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Why Mosquitoes Cannot Transmit AIDS

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Media releases concerning the possibility of mosquitoes transmitting AIDS (Acquired Immune Deficiency Syndrome) were common when the disease was first recognized, and the subject is still addressed by tabloids that seek captivating headlines to increase their circulation. The topic was initiated by reports from a small community in southern Florida where preliminary evidence suggested that mosquitoes may have been responsible for the higher than average incidence of AIDS in the local population. The media was quick to publicize claims that mosquitoes were involved in AIDS transmission despite findings of scientific surveys of the National Centers for Disease Control (CDC) that clearly demonstrated that mosquito transmission of AIDS in that community appeared highly unlikely. Nevertheless, media releases perpetuated the concept that mosquitoes transmitted AIDS, and many people still feel that mosquitoes may be responsible for transmission of this infection from one individual to another.

There are three theoretical mechanisms which would allow blood-sucking insects such as mosquitoes to transmit HIV.

1. In the first mechanism, a mosquito would initiate the cycle by feeding on an HIV positive carrier and ingest virus particles with the blood meal. For the virus to be passed on, it would have to survive inside the mosquito, preferably increase in numbers, and then migrate to the mosquito's salivary glands. The infected mosquito would then seek its second blood meal from an uninfected host and transfer the HIV from its salivary glands during the course of the bite. This is the mechanism used by most mosquito-borne parasites, including malaria, yellow fever, dengue, and the encephalitis viruses.
2. In the second mechanism, a mosquito would initiate the cycle by beginning to feed on an HIV carrier and be interrupted after it had successfully drawn blood. Instead of resuming the partial blood meal on its

original host, the mosquito would select an AIDS-free person to complete the meal. As it penetrated the skin of the new host, the mosquito would transfer virus particles that were adhering to the mouthparts from the previous meal. This mechanism is not common in mosquito-borne infections, but equine infectious anemia is transmitted to horses by biting flies in this manner.

3. The third theoretical mechanism also involves a mosquito that is interrupted while feeding on an HIV carrier and resumes the partial blood meal on a different individual. In this scenario, however, the AIDS-free host squashes the mosquito as it attempts to feed and smears HIV contaminated blood into the wound. In theory, any of the mosquito-borne viruses could be transmitted in this manner providing the host circulated sufficient virus particles to initiate re-infection by contamination.

Each of these mechanisms has been investigated with a variety of blood sucking insects and the results clearly show that mosquitoes cannot transmit AIDS. News reports on the findings, however, have been confusing, and media interpretation of the results has not been clear. The average person is still not convinced that mosquitoes are not involved in the transmission of a disease that appears in the blood, is passed from person to person and can be contracted by persons that share hypodermic needles. Here are just some of the reasons why the studies showed that mosquitoes cannot transmit AIDS:

Mosquitoes Digest the Virus that Causes AIDS

When a mosquito transmits a disease agent from one person to another, the infectious agent must remain alive inside the mosquito until transfer is completed. If

the mosquito digests the parasite, the transmission cycle is terminated and the parasite cannot be passed on to the next host. Successful mosquito-borne parasites have a number of interesting ways to avoid being treated as food. Some are refractory to the digestive enzymes inside the mosquito's stomach; most bore their way out of the stomach as quickly as possible to avoid the powerful digestive enzymes that would quickly eliminate their existence. Malaria parasites survive inside mosquitoes for 9-12 days and actually go through a series of necessary life stages during that period. Encephalitis virus particles survive for 10-25 days inside a mosquito and replicate enormously during the incubation period. Studies with HIV clearly show that the virus responsible for the AIDS infection is regarded as food to the mosquito and is digested along with the blood meal. As a result, mosquitoes that ingest HIV-infected blood digest that blood within 1-2 days and completely destroy any virus particles that could potentially produce a new infection. Since the virus does not survive to reproduce and invade the salivary glands, the mechanism that most mosquito-borne parasites use to get from one host to the next is not possible with HIV.

Mosquitoes Do Not Ingest Enough HIV Particles to Transmit AIDS by Contamination

Insect-borne disease agents that have the ability to be transferred from one individual to the next via contaminated mouthparts must circulate at very high levels in the bloodstream of their host. Transfer by mouthpart contamination requires sufficient infectious particles to initiate a new infection. The exact number of infectious particles varies from one disease to the next. HIV circulates at very low levels in the blood—well below the levels of any of the known mosquito-borne diseases. Infected individuals rarely circulate more than 10 units of HIV, and 70 to 80% of HIV-infected persons have undetectable levels of virus particles in their blood. Calculations with mosquitoes and HIV show that a mosquito that is interrupted while feeding on an HIV carrier circulating 1000 units of HIV has a 1:10 million probability of injecting a single unit of HIV to an AIDS-free recipient. In laymen's terms, an AIDS-free individual would have to be bitten by 10 million mosquitoes that had begun feeding on an AIDS carrier to receive a single unit of HIV from contaminated mosquito mouthparts. Using the same calculations,

crushing a fully engorged mosquito containing AIDS positive blood would still not begin to approach the levels needed to initiate infection. In short, mechanical transmission of AIDS by HIV-contaminated mosquitoes appears to be well beyond the limits of probability. Therefore, none of the theoretical mechanisms cited earlier appear to be possible for mosquito transmission of HIV.

Mosquitoes Are Not Flying Hypodermic Needles

Many people think of mosquitoes as tiny, flying hypodermic syringes, and if hypodermic needles can successfully transmit HIV from one individual to another then mosquitoes ought to be able to do the same. We have already seen that HIV-infected individuals do not circulate enough virus particles to result in infection by contamination. However, even if HIV-positive individuals did circulate high levels of virus, mosquitoes could not transmit the virus by the methods that are employed in used syringes. Most people have heard that mosquitoes regurgitate saliva before they feed, but are unaware that the food canal and salivary canal are separate passageways in the mosquito. The mosquito's feeding apparatus is an extremely complicated structure that is totally unlike the crude single-bore syringe. Unlike a syringe, the mosquito delivers salivary fluid through one passage and draws blood up another. As a result, the food canal is not flushed out like a used needle, and blood flow is always unidirectional. The mechanics involved in mosquito feeding are totally unlike the mechanisms employed by the drug user's needles. In short, mosquitoes are not flying hypodermic needles and a mosquito that disgorges saliva into your body is not flushing out the remnants of its last blood meal.

For more in depth information on this topic see Staff Paper #1, *Do Insects Transmit AIDS?*, OTA series on AIDS-Related Issues, Health Program, Office of Technology Assessment, United States Congress, Washington, D.C. 20510-8025.

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