Arthropod-borne viruses are vectored to people primarily through the bites of infected mosquitoes. Other important vectors of human disease causing pathogens are ticks. Other modes of virus transmission include blood transfusion, organ transplantation, perinatal transmission, breast feeding, and in the case of the Zika virus, sexual intercourse.

Over 130 arboviruses are known to cause human disease. In the US, most (but not all) are maintained in transmission cycles between arthropods and vertebrate hosts (birds or small mammals). Humans usually become infected when bitten by infected mosquitoes or ticks. Most human arboviral infections are asymptomatic.

West Nile virus is the leading domestically vectored arboviral disease in the US. Other arboviruses cause less significant epidemics of neuroinvasive disease (symptoms include meningitis, encephalitis, and acute flaccid paralysis).

Those of greatest significance are listed in endemic and exotic groups.

Endemic arboviruses under surveillance include: St. Louis Encephalitis, West Nile, Western Equine Encephalitis, Eastern Equine Encephalitis, Powassan Virus Disease, Unspecified California Serogroup virus (including LaCrosse Viruses & Jamestown Canyon virus).

Exotic arboviruses under surveillance include: Chikungunya, Dengue, Zika.


The maps document cases over time and geographic location.

<table>
<thead>
<tr>
<th>Arbovirus</th>
<th>Human cases in US</th>
</tr>
</thead>
<tbody>
<tr>
<td>West Nile</td>
<td>2060</td>
</tr>
<tr>
<td>Disease</td>
<td>Cases</td>
</tr>
<tr>
<td>-------------------------</td>
<td>-------</td>
</tr>
<tr>
<td>St. Louis Encephalitis</td>
<td>19</td>
</tr>
<tr>
<td>Eastern Equine Encephalitis</td>
<td>5</td>
</tr>
<tr>
<td>Western Equine Encephalitis</td>
<td>0</td>
</tr>
<tr>
<td>LaCrosse</td>
<td>48</td>
</tr>
</tbody>
</table>
Powassan Virus Disease 6

Dengue local 211

Dengue travel 540

Chikungunya local 202 US territories
Chikungunya
travel
673

Zika
2015-2016
States: 312 travel (we do not have county-by-county maps yet)
Territories: 3 travel & 349 locally acquired (37 pregnant woman & 1 Guillain-Barré)

What is local transmission?

A person with no travel history is bitten by an infected mosquito where they live, work, learn, or play.
I. West Nile - mosquito-borne zoonotic Flavivirus
- First confirmed case in the Western Hemisphere, New York City 1999
- Took roughly 5 years to spread across North America
- Primarily Passeriformes (perching birds) serve as the prime reservoir

A. Vector - most commonly transmitted to humans by mosquitoes

1. Culex spp. are primary vectors, and species depends on region, e.g., Cx. pipiens and Cx. restuans are responsible for up to 80% of human infections in New York; Cx. tarsalis and Cx. quinquefasciatus are the main vectors in the desert southwest. Considering the ecology of competent vector species, the main US vectors are considered to be Cx. pipiens (northern US), Cx. quinquefasciatus (southern US), additionally Cx. tarsalis (everywhere with the exception of the northeast) and Cx. restuans (midwest and northeast).

2. Characteristics
   (i) Identification – get an entomologist to do it, it involves specialized keys and microscopy. At best in the field two broad groups of mosquitoes can be distinguished. Culicine females (includes Culex and Aedes species) have short palps relative to anopheline. Anopheline mosquitoes (includes Anopheles species) sit with heads low and abdomen high, culicine females hold their bodies horizontal. Anopheline larvae float horizontal to the water surface when resting, culicine larvae float with head low and siphon at right angles to the water surface.
   (ii) Habits – Life tables depend upon environmental conditions, but most species can go from egg to adult in 2-weeks or less. The metamorphosis is typical holometabolism: females lay eggs singly or in batches. Eggs hatch in the presence of water and the larvae are obligately aquatic, filter-feeders. Larvae pass through 4 instars and pupae are non-feeding, but active. Adults both feed on nectar, only females take blood meals.

During the larval stage, the mosquito lives in water and feeds on particles of organic matter, microscopic organisms or plant material; after several instars it then develops into a pupa. Unlike the straight-bodied larva, the pupa is comma-shaped and also lives in water. It does not feed and becomes an adult after one or two days.

Culex spp. eggs are laid in raft-shaped batches on the water surface.

B. Vector Control

1. Breeding ground characteristics - Culex preferred oviposition (egg-laying) habitats include rainwater barrels, catch basins, storm drains, septic tanks rich in organic material. Cx. pipiens and Cx. quinquefasciatus are commonly found in sewage systems, drainage systems, containers, and open stagnant swamps and pastures.

2. Control
(i) County – Some counties (most in urbanized areas) are actively conducting surveillance, take resident bite and breeding site reports, monitor for breeding sites, conduct pathogen tests, and undertake both larviciding and adulticiding efforts.

(ii) Property Owner – Actively survey property using a management plan (document). Report surrounding issues off-site to county or state (maintain documented reports). Focus efforts on reducing breeding sites and larviciding. Use the most effective biocontrol options and reduced-hazard pesticide products by design (have a mosquito management plan). Manage buildings to minimize breeding sites, and minimize building access. Educate and encourage property users to wear appropriate clothing and insect repellents when necessary.

