Nipah Virus Transmission from Bats to Humans Associated with Drinking Traditional Liquor Made from Date Palm Sap, Bangladesh, 2011–2014

[Announcer] This program is presented by the Centers for Disease Control and Prevention.

Nipah virus is a bat-borne emerging infection, and *Pteropus* species bats are the wildlife reservoir. It was discovered in an outbreak in Malaysia in 1998 that affected 283 people and caused 109 deaths. Subsequently, outbreaks of the infection have occurred nearly every year in Bangladesh and occasionally in India. A total of 33 outbreaks of Nipah virus encephalitis were reported in Bangladesh and India during 2001 through 2014, and epidemiologic investigations implicated bat-borne and human-to-human transmission. During 2004 through 2012, a total of 157 infections were reported in Bangladesh, and 22 percent of these occurred through human-to-human transmission.

Investigations of Nipah virus-associated outbreaks in Bangladesh identified consumption of fresh date palm sap as the primary route of bat-to-human transmission. In Bengali culture, sap harvested from the date palm tree is commonly used for fresh consumption and fermentation. Moreover, in Asia, Australia, and Africa, fermented date palm sap is used to make alcoholic drinks, known as toddy, *tari*, or palm wine. In Bangladesh, date palm sap is typically collected in clay pots that are attached to the tree. A top section of the date palm tree bark is shaved, allowing the sap to ooze overnight into the collection pot. A previous Nipah virus study reported that *Pteropus* bats frequently fed on the shaved bark and often contaminate the sap with saliva, urine, and excreta. *Pteropus* bats are also known to occasionally shed Nipah virus in their secretions and excretions.

Since 2006, the Institute of Epidemiology, Disease Control, and Research in Dhaka, Bangladesh, under the Ministry of Health and Family Welfare of Bangladesh, has collaborated with the International Centre for Diarrhoeal Diseases Research, Dhaka, on hospital-based encephalitis surveillance in the areas where Nipah virus-associated outbreaks have been reported. From December 2010 through March 2014, the surveillance identified 18 clusters of Nipah virus infection; in 15 of these clusters, the index case-patients had exposure to fresh date palm sap before illness onset. For the remaining 3 clusters, the patients had no known contact with date palm saps, bats, or sick animals other than bats. Recognizing the potential for new pathways of transmission, the authors investigated other possible exposures to Nipah virus by applying epidemiologic and anthropological approaches in the study of these 3 Nipah virus disease clusters. They used the epidemiologic study to explain the proximate individual-level factors linked to the disease outbreak and an anthropological approach to explain local perceptions, behaviors, and practices that might have contributed to the disease occurrence. The objectives of the investigation were to describe the clinical signs and symptoms of the case-patients and determine the possible route of transmission for these clusters.

Three clusters were identified, consisting of 14 case-patients (9 with confirmed Nipah virus infection, 5 with probable Nipah virus infection). Eight of the 14 case-patients were primary. Seven had illness onset during January through March 2011 in Rangpur District (first cluster), 3 had illness onset in February 2012 in Rajshahi District (second cluster), and 4 had illness onset during January through February 2014 in Rangpur District (third cluster). Eight drank *tari* before

their illness onset, whereas 6 only had exposure to other case-patients. None of the primary case-patients had any history of drinking fresh date palm sap or exposure to sick humans or animals. All of the illnesses began with fever. All 8 of the primary case-patients had altered mental status followed by loss of consciousness and death. The median duration from illness onset to death was 6 days. All 6 secondary case-patients survived. The median age of all 14 case-patients was 32. All the primary case-patients were male, and all the secondary case-patients were female.

The area of Rangpur where the case-patients lived was well known for its *tari* production and was the largest *tari*-producing area in the district. An estimated 500 date palm trees grow in that area, which produces and supplies *tari* throughout the district. *Tari* retailers from different subdistricts of Rangpur also come to this area to buy *tari* at a wholesale price. Villagers reported they did not have regular access to fresh date palm sap because almost all the date palm sap from the village was made into *tari*.

In the Nipah virus-affected area of Rajshahi, the *tari* is produced in small quantities. An estimated 15 date palm trees grow in the affected community.

The *tari* production process was identical in each of the affected communities. The process of preparing the date palm trees for *tari* production was similar to the process for collecting date palm sap for fresh consumption. To prepare the tree for tapping, the sap harvesters cut the old leaves close to the top of the trees with a knife to expose the tender part of the tree. To tap the tree, the harvesters shave a V-shaped cut at the top of the tree and set a bamboo spigot at the end of the cut. After 3 to 5 days, the V cut is shaved again, and an earthen pot is hung under the spigot to catch the sap that oozes out. For fresh date palm sap, the harvesters need to clean and dry the sap collection pots after each episode of sap collection. However, *tari* harvesters from both affected communities reported that they use the same earthen pot for sap collection for several days without cleaning it so that yeast can form at the bottom of the earthen pot. Yeast aids the fermentation of the fresh date palm sap in the pot.

In Rangpur, the date palm sap is harvested for *tari* year round. The harvesters reported that date palm sap can be collected from each tree for 3 to 4 days a week for 4 months at a time, and then the tree is left to recover for the next 7 to 8 months. The harvesters stagger the tapping of trees so there is continuous supply of date palm sap to make *tari* throughout the year. The harvesters reported that they harvest more sap during winter than during other seasons because of higher demand for *tari* from consumers. Moreover, they reported that the sap flows more freely from each tree during the winter. In the affected communities, the harvesters reported that every day from 8 a.m. until noon, they collect the sap from the hanging earthen pots and accumulate the collected sap in other earthen pots or containers and leave the hanging pots on the trees. In Rangpur, the harvesters bring *tari* to their house and immediately sell it to retailers and consumers from morning until late at night. In the affected area of Rajshahi, after being removed from the trees, the *tari* pots are kept in a betel leaf garden, and the harvesters sell *tari* from there.

