Mosquito-Borne Zika virus: History, Transmission Ecology, Prevention and Education

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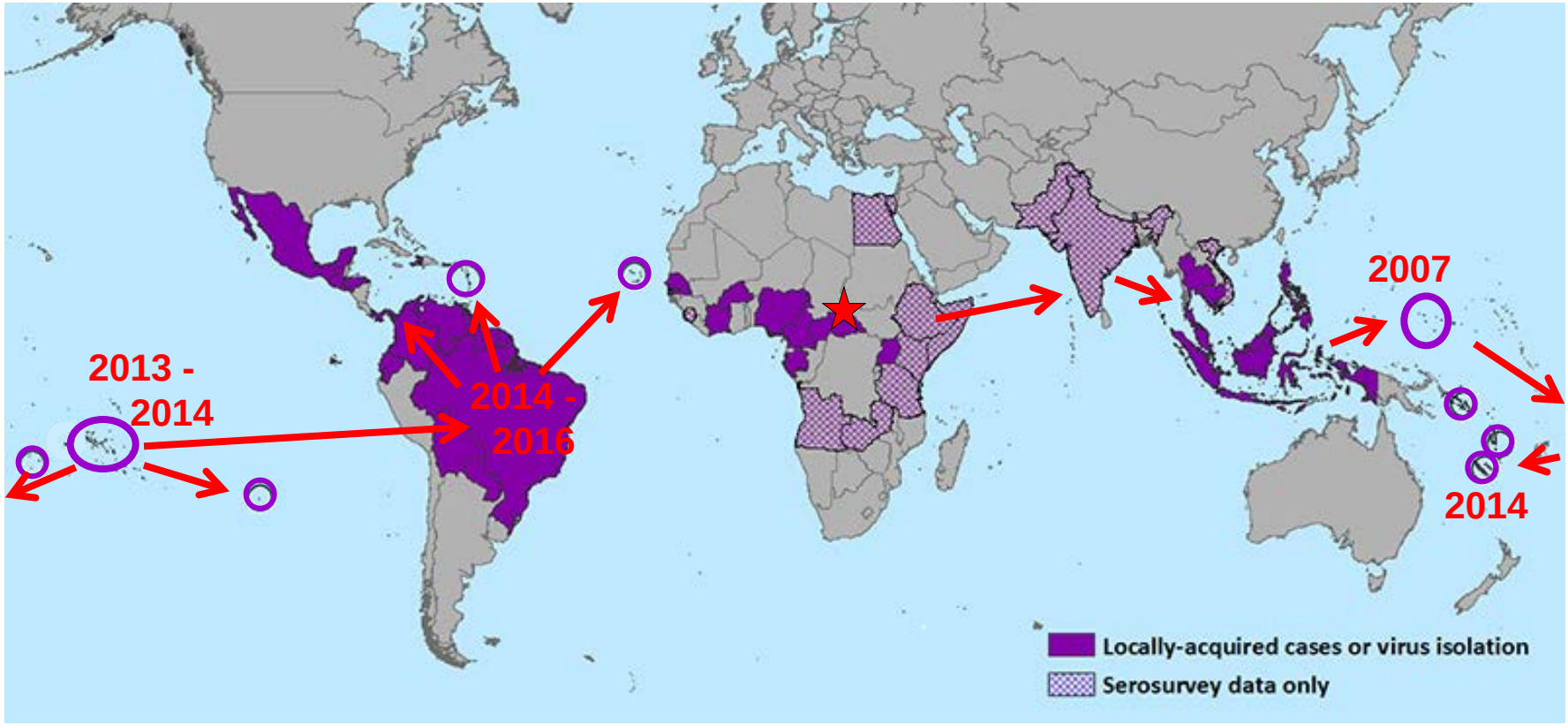
A Brief History of Zika Virus

Zika virus was discovered in the Zika Forest, Uganda 1947
From 1947 – 2007, serological and other lab evidence of Zika virus infections had been found in people from Africa to Asia and the Western Pacific nations.
The first large Zika outbreak ever recorded - Yap Island, Micronesia in 2007.
A second large Zika outbreak - French Polynesia and other Pacific Islands 2013 –14.
Zika arrived in Brazil in 2014 and spread to other parts of the Americas 2015 – 16.