C. Risk of Injury or Death

1. 80% asymptomatic
2. 20% symptomatic
   (i) Febrile illness, encephalitis (inflammation of the brain) or meningitis (inflammation of the lining of the brain and spinal cord). Common signs and symptoms include: fever, headache, body aches, vomiting, diarrhea, fatigue, skin rash.
   (ii) <1% develop a serious, sometimes fatal, neurologic illness. Signs and symptoms of neurological infections include: high fever, severe headache, stiff neck, disorientation or confusion, stupor or coma, tremors or muscle jerking, seizures, partial paralysis or muscle weakness.
   (iii) Risk factors: Case numbers peak June - September. Cases have been reported in all 48 continental states. Most people who do become sick recover fully. Chances of severe or fatal infections are increased if you are older, or have certain medical conditions like cancer, diabetes, hypertension, kidney disease or conditions requiring organ transplant.

II. Zika – mosquito-borne Flavivirus
   • While periodic Zika outbreaks have been reported since 1947, Zika was not identified as a global health concern until 2015 - local mosquito-borne transmission of Zika virus has been reported in the Commonwealth of Puerto Rico, the US Virgin Islands, and America Samoa
   • No local transmission in the continental US yet
   • Primate reservoir hosts

Chikungunya – mosquito-borne Alphavirus
   • First confirmed case in the Western Hemisphere, Caribbean 2013
   • First locally acquired US case in continental states (Florida) 2014, travel cases have been reported in almost all states at this point
   • Primates and a number of non-primate animal groups

Dengue - mosquito-borne Flavivirus (4 serotypes)
   • Documented in the Americas after WWII, a vector eradication plan was implemented until the early 1970s
   • Just over a decade later the vector had reestablished back into the US once more
   • Primate reservoir hosts

A. Vector – all three most commonly transmitted to humans by mosquitoes
1. Aedes spp. are primary vectors, and species depends on region. Ae. aegypti and Ae. albopictus are primary vectors in the areas where they exist, many distribution maps are inaccurate.

2. Characteristics
   (i) Identification – **get an entomologist to do it, unless you are dealing with adult stages only.** Even with a hand lens most people can distinguish the mosquitoes due to markings.
   (ii) Habits – Life tables depend upon environmental conditions, but both species can go from egg to adult in 9 days or less. The metamorphosis is typical holometabolism as previously described. Aedes spp. eggs are laid singly on damp surfaces near to the water.

B. Vector Control

1. Breeding ground characteristics - Ae. aegypti and Ae. albopictus use natural and artificial water-holding containers (e.g., treeholes, discarded tires, artificial containers, clogged gutters) to lay their eggs. Ae. aegypti can tolerate direct sun to a greater extent relative to Ae. albopictus so some locations have both species breeding in slightly different niches.

2. Control
   (i) County – Some counties (most in urbanized areas) are actively conducting surveillance, take resident bite and breeding site reports, monitor for breeding sites, conduct pathogen tests, and undertake both larviciding and adulticiding efforts. However, Ae. aegypti and Ae. albopictus are not efficiently captured by the most commonly used mosquito traps, such as the CDC miniature light trap.
   (ii) Property Owner – As described previously. However, Ae. aegypti only need a very small volume of water to develop successfully, so eliminating all breeding sites may well be impossible. Limit water catching plants and avoid saucers under plant pots that are not drilled with drainage holes. Avoid indoor plants like lucky bamboo that stand in water as the mosquitoes will breed happily indoors also.

C. Risk of Injury or Death

<table>
<thead>
<tr>
<th>West Nile</th>
<th>Chikungunya</th>
<th>Dengue</th>
<th>Zika</th>
</tr>
</thead>
<tbody>
<tr>
<td>1° vector</td>
<td>Culex</td>
<td>Aedes</td>
<td>Aedes</td>
</tr>
<tr>
<td>Human hosts</td>
<td>Incidental</td>
<td>1° Aedes</td>
<td>1° Aedes</td>
</tr>
<tr>
<td>% symptomatic</td>
<td>&lt;20%</td>
<td>72-97%</td>
<td>Can be 50%</td>
</tr>
<tr>
<td>% chronic disease</td>
<td>&lt;1%</td>
<td>30-40%</td>
<td>Variable</td>
</tr>
<tr>
<td>% fatal</td>
<td>&lt;1%</td>
<td>&lt;0.1%</td>
<td>&lt;1-50% (DF,DHF)</td>
</tr>
<tr>
<td>Symptoms</td>
<td>Fever, headache, body aches, skin rash, and swollen lymph nodes</td>
<td>Fever, joint pain/swelling headache, muscle pain, rash</td>
<td>Fever, headache, eye pain, joint and muscle pain, fatigue, rash, nausea/vomiting, bleeding</td>
</tr>
</tbody>
</table>
Bibliography

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University of Arizona, Associate Professor and Associate Specialist – Urban Entomologist
Teaching Extension and Research efforts focus on pest ecology and reduced-hazard management of public health pests, including venomous arthropods, disease vectors, and bed bugs.

Curriculum Vitae

http://cals.arizona.edu/apmc/docs/CURRICULUM-VITAE_DHG_012016.pdf