

The risk of human Nipah virus infection directly from bats (*Pteropus hypomelanus*) is low

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Abstract

Nipah virus was responsible for the outbreak of fatal encephalitis in Malaysia and Singapore in 1998 – 1999. The migratory pteropid fruit bats, which are probably the natural hosts of the virus, are found ubiquitously throughout South East Asia. In many rural areas in South East Asia, humans live close to the natural habitats of the bats. We report a serological survey of residents in an island off the east coast of Peninsula Malaysia, who live in close proximity to a roosting colony of island flying foxes (*Pteropus hypomelanus*) from which Nipah virus has been isolated. The objective was to determine the relative risk of Nipah virus infection in humans directly from the bats. One hundred and fifty three adults in Tioman island (8% of the adult population) were surveyed. The mean age was 37 years, 52% were males. Fifty-eight subjects resided in Air Batang, a village with the roosting colony of *Pteropus hypomelanus*. This constituted 39% of the village adult population. Most of the subjects were employed in tourism related industry and 50% has resided in the island for more than 5 years. Ten percent has previous physical contact, and 19% has consumed fruits partially eaten by the bats. None has a history of previous central nervous system infection. The Nipah serology in all of the subjects was negative. *Conclusion:* The risk of human contracting infection of Nipah virus from bats is low.

INTRODUCTION

An outbreak of fatal viral encephalitis caused by the Nipah virus occurred among pig farmers in Malaysia in September 1998 to June 1999.¹⁻⁷ The outbreak subsequently spread to involve abattoir workers in Singapore.^{8,9} In Malaysia, the outbreak affected 265 patients nationwide with more than 105 mortalities.^{3,6} The outbreak began in the pig farms near Ipoh, some 200 km north of Kuala Lumpur. The disease was thought to spread from infected pigs to humans through close contacts.^{6,7} The disease spread among pigs in infected farms through direct contact with infected excretory and secretory fluids. The virus spread among pig farms across the country through the movement of infected pigs.¹⁰ Other than pigs and humans, the virus could also infect dogs, cats, horses and goats.¹⁰

Malaysia has diverse bat fauna, with at least 13 species of fruit bats, including two species of flying foxes (pteropid bats) and more than 60 species of insectivorous bats.¹¹ A serological survey during the outbreak demonstrated neutralizing antibodies in 5 species of bats, 4 species of fruit bats and one species of

insectivorous bats. This included 31% positive antibody status to *Pteropus hypomelanus* (island flying foxes) and 17% positive antibody status to *Pteropus vampyrus* (Malayan flying foxes) in Peninsular Malaysia.¹² The virus was later isolated from the urine and swabs of a partially eaten 'jambu air' fruit (*Eugenia aquea*) of the island flying foxes (*Pteropus hypomelanus*) in Tioman island off the east coast of Peninsula Malaysia.¹³ Therefore, the pteropid bats could have served as the natural reservoir of the virus and might have infected the pigs when they fed on fruits in trees planted within the pig farms.¹⁴ The infected pigs in turn transmitted the virus to man and other animals.^{7,10,14}

Fruit trees are common throughout the villages in South East Asia, and flying foxes, especially *Pteropus vampyrus* are migratory in nature. In some of these villages, such as those in Tioman island, the bats live in close proximity to the human habitats. Although no illness in humans attributed to Nipah infection from the bats has been reported previously, the risk has not been studied. It is also known that Nipah infection may be asymptomatic^{15,16}, and in addition, as the

Nipah virus was only discovered in 1999², central nervous system infection prior to this date from Nipah virus would not have been diagnosed.

Tioman island is 25-km off the east coast of Peninsular Malaysia. In recent years, it has developed into a popular resort island due to the many pristine beaches. In the Year 2000 National Census, the population of the island was 2,907 residing in various villages along the coast. Most of the residents were Muslims who, for religious reason, would shun from any contact with pigs. Domestic animals such as cats and cows were few, as tourism has replaced fishing and agriculture as the main means of livelihood. There was no pig in the island. Large numbers of island flying foxes (*Pteropus hypomelanus*) were found

to roost all over the island. The main population of the island flying foxes was found in Air Batang, a village with a population of 204 residents. The pteropid fruit bats fed and roosted on the fruit trees within the compound of the village (Figure 1), directly over houses, backyards and pedestrian paths. Their urine, faeces and partially eaten fruits were often deposited on the ground under the roosting trees. The Tioman island, in particular the Ayer Batang village is thus an ideal place to study whether the pteropid fruit bats is able to cause disease directly to humans. We undertook a serological survey among the adults of all the villages in Pulau Tioman to quantify the risk of direct human Nipah infection from the bats.



Figure 1. A colony of island flying foxes (*Pteropus hypomelanus*) in a “Ketapang” tree on Tioman island.

