, India, is facing a resurgence of the Nipah virus, with two confirmed fatalities and additional suspected cases awaiting test results. The government has responded swiftly by implementing mass testing and quarantine measures in the affected area. Despite the absence of specific treatments or vaccines for Nipah virus, authorities are taking proactive steps to contain the outbreak. The region's environmental risk factors, including deforestation and urbanization, continue to amplify the risk of zoonotic spillover events. To address this ongoing threat, future prospects include enhancing surveillance systems for early case detection, accelerating research into Nipah virus vaccines and treatments, and engaging communities through public awareness campaigns. Global collaboration on infectious disease surveillance and response protocols is crucial, given the potential global impact of Nipah virus outbreaks. Additionally, capacity building efforts will focus on strengthening healthcare systems in high-risk regions, including healthcare worker training and the establishment of adequate facilities. In sum, the current resurgence underscores the urgent need for preparedness, response, and research efforts to combat the Nipah virus and protect public health.

Abbreviations

NiV	Nipah virus
Paramyxoviridae family	Paramyxoviridae
NiV infection	Nipah virus infection
Genus <i>Pteropus</i>	<i>Pteropus</i> (Referring to the fruit bat genus)
ELISA	Enzyme-linked immunosorbent assay
RT-PCR	Real-time polymerase chain reaction
WHO	World Health Organization

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References

- Paul D, Mohanty A, Shah A, Padhi BK, Sah R (2023) Outbreak of an emerging zoonotic Nipah virus: an emerging concern. *Journal of Biosafety and Biosecurity* 5(2):57–59
- <https://www.cdc.gov/vhf/nipah/about/index.html>. Accessed on 12–09–2023
- <https://www.cdc.gov/vhf/nipah/transmission/index.html>. Accessed on 12–09–2023
- <https://www.cdc.gov/vhf/nipah/symptoms/index.html>. Accessed on 12–09–2023
- <https://www.cdc.gov/vhf/nipah/prevention/index.html>. Accessed on 12–09–2023
- <https://zeenews.india.com/india/nipah-virus-threat-in-kerala-symptoms-prevention-and-cure-must-know-details-2661452.html>. Accessed on 12–09–2023
- <https://www.reuters.com/world/india/indias-kerala-state-reports-two-deaths-due-nipah-virus-official-2023-09-12/>. Accessed on 12–09–2023
- <https://www.indiatoday.in/india/story/nipah-virus-cases-confirmed-in-kerala-centre-sends-team-experts-2434838-2023-09-12>. Accessed on 12–09–2023
- <https://www.onmanorama.com/news/kerala/2023/09/12/nipah-virus-confirmed-kozhikode-deaths.amp.html>. Accessed on 12–09–2023
- <https://www.who.int/news-room/fact-sheets/detail/nipah-virus>. Accessed on 12–09–2023
- <https://www.who.int/emergencies/disease-outbreak-news/item/2023-DON442>. Accessed on 12–09–2023
- <https://www.ndtv.com/health/kerala-reports-two-nipah-virus-deaths-know-symptoms-transmission-preventive-measures-and-more-4384048>. Accessed on 12–09–2023
- <https://indianexpress.com/article/health-wellness/nipah-virus-kerala-signs-symptoms-prevention-8936345/>. Accessed on 12–09–2023
- <https://www.hindustantimes.com/cities/others/kerala-reports-2-suspected-nipah-virus-deaths-in-kozhikode-state-on-high-alert-101694493815075.html>. Accessed on 12–09–2023
- <https://www.indiatoday.in/india/story/two-unnatural-deaths-due-to-fever-in-kerala-nipah-virus-suspected-2434450-2023-09-12>. Accessed on 12–09–2023
- Goh KJ, Tan CT, Chew NK, Tan PS, Kamarulzaman A, Sarji SA, Wong KT, Abdullah BJ, Chua KB, Lam SK (2000) Clinical features of Nipah virus encephalitis among pig farmers in Malaysia. *N Engl J Med* 342(17):1229–1235
- Hsu VP, Hossain MJ, Parashar UD, Ali MM, Ksiazek TG, Kuzmin I, Niezgodna M, Rupprecht C, Bresee J, Breiman RF (2004) Nipah virus encephalitis reemergence, Bangladesh. *Emerg Infect Dis* 10(12):2082
- Chadha MS, Comer JA, Lowe L, Rota PA, Rollin PE, Bellini WJ, Ksiazek TG, Mishra AC (2006) Nipah virus-associated encephalitis outbreak, Siliguri, India. *Emerg Infect Dis* 12(2):235
- Luby SP, Rahman M, Hossain MJ, Blum LS, Husain MM, Gurley E, Khan R, Ahmed BN, Rahman S, Nahar N, Kenah E (2006) Foodborne transmission of Nipah virus, Bangladesh. *Emerg Infect Dis* 12(12):1888
- Thomas B, Chandran P, Lilabi MP, George B, Sivakumar CP, Jayadev VK, Bindu V, Rajasi RS, Vijayan B, Mohandas A, Hafeez N (2019) Nipah virus infection in Kozhikode, Kerala, South India, in 2018: epidemiology of an outbreak of an emerging disease. *Indian journal of community medicine: official publication of Indian Association of Preventive & Social Medicine* 44(4):383
- Banerjee S, Gupta N, Kodan P, Mittal A, Ray Y, Nischal N, Soneja M, Biswas A, Wig N (2019) Nipah virus disease: a rare and intractable disease. *Intractable & rare diseases research* 8(1):1–8
- <https://www.who.int/southeastasia/outbreaks-and-emergencies/health-emergency-information-risk-assessment/surveillance-and-risk-assessment/nipah-virus-outbreak-in-kerala>. Accessed on 13–09–2023
- Nazmunnahar Ahmed I, Roknuzzaman AS, Islam MR (2023) The recent Nipah virus outbreak in Bangladesh could be a threat for global public health: a brief report. *Health Sci Rep.* 6(7):e1423
- <https://www.cdc.gov/vhf/nipah/index.html>. Accessed on 13 Sept 2023
- Pollak NM, Olsson M, Marsh GA, Macdonald J, McMillan D (2023) Evaluation of three rapid low-resource molecular tests for Nipah virus. *Front Microbiol* 9(13):5237
- <https://www.ecdc.europa.eu/en/infectious-disease-topics/z-disease-list/nipah-virus-disease/factsheet-nipah-virus-disease>. Accessed on 13 Sept 2023
- Joshi J, Shah Y, Pandey K, Ojha RP, Joshi CR, Bhatt LR, Dumre SP, Acharya PR, Joshi HR, Rimal S, Shahi R (2023) Possible high risk of transmission of the Nipah virus in South and South East Asia: a review. *Tropical Medicine and Health* 51(1):44
- Donaldson H, Lucey D (2018) Enhancing preparation for large Nipah outbreaks beyond Bangladesh: preventing a tragedy like Ebola in West Africa. *Int J Infect Dis* 1(72):69–72
- Montgomery JM, Hossain MJ, Gurley E, Carroll DS, Croisier A, Bertherat E, Asgari N, Formenty P, Keeler N, Comer J, Bell MR (2008) Risk factors for Nipah virus encephalitis in Bangladesh. *Emerg Infect Dis* 14(10):1526
- Chew MH, Arguin PM, Shay DK, Goh KT, Rollin PE, Shieh WJ, Zaki SR, Rota PA, Ling AE, Ksiazek TG, Chew SK (2000) Risk factors for Nipah virus infection among abattoir workers in Singapore. *J Infect Dis* 181(5):1760–1763
- Epstein JH, Field HE, Luby S, Pulliam JR, Daszak P (2006) Nipah virus: impact, origins, and causes of emergence. *Current infectious disease reports* 8(1):59–65
- Yu J, Lv X, Yang Z, Gao S, Li C, Cai Y, Li J (2018) The main risk factors of Nipah disease and its risk analysis in China. *Viruses* 10(10):572
- Soman Pillai V, Krishna G, Valiya VM (2020) Nipah virus: past outbreaks and future containment. *Viruses* 12(4):465
- Skowron K, Bauza-Kaszewska J, Grudlewska-Buda K, Wiktorczyk-Kapischke N, Zacharski M, Bernaciak Z, Gospodarek-Komkowska E (2022) Nipah virus—another threat from the world of zoonotic viruses. *Front Microbiol* 25(12):811157
- Gómez Román R, Wang LF, Lee B, Halpin K, de Wit E, Broder CC, Rahman M, Kristiansen P, Saville M (2020) Nipah@ 20: Lessons learned from another virus with pandemic potential. *MSphere* 5(4):10–128
- <https://preventepidemics.org/epidemics-that-didnt-happen/nipah/>. Accessed on 13–09–2023
- Ambat AS, Zubair SM, Prasad N, Pundir P, Rajwar E, Patil DS, Mangad P (2019) Nipah virus: a review on epidemiological characteristics and

- outbreaks to inform public health decision making. *J Infect Public Health* 12(5):634–639
38. Singhai M, Jain R, Jain S, Bala M, Singh S, Goyal R (2021) Nipah virus disease: recent perspective and one health approach. *Ann Glob Health* 87(1)
 39. <https://www.who.int/emergencies/disease-outbreak-news/item/2023-DON490>. Accessed on 25–12–2023
 40. Garbuglia AR, Lapa D, Pauciuolo S, Raoul H, Pannetier D (2023) Nipah virus: an overview of the current status of diagnostics and their role in preparedness in endemic countries. *Viruses* 15(10):2062
 41. <https://www.cdc.gov/vhf/nipah/diagnosis/index.html>. Accessed on 25 Dec 2023
 42. Srivastava S, Kumar S, Jain S, Mohanty A, Thapa N, Poudel P, Sah R (2023) The global monkeypox outbreak: a comprehensive review. *Vaccines* 11(6):1093
 43. <https://www.cdc.gov/vhf/nipah/prevention/index.html>. Accessed on 25–12–2023
 44. Srivastava S, Sharma D, Kumar S, Sharma A, Rijal R, Asija A et al (2023) Emergence of Marburg virus: a global perspective on fatal outbreaks and clinical challenges. *Front Microbiol* 14
 45. <https://www.cdc.gov/vhf/nipah/treatment/index.html>. Accessed on 25–12–2023
 46. Srivastava S, Deb N, Roy P, Jaiswal V, Sah S, Pandey Y, Mohanty A, Sah R (2023) Recent Nipah virus outbreak in India: lessons and imperatives. *Ther Adv Infect Dis* 10:20499361231208536
 47. Suryawanshi P, Sarode S, Tripathy S (2023) Management of Nipah outbreak in India: a plea for immediate action. *Glob Epidemiol* 6
 48. Uwishema O, Wellington J, Berjaoui C (2022) A short communication of Nipah virus outbreak in India. An urgent rising concern. 82:104599

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