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New Findings Linked to Rise of Deadly Nipah Virus Outbreaks in South Asia

Researchers will present new findings probing factors related to deadly Nipah virus outbreaks in India and Bangladesh this year. While the overall number of cases remains relatively small, the fact that 40% to 75% of people infected with Nipah virus die and outbreaks appear to be occurring more regularly has experts on high alert.

- Evidence from scientists with the International Center for Diarrheal Disease Research in Bangladesh (icddr,b) reveals that the 2023 outbreaks in that country "exceeded the past eight-year record and several instances of human-to-human spread indicate the potential (for Nipah virus) to cause larger epidemics in the future." The study notes that of the 14 Nipah cases so far this year, 71% percent were fatal.

- A study presented by Dr. Ariful Islam from the EcoHealth Alliance focuses on a suspected cause of infections — drinking raw date palm sap contaminated with urine from infected bats, the animals believed to be the main source of Nipah virus "spillovers." It found 73% of people living in areas experiencing outbreaks in Bangladesh report regularly drinking raw date palm sap, highlighting the risk for populations with particularly high rates of consumption. A related study from the EcoHealth Alliance finds the loss of wild fruit trees in rural areas of Bangladesh has driven bats into more populated regions where they now "compete" with people for both fruit and sap from cultivated date palm trees. It notes that "the findings of the study highlight the significance of human-bat feeding competition" as a driver of Nipah virus outbreaks.

- A puzzling aspect about the disease is that while bats, notably the Indian flying fox, are viewed as a likely source of human outbreaks, icddr,b researchers note that "viral shedding is rarely detected" in bat roosts near human infections. A new study presented at the meeting provides supporting evidence after sampling more than 3000 bats, finding that while 14% had indications of past infections, only five of the bats they tested were "actively shedding" the virus. The study also found evidence that bats have been infected with other related viruses and the authors emphasize the importance of research and surveillance in these bats.

CONFERENCE SCIENTIFIC ABSTRACTS FOLLOW BELOW

A comprehensive review of clinical presentations of Nipah virus infection: Evidence generated from Nipah virus outbreaks of 2023, Bangladesh

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Nipah virus (NiV) is endemic to Bangladesh, and human infections have been reported almost every year since 2001. Till March 2023, Bangladesh experienced ten outbreaks of Nipah virus infection. Team of experts led by the Institue of Epidemiology, Disease Control and Research (IEDCR) conducted the outbreak investigations with support from icddr,b, and EcoHealth Alliance to detect more cases linked to the outbreaks and to prevent further spread in the community and healthcare setting. The teams identified the source of infection and obtained comprehensive information of the patients since their exposure to the virus. From January 4 to March 2, 2023, three clusters and seven sporadic Nipah outbreaks were identified from seven districts of Bangladesh. A total of 14 Nipah cases were reported, which included 86% (12/14) laboratory-confirmed and 14% (2/14) probable cases. There were 11 cases of primary infection, all with the history of raw date palm sap consumption prior to symptom onset. During the investigations, 675 contacts were identified; among them, three individuals were infected with the Nipah virus, indicating person-to-person transmission. On average, Nipah infection was confirmed 8 (range, 4 to 14) days after symptom onset and 3 (range, 1 to 9) days after hospitalization. The median incubation period was 11 days, ranging from 1 to 18 days. Most cases were males (57%) with a median age of 20 (15 days to 70 years) years. Ten (71%) cases died during the infection; the rest survived with significant neurological sequelae. In most cases, symptoms started with fever (100%) followed by headache (64%) and vomiting (64%). Subsequently, all patients developed signs of neurological manifestations ranging from incoherent behavior, confusion, increased salivation, neck stiffness, altered level of consciousness to coma. This year's outbreaks exceeded the past eight-year record, and several instances of human-to-human spread indicate the potential to cause larger epidemics in the future. The findings of these outbreak investigations highlight the urgent need for increased efforts in developing vaccines and treatments for Nipah virus infection.

