

## Can mosquitoes transmit AIDS?

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### SUMMARY

Surveys to determine knowledge regarding AIDS have shown in many countries, including Papua New Guinea, that a large proportion of the literate population still mistakenly believe that mosquitoes can transmit the AIDS virus from one person to another. In this paper we review the theoretical mechanisms which would allow blood-sucking insects such as mosquitoes to transmit virus and discuss the evidence against transmission of HIV by mosquitoes. AIDS is a sexually transmitted disease with no scientific evidence for arthropod transmission.

### Introduction

Acquired immune deficiency syndrome (AIDS) is caused by a retrovirus called human immunodeficiency virus (HIV). When AIDS was first recognized, there were many newspaper reports on the possibility of mosquitoes being involved in its transmission. Almost half of 6625 men and women interviewed in Zaire in 1988 to determine existing levels of knowledge regarding AIDS believed in the transmission of AIDS by mosquitoes (1). Similarly in Zimbabwe, nearly half of 4189 teacher-trainees interviewed, about six months after a national AIDS awareness campaign began, thought that mosquitoes were capable of transmitting AIDS (2). A recent survey involving 1500 high school students (grade 10) from 14 schools in 4 different provinces in Papua New Guinea revealed that more than a third of them (34%) considered mosquitoes to be carriers of HIV (3).

Although mosquitoes are known to be vectors of certain death-threatening viral diseases such as yellow fever, dengue fever and Japanese encephalitis, there is no evidence that mosquitoes can transmit HIV. In this paper we review the theoretical mechanisms which would allow blood-sucking insects such as mosquitoes to transmit virus and discuss the

evidence against the transmission of HIV by mosquitoes.

### Theoretical mechanisms for the possible transmission of HIV by mosquitoes

#### *Biological transmission*

A mosquito feeding on a person infected with HIV could ingest the virus which then undergoes multiplication within the mosquito and migrates to its salivary glands. When the infected mosquito seeks a second blood-meal from an uninfected person, it could transfer the HIV from its salivary gland during the course of feeding. This is the mechanism involved in the transmission of yellow fever and dengue.

#### *Mechanical transmission*

Human defensive behaviour may prevent a partially blood-fed mosquito from completing a blood-meal on a person infected with HIV. However, instead of resuming feeding on the same person the mosquito may select an uninfected person to complete its feeding on. As it penetrates the skin of the new host, the mosquito could transfer HIV particles that were adhering to the mouthparts from the previous partial blood-meal. This is purely mechanical transmission because the virus does not undergo any multiplication or development in the mosquito. Mechanical

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transmission is not a common mechanism that mosquitoes use to spread infection but it is the method by which houseflies transmit the virus that causes poliomyelitis.

#### *Transmission through mosquito squashes*

Squashing mosquitoes is thought of by many people as an instinctive reaction triggered by the sight of the creatures on human skin. A mosquito that had had a partial blood-meal from an HIV carrier and resumed feeding on an uninfected person may be squashed into a cut in the skin. Viral infection could be initiated in this way depending on the quantity of viral particles contained in the partial blood-meal. Fully engorged mosquitoes usually contain between 1 and 3 µl of blood.

#### **Why HIV cannot be transmitted by mosquitoes**

Each of the three mechanisms has been investigated with a variety of blood-sucking insects and the results clearly show that AIDS cannot be transmitted by mosquitoes (4). For biological transmission to be possible the disease organism must remain alive inside the mosquito until it can be transferred. In the case of yellow fever it takes about 12 days for the virus to complete its cycle in the mosquito and appear in the saliva.

Studies with HIV have shown clearly that the virus disappears in the mosquito after about 1-2 days, the time required for the mosquito to digest the blood-meal. The mosquito regards HIV as food and digests it along with the blood. Since the virus does not survive to reproduce and invade the salivary glands, biological transmission of HIV is not possible.

Mechanical transmission of virus particles has been shown only for infections that result in high viraemia. HIV circulates at very low levels in the blood – well below the levels of any of the known mosquito-borne viruses – and is far less infectious. Mechanical transmission has been experimentally demonstrated for bovine leukaemia virus (BLV) and Rift Valley fever (RVF) virus using mosquitoes (5). However, RVF is characterized by high viraemia, which is not observed in the case of AIDS patients. In experimental studies of mechanical transmission of RVF virus, it

was shown that around one million infectious units/ml of host blood were required before mechanical transmission could be demonstrated. What constitutes a natural infective unit of HIV is not known but it is less than for RVF virus. HIV carriers normally have one in a million lymphocytes that are likely to be infected, which suggests that the level of infection in HIV carriers could be around six orders of magnitude too low for mechanical transmission to be expected (5). In fact, it has been calculated that an AIDS-free individual would have to be bitten by 10 million mosquitoes that had been feeding on an HIV carrier to receive a single unit of HIV from contaminated mosquito mouthparts. Based on the same calculations, it can be shown that crushing a mosquito containing HIV particles would still not begin to approach the levels needed to initiate infection. Therefore transmission of HIV via fresh blood in the mosquito gut is well beyond the limits of probability. BLV does not usually have a high viraemia but, unlike HIV, it causes lymphocytosis, increasing the number of blood lymphocytes, so that although the proportion of infected cells may be low, the overall number is quite high.

Studies on risk factors for the spread of AIDS in rural Africa showed that exposure to mosquitoes (as assessed by history of malaria) were not risk factors for HIV (6). In many areas where both AIDS and malaria are highly prevalent and people are exposed to mosquito bites throughout the year, it is rare to find children of the 5-10 year age group infected with HIV despite the fact that the prevalence of malaria in this age group is high. AIDS is a sexually transmitted disease with no evidence of arthropod transmission.

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