A Brief History of Zika Virus and its Transmission

The Zika virus is most commonly transmitted in a "mosquito-to-human-to-mosquito cycle" and is known to have "African" and "Asian" variants.

The Zika virus variant that caused the 2007 outbreak on Yap Island, and all of the subsequent large outbreaks has been the Asian variant.

It is possible that the Asian variant of Zika virus has evolved the ability to cause much larger disease outbreaks than the African variant.

***Aedes aegypti* (yellow fever mosquito) was historically associated with Zika transmission, but other closely related *Aedes* mosquito species in "*Stegomyia* Subgenus" have also been associated with Zika transmission and include:**

- ***Aedes hensilli* - on Yap Island**
- ***Aedes polynesiensis* – in French Polynesia and other Polynesian Island chains and,**
- ***Aedes albopictus*, the Asian tiger mosquito in Gabon and in Singapore.**

Asian tiger mosquitoes are very common throughout the southeastern U.S., but *Aedes aegypti* mosquitoes are only common in the most southern areas of the U.S. (Southern Florida and Southern Texas).

Yap Island Zika Outbreak , 2007

Investigators of the Yap Island outbreak were only able to observe and record Zika symptoms in 31 symptomatic patients that had laboratory confirmed Zika infections.

Number of Patients (%)	Illness Sign or Symptom
28 (90 %)	Macular or papular rash
20 (65 %)	Fever
20 (65 %)	Arthritis or arthralgia
19 (55 %)	Conjunctivitis (red eyes)
15 (48 %)	Myalgia (body aches)
14 (45 %)	Headache
12 (39 %)	Pain behind eyes
6 (19 %)	Swelling of limbs
3 (10 %)	Vomiting

Symptoms seen in **>50%** of patients

Up to 80% of persons infected with Zika do not develop symptoms.

Clinical Signs and Symptoms in Zika Virus Patients (N=683) in Puerto Rico, November 1, 2015 – April 14, 2016

Signs and Symptoms	No. of patients	(%)
Rash	505	74%
Myalgia (body pain)	462	68%
Headache	433	63%
Fever	429	63%
Arthralgia (joint pain)	428	63%
Eye pain	350	51%
Chills	344	50%
Sore throat	233	34%
Petechiae	213	31%
Conjunctivitis	137	20%
Nausea/Vomiting	123	18%
Diarrhea	115	17%

Symptoms seen in **>50%** of patients

Patients were aged 35 days – 89 years (median age ==34 years); Travel outside of Puerto Rico and U.S. in the 14 days before illness onset; All GBS patients were hospitalized; Signs and symptoms were reported by the patients' clinicians

Patients (N=683) with Zika Virus in Puerto Rico
November 1, 2015 – April 14, 2016

Characteristic	No. of patients	(%)
Female	436	64%
Pregnant	65	10%
Hospitalized	17	2%
Severe Thrombocytopenia	9	>1%
Suspected Guillain-Barre Syndrome	5	<1%
Deaths (Severe Thrombocytopenia)	1	<1%

Patients were aged 35 days – 89 years (median age ==34 years)
Travel outside of Puerto Rico and U.S. in the 14 days before illness onset
All GBS patients were hospitalized
Defined as blood platelet levels < 100,000 cells/mm3
Sins and symptoms were reported by the patients' clinicians

The Various Means of Zika Virus Transmission

Zika virus may be transmitted by:

1. **Infectious mosquito bites from *Aedes aegypti* and/or *Aedes albopictus* mosquitoes.**
2. **Infection of unborn children by their infected mothers.**
3. **Sexual transmission of Zika virus in infected sperm.**
4. **Blood transfusions from asymptomatic, Zika - infected blood donors.**