ONE HEALTH APPROACH TO NIPAH VIRUS OUTBREAK INVESTIGATION AMIDST OF COVID-19 PANDEMIC IN BANGLADESH, 2021-2022

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Nipah virus (NiV) is an emerging bat-borne virus causing fatal encephalitis outbreaks. Until 2020, Bangladesh reported 319 NiV cases with >70% mortality. Amidst the COVID-19 pandemic, A multidisciplinary team investigated five suspected NiV spillover events in three districts of Bangladesh between 2021 and 2022 to identify the source, behavioral risk practices, and environmental exposures. We collected epidemiological, behavioral, and ecological data from outbreak communities and biological specimens of bats. We captured 60 *Pteropus medius* bats per outbreak event and environmental pool urine samples (N=314) from seven bat roosts within 10km radius of the outbreak's epicenter. The bat samples were tested for NiV by rRT-PCR and consensus PCR assay targeting rdrp genes of paramyxovirus (PMV) to detect known and novel PMV and to screen serum samples using multiplex Luminex assay for henipavirus panel. We detected two novel henipa-like paramyxoviruses in bats. The seroprevalence of NiV was 15.2% (34, CI: 10.74%-20.56%), and Hendra virus was 1.3% (3/224), Cedar 1.3% (3/224), Mojiang 0.9% (2/224) and Kumasi virus 1.3% (3/224). The behavioral investigation showed that all cases had a history of drinking contaminated raw date palm sap (RDPS) within 14 days prior to the onset of symptoms. In the outbreak communities, the participants have the habit of drinking RDPS 73.1% (CI: 67.04%-78.51%), eating bat bitten fruits 17.96% (CI: 13.36%-23.35%). Moreover, around 47% of the respondents had date palm trees in their household, among 74.78% were nursing. Serological and virological data showed diverse henipavirus circulating in bats. The high density of date palm trees and habits of drinking raw sap and eating half-eaten fruits in the outbreak communities. Drinking bat contaminated RDPS might be the source of NiV infection in humans. We recommend stringent one health surveillance and awareness campaigns in high-risk communities to reduce human-bat interactions and minimize spillover of the bat-borne virus to humans.

Land use change drives bat roosting ecology and human-bat food competition on cultivated food resources promotes Nipah virus spillover to humans in Bangladesh

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Understanding the bat roosting and feeding ecology in rapidly changing landscape like Bangladesh is critical to design effective interventions of Nipah virus (NiV) spillover to humans. Hence, this study aimed to determine how land use change drives bat roosting ecology and human-bat food competition on cultivated food resources promotes viral transmission to humans in Bangladesh. We performed an ecological and qualitative survey in eight NiV outbreaks and non-outbreak districts in Bangladesh between 2021 and 2022. We conducted an observational study on bat roost ecological characteristics, human-bat interactions and 65 ethnographic interviews with fruit orchard owners, raw date palm sap (RDPS) harvesters, consumers, and bat hunters. We identified 61 bat roosts, 85.2% of which are within 30 meters of human dwellings and 14.8% near croplands and marketplaces. Domestic animals graze underneath 85% of bat roosts. 40% of the roosts were disturbed by roost tree cutting and hunting. Hunters hunt bats for their own protein needs, for sale, and for traditional medicinal purposes. The participants reported rapid conversion of forest areas to agricultural land, human settlements, and urbanization. People have planted more timber trees than fruits trees. The wild fruits trees are scarce in their communities. Consequently, bats are heavily dependent on human cultivated fruit resources and RDPS drinking and roosting close to human residences. Participants reported declining local bat populations due to hunting and ecological changes. People reported eating unwashed dropped fruits and bat bitten fruits and occasionally feed to their household animals. Orchard owners use mist net to protect bat visiting in their garden and bat entangled on net and died. The findings of the study highlight the significance of human-bat feeding competition on cultivated fruit resources in modified landscapes, as well as shared RDPS by bats and people, as critical pathways of NiV spillover in Bangladesh. We recommend future study on ecological and behavioral interventions to prevent bat borne viral spillover from bats to humans and domestic animals in Bangladesh.

Spatial variation in Nipah virus seroprevalence among *Pteropus medius* bats in Bangladesh

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The Indian flying fox, *Pteropus medius*, is the known reservoir for the Nipah virus (NiV) in Bangladesh, causing spillovers into humans every year. Previous studies of bat roost nearby human cases demonstrated that viral shedding is rarely detected and that prevalence of IgG antibodies against NiV in these flying foxes varied from 14-60%. Many questions remain about the ecology of this virus, including whether spatial and temporal differences in spillover are associated with differences in transmission or behaviors among reservoir hosts. During 2019-2022, we investigated seroprevalence and NiV shedding among flying foxes in Bangladesh at four roosts: one large roost (Cox's Bazar>2000) outside NiV spillover areas, and one large (Faridpur>2000) and two smaller roosts (Naogaon and Rangpur<1000) nearby spillover sites. Once per month, we collected throat and urine swabs and a blood sample from 100-200 bats. We used a multiplex immunoassay to detect antibodies against the receptor-binding protein from NiV virus and four other species of *Henipavirus* (Hendra, Cedar, Mojang, and Ghana virus) and rRT-PCR to detect viral shedding in swabs. We sampled 3023 bats; overall, NiV seroprevalence was 14% and 5 bats (<0.01%) were found to be actively shedding NiV. Seroprevalence was similar between the two large roosts (17% vs 19%), nearby and far away from spillover sites. However, two smaller roost sites nearby spillover areas had much lower seroprevalence (6% in Naogaon and 5% in Rangpur) than larger roosts, suggesting that NiV transmission within bat roosts may be influenced by population size. Investigations into bat movement between roosts and bat feeding behavior differences by roost size could further explain how roost size may contribute to these patterns. Although none of the other henipaviruses included in the immunoassay circulate in bats in Bangladesh, many individual bat antisera were co-positive with those antigen targets, suggesting that other unknown henipaviruses may circulate in these bats. Given the human health risks posed by NiV, describing the other henipaviruses that may circulate in these reservoir hosts should be a research priority.