METHODS

We visited the island on 20th – 22nd September 2001 and 25th – 27th April 2002. The subjects were recruited by making home-to-home visit in the various villages accompanied by the medical staffs of the Tioman Island Health Clinic. Prior approval was obtained from the Penghulu (headman) and announcement of the study was made in the mosque during Friday prayers to facilitate corporation from the villagers. Adults who have stayed in the island for longer than 6 months were recruited. After obtaining consent we administered a standard questionnaire which included questions related to demographic data, contacts with bats and other mammals, exposure to fruit trees, previous traveling to Nipah outbreak areas, and past medical history. Blood was taken for Nipah serology. The serum samples were tested with an IgG-captured enzyme-linked immunosorbent assay (ELISA) for antibodies against Nipah virus antigens in the virology laboratory in the Department of Medical Microbiology, University of Malaya, one of the reference laboratories during the initial outbreak.²

RESULTS

On the first visit, 113 subjects consented to participate in the study. Another 40 subjects were recruited in the second visit, making a total of 153 subjects. This represented 8% of the total adult population of 1,926. The mean age was 38 ± 15 years. The subjects consisted of Malays (84%), Indonesians (8%), Chinese (6%) and Thais (2%). One hundred and forty one subjects (92%) were Muslims and 79 (52%) were males. The subjects were from Air Batang (38%), Salang (33%), Juara (11%), Berjaya (10%), Paya (1%), and Tekek (7%). The 58 subjects from Air Batang represented 39% of the total adult population in the village of 150. Except for 21 housewives, 8 farmers, 3 carpenters, and 1 each of fisherman, policeman and electrician, the rest of the subjects were working in the tourism industry. Most of the subjects were permanent residents in the island, with 50% staying there for more than 5 years, and 20% for more than 10 years. None of the subjects has been to the Nipah encephalitis affected areas during the outbreak.¹⁻⁷

Fifteen subjects (10%) have indicated previous physical contact with the fruit bats. The other animals where the subjects had previous physical contacts were: monkeys (16%), rats (13%), squirrels (13%), cats (14%), cows (3%), and chicken (1%). Twenty-nine subjects (19%) have

consumed fruits partially eaten by bats.

Two of the subjects had a history of chronic headache, and one had fainting episodes. Apart from these, none had previous history of central nervous system infection. The Nipah serology in all of the 153 subjects was negative. The Nipah seropositive prevalence for adult population in Tioman island was thus 0-1.9% (95% CI), while that of the Air Batang village is 0-4% (95% CI).

DISCUSSION

The villagers in Tioman island, particularly those in the Air Batang village, live in close proximity for decades with the *Pteropus hypomelanus* which have previously been shown to carry the Nipah virus.^{12,13} This study shows that the risk of the pteropid fruit bats directly infecting the human population living close by is low, though Nipah virus has been cultured from the urine and saliva of the bats.¹³ There were several reasons which can be postulated for such a low infectivity rate. The villagers did not regard the bats as domestic pets. The villagers did not regard the fruit bats as food or medicine; neither did they hunt the bats to sell for the same purpose. Thus, there was little physical contact with the bats. The subjects who said that they had previous physical contact with the bats indicated that they did so only occasionally. As the fruits in the island were abundant, only a proportion of the villagers admitted to occasionally eating fruits partially consumed by the bats, after shaving off the portion previously half-eaten. It has also been observed that the fruit bats only appeared to urinate and defecate at their roosting place, after returning from their foray for food, which was at five in the early morning.¹³ This was one and half hours before sunrise, and the start of the human activities in the island. The viral load in urinary and respiratory secretions of the bats may also not be sufficient to infect humans directly.

In the interpretation of this study, one should be cautioned that this study is based on demonstration of positive Nipah serology, and a previous history of central nervous system infection. However, the duration of persistence of positive Nipah serology is uncertain. The IgG-captured ELISA is a sensitive marker for previous Nipah infection, the positive rate approaches 100% by day 25-26 and is known to persist beyond 8 months.¹⁷ In the longest follow-up study to date, the serology remains positive up to 22 months after the initial infection in relapsed or late-onset Nipah encephalitis patients.¹⁸ However, there is

no report beyond this period, especially in patients who do not have relapsed or late-onset encephalitis. As Nipah encephalitis has a high mortality of 40%^{3,6}, it is possible that the fatal cases from previous Nipah encephalitis may have been missed in this survey.

There has been recent report of antibodies to Nipah-like virus being demonstrated in fruit bats (*Pteropus lylei*) obtained in restaurants in Cambodia. In preliminary studies in Indonesia, antibodies to Nipah-like viruses have been detected in other *Pteropus* spp.¹⁹ There should be continuing vigilance for Nipah virus in causing human disease both directly or through other infected animals in the region.

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