The *tari* sellers and harvesters reported that *tari* consumers are men and included truck and bus drivers, day laborers, rickshaw pullers, and local farmers. They also reported that *tari* is less expensive than other illegal alcohol available for sale and that making *tari* is less laborious than collecting fresh date palm sap because harvesters do not need to clean and dry the earthen pots after each collection. They added that making *tari* is more profitable than selling fresh date palm sap.

The authors observed bat roosts in the affected community of Rangpur, and date palm sap harvesters reported that they frequently observe bats flying near the date palm trees. The harvesters reported that they often find bat excreta in and on the sap pots. The harvesters reported filtering *tari* with a net or cloth before selling it to remove the excreta. In Rajshahi, the villagers reported that there is no bat roost in their community. However, they reported seeing bats visiting date palm trees at night. None of the harvesters in Rajshahi reported filtering *tari* before selling it to consumers.

The laboratory, clinical, and qualitative findings in this study suggest that the 14 case-patients in the 3 clusters who were investigated were infected with Nipah virus. The primary Nipah virus case-patients identified in the clusters drank *tari* regularly in the evenings before their illness onsets, and none of them had a history of fresh date palm sap consumption or any exposure to other Nipah virus case-patients, which were the main transmission pathways for Nipah virus infection identified in previous outbreak investigations in Bangladesh. Moreover, none of the case-patients had exposure to sick animals, another possible pathway for Nipah virus transmission reported in studies conducted in Malaysia and Singapore.

Because *tari* fermentation was a continuous process and date palm sap was fermented inside the *tari* pots while they were hanging in the trees, some date palm sap added to the *tari* might technically be fresh sap. However, the primary case-patients probably did not consume fresh date palm sap because *tari* was collected from 8 a.m. to noon but the primary case-patients drank *tari* only in the evening, which suggests that all the sap they consumed was at least partially fermented by the time of consumption. Finding from this investigation suggest that drinking *tari* is a potential source of Nipah virus infection in Bangladesh. Investigators in India had similar findings during an outbreak reported in 2007 in West Bengal near the border with Bangladesh.

Previous studies have shown that fruit bats frequently lick the date palm sap and occasionally urinate inside the collection pots. In the investigation, the reported evidence of bats visiting date palm trees, the presence of bat excreta inside *tari* pots, the reported use of the same pot for several days without cleaning, and the accumulation of sap from multiple pots into 1 pot suggests that sap is probably contaminated with bat urine or saliva during collection and fermentation.

Nipah virus can survive up to 4 days in bat urine and at least 1 day in sap contaminated with bat urine when kept at an average temperature of 19 degrees centigrade. A study to determine viability of Nipah virus in artificial palm sap contaminated with Nipah virus found no statistically significant reduction in Nipah virus titers for at least 7 days when kept at a temperature of 22 degrees centigrade. Generally, viruses like Nipah virus are susceptible to alcohol. A 60 percent to 70 percent alcohol solution is recommended for sterilizing contaminated objects. A study conducted in India showed that *tari* derived naturally from fermenting date palm sap contains 5 to 8 percent alcohol. This alcohol concentration might not have been high enough or sufficiently distributed throughout the *tari* to sterilize the Nipah virus, therefore allowing persistence of viable virus and transmission of Nipah virus to *tari* consumers during the winter months, when the ambient temperature ranges from 15 to 28 degrees centigrade.

In Bangladesh, family caregivers commonly provide close-contact care to hospitalized patients. Infected patients can often shed the virus through body secretions and excretions and can contaminate foods and surfaces, including bed rails, bed sheets, and towels. Close contact is the most likely route through which family caregivers became infected. Family caregivers identified in this study had direct contact with primary case-patients and their body secretions.

Because harvesting date palm sap for *tari* production is similar to harvesting it for consumption of fresh date palm sap, the intervention of using bamboo skirts to cover the shaved part of the date palm tree and the sap collection pots to prevent bat contact and possible Nipah virus introduction is worth exploring. The use of bamboo skirts is already a successful, affordable, and culturally acceptable method to prevent bat access to date palm sap, and this strategy could also be used to prevent Nipah virus transmission from *tari* consumption. In addition, *tari* harvesters from ethnic minority communities have limited access to mass media because of their ethnic, religious, and linguistic minority status in Bangladesh. Efforts should be made to raise their awareness about strategies that interrupt bat access to date palm sap. As a next step, we recommend testing Nipah virus survival in *tari* at different levels of alcohol concentration.

Drinking *tari* might also be a route of exposure for other batborne viruses. A total of 55 newly described viruses from 7 virus families were recently identified in urine and saliva from *Pteropus* species bats in Bangladesh, suggesting that these bats could also contaminate *tari* with other viruses that could cause disease in humans. Date palm sap is harvested for fermentation in many areas where *Pteropus* species bats and other fruit bats are native, including Australia, Asia, and Africa. Consumers of fermented drinks and other date palm products that are harvested using similar processes as in Bangladesh might be at risk for Nipah virus infection and other batborne diseases.

You can read the entire article, Nipah Virus Transmission from Bats to Humans Associated with Drinking Traditional Liquor Made from Date Palm Sap, Bangladesh, 2011 through 2014, in the April 2016 issue of Emerging Infectious Diseases, online at cdc.gov/eid.

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