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EDITORIAL

# Preparing the United States for Zika Virus: Pre-emptive Vector Control and Personal Protection

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Discovered in 1947 in a monkey in the Zika forest of Uganda, Zika virus was dismissed as a cause of a mild illness that was confined to Africa and Southeast Asia and transmitted by *Aedes* mosquitoes. In 2007, Zika virus appeared outside of its endemic borders in an outbreak on the South Pacific Island of Yap. In 2013, Zika virus was associated with a major neurological complication, Guillain-Barré syndrome, in a larger outbreak in the French Polynesian Islands. From the South Pacific, Zika invaded Brazil in 2015 and caused another severe neurological complication, fetal microcephaly. The mosquito-borne transmission of Zika virus can be propagated by sexual transmission and, possibly, by blood transfusions, close personal contacts, and organ transplants, like other flaviviruses. Since these combined mechanisms of infectious disease transmission could result in catastrophic incidences of severe neurological diseases in adults and children, the public should know what to expect from Zika virus, how to prevent infection, and what the most likely failures in preventive measures will be. With federal research funding stalled, a Zika vaccine is far away. The only national strategies to prepare the United States for Zika virus invasion now are effective vector control measures and personal protection from mosquito bites. In addition to a basic knowledge of *Aedes* mosquito vectors and their biting behaviors, an understanding of simple household vector control measures, and the selection of the best chemical and physical mosquito repellents will be required to repel the Zika threat.

*Key words:* Zika virus, arboviruses, mosquito-borne infectious diseases, *Aedes aegypti*, *Aedes albopictus*

Four unexpected mosquito-borne arboviruses immigrated to the Americas from the tropics within 3 decades.[1] First, dengue slipped into the Americas from Southeast Asia (1980s) and is now established on the Mexican border. Then West Nile virus arrived from Africa and the Middle East (1999) and quickly crossed the continental United States. Recently, chikungunya arrived from the Caribbean via East Africa and India (2013), and Zika virus invaded the Americas from the South Pacific (2015).[1] Although all of the mechanisms responsible for these viral migrations cannot be explained, the global movements of these tropical viruses have been facilitated by international air travel capable of transporting virus-infected humans from endemic regions to anywhere in a warming world within 24 hours.

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## THE EPIDEMIOLOGY OF ZIKAVIRUS DISEASE

First discovered in 1947 in a rhesus monkey in the Zika forest of Uganda, Zika virus was dismissed as a cause of a periodic, mild febrile illness with rash and conjunctivitis confined to Africa and Southeast Asia.[2] Decades later, Zika erupted outside of its endemic borders on the South Pacific island of Yap in 2007.[3] The Yap outbreak was once again characterized by uncomplicated, short-term febrile illnesses.[3] However, by 2013, Zika virus was first associated with a major neurological complication, Guillain-Barré syndrome (GBS), an ascending flaccid paralysis, with over 40 cases reported in a larger outbreak

in the French Polynesian Islands.[4] From the French Polynesian Islands, Zika moved to Easter Island and then on to the Americas, invading Brazil in 2015.[5]

Clinical and neuroimaging studies have demonstrated that Zika's neurological complications represent a spectrum of central nervous system disorders with GBS linked to myelitis and meningoencephalitis, and microcephaly associated with severe brain, optic nerve, and chorioretinal damage. The Zika virus has now caused over 4000 cases of congenital microcephaly, a tragic birth defect characterized by a small, misshapen head with severe brain and ocular malformations, in Brazil.[5] Zika virus has been detected in the amniotic fluid and placentas of infected mothers and in the brains of microcephalic stillbirths and neonates.[5] In just a short period of time (2007–2013), the Zika virus has gained the capability to cause not only asymptomatic (80%) or mild (20%) illnesses in most people, but also severe neurological complications in adults and infants.

In an unprecedented method of arthropod-borne disease transmission, the sexual transmission of the Zika virus from males and females to their sex partners was confirmed serologically by rising immunoglobulin M Zika antibody titers and molecularly by viral RNA detection by reverse transcriptase-polymerase chain reaction.[6,7] In addition to local mosquito-transmitted infections, the spread of Zika virus disease will be accelerated by sexual transmission, blood and body fluid contact, and organ transplantation. Such combined mechanisms of infectious disease transmission could result in catastrophic incidences of severe neurological diseases in adults and children.

Since 2015, over 3000 Americans have contracted Zika virus disease while travelling in Zika-endemic regions. Today, the mosquito-borne, local transmission of Zika virus disease occurs as close to the US mainland as its Caribbean territory, Puerto Rico, which is experiencing a $70 billion debt crisis and a weakened public health infrastructure. Puerto Rico has reported over 17,000 mosquito-transmitted cases of Zika virus disease, with over 800 in pregnant women, 1 fatal case of GBS, and 1 neonatal fatality with microcephaly.

Although travel-related or imported Zika virus disease is still the predominant mode of disease transmission in the United States, local mosquito transmission is the predominant mode of disease transmission in the Caribbean and throughout Latin America. The local mosquito transmission of Zika virus disease has now been reported in Florida and is anticipated to occur in additional states shortly as more infected people arrive in the United States from hyperendemic nations in the Caribbean and Latin America.

As the numbers of imported and mosquito-borne cases of Zika virus disease are increasing over time in the

**Figure 1.** A female *Aedes aegypti* or yellow fever mosquito is acquiring a blood meal from a human host. This daytime-biting mosquito prefers to blood-feed feed on humans more than on animals and is a competent vector of Zika virus and other flaviviruses, including yellow fever virus, dengue virus, and chikungunya virus. Note the white bands on its legs and the silvery white lyre-shaped markings on its dorsal thorax. Source: The United States Centers for Disease Control and Prevention (CDC) Public Health Image Library (PHIL), PHIL ID 9253, Professor Frank Hadley Collins, Director, Center for Global Health and Infectious Diseases, University of Notre Dame. Photographer: James Gathany, Biomedical Photographer, CDC.

**Figure 2.** A female *Aedes albopictus* or Asian tiger mosquito is blood-feeding on a human host. This daytime-biting mosquito feeds on both animals and man and is a competent transmitting vector for chikungunya and dengue viruses. *A albopictus* is suspected to be a competent vector for the Zika virus, which is transmitted by several other *Aedes* species in addition to *Aedes aegypti,* the predominant vector in Latin America and the Caribbean. *A albopictus* has white bands on its legs like *A aegypti* and a single, longitudinal silvery white line on its dorsal thorax, which helps to distinguish it from *A aegypti.* Source: The United States Centers for Disease Control and Prevention (CDC) Public Health Image Library (PHIL), PHIL ID 1864, Professor Frank Hadley Collins, Director, Center for Global Health and Infectious Diseases, University of Notre Dame. Photographer: James Gathany, Biomedical Photographer, CDC.