Mosquito Borne Disease Transmission and Control

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Mosquito-borne Arboviral Diseases in Virginia.

1. **Eastern equine encephalitis (EEE):** - Uncommon (5 human cases in past 30 years); coastal plain & low piedmont area.

2. **St. Louis encephalitis (SLE):** - Somewhat uncommon (12 human cases in past 30 years); urbanized areas of piedmont region.

3. **West Nile virus (WNV):** - New, common (60 human cases & 4 deaths in last 3 years); all over state

4. **La Crosse encephalitis (LAC):** - Somewhat common, under-reported (20 human cases reported in past 30 years); southwest and western mountain zone of Virginia.
Transmission Cycle of EEE, SLE and WNV.

Mosquito (Vector) → Incidental infections → Dead End Hosts

EEE → SLE → WNV

Bird (Amplifying Hosts)

Humans

Horses

EEE → SLE → WNV

EEE → WNV
American Mosquito Species Associated with Eastern equine encephalitis (EEE)

Primary Vector, Possible Bridge Vector

Culiseta melanura *

Aedes albopictus *
Aedes vexans *
Ochlerotatus canadensis *
Ochlerotatus sollicitans *
Coquillettidia perturbans *
Culex salinarius *
Culex nigrialpus

Potential Bridge Vectors

* Mosquito species found in Virginia
American Mosquito Species Associated with St. Louis encephalitis (SLE)

Primary Vectors & Potential Bridge Vectors

- Culex pipiens *
- Culex quinquefasciatus
- Culex restuans *
- Culex nigrialpus
- Culex salinarius *
- Culex tarsalis

* Mosquito species found in Virginia
Mosquito Species Associated with West Nile Virus (WNV)

Primary Vectors & Potential Bridge Vectors

- Culex pipiens *
- Culex quinquefasciatus
- Culex restuans *
- Culex nigrialpus
- Culex tarsalis
- Culex erraticus *
- Culex salinarius *
- Aedes albopictus *
- Aedes vexans *
- Occlerotatus japonicus *
- Occlerotatus triseriatus *

* Mosquito species found in Virginia
Transmission Cycles of La Crosse encephalitis (LAC)

- **Rodent Hosts**
  - Larvae
  - Pupae
  - Infected Eggs
  - Transovarially Infected Adult Females

- **Humans** (incidental infections)

- **Dead End Hosts**

The cycle involves mosquito-transmitted infection to rodents, then back to mosquitoes, with humans and dead end hosts as incidental infections.
American Mosquito Species Associated with La Crosse encephalitis (LAC)

Primary Vector & Bridge Vector

Ochlerotatus triseriatus *

Bridge Vectors

Aedes albopictus *
Culiseta inornata *
Ochlerotatus canadensis *
Ochlerotatus communis
Ochlerotatus dorsalis
Ochlerotatus japonicus *
Ochlerotatus melanimon
Ochlerotatus stimulans

* Mosquito species found in Virginia
Other Mosquito-borne Diseases seen in Virginia.

Malaria – Uncommon (four locally transmitted human cases in past 10 years; many imported cases each year).

Transmission Cycle of Malaria: Humans and Mosquitoes are the only significant disease reservoirs.
American Mosquito Species Associated with Malaria

Primary Vectors

- Anopheles quadrimaculatus *
- Anopheles punctitennis *
- Anopheles freeborni

* Mosquito species found in Virginia
Dengue, a Mosquito-borne Arbovirus that Might Occur in Virginia.

Dengue has never occurred as a locally transmitted disease in Virginia. Local Transmission was seen in Hawaii as well as Texas, Florida and other Gulf Coast states over past 30 years; many imported cases seen in U.S. each year.

Transmission Cycles of Dengue: Humans and mosquitoes are the main reservoir species. The sylvatic cycle is only active in parts of Southeast Asia and Africa.
American Mosquito Species Associated with Dengue

Primary Vectors

Aedes aegypti *
Aedes albopictus *

* Mosquito species found in Virginia
Discovery and spread of WNV in the United States in 1999

WNV hospitalized 62 persons in 1999 and seven patients died. WNV was detected in 194 birds and 25 horses (8 horses died).
National Distribution of WNV Human Cases in 2001

2001
66 Human Cases
9 Fatalities
National Distribution of WNV Human Cases in 2002

2002
4161 Human Cases
277 Fatalities
National Distribution of WNV Human Cases in 2003

2003
9862 Human Cases
264 Fatalities
National Distribution of WNV Human Cases in 2004

2004
2470 Human Cases
88 Fatalities
# National WNV Activity by Year

<table>
<thead>
<tr>
<th>YEAR</th>
<th>1999</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
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</thead>
<tbody>
<tr>
<td><strong>Human Cases</strong></td>
<td>62</td>
<td>20</td>
<td>66</td>
<td>4,161</td>
<td>9,862</td>
<td>2,470</td>
</tr>
<tr>
<td><strong>WNND Cases</strong></td>
<td></td>
<td></td>
<td></td>
<td>2,587</td>
<td>897</td>
<td></td>
</tr>
<tr>
<td><strong>Median Age (All Cases)</strong></td>
<td>77</td>
<td>62</td>
<td>68</td>
<td>55</td>
<td>47</td>
<td>52</td>
</tr>
</tbody>
</table>

Case age range in 2004 was (1 month - 99 yrs.)

<table>
<thead>
<tr>
<th>YEAR</th>
<th>1999</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
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</thead>
<tbody>
<tr>
<td><strong>Human Deaths</strong></td>
<td>7</td>
<td>2</td>
<td>9</td>
<td>277</td>
<td>264</td>
<td>88</td>
</tr>
</tbody>
</table>

Mortality age range in 2004 was (43 - 95 yrs.)

| | 11% | 10% | 14% | 7% | 3% | 4% |
| **Mortality %** | | | | | | |

% of WNND Cases 10.2% 9.8%

| | 68 | 77 | 70 | 77 | 77 | 73 |
| **Median Age (Mortality)** | | | | | | |

Source, CDC; Jan.11, 2005
Commonly Used Methods of Mosquito Control for Disease Prevention
Commonly Used Mosquito Control Tactics:

1. Larval and adult mosquito surveillance
2. Larval mosquito control (larvicide applications)
3. Habitat management (drainage control and breeding habitat elimination/modification)
4. Public education
5. Adult mosquito control (ULV aerosol applications / fogging, barrier treatments)
6. Biological mosquito control (mosquito fish)
Larval Mosquito Control: Larvicide applications are the most widely used and efficient mosquito control tactic.

Larvicides are applied to aquatic breeding habitats to kill immature mosquitoes before they can become flying, blood-feeding, reproductive adults.
Larval Mosquito Control: Several of the most important WNV and SLE vectors commonly breed in puddles that occur in underground storm-sewer systems (e.g., catch basins and man-holes).

Larvicide applications to underground bodies of water can be difficult because they are often inaccessible.

Most WNV and SLE prevention programs have extensive larviciding programs for their of storm-sewer systems.
Habitat Management: Drainage control and breeding habitat elimination/modification are widely applied mosquito control tactics.

Ditches are made to flow, puddles are filled or drained, and artificial containers of water are removed or drained.

Shallow, temporary ponds can be deepened and/or made permanent to discourage colonization by mosquitoes and encourage the establishment of predatory species.
Public Education: A large portion of the WNV, SLE and LAC vector mosquito population originates from artificial breeding habitats (water containers) found around homes on private property.

Public education tells citizens how to eliminate or treat mosquito breeding habitats on their own property and how to protect themselves against mosquito bites.
Ground-based Applications

**Adult Mosquito Control:**
Fogging and ULV aerosol applications are used to treat large areas (volumes of air) to kill flying adult mosquitoes.

Aerial Applications

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ULV aerosol applications are most commonly used to reduce large mosquito populations that have escaped larval control, and/or when the potential for disease transmission is very high.

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Ground-based Applications

Aerosols have little impact on sheltered or resting adult mosquitoes.
Adult Mosquito Control: Some WNV and SLE control programs make ULV Aerosol or thermal fog applications to the insides of urban storm sewer systems to kill the adult Culex mosquito species that breed in, and take refuge in such underground habitats.

Storm Sewer Fogging
Biological Mosquito Control: Mosquito fish (*Gambusia* species) are minnow-sized fish that function well in the shallow aquatic habitats that larval mosquitoes prefer.

Many county and municipal mosquito control programs breed mosquito fish in hatcheries and release them in appropriate habitats, or hand them out to citizens for control of immature mosquitoes in aquatic habitats.

Mosