Zika Virus

Stephen Higgs
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Biosecurity Research Institute (BRI): Pat Roberts Hall:
Mosquitoes pose a very significant health threat to much of the world's population.

Mosquito-borne Viruses of Significant Public Health Importance

- **Dengue fever**
  - 50-100 M cases, > 500,000 DHF/DSS cases
  - >20,000 deaths
  - 2.5-3 billion at risk in >100 countries

- **Chikungunya fever**
  - Estimated >1.7M cases in Caribbean, S & C America (ongoing)

- **Yellow fever**
  - Estimated 200,000 cases, 30,000 deaths

- **Japanese encephalitis**
  - Estimated 35-50,000 cases, 10,000 deaths

- **West Nile**
  - Estimated >2M infections in the USA between 1999-2015, 1,600 deaths

Based on WHO reports and CDC data.
Factors Related to Arbovirus Emergence

Human demographics and behavior
Technology and industry
Economic development and land use
International travel and commerce
Microbial adaptation and change
Breakdown of public health measures

Almost 2 billion people travel aboard commercial airlines every year

Lancet, 2009. Feb19 issue
Zika virus: Discovery

Rockefeller Foundation dedicated to arbovirus discovery 1947 (sentinel macaque), 1948 (mosquito), 1954 (human)
Zika virus: Discovery

Adapted from National Academy presentations by R. Rosenberg (platform photo by B. Beard)
And presentation by Scott Weaver
A member of the Flaviviridae family of RNA viruses

Genome is single positive strand of RNA ~ 10,600 nt
Transmitted by mosquitoes

Virus particle contains a lipid bilayer, one genome RNA, and three distinct types of viral proteins,:

1. E - envelope protein
3. C - capsid or core protein
Zika virus: Genetics


Adapted from National Academy presentation by R. Rosenberg
Zika Virus probably originated in Africa

Adapted from National Academy presentation by S. Weaver
Molecular evolution of Zika virus, an neglected emerging disease in Africa and Asia

Oumar Faye1, Ousmane Faye1, Caio César de Melo Freire2, Juliana Velasco de Oliveira2, Chen Rubing3, Paolo M de Andrade Zanotto2, Diallo Mawlouth1, Amadou Alpha Sall1

From Institut Pasteur International Network Annual Scientific Meeting
Hong Kong, 22-23 November 2010

Zika virus (ZIKV) is an arbovirus transmitted by mosquitoes isolated for the first time in Zika forest, Uganda in 1947 and repeatedly isolated in sub-Saharan Africa and South East Asia. Until 2000, only few human cases were reported but in 2007, the first major human outbreak was notified in Yap island, Micronesia leading to 99 cases. Despite the widespread distribution of Zika virus, very limited information is available on the genetic relationship between the circulating strains. Therefore, we undertook a study on phylogeny and phyleodynamics ZIKV in Africa and Asia. Partial and full length genome sequences of 38 strains from Senegal, Ivory Coast, Burkina Faso, Central African Republic and Malaysia were analysed. Phylogenetic reconstructions and data were performed while recombination and viral population migrations were investigated. Phylogenetic analysis of the E, NS5 and NS5/3′NC gene showed two strains. Asian strains may represent a divergent lineage related to a common ancestor with spread throughout Southeast Asia and the Pacific from Africa.

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Genetic Characterization of Zika Virus Strains: Geographic Expansion of the Asian Lineage

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Abstract

Background: Zika virus (ZIKV) is a mosquito-borne flavivirus distributed throughout much of Africa and Asia. Infection with the virus may cause acute febrile illness that clinically resembles dengue fever. A recent study indicated the existence of three geographically distinct viral lineages; however, this analysis utilized only a single viral gene. Although ZIKV has been known to circulate in both Africa and Asia since at least the 1950s, little is known about the genetic relationships between geographically distinct virus strains. Moreover, the geographic origin of the strains responsible for the epidemic that occurred on Yap Island, Federated States of Micronesia in 2007, and a 2010 pediatric case in Cambodia, has not been determined.

Methodology/Principal Findings: To elucidate the genetic relationships of geographically distinct ZIKV strains and the origin of the strains responsible for the 2007 outbreak on Yap Island and a 2010 Cambodian pediatric case of ZIKV infection, the nucleotide sequences of the open reading frame of five isolates from Cambodia, Malaysia, Nigeria, Uganda, and Senegal collected between 1947 and 2010 were determined. Phylogenetic analyses of these and previously published ZIKV sequences revealed the existence of two main virus lineages (African and Asian) and that the strain responsible for the Yap epidemic and the Cambodian case most likely originated in Southeast Asia. Examination of the nucleotide and amino acid sequence alignments revealed the loss of a potential glycosylation site in some of the virus strains, which may correlate with the passage history of the virus.

Conclusions/Significance: The basal position of the ZIKV strain isolated in Malaysia in 1966 suggests that the recent outbreak in Micronesia was initiated by a strain from Southeast Asia. Because ZIKV infection in humans produces an illness clinically similar to dengue fever and many other tropical infectious diseases, it is likely greatly misdiagnosed and underreported.
Molecular Evolution of Zika Virus during Its Emergence in the 20th Century

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Abstract

Zika virus (ZIKV) is a mosquito-borne flavivirus first isolated in Uganda in 1947. Although entomological and virologic surveillance have reported ZIKV enzootic activity in diverse countries of Africa and Asia, few human cases were reported until 2007, when a Zika fever epidemic took place in Micronesia. In the context of West Africa, the WHO Collaborating Centre for Arboviruses and Hemorrhagic Fever at Institut Pasteur of Dakar (http://www.pasteur.fr/recherche/banques/CRORA/) reports the periodic circulation of ZIKV since 1968. Despite several reports on ZIKV, the genetic relationships among viral strains from West Africa remain poorly understood. To evaluate the viral spread and its molecular epidemiology, we investigated 37 ZIKV isolates collected from 1968 to 2002 in six localities in Senegal and Côte d’Ivoire. In addition, we included strains from six other countries. Our results suggested that these two countries in West Africa experienced at least two independent introductions of ZIKV during the 20th century, and that apparently these viral lineages were not restricted by mosquito vector species. Moreover, we present evidence that ZIKV has possibly undergone recombination in nature and that a loss of the N154 glycosylation site in the envelope protein was a possible adaptive response to the Aedes dalzielli vector.
**ZIKV transmission cycles**

**SYLVATIC CYCLE**
- *Pattas monkey*
  - *Erythrocebus patas* (wadi or hussar monkey)
- *Primates*
  - *Vervet monkey*
  - *Chlorocebus sabaeus*
- *Rodents?*
  - Gerbils, *Tutex indica*, jirds, *Meriones hurrianae*
- Sheep and goats?
- *Aedes aegypti*, *Aedes albopictus*, *Aedes hensilli?*

**URBAN CYCLE**
- *Aedes aegypti*, *Aedes albopictus*, *Aedes hensilli?*
- *Anopheles coustani*, *An. gambiae s.l.*
- *Mansonia uniformis*, *Culex perfuscus*
Zika virus: Spread

Adapted from National Academy presentation by R. Rosenberg

1947
Discovery
Zika virus: Spread

Adapted from National Academy presentation by R. Rosenberg
Zika virus: Spread

Adapted from National Academy presentation by R. Rosenberg
Zika virus: Spread

Adapted from National Academy presentation by R. Rosenberg
Zika virus: Yap Island

Adapted from National Academy presentation by R. Rosenberg
Zika Virus Outbreak on Yap Island, Federated States of Micronesia

Mark R. Duffy, D.V.M., M.P.H., Tai-Ho Chen, M.D.,
W. Thane Hancock, M.D., M.P.H., Ann M. Powers, Ph.D.,
Jacob L. Kool, M.D., Ph.D., Robert S. Lanciotti, Ph.D., Moses Pretrick, B.S.,
Maria Marfel, B.S., Stacey Holzbauer, D.V.M., M.P.H.,
Christine Dubray, M.D., M.P.H., Laurent Guillaumot, M.S., Anne Griggs, M.P.H.,
Martin Bel, M.D., Amy J. Lambert, M.S., Janeen Laven, B.S., Olga Kosoy, M.S.,
Amanda Panella, M.P.H., Brad J. Biggerstaff, Ph.D., Marc Fischer, M.D., M.P.H.,
and Edward B. Hayes, M.D.
49 confirmed and 59 probable cases of Zika virus disease. Most patients had mild illness.

Rash, fever, arthralgia, and conjunctivitis were common symptoms. No hospitalizations, hemorrhagic manifestations, or deaths due to Zika virus were reported.

Estimated that 73% of Yap residents 3 years of age or older were infected with Zika virus (more than 900 people in total).

The mosquito vector was not identified but *Aedes hensilli* was the predominant mosquito species identified.
Infection rates of up to 86%, 62%, and 20% and dissemination rates of 23%, 80%, and 17% for Zika, chikungunya, and dengue-2 viruses respectively,
2013 – French Polynesia
• Estimated 28,000 (11% population) – clinically similar to Yap, but...
• First suspect association Guillan-Barré syndrome
• 2015 retrospective case review: increase in microcephaly
• 2014 – New Caledonia, Cook Islands, Solomons, Easter Island
• Asian genotype – Yap, Cambodia
Rapid Communications

Evidence of perinatal transmission of Zika virus, French Polynesia, December 2013 and February 2014

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A Zika virus (ZIKAV) outbreak started in October 2013 in French Polynesia, South Pacific. We describe here the clinical and laboratory features of two mothers and their newborns who had ZIKAV infection as confirmed by ZIKAV RT-PCR performed on serum collected within four days post-delivery in date. The infants’ infection most probably occurred by transplacental transmission or during delivery. Attention should be paid to ZIKAV-infected pregnant women and their newborns, as data on the impact on them are limited.

Since October 2013, French Polynesia has experienced the largest outbreak of Zika virus (ZIKAV) infection ever reported, with an estimate of 28,000 ZIKAV infections in early February 2014 (about 11% of the population) [1,2]. We report here evidence of perinatal transmission of ZIKAV in French Polynesia in December 2013 for premature newborns was started due to hypoglycaemia and breastfeeding was started, in addition, from the third day post-delivery (day 3). On day 3, the mother presented a mild fever (37.5-38 °C) with pruritic rash and myalgia. The following day, after a three-hour ultraviolet light session for neonatal jaundice, the newborn presented transiently an isolated diffuse rash. Both mother and infant evolved favourably.

Laboratory features
All available samples collected from Mother 1 and Newborn 1 until day 3 and from Mother 2 and Newborn 2 until day 13 were tested for ZIKAV and dengue virus (DENV). No other pathogens were tested for, given the co-circulation of DENV (serotypes 1 and 3) [3] and ZIKAV.
Zika virus infection complicated by Guillain-Barré syndrome – case report, French Polynesia, December 2013

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Zika fever, considered as an emerging disease of arboviral origin, because of its expanding geographic area, is known as a benign infection usually presenting as an influenza-like illness with cutaneous rash. So far, Zika virus infection has never led to hospitalisation. We describe the first case of Guillain–Barré syndrome (GBS) occurring immediately after a Zika virus infection, during the current Zika and type 1 and 3 dengue fever co-epidemics in French Polynesia. Elevated distal motor latency, elongated F-wave, conduction block and acute denervation, without axonal abnormalities. The administration of intravenous polyvalent immunogloobulin (0.4 g/kg/day for 5 days) allowed a favourable evolution, with no respiratory impairment necessitating tracheotomy or intensive care unit monitoring, and the patient was discharged home at Day 13. Paraparesis persisted after the end of hospitalisation, that imposed the use of a walking frame, and the facial palsy slowly disappeared. At Day...
Zika virus: Spread

Adapted from National Academy presentation by R. Rosenberg
Since May 14, 2015, Brazil’s Ministry of Health has reported 16 Zika virus cases. This is the first report of this virus in Brazil.

Zika virus is spread to humans through the bite of infected mosquitoes that are from the same family as the dengue mosquito (den breakbone fever). Symptoms usually appear 3-12 days after being bitten. Symptoms are generally mild and can include:

- Fever
- Rash
- Headache
- Joint pain
- Conjunctivitis

According to the Health Minister, Arthur Chioro, eight patients are from Camaçari city, in the State of Bahia. The other cases were confirmed in cities of Rio Grande do Norte. The number could rise, as other 1,200 cases, mostly in the Northeast, are still being investigated.

Researchers at the UFBA (Federal University of Bahia) who were investigating a “mysterious disease” in the Northeast, as Folha published in early May, identified the virus.

The suspicion is that it has arrived in Brazil with tourists at the World Cup. Chioro believes the existence of confirmed cases of Zika virus in the country "does not worry".
Zika Case Distribution by Week: March 9

- 193 travel associated cases
- 0 locally transmitted cases
- US territories
  - 1 travel
  - 173 local

Only 4 cases of Zika virus in Peru: All are travel-related
MOSQUITO INFECTIONS
ZIKV transmission cycles

SYLVATIC CYCLE

Patas monkey
Erythrocebus patas (wadi or hussar monkey)

Ae. africanus, Ae. apicoargenteus, Ae. dalzieli,
Ae. furcifer (inc males), Ae. hirsutus, Ae. luteocephalus,
Ae. metallicus, Ae. unilinaetus, Ae. vitattus.
Anopheles coustani, An. gambiae s.l.
Mansonia uniformis, Culex perfuscus

URBAN CYCLE

Vervet monkey
Chlorocebus sabaeus

Rodents?
gerbils, Tutex indica,
jirds, Meriones hurrianae
Sheep and goats?

Ae. aegypti
Ae. albopictus
Ae. hensilli ?
The first isolation of Zika virus from mosquito samples was made in 1948 from *Aedes africanus*.

Lately, many other *Aedes* species have been surveyed for the detection of Zika virus, and thus far, Zika virus has been detected by RT-PCR or isolated from many mosquito species, human beings, and non-human primates.
Zika Virus in Gabon (Central Africa) – 2007: A New Threat from *Aedes albopictus*?

Gilda Grard¹, Mélanie Caron¹, Illich Manfred Mombo¹,², Dieudonné Nkoghe¹,³, Statiana Mboui Ondo¹, Davy Jiolle²,⁴, Didier Fontenille², Christophe Paupy²,⁴, Eric Maurice Leroy¹,²

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**Abstract**

**Background:** Chikungunya and dengue viruses emerged in Gabon in 2007, with large outbreaks primarily affecting the capital Libreville and several northern towns. Both viruses subsequently spread to the south-east of the country, with new outbreaks occurring in 2010. The mosquito species *Aedes albopictus*, that was known as a secondary vector for both viruses, recently invaded the country and was the primary vector involved in the Gabonese outbreaks. We conducted a retrospective study of human sera and mosquitoes collected in Gabon from 2007 to 2010, in order to identify other circulating arboviruses.

**Methodology/Principal Findings:** Sample collections, including 4312 sera from patients presenting with painful febrile disease, and 4665 mosquitoes belonging to 9 species, split into 247 pools (including 137 pools of *Aedes albopictus*), were screened with molecular biology methods. Five human sera and two *Aedes albopictus* pools, all sampled in an urban setting during the 2007 outbreak, were positive for the flavivirus Zika (ZIKV). The ratio of *Aedes albopictus* pools positive for ZIKV was similar to that positive for dengue virus during the concomitant dengue outbreak suggesting similar mosquito infection rates and, presumably, underlying a human ZIKV outbreak. ZIKV sequences from the envelope and NS3 genes were amplified from a human serum sample. Phylogenetic analysis placed the Gabonese ZIKV at a basal position in the African lineage, pointing to ancestral genetic diversification and spread.

**Conclusions/Significance:** We provide the first direct evidence of human ZIKV infections in Gabon, and its first occurrence in the Asian tiger mosquito, *Aedes albopictus*. These data reveal an unusual natural life cycle for this virus, occurring in an urban environment, and potentially representing a new emerging threat due to this novel association with a highly invasive vector whose geographic range is still expanding across the globe.
Zika virus: Vectors

*Aedes albopictus* the Asian Tiger Mosquito (photo S. Higgs)

Ae. albopictus movement between countries

Between 1989 and 1994, 7.5M tyres imported into USA, (5M from 14 Asian Countries including 4.7M from Japan). 6M were exported from the USA.
Ae. albopictus movement within countries
Zika virus: Vectors

Adapted from National Academy presentation by T. Monath

Brady et al Parasites and Vectors 2014, 7:338
Zika virus/viral RNA have been detected in a number of species of mosquitoes in several genera

Aedes aegypti,
Ae. africanus,
Ae. apicoargenteus,
Ae. dalzieli
Aedes furcifer (including males)
Ae. hirsutus
Ae. luteocephalus
Ae. metallicus
Ae. unilinaetus
Ae. vitattus.
Anopheles coustani,
An. gambiae s.l
Mansonina uniformis
Culex perfuscus

Studies show that the extrinsic incubation period in mosquitoes is about 10 days.
Zika virus: Vectors

Adapted from National Academy presentation by T. Monath
Aedes albopictus
A Female Mosquito Typically Becomes Exposed Naturally to a Virus When Feeding on a Viraemic Host

Labium (sheath) fold back as the stylets penetrate the skin to obtain blood
Engorgement of blood
Engorgement of blood
Engorgement of blood from a viremic vertebrate
Engorgement of blood from a viremic vertebrate

Hemocoel – “open” circulatory system in which organs are suspended
Virus Entry into Midgut Cells

For the enveloped arboviruses, it is generally assumed that the surface structural proteins interact with receptors on the midgut epithelial cell membrane and following attachment, fusion of the viral envelope and cellular membrane occurs.

Although infection is probably a receptor-mediated event, no specific receptor has been identified in the mosquito midgut.
Virus infection: binding to receptor? The basis of specificity?

ZIKV and Aedes aegypti/albopictus
Virus replication and spread
Spread of virus within midgut
Dissemination from the midgut into the hemocoel
Dissemination from the midgut into the hemocoel

- Nervous system
- Salivary glands
- Fat body
- Hemocoel
West Nile virus: Infection of muscles around the midgut
Virus replication in secondary tissues
Infection of the fat body by Sindbis virus
WNV in Nervous System of *Cx.p.q.* at 14 days pi

- Cerebral ganglion (brain)
- Suboesophageal ganglion
- Ommatidia
- Ventral nerve chord
- Thoracic ganglion

X 10
SINDV in the Ventral Nerve Chord & Abdominal Ganglia
CHIKV 5’GFP in a Pair of Ae. albopictus Salivary Glands
Collection of Saliva from Individual Mosquitoes for Viral or Protein Analysis.

**Salivary glands of Aedes aegypti**

- 10% PAGE, silver stained

**Markers**

- 1 Female

**Proteins Detected**

- Sialokinin I (1.4kDa)
- D7 protein (37kDa)
- Glucosidase (68kDa)
- Apyrase (68kDa)
- Amylase (97kDa)

Salivary glands of *Aedes aegypti* 10% PAGE, silver stained
West Nile Virus in *Culex pipiens quinquefasciatus* Saliva
Saliva

West Nile Virus particles

Cytoplasm
HUMAN INFECTIONS
During an epidemic of jaundice in Eastern Nigeria infection with Zika virus was shown to have occurred in three patients, one by isolation of the virus and two by a rise in serum antibodies. Two of these patients gave evidence of liver damage. Serological studies indicate a relationship between jaundice and the development of virus neutralizing bodies in the serum.
SUMMARY

(1) has been inoculated with the Eastern Nigerian strain of Zika virus.

(2) Following an incubation period of 82 hours a mild, short-lived febrile condition occurred without evidence of involvement of any particular tissue or viscus.

(3) Zika virus was isolated from the blood during the febrile period.

(4) Aedes aegypti fed at the times of virus isolation failed to transmit the infection to infant white mice.

(5) A rise in serum antibody to both Zika and yellow fever viruses was demonstrated by both mouse protection and haemagglutination inhibition tests.
DOi: 10.3201/eid1705.101939


**Probable Non–Vector-borne Transmission of Zika Virus, Colorado, USA**

Potential Sexual Transmission of Zika Virus

Didier Musso, Claudine Roche, Emilie Robin, Tuxuan Nhan, Anita Toissier, Van-Mai Cao-Lormeau

In December 2013, during a Zika virus (ZIKV) outbreak in French Polynesia, a patient in Tahiti sought treatment for hemospermia, and ZIKV was isolated from his semen. ZIKV transmission by sexual intercourse has been previously suspected. This observation supports the possibility that ZIKV could be transmitted sexually.

Zika virus (ZIKV) is a mosquito-borne arbovirus in the family *Flaviviridae*, genus *Flavivirus*. It was first isolated in 1947 from a rhesus monkey in the Zika forest of Uganda (1). Sporadic human cases were reported from the 1960s in Asia and Africa. The first reported large outbreak occurred in 2007 on Yap Island, Federated States of Micronesia (2). The largest known ZIKV outbreak reported started in October 2013 in French Polynesia, South Pacific (3), a territory of France comprising 118 inhabited islands; an estimated 28,000 persons (11% of the population) sought medical care for the illness (4). The most common symptoms of Zika fever are rash, fever, arthralgia, and conjunctivitis. Most of the patients had mild disease, but severe neurologic complications have been described in other patients in French Polynesia (5).

The Study

In early December 2013, during the ZIKV outbreak, a 44-year-old man in Tahiti had symptoms of ZIKV infection: arthralgia, low grade fever (temperature from 37.5°C to 38°C) and arthralgia. Symptoms lasted 4 days. Eight weeks later, he described a second episode of symptoms compatible with ZIKV infection: temperature from 37.5°C to 38°C, afebrile arthralgia, and a dense peripheral lymphocytosis. He had normal semen analysis with zero sperm/mL. However, semen confirmed hemospermia. We extracted RNA using the NucliSens easyMAG system (bioMérieux, Marcy l’Etoile, France) from 200 µL of blood and from 500 µL of semen and urine, both were eluted by 50 µL of elution buffer. We used 5 µL of RNA extracted for amplification. We tested blood and semen RNA extracts using real-time reverse transcription PCR (rRT-PCR) as described using 2 primers/probe amplification sets specific for ZIKV (3).

The rRT-PCR results were positive for ZIKV in semen and negative in blood, and confirmed by sequencing of the genomic position 756–1138 encompassing the prM/E protein coding regions of ZIKV. The generated sequence (GenBank accession no. KM014700) was identical to those previously reported at the beginning of the ZIKV outbreak (3). Three days later, we collected a urine sample, then a second set of blood and semen samples. Semen and urine from this second collection were not found to contain traces of blood by both direct and macroscopic examinations. rRT-PCR detected ZIKV RNA in the semen and urine, but not in the blood sample.

We quantified ZIKV RNA loads using an RNA synthetic transcript standard that covers the region targeted by the 2 primers/probe sets. RNA loads were: 2.9 × 10^7 copies/mL and 1.1 × 10^8 copies/mL in the first and second semen samples, respectively, and 3.8 × 10^7 copies/mL in the urine sample.

We cultured semen and urine as described for dengue virus cultured from urine (6). Briefly, 200 µL of each sample diluted in 200 µL of 1% fetal calf serum (FCS) minimum essential medium (MEM) were inoculated
ZIKV IN THE AMERICAS
Zika Virus Global Distribution before May 2015
Brazil has confirmed cases of Zika virus infection

Since May 14, 2015, Brazil's Ministry of Health has reported 16 cases of Zika virus. This is the first report of this virus in Brazil.

Zika virus is spread to humans through the bite of infected mosquitoes, which are of the same family as the dengue mosquito (den vector of dengue fever). Symptoms usually appear 3-12 days after being bitten. Symptoms are generally mild and can include:

FOLHA DE S.PAULO

Ministry of Health Confirms 16 Cases of Zika Virus in Brazil

Brazil’s Ministry of Health has confirmed that 16 patients were infected by the Zika virus. The infectious agent, unprecedented in the country, is transmitted by the mosquito Aedes aegypti, the same vector as dengue fever.

According to the Health Minister, Arthur Chioro, eight patients are from Camaçari city, in the State of Bahia. The other cases were confirmed in cities of Rio Grande do Norte. The number could rise, as another 1,200 cases, mostly in the Northeast, are still being investigated.

Researchers at the UFBA (Federal University of Bahia) who were investigating a "mysterious disease" in the Northeast - as Folha published in early May - identified the virus. The suspicion is that it has arrived in Brazil with tourists at the World Cup. Chioro believes the existence of confirmed cases of Zika virus in the country "does not worry."
Zika Virus in Brazil, May 2015

Countries that have past or current evidence of Zika virus transmission (as of May 2015)

- **Locally-acquired cases or virus isolation**
- **Serosurvey data only**
Zika Virus in Dominican Republic, 3 June 2015
Zika Virus in Brazil, October 2015
WHO director general Dr Margaret Chan: "The level of concern is high as is the level of uncertainty"

Zika virus: Up to four million Zika cases predicted

James Gallagher
Health editor, BBC News website

4 hours ago | Health

Three to four million people could be infected with Zika virus in the Americas this year, the World Health Organization (WHO) predicts.

Updated: 2 MINUTES AGO

Zika "spreading explosively," global health experts warn

January 27 8:25 PM EST

Watchdog questions Wounded Warrior Project's outlays

Updated: 10 MINUTES AGO

A disease linked to the Zika virus in Latin America poses a global public health emergency requiring a united response, says the World Health Organization.

Updated: 16 MINUTES AGO

The virus is linked to thousands of cases of microcephaly in Brazil

Updated: 2 MINUTES AGO

Zika-linked condition: WHO declares global emergency

Michelle Roberts
Health editor, BBC News online

16 hours ago | Health

A disease linked to the Zika virus in Latin America poses a global public health emergency requiring a united response, says the World Health Organization.
WHAT IS HAPPENING WITH ZIKA VIRUS IN THE AMERICAS?
• Evidence from small case series in outbreak settings
• Majority of cases are asymptomatic. Clinical attack rate: 18%
• Self-limiting illness (immunocompetent)
• Viremia short but shedding may be prolonged in urine (15d) and semen (62d)
• Knowledge gaps:
  Duration of viremia and viral shedding. Implications of prolonged shedding
Where Zika Virus Is In The Americas

Countries and territories with CDC travel alerts related to the Zika virus

Zika virus is transmitted:

- **By mosquitos of the Aedes genus**
  The same mosquitos that spread dengue and chikungunya viruses.

- **From mother to child**
  It’s rare, but a woman infected with Zika can pass the virus to her child during birth, or possibly to the fetus during pregnancy.

- **Possibly through blood or sexual contact**
  This link is not confirmed.

Source: WHO, CDC
Health experts strongly suspect a link between the virus and microcephaly

Zika: Panama has 'first microcephaly case outside Brazil'

2 hours ago | Latin America & Caribbean

Panama has registered a baby born with a brain disorder believed linked to the Zika virus, in what is thought to be the first such case outside Brazil in the current outbreak.
• Evidence with Guillain-Barré Syndrome (GBS). 42 cases during outbreak in French Polynesia (pop. 270,000). 100-200 GBS among ~400k-1m cases during Brazil epidemic. One confirmed case (Oehler et al, Eurosurveillance, 2014)

• Knowledge gaps
  Association? Barrier of diagnosing post infectious process in populations previously exposed to flaviruses
• Clinical presentation and outcomes? Anecdotal experience: classic GBS, responsive to IVIG
• Risk after exposure, either symptomatic or asymptomatic infection?
• Confounding with chikungunya
• Other neurological manifestations?: isolated sensory disturbances, encephalitis, ADEM

Adapted from National Academy presentation by A. Ko
CONTROL OF ZIKA VIRUS IN THE AMERICAS
Arbovirus Control = Vector Control ( +/- Vaccination)
Public awareness: repellants, avoidance

**GOING TO THE AMERICAN TROPICS?**

**MOSQUITOES** spread DENGUE, CHIKUNGUNYA, ZIKA, and other diseases

Mosquitoes bite day and night. Prevent mosquito bites:
- Use insect repellent
- Use air conditioning or window/door screens
- Wear long-sleeved shirts and long pants

**DON’T LET MOSQUITOES RUIN YOUR TRIP**

For more information, visit [www.cdc.gov/travel](http://www.cdc.gov/travel)
“Alternative Approaches to Control Dengue and Chikungunya”

Release of Insects carrying a Dominant Lethal gene (RIDL)

*Wolbachia* spp – infected mosquitoes. Intracellular bacteria that infects multiple tissues including ovaries and salivary glands.
The Aedes aegypti mosquitoes are the transmitters of three viruses

GM mosquito expansion announced

4 days ago | Science & Environment

A company producing GM mosquitoes says it is to open a new factory in Brazil as it expand its operations.
In French Polynesia, 42 of 1,505 (3%) blood donors, although asymptomatic at the time of blood donation, were found positive for Zika virus genome by PCR.

Media in Brazil reported a case of transfusion-transmitted Zika virus infection in March 2015 from an asymptomatic 52-year-old donor in of Campinas (Unicamp)
Public awareness

Brazil warns against pregnancy due to spreading virus
By Shasta Darlington, CNN

Story Highlights
Officials link Zika, a mosquito-borne virus, to a surge in a newborn neurological

"If families can put off their pregnancy plans, that's what we're recommending."

Zika virus triggers pregnancy delay calls
1 day ago | Latin America & Caribbean

Officials in four Latin American and Caribbean nations have warned women to avoid pregnancy amid concerns over an illness causing severe birth defects.

Zika: US issues fresh guidance amid birth defect fears
3 hours ago | Latin America & Caribbean

US health officials have issued new guidance to deal with the Zika virus, which is feared to cause birth defects.
Zika virus travel warnings spread to Africa and Oceania

Travel warnings to pregnant women have been extended to eight more countries or territories amid concerns over an illness causing severe birth defects.

Pregnant Britons' Zika travel warning

Michelle Roberts
Health editor, BBC News online

7 hours ago | Health

Pregnant Britons are being advised to reconsider travel to areas where Zika virus outbreaks are happening.

Zika virus: Airlines are refunding tickets to Latin America

Jim Boulden

London (CNNMoney) -- Airlines are starting to offer refunds to passengers who have booked flights to countries in central and south America caught up in the Zika virus.
Funding

Obama calls for urgent action on Zika

Zika virus: President Obama calls for urgent action

US President Barack Obama has called for urgent action against the Zika virus, which has been linked to babies being born with underdeveloped brains.
Brazil Zika outbreak: New test kits for mosquito-borne viruses

The Brazilian Health ministry says it's developed new testing kits to rapidly identify the presence of three viruses - Dengue, Zika and Chikungunya - all carried by the same mosquito.
ZIKV: WHAT IS LEFT TO DO?

New vectors in the Americas
New control (RIDL, Wolbachia)
Insecticides
Repellants

Surveillance
Predictive models

Reagents
Detection
Diagnostics (differential)

VECTORS

ENVIRONMENT

Salivary effects

ZIKA VIRUS

HOST

New Vertebrates
(NW primates, rodents, livestock)

Viral genetics:
Asian vs African infectivity pathogenicity

Disease
Guillain-Barre microcephaly sexual transmission persistence

Treatments
Vaccines

Animal Models
ZIKV transmission cycles in the Americas?

SYLVATIC CYCLE

URBAN CYCLE

Primates

Vectors

Ae. aegypti
Ae. albopictus

KANSAS STATE UNIVERSITY

Biosecurity Research Institute
# New World Primates (135 spp.)

<table>
<thead>
<tr>
<th>FAMILY</th>
<th>COMMON NAME</th>
<th>NUMBER of SPECIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Family Callitrichidae</td>
<td>Marmosets and Tamarins</td>
<td>20 marmosets 22 tamarins</td>
</tr>
<tr>
<td>Family Cebidae</td>
<td>Capuchins and Squirrel monkeys</td>
<td>9 capuchins 5 squirrel</td>
</tr>
<tr>
<td>Family Aotidae</td>
<td>Night/Owl monkeys</td>
<td>11</td>
</tr>
<tr>
<td>Family Pitheciidae</td>
<td>Titis, Sakis and Uakaris</td>
<td>29 titis 10 sakis 5 uakari</td>
</tr>
<tr>
<td>Family Atelidae</td>
<td>Howler, Spider, Wooly spider &amp; Wooly</td>
<td>10 howler 7 spider 2 wooly spider 5 woolly</td>
</tr>
</tbody>
</table>
Results Over-all prevalence rates were highest for WN, DEN and JE viruses (3.2% to 7.8%) followed by ZIKA (2.4%) and the other four viruses (Table I). CF titres were high (1:16 and/or 1:32) for certain samples of each virus except CHIK (Table II). All ZIKA and RF titres were 1:8 or higher. Between 60% and 70% of the WN, JE, SIN, and UGS titres were 1:8 or higher. In rodent sera, 72% (18 of 25) reacted to one virus and 28% (7 of 25) reacted to two or more (mostly two) viruses. High eF titres (1:16 and/or 1:32) were obtained with WN, JE, SIN, ZIKA, and RF viruses (Table III).
SOURCES FOR MORE INFORMATION
On Tuesday, February 16, 2016, the National Academies of Sciences, Engineering and Medicine is hosting a national workshop entitled "Research Priorities to Inform Public Health and Medical Practice for Domestic Zika Virus" at the National Academies of Science in Washington, DC. This workshop is in response to a fast-track workshop request from the HHS Assistant Secretary of Preparedness and Response as a result of the emergence of the Zika virus in the U.S. While the focus will be domestic in nature, an international perspective on the emergence of the virus cannot be overlooked. The specific workshop focus is to identify the research priorities associated with this virus that will inform public health and medical practice moving forward.

Several ASTMH experts are participating including, President Steve Higgs, PhD, FRES, FASTMH, former presidents Duane Gubler, ScD, and Tom Monath, MD, FACP, FASTMH, and former councilors Scott Weaver, PhD, FASTMH, and Mary E. Wilson, MD. See the complete agenda and speakers [here](#).

Plenary sessions and discussions will be available via live video webcast. Following the event, a brief written document based on the presentations and discussions held at the workshop will be prepared. No consensus findings or recommendations will be issued.
Main conclusions

- This is the first documented outbreak of Zika virus (ZIKV) infection in Brazil and the Americas.
- Vigilance should be enhanced towards the detection of imported cases of ZIKV infection in EU Member States, EU Overseas Countries and Territories, and EU Outermost Regions, in particular where potential vectors are present. Early detection of cases is essential to reduce the risk of autochthonous transmission in regions where potential vectors are established.
- Clinicians and travel medicine clinics should be aware of the evolution of ZIKV-affected areas in Brazil and the Pacific region and should include ZIKV infection in their differential diagnosis for travellers from those areas. Fever and/or macular or papular rash not attributable to dengue or chikungunya infection among travellers returning from areas currently experiencing ZIKV outbreak should prompt further investigation for ZIKV infection.
- Imported ZIKV cases are possible in EU Overseas Countries and Territories and EU Outermost Regions, with onwards autochthonous transmission where potential vectors are present.
- Autochthonous transmission in EU Members States in continental Europe, arising from imported cases during the summer season in areas where Aedes albopictus are established, cannot be excluded. Vigilance during the mosquito season is required in areas where potential vectors are present.
- The laboratory capacity to confirm suspected ZIKV infections should be strengthened in the European region in order to differentiate ZIKV infections from other arboviral dengue-like infections.
- Blood safety authorities need to be vigilant regarding the epidemiological situation and might wish to consider deferral of donors with relevant travel history, in line with measures defined for West Nile virus.
- As exposure to infected mosquitoes is the principal risk for infection, prevention of ZIKV infection is based...
Zika Virus: What you need to know

Zika is:

- A virus spread through Aedes species mosquito bites. Aedes mosquitoes also spread dengue and chikungunya viruses.
- A risk to anyone travelling to a region of the world where Zika virus is found.

Global risk

Outbreaks have occurred in parts of Africa, Southeast Asia, and the Pacific Islands. In May 2015, Brazil reported the first outbreak of Zika virus in the Americas.

Zika virus is not currently found in the United States. However, cases of Zika have been previously reported in returning travelers.
RECENTLY IN THE AMERICAN TROPICS?

MOSQUITOES spread DENGUE, CHIKUNGUNYA, ZIKA, and other diseases.

Watch for fever with, muscle, or eye pain, or a rash in the next 2 weeks.

If you get sick, see a doctor. Tell the doctor where you traveled.

