Zika: Responding to the Challenges of an Emerging Infection

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Massachusetts Department of Public Health

Presenter Disclosure Information
Alfred DeMaria, Jr., M.D.

<table>
<thead>
<tr>
<th>Consultant</th>
<th>No relevant conflicts of interest to declare</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grant Research/Support</td>
<td>No relevant conflicts of interest to declare</td>
</tr>
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<td>Speaker’s Bureau</td>
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<tr>
<td>Major Stockholder</td>
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<tr>
<td>Other Financial or Material Interest</td>
<td>No relevant conflicts of interest to declare</td>
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</table>
Why Zika?

Why Does Zika Virus Epitomize Lessons Learned About Emerging Infection in the Past 25 Years?

COMMUNICATIONS

ZIKA VIRUS

(1). ISOLATIONS AND SEROLOGICAL SPECIFICITY

by

G. W. A. DICK,

The National Institute for Medical Research, London

and

S. F. KITCHEN,

Formerly staff member of the Division of Medicine and Public Health, The Rockefeller Foundation, New York, U.S.A.

and

A. J. HADDOW,

Formerly staff member of International Health Division, The Rockefeller Foundation, New York, U.S.A.

(From the Virus Research Institute, Entebbe, Uganda.)

The isolation of filterable viruses from mosquitoes taken in Uganda has already been recorded on several occasions. Two of the agents so recovered, although well known, had not previously been identified by isolation from mosquitoes in Uganda, viz., yellow fever virus (MAHAPOT et al., 1962; SMITHburn and HARDOW, 1966; SMITHburn et al., 1940) and Rift Valley fever virus (SMITHburn et al., 1940). A third which was called Mongo encephalomyelitis (DICK et al., 1948) (now known to be identical with Columbia SK/MM and encephalomyelitis viruses (DICK, 1949; WARRIN et al., 1949) has been isolated on several occasions from Tsetseflies (DICK et al., loc. cit.; DICK and HARDOW, unpublished). GILlett and DICK (unpublished) have, however, failed to transmit this agent to the laboratory by three species of Tsetseflies. The isolation of three hitherto unknown, filterable viruses secured from wild mosquitoes in Uganda has been described,
ZIKA VIRUS: A REPORT ON THREE CASES OF HUMAN INFECTION DURING AN EPIDEMIC OF JAUNDICE IN NIGERIA

BY

F. N. MACNAMARA*

Acting Director, Virus Research Institute, Yaba, Nigeria

Zika virus was first isolated from a captive rhesus monkey stationed in the forest of Zika near Entebbe, Uganda, during the course of research into the epidemiology of yellow fever (Dick et al., 1952). Later it was isolated from a batch of wild-caught mosquitoes.

This virus was known by serological surveys to infect man in Uganda and Nigeria (Dick, 1952; Macnamara, 1952) yet nothing was known of the clinical manifestations of the infection.

During the investigation in Afikpo Division, Eastern Nigeria, of an outbreak of jaundice suspected of being yellow fever, Zika virus was isolated from one patient, and two other patients exhibited a rise in titre of serum antibodies against this virus.

Serological examination of specimens taken from other patients was made in an attempt to evaluate the relationship between the occurrence of jaundice and Zika virus.
Confirmed and Probable Cases of Zika Virus Disease on Yap among Persons Seeking Health Care, According to Week of Onset of Illness during the Period from April through July 2007

Probable cases (N=59)  Confirmed cases (N=49)

Week of Onset of Illness

ProMED Bulletin 19-05-16 19:30:58

SUBJECT: Zika Virus in Brazil: 1947-2016, and 2016 Zika virus spread, RVSP

Archive Number: 20160519.2390848

PROVIDING HEALTH - BRAZIL, SOUTHAMERICA, AND OTHER AREAS (2016)

REQUEST FOR INFORMATION

A. ProMED-mail post

http://www.promedmail.org

moderated by a juggling of the International Society for Infectious Diseases

http://www.isid.org

In the posting:

[1] Brazil (Northeast) official information
[2] Brazil (de eh, June 2016)

VIX

[1] Brazil (Northeast) official information

News: Wed 19 Apr 2016

 Initio, Brazil, Health Surveillance, Ministry of Health of Brazil (in Portuguese, trad. Med CR, edited)


ProMED-mail: Brazil/160419.2390848

SVS (Secretariat of Health Surveillance) monitors cases of rash fever in the Northeast

Sick employees (all since the end of February 2016) have been registering rash fever cases of a rash fever in the Northeast. According to reports shared by the health departments of the states of Rio de Janeiro, Pernambuco, Piauí, Pará, Maranhão, and Ceará, all cases have a foreign history with sporadic recovery, every without treatment. According to information provided by the Ministry of Health, 407 cases of rash fever have been identified in the region. It is necessary to highlight that these cases have no serious cases or deaths.

The most common signs and symptoms are: rash (red spots) and fever (febrile). No laboratory tests, cases with lower grade fever or no fever, with or without headache, pain in the joints, pain in the muscles, and muscle pain. The age group 20-40 years was the most affected. But there are reports of babies 4 months old and another 90 years old.

According to the clinical features, the main suspect is the Zika virus. However, laboratory tests for diagnosis are not only characteristic of dengue cases. However, some samples tested for measles, rubella, chikungunya, and parvovirus were negative.
Cumulative number of countries and territories by WHO region reporting mosquito-borne Zika virus transmission for the first time in years (2007–2014), and monthly from 1 January 2015 to 16 November 2016.
Zika Virus

- Flavivirus, family *Flaviviridae*
- Positive sense, single-stranded RNA virus
- 3 structural and 7 nonstructural proteins, expressed as a single polyprotein that undergoes cleavage
- Closest relative Spondweni virus
- African and Asian lineages
- Enters skin cells at bite wound and travels to lymphatics and bloodstream
- Neurotropic

Incubation Period from Exposure to Onset of Symptoms among Reported Zika Cases with Symptoms

Bull World Health Organ E-pub: 1 Apr 2016. doi: http://dx.doi.org/10.2471/BLT.16.174540
SYMPTOMS OF ZIKA VIRUS

- HEADACHE
- FEVER
- PAINFUL OR RED EYES
- JOINT PAIN
- ITCHING/RASH
- MUSCLE PAIN
Differential Diagnosis

- Dengue
- Chikungunya
- Leptospirosis
- Malaria
- Rickettsial infection
- Parvovirus
- Group A streptococci
- Rubella
- Measles
- Adenovirus
- Enterovirus

Seropositivity Rates (%) for Anti-Zika Antibody

<table>
<thead>
<tr>
<th>Country</th>
<th>Years</th>
<th>Children</th>
<th>Adults</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uganda</td>
<td>1945-52</td>
<td>11.3</td>
<td>12.7</td>
<td>11.9</td>
</tr>
<tr>
<td>Tanzania</td>
<td>1945-52</td>
<td>13.3</td>
<td>19.0</td>
<td>16.7</td>
</tr>
<tr>
<td>Nigeria</td>
<td>1955</td>
<td></td>
<td></td>
<td>55.1</td>
</tr>
<tr>
<td>Angola</td>
<td>1960</td>
<td>15.9</td>
<td>38.7</td>
<td>27.0</td>
</tr>
<tr>
<td>Central African Republic</td>
<td>1961-62</td>
<td></td>
<td></td>
<td>48.8</td>
</tr>
<tr>
<td>Nigeria</td>
<td>1966-67</td>
<td>0.0</td>
<td>5.1</td>
<td>1.8</td>
</tr>
<tr>
<td>Kenya</td>
<td>1968</td>
<td>2.4</td>
<td>11.2</td>
<td>7.8</td>
</tr>
<tr>
<td>Nigeria</td>
<td>1969-71, 1972</td>
<td>52.3</td>
<td>71.7</td>
<td>64.0</td>
</tr>
<tr>
<td>Senegal</td>
<td>1972, 1975</td>
<td></td>
<td></td>
<td>58.3</td>
</tr>
<tr>
<td>Uganda</td>
<td>1984</td>
<td></td>
<td>6.1</td>
<td></td>
</tr>
<tr>
<td>Malaya</td>
<td>1953-54</td>
<td></td>
<td></td>
<td>75.0</td>
</tr>
<tr>
<td>Vietnam</td>
<td>1954</td>
<td></td>
<td></td>
<td>4.0</td>
</tr>
<tr>
<td>Indonesia</td>
<td>1983</td>
<td></td>
<td></td>
<td>12.7</td>
</tr>
<tr>
<td>Borneo</td>
<td>1996-97</td>
<td></td>
<td></td>
<td>44.1</td>
</tr>
<tr>
<td>Yap</td>
<td>2007</td>
<td></td>
<td></td>
<td>74.3</td>
</tr>
<tr>
<td>French Polynesia</td>
<td>2011-13</td>
<td></td>
<td></td>
<td>0.8</td>
</tr>
<tr>
<td>French Polynesia</td>
<td>2014</td>
<td>66.0</td>
<td></td>
<td>50.0</td>
</tr>
</tbody>
</table>

Why Zika?
Epidemiological Alert
Increase of microcephaly in the northeast of Brazil
17 November 2015

Given the unusual increase in cases of microcephaly in some northeast states of Brazil, the Pan American Health Organization (PAHO) / World Health Organization (WHO) calls upon Member States to remain alert to the occurrence of similar events in their territories and to notify its occurrence through the channels established under the International Health Regulations (IHR).

Situation summary
In October 2015 the Brazil Ministry of Health reported an unusual increase in cases of microcephaly in the state of Pernambuco, located in the northeast of Brazil. On average, the state of Pernambuco registered 10 cases of Microcephaly CIE-10: Q02

Microcephaly is a neurological disorder in which the occipitofrontal circumference is smaller than that
Number of reported cases of microcephaly in full-term newborns following laboratory-confirmed Zika virus transmission — Pernambuco, Paraíba, and Bahia states, Brazil, 2015

Known Causes of Microcephaly

- Genetic mutations
- Exposure to alcohol, drugs or toxic chemicals during pregnancy
- Malnutrition during pregnancy
- Infections, such as rubella, during pregnancy
- Lack of blood supply to the fetal brain

MMWR/ March 11, 2016 / 65(9):242–247
Factors in Zika Virus Infection in Pregnancy

- Viremia
- Gestational age
- Transplacental transmission
- Placental infection
- Congenital infection
- Antibody – specific and cross-reactive

Why Microcephaly? Why Now?

- Not noticed before
- Immunity acquired in childhood
- Interaction with other factor
  - Infection due to related viruses
- Change in the virus
More Than Microcephaly

- Retinal lesions
- Sensorineural hearing loss
- Arthrogryposis
- Neuropsychomotor developmental delay
- Hydrops fetalis
- Fetal demise, miscarriage
Suggested timeframe to wait before trying to get pregnant

Possible exposure via recent travel or sex without a condom with a partner infected with Zika

<table>
<thead>
<tr>
<th>Women</th>
<th>Men</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wait at least 8 weeks after symptoms start or last possible exposure</td>
<td>Wait at least 6 months after symptoms start or last possible exposure</td>
</tr>
</tbody>
</table>

People living or frequently traveling to areas with Zika

<table>
<thead>
<tr>
<th>Women</th>
<th>Men</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive Zika test</td>
<td>Wait at least 8 weeks after symptoms start</td>
</tr>
</tbody>
</table>

No testing performed or negative test

| Talk with doctor or healthcare provider | Talk with doctor or healthcare provider |
Reported cases of confirmed and suspected Guillain-Barré syndrome (n = 56), by Zika virus laboratory result and month of onset of neurologic signs — Puerto Rico, January 1–July 31, 2016

(MMWR/Early Release/August 26, 2016/65)
Guillain Barré Syndrome

- Acute inflammatory demyelinating polyneuropathy (AIDP)
  - AIDP with secondary degeneration
- Acute motor axonal neuropathy (AMAN)
  - Acute motor sensory axonal neuropathy (AMSAN)
- Miller Fisher syndrome
  - Cranial nerve involvement, ataxia

Guillain-Barré Disability Scale

0Healthy
1Minor symptoms or signs of neuropathy but capable of manual work/capable of running
2Able to walk without support of a stick (5 m across an open space) but incapable of manual work/running
3Able to walk with a stick, appliance of support (5 m across an open space)
4Confined to bed or chair bound
5Requiring assisted ventilation (for any part of the day or night)
6Death
Zika Virus Infection

- Asymptomatic (80%)
- Symptomatic (20%)
  - Fever, rash, conjunctivitis
  - Congenital infection
  - Guillain Barré syndrome
  - Uveitis
  - Encephalitis
  - Thrombocytopenia

Molecular testing
(<7 days after symptom onset)

RT-PCR / NS1
dengue

(Real time) PCR-
Zika virus

(Real time) PCR-
chikungunya virus

Positive: dengue
virus Confirmed

Negative: Perform
antibody testing $^2$

Positive: Zika
virus Confirmed

Negative: Perform
antibody testing $^2$

Positive: chikungunya
virus confirmed

Negative: Perform
antibody testing $^2$
Results of RT-PCR testing for Zika virus RNA in urine specimens of 70 persons with travel-associated Zika virus disease, by number of days after onset of symptoms — Florida, 2016

Prolonged Zika Viral Detection (PCR) (as of 11/22/2016)

- Serum (7-14 days)
- Whole blood - RBCs (58-81 days)
- Viremia in pregnant women (53 days)
- Newborn (54 days)
- Semen (62-188 days)
- Vaginal fluid (14 days)
- Saliva (91 days)
- Urine (91 days)
- Breast milk (4 days)
Phlogenetic Tree of Mosquitoborne Flaviviruses

After Lazear and Diamond, 2016
Interpretation of results of antibody testing for suspected Zika virus infection - United States, 2016

<table>
<thead>
<tr>
<th>Zika virus and dengue virus IgM ELISA</th>
<th>Zika virus PRNT</th>
<th>Dengue virus PRNT</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive or equivocal (either assay)</td>
<td>≥10</td>
<td>&lt;10</td>
<td>Recent Zika virus infection</td>
</tr>
<tr>
<td>Positive or equivocal (either assay)</td>
<td>&lt;10</td>
<td>≥10</td>
<td>Recent dengue virus infection</td>
</tr>
<tr>
<td>Positive or equivocal (either assay)</td>
<td>≥10</td>
<td>≥10</td>
<td>Recent flavivirus infection; specific virus cannot be identified</td>
</tr>
<tr>
<td>Any result (either or both assays)</td>
<td>&lt;10</td>
<td>&lt;10</td>
<td>No evidence of Zika virus or dengue virus infection</td>
</tr>
<tr>
<td>Inconclusive in one assay AND inconclusive or negative in the other</td>
<td>≥10</td>
<td>&lt;10</td>
<td>Evidence of Zika virus infection; timing cannot be determined</td>
</tr>
<tr>
<td>Inconclusive in one assay AND inconclusive or negative in the other</td>
<td>&lt;10</td>
<td>≥10</td>
<td>Evidence of dengue virus infection; timing cannot be determined</td>
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<td>Inconclusive in one assay AND inconclusive or negative in the other</td>
<td>≥10</td>
<td>≥10</td>
<td>Evidence of flavivirus infection; specific virus and timing cannot be determined</td>
</tr>
</tbody>
</table>
Zika Virus Modes of Transmission

- Established
  - Mosquitoborne
  - Transplacental
  - Intrapartum
  - Sexual - male to female, male to male, female to male
  - Blood and body fluid – laboratory needlestick, caregiver
  - Transfusion
- Theoretical
  - Organ or tissue transplantation
  - Breast milk

Revised Recommendations for Reducing the Risk of Zika Virus Transmission by Blood and Blood Components

**Guidance for Industry**

This guidance is for immediate implementation.

FDA is issuing this guidance for immediate implementation in accordance with 21 CFR 10.31(g)(2) without notice-and-comment rule making because the agency has determined that prior public participation is not feasible or appropriate.

FDA invites comments on this guidance. Submit one set of either electronic or written comments on this guidance at any time. Submit electronic comments to http://www.regulations.gov. Submit written comments to the Division of Dockets Management (HFA-305), Food and Drug Administration, 5600 Fishers Lane, Rm. 1061, Rockville, MD 20852. You should identify all comments with the docket number listed in the notice of availability that publishes in the Federal Register. FDA will review any comments we receive and revise the guidance when appropriate.

Additionally, copies can be obtained from the Office of Communication, Outreach, and Development (OCOD), 10903 New Hampshire Ave., Bldg. 71, Rm. 3028, Silver Spring, MD 20993-0002, by calling 1-800-835-4700 or 240-402-0718; or email ocod@fda.hhs.gov, or from the Internet at http://www.fda.gov/BiologicBloodVaccines/GuidanceComplianceRegulatoryInformation/Guida nceIndex.htm.

For questions on the content of this guidance, contact OCOD at the phone numbers or email address listed above.

U.S. Department of Health and Human Services
Food and Drug Administration
Center for Biologics Evaluation and Research
August 2016

Individual donor NAT

Phase in Florida, Puerto Rico and in 11 other states in 4 weeks and all by 12 weeks

120 day deferral and “look-back”

No travel screen with ID NAT

Implement within 4 weeks of guidance

Implement within 11 weeks of guidance
PROTECT YOURSELF from MOSQUITO BITES

Mosquitoes spread chikungunya, dengue, and Zika viruses.

Use insect repellent. Look for the following active ingredients:
- DEET
- PICARIDIN
- IR3535
- OIL OF LEMON EUCALYPTUS
- PIRACANTHRANE DIOXIDE

Wear long-sleeved shirts and long pants or use insect repellent. For extra protection, treat clothing with permethrin.

Sick with CHIKUNGUNYA, DENGUE, or ZIKA?

Protect yourself and others from mosquito bites during the first week of illness.

Protect family and friends
- During the first week of illness, chikungunya, dengue, or Zika virus can be found in the blood.
- A mosquito that bites you can become infected.
- An infected mosquito can bite a family member or neighbor and make them sick.

Watch for these symptoms
See your doctor if you develop a fever with any of the following symptoms:
- Muscle or joint pain
- Headache, especially with pain behind the eyes
- Rash
- Conjunctivitis (red eyes)

For more information:
- www.cdc.gov/chikungunya
- www.cdc.gov/dengue
- www.cdc.gov/zika

Protect yourself from mosquito bites
- Wear long-sleeved shirts and long pants.
- Use door and window screens to keep mosquitoes outside.
- Use insect repellent.
Zika Virus Transmission Cycle
Global Distribution of *Aedes aegypti*
**Aedes aegypti**

It takes about 7-10 days for an egg to develop into an adult mosquito.

*Female mosquitoes lay eggs in containers that hold water.*

*Eggs hatch within a few days to months when covered with water.*

*Eggs hatch.*

*Larvae live in water. They develop into pupae in as few as 5 days.*

*Pupae live in the water. They develop into adult, flying mosquitoes in 2-3 days.*

**Dengue fever**

- **Febrile phase**
  - sudden-onset fever
  - headache
  - mouth and nose bleeding
  - muscle and joint pains
  - vomiting
  - rash
  - diarrhea

- **Critical phase**
  - hypotension
  - pleural effusion
  - ascites
  - gastrointestinal bleeding

- **Recovery phase**
  - altered level of consciousness
  - seizures
  - itching
  - slow heart rate
Areas with Yellow Fever
Global Distribution of *Aedes albopictus*

Kraemer et al. eLife 2015;4:e08347. DOI: 10.7554/eLife.08347
NASA Risk-Assessment Map Shows *Aedes aegypti* Potential Abundance for July and the Monthly Average Number Arrivals to the U.S. by Air and Land from Countries on the Center for Disease Control Zika Travel Advisory

http://www.nasa.gov/topics/earth/index.html

Zika Cases Reported in the United States

(AS OF November 23, 2016)

Active Zika Virus Transmission in Florida

Factors Related to Arbovirus Transmission

- Reservoir host present
- Vector(s) present
  - Favorable climate
  - Habitat and food sources present
- Vectorial competence
  - Abundance
  - Bites reservoir host
  - Sustains virus replication
  - Virus incubation period consistent with life cycle and biting behavior
  - Pathogen reaches saliva
- Vectorial capacity
  - Physiology
  - Host preference
  - Biting behavior
  - Contact probability
Transmission of Eastern Equine Encephalitis (EEE) Virus, West Nile Virus (WNV) and Zika Virus – Vectors and Vector Characteristics

<table>
<thead>
<tr>
<th>Virus host reservoir</th>
<th>EEE</th>
<th>WNV</th>
<th>Zika</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birds</td>
<td>Birds</td>
<td>Humans</td>
<td></td>
</tr>
</tbody>
</table>

**Amplifying vector(s)**

<table>
<thead>
<tr>
<th>Primary species</th>
<th>EEE</th>
<th>WNV</th>
<th>Zika</th>
</tr>
</thead>
<tbody>
<tr>
<td>Culiseta melanura</td>
<td>Culex species</td>
<td>1. Aedes aegypti</td>
<td>2. A. albopictus</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Breeding habitat</th>
<th>EEE</th>
<th>WNV</th>
<th>Zika</th>
</tr>
</thead>
<tbody>
<tr>
<td>White cedar/red maple swamp</td>
<td>Puddles and containers, dirty water</td>
<td>Containers</td>
<td></td>
</tr>
</tbody>
</table>

**Transmitting vector(s)**

<table>
<thead>
<tr>
<th>Primary species</th>
<th>EEE</th>
<th>WNV</th>
<th>Zika</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coquillettidia perturbans, Aedes vexans, other bridge mosquitoes</td>
<td>Culex species</td>
<td>1. Aedes aegypti</td>
<td>2. A. albopictus</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Primary host</th>
<th>EEE</th>
<th>WNV</th>
<th>Zika</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mammals and birds</td>
<td>Birds</td>
<td>1. Humans</td>
<td>2. Mammals</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Breeding habitat</th>
<th>EEE</th>
<th>WNV</th>
<th>Zika</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cattail swamps, flood plain</td>
<td>Puddles and containers, dirty water</td>
<td>Containers</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Habitat of adults</th>
<th>EEE</th>
<th>WNV</th>
<th>Zika</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural</td>
<td>Tree canopy, ubiquitous</td>
<td>Peridomestic</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Biting habits</th>
<th>EEE</th>
<th>WNV</th>
<th>Zika</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dawn/dusk, outdoors; one host meal</td>
<td>Dawn/dusk, outdoors; one host meal</td>
<td>All day, indoor/outdoor; multiple host meal</td>
<td></td>
</tr>
</tbody>
</table>
Prevention

- Reduce mosquito exposure
  - Window and door screens
  - Mosquito netting
  - Staying indoors at peak mosquito times

- Reduce mosquito bites
  - Clothing
  - Repellents – use according to product label

- Reduce mosquitoes
  - Reduce standing water
  - Mosquito control
    - Reduce breeding environment
    - Larvicide
    - Adulticide
Mosquito Repellents

- DEET (N-N-diethyl-meta-toluamide)
  - Should not be used on infants under two months of age and should be used in concentrations of 30% or less on older children
- Picaridin (KBR 3023)
- IR3535 (3-[N-butyl-N-acetyl]-aminopropionic acid)
- Oil of lemon eucalyptus [p-menthane 3, 8-diol (PMD)]
  - Should not be used on children under three years of age
- Permethrin
  - Intended for use on items such as clothing, shoes, bed nets and camping gear and should not be applied to skin

Mosquito Control Methods Under Development

- Pathogenic fungal larvicides
- Release of insects with dominant lethality
  - Female-specific late-acting flightless phenotype
- Toxic sugar baits
- Symbionts that block transmission
  - Wolbachia species
- Anti-pathogen genes
- Indoor residual spraying, curtains
- Lethal ovitraps
- Auto-dissemination of insecticide
- Molecular and other new insecticides
Diagram of an Autocidal Gravid Ovitrap used to attract and capture female *Aedes aegypti* mosquitoes


Reduced Incidence of Chikungunya Virus Infection in Communities with Ongoing *Aedes Aegypti* Mosquito Trap Intervention Studies - Salinas and Guayama, Puerto Rico, November 2015 - February 2016

*MMWR*, May 13, 2016 / 65(18)
Average number of adult female Aedes aegypti mosquitoes collected per trap, by date
Miami-Dade County, Florida, July–August 2016

Insecticide Resistance Testing in Puerto Rico (CDC)

What’s Next in Mosquitoes?

<table>
<thead>
<tr>
<th>Togaviruses</th>
<th>Flaviviruses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eastern equine</td>
<td>West Nile</td>
</tr>
<tr>
<td>Western equine</td>
<td>St. Louis</td>
</tr>
<tr>
<td>Venezuelan</td>
<td>Dengue</td>
</tr>
<tr>
<td>Chikungunya</td>
<td>Yellow fever</td>
</tr>
<tr>
<td>Mayaro</td>
<td>Zika</td>
</tr>
<tr>
<td>Sindbis</td>
<td>Spondweni</td>
</tr>
<tr>
<td>Ross River</td>
<td>Usutu</td>
</tr>
<tr>
<td><strong>Bunyaviruses</strong></td>
<td><strong>Japanese</strong></td>
</tr>
<tr>
<td>California group</td>
<td>Murray Valley</td>
</tr>
<tr>
<td>(LaCrosse, Jamestown Canyon, etc.)</td>
<td></td>
</tr>
<tr>
<td>Cache Valley</td>
<td>Here before 1999</td>
</tr>
<tr>
<td>Tensaw</td>
<td>Here since 1999</td>
</tr>
<tr>
<td>Rift Valley</td>
<td>Could come</td>
</tr>
<tr>
<td></td>
<td>Unlikely?</td>
</tr>
</tbody>
</table>
Number of People Killed by Animals Per Year (gatesnotes.com)

- Mosquito: 725,000
- Human: 4,000,000
- Dog: 25,000
- Shark: 2,000
- Wolf: 100
- Lion: 100
- Elephant: 10
- Crocodile: 100
- Hippopotamus: 1,000
- Freshwater snail: 10,000
- Tsetse fly: 2,500
- Kissing bug: 10,000
- Ascaris: 500
- Tapeworm: 10,000
- Crocodile: 2,000
- Mosquito: 25,000
- Dog: 2,000
- Snake: 1,000
- Elephant: 100
- Lion: 100
- Wolf: 10
- Shark: 10