Zika virus reservoir hosts (the animals from whose blood, mosquitoes become infected):

1. **Currently the only known reservoirs of Zika virus for mosquitoes are primates (i.e., apes, monkeys, or people).**
2. **It is not yet known if other mammals or other animals can participate in the Zika transmission cycle**

Two Mosquito Species are Capable of Transmitting the Zika Virus in Virginia

Aedes aegypti
the yellow fever mosquito

Aedes aegypti, the yellow fever mosquito are the most efficient vector of Zika because they feed almost exclusively on primates including humans, and as humans serve as reservoirs for this virus, this mosquito will always vector the virus from one person to another.

Aedes albopictus
the Asian tiger mosquito

Ae. albopictus the Asian tiger mosquito is a much less efficient Zika vector because although it likes to feed on people, it also likes to feed on a variety of other animals including dogs and cats (which are not known reservoir species), so it is less likely to become infected with the Zika virus, and is less likely to transmit Zika to a person if it is infected.

Currently, the most common urban / suburban pest mosquito in Virginia is the Asian tiger mosquito

Asian tiger mosquito - *Aedes albopictus*

Aedes aegypti **mosquitoes are known to have an old established population on Capitol Hill in Washington D.C., and they are occasionally found at adjacent sites around northern Virginia and in Maryland, but so far, they have not become common in Virginia or Maryland**

Aedes aegypti and Asian tiger mosquitoes lay eggs exclusively in artificial and natural containers of water.

Natural Containers

Artificial Containers

These container breeding habitats are most often found around homes, and populations of these mosquitoes can be abundant in shady neighborhoods.

Plastic sheets/tarps holding water

Plastic downspout extensions holding water

Plant pot trays

Old tires

Unmaintained pools

The most effective and environmentally sound method of eliminating Asian tiger mosquitoes and *Ae. aegypti* is to eliminate, dump, or treat their container habitats.

As the containers used by these mosquitoes are mostly found on people's private property, this method of control can only be accomplished with the complete cooperation and assistance of the public.

The Mosquito Season in Virginia

The *Aedes* mosquito species that transmit Zika are active from May through October in Virginia.

Their mosquito season is determined by photoperiod, not temperature.

Regardless of warm winter or spring weather, Asian tiger mosquito eggs will not hatch any earlier than April.

Otherwise, if mosquito eggs hatched on warm winter days, or too early in the spring and the weather became frigid again, the whole generation would die. Hatching according to day length is a fail-safe to help prevent this.

The speed of mosquito development is determined by temperature.

After April, eggs will hatch and develop into adults slowly in cool weather and faster in warm weather

The Mosquito Flight and Biting Behavior

Asian tiger mosquitoes and *Aedes aegypti* have very similar flight and biting behavior

Both species spend most of their time sitting in the bushes or on walls, and only become active when people or animals approach.

Outdoors, these mosquitoes bite primarily during the daylight hours and will be most active in the morning 8:00 AM to 11:00 AM, or afternoon 3:00 PM to 7:00 PM.

These mosquitoes will readily fly in open doors and windows and bite indoors during both day and nighttime hours.

These mosquitoes are cautious, sneaky biters; tend to stay out of our direct line-of-sight and bite people mainly on the ankles, legs, and backs and sides of arms and body.

Virginia's Plan for Zika Prevention

In 2016, the Virginia Department of Health (VDH) put together a Zika Response Plan to prevent the local spread of Zika virus. This plan has been updated for 2017.

Zika case surveillance by health department epidemiologists identifies Zika cases and determines if they:

1. contracted the virus outside of Virginia, or in Virginia;

2. are likely to still be viremic (had virus circulating in their blood); based on exposure dates, laboratory test results, and illness onset dates.

3. have mosquitoes around their homes, or have had exposure to mosquitoes at home or elsewhere in VA.

Virginia's Plan for Zika Prevention

Patients who are likely to have contracted Zika in Virginia, or who are likely to be viremic, and who had exposure to mosquitoes or to mosquito bites in VA, are asked if mosquito surveillance personnel can visit their home and any other sites where they had been exposed to mosquitoes.

When patients consent to a home site inspection or inspection of other sites of exposure, mosquito surveillance personnel inspect the property/properties, set traps to collect mosquitoes, and dump, treat or recommend treatment for any container habitats present.

If significant mosquito populations are found, adulticide - ULV or barrier treatments are made, or recommended, and inspection for control of container habitats and/or adult mosquito control may be extended to neighboring properties.

Virginia's Plan for Zika Prevention

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If no significant mosquito population is found on a property, the patient is counseled to avoid mosquito bites for several weeks and to dress protectively and/or use mosquito repellents when in places where mosquitoes could be active.

For patients with imported Zika infections, the surveillance and control effort would focus primarily on immediate area around the patient's home.

For patients who are likely to have contracted Zika in Virginia, mosquito surveillance and control operations may be extended out into the surrounding neighborhood in a radius of up to 200 meters.

Virginia's Plan for Zika Prevention

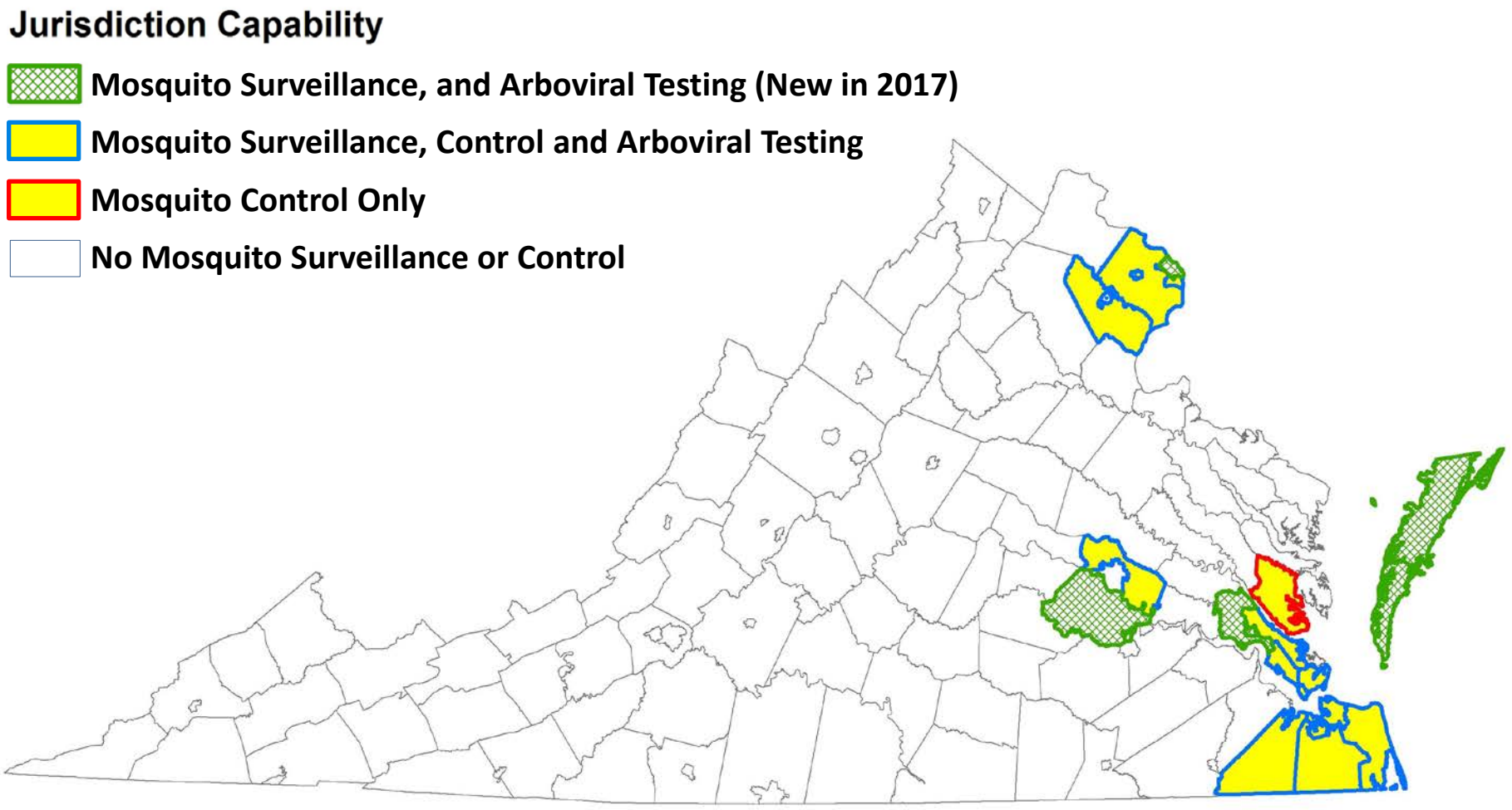
In jurisdictions that have mosquito surveillance and control capabilities, home site visits are performed by local mosquito control personnel.

In jurisdictions with no mosquito surveillance and control capabilities, patient home site inspections are performed by Health Department - Environmental Health (EH) Personnel or by contract "roving mosquito surveillance personnel" who work out of the VDH central office in Richmond.

As most EH personnel and roving surveillance personnel have no license /certification to apply insecticides, they provide "consumer-packaged larvicide products" to homeowners for use in mosquito breeding containers that cannot be dumped . They would recommend adult mosquito control by contractors for the properties with excessive adult mosquitoes.

Consumer - Packaged Larvicide Products

Virginia Jurisdictions Having Mosquito Surveillance and Control Capabilities



Mosquito control programs are found primarily in some of Virginia's most heavily populated jurisdictions.

Virginia's Plan for Zika Prevention

During the course of 2016, the Virginia Department of Health put out a bid for contract proposals by mosquito control companies, and established contracts with two companies to conduct mosquito control in Virginia jurisdictions that lacked their own control capability.

Contracted mosquito control activities would include:

1. **Door to door educational outreach in a target neighborhood,**
2. **Mosquito trapping/surveillance,**
3. **Identification, dumping and or treatment of container habitats,**
4. **Adulticide treatments (ULV, or barrier treatments in yards),**
5. **Truck-mounted ULV adulticide treatments if necessary,**
6. **Aerial (aircraft) application of ULV adulticides if necessary**
7. **Aerial (aircraft) application of larvicide droplets if necessary***

*** The contract is currently being modified to add truck-mounted application of aerosol larvicides**

Virginia's Plan for Zika Prevention

In addition to mosquito surveillance and control activities, VDH has also worked to improve public education about mosquito prevention and Zika avoidance through public information campaigns

Outreach activities have included:

1. **Printing and distribution of educational materials such as door hangers, and flyers for citizens, and educational materials for pregnant women.**

2. **Screening of short Zika prevention videos on TV screens in Virginia's international airports, and on movie theater screens around VA.**

3. **Distribution of self-protection kits containing prevention literature, condoms, and mosquito repellents to be handed out to pregnant women by clinics around VA.**

How Physicians / Healthcare Providers can Educate Patients for Zika Prevention

When a patient with an apparent Zika infection is seen, the patient can be advised to prevent its spread with the following messages:

1. **Avoid mosquito bites around the home;**
2. **Wear long sleeved shirts and pants as well as shoes and socks and / or repellents on exposed skin when outdoors;**
3. **The repellents containing 20% Picaridin, or up to 30% DEET are most effective;**
4. **Make sure that open doors and windows are well screened.**

Questions?