For more information, visit www.cdc.gov/travel
ViPR Zika portal website

ViPR Zika Portal
12 FEB 2016
www.viprbrc.org

- Easy rapid access to Zika-related news and data
- Consistent annotation of mature peptide predictions
- Zika genotype annotations
- Comparative genomics tools for all Flaviviruses
- Personal workspaces for storing private data and analysis results
ASTMH/ACAV STATEMENT on Zika Virus

"Many of us in the research community are very concerned that Zika has the potential to spread further and become permanently established in the Americas," said Stephen Higgs, PhD, FRS, FASTMH, President of the American Society of Tropical Medicine and Hygiene and Director, Biosecurity Research Institute at Kansas State University. "Given the successful spread and establishment of chikungunya virus in the Americas by the same mosquitoes that carry Zika, it is vital that people take steps to avoid being bitten by them."

New President Discusses Goals for ASTMH Over the Next Year

Newly elected ASTMH President Stephen Higgs, PhD, FASTMH, recently took part in a Q&A about his vision for ASTMH, its strengths and weaknesses, and what he plans to focus on during the next 12 months. He spoke about what he is hoping to achieve as the new ASTMH President, his vision for ASTMH, the Society's strengths and some of its weaker points--and his plans to make those weaker points stronger.
¿Hasta dónde puede llegar la epidemia de zika?

Publicado por gonzalopez el feb 5, 2016

Compartir

Algunos virus pueden pasar desapercibidos durante decenas de años. Pero en un momento dado, los movimientos de población o el contacto con animales pueden convertirlos en los impulsores de enfermedades emergentes. Entonces, estos minúsculos microbios pueden cruzar océanos y colonizar nuevos continentes, transformando todo a su paso y a veces generando nuevas e impredecibles enfermedades.

Stephen Higgs es experto en enfermedades infecciosas. Además de investigador en la Universidad de Kansas, es presidente de la «American Society of Tropical Medicine and Hygiene» y editor jefe de la revista «Vector-Borne and Zoonotic Diseases». En concreto, su trabajo se ha centrado en las interacciones entre mosquitos y vertebrados, por lo que conoce bien el comportamiento de virus similares al zika que usan los insectos como vectores. En esta ocasión, respondió a varias preguntas sobre el zika a través de correo electrónico:
Member Q&A: Kathryn A. Hanley (ACAV) and Stephen J. Thomas Discuss Zika Virus

Posted 16 February 2016

“ASTMH has a long history of scientists and physicians working on mosquito-borne diseases ... It will be important to expand these studies of Zika virus into the Americas.”
– Kathryn A. Hanley, PhD, ACAV Chair

Kathryn A. Hanley, PhD, American Committee on Arthropod-borne Viruses (ACAV) Chair, Adjunct Associate Professor at the University of New Mexico School of Medicine and Adjunct Associate Professor at the University of Texas at El Paso. The Hanley Lab at New Mexico State investigates the molecular biology, evolution and ecology of emerging RNA viruses like dengue and influenza, with the goal of using this basic knowledge to design better methods to control their spread.

Stephen J. Thomas, MD, FACP, FIDSA, FASTMH, serves as the Deputy Commander for Operations at the Walter Reed Army Institute of Research (WRAIR). He also sits on scientific advisory committees and boards for the Department of Defense, NIH, non-governmental organizations, and numerous pharmaceutical companies working on flavivirus vaccine development efforts. In addition, he is a member of the WHO’s Dengue Vaccine Working Group advising the Strategic Advisory Group of Experts (SAGE) on immunizations.

What is Zika virus? Where did it originate and how has it spread?

The Zika virus (ZIKV) is a flavivirus. It was first isolated in 1947 in Zika forest near Uganda, Africa. The Zika virus can be transmitted to humans through the bite of an infected Aedes mosquito. The virus can also be transmitted through blood transfusions or from mother to baby during pregnancy or childbirth. The first outbreak of Zika virus in the Americas was detected in 2015 in Brazil. Since then, the virus has spread to other countries in the region, including the United States.
VIEW WEBINAR: ASTMH CLINICAL TRAINEE/STUDENT LEADERSHIP GROUP ON ZIKA VIRUS

On February 22, 2016, Society member and expert in vector biology, Dawn Wesson, PhD, Tulane University, and Susan McLellan, MD, MPH, FASTMH, Past-President of the Clinical Group, held a webinar on the Zika virus and its potential to spread in the US.

This one-hour webinar includes Q&A. View the archived webinar here.
Q&A with Member Scott Weaver, PhD, FASTMH, on Zika

Posted 15 March 2016

"With emerging viral diseases we just seem to be moving from emergency to emergency without a kind of sustained effort needed to maintain our capabilities, and to figure out a way to control vectors like Aedes aegypti, and Aedes albopictus." - Scott Weaver, PhD, FASTMH

Scott Weaver, PhD, FASTMH, a former ASTMH Councilor, is a leading expert on arboviruses—viruses transmitted by mosquitoes, ticks, or other arthropods. His research includes mechanisms of emergence from enzootic cycles, evolution, mosquito-virus interactions, and vaccine development.
Many of the slides in this presentation were obtained from open source material and PowerPoints from the National Academies website. Slides were from presentations by Albert Ko, Richard Kuhn, Tom Monath, Ron Rosenberg (some original pictures by Ben Beard), and Scott Weaver. Refer to website for original images.

Many journals have provided open access to articles about Zika virus, for example Lancet, and Trans. R.S.T.M.H.
Sexta Conferencia Anual ASTMH Latinoamérica en Perú

“ALAN J. MAGILL”

21- 23 de Marzo del 2016
Centro de convenciones de Lima
THANK YOU

GRACIAS

BRI Website: http://www.bri.k-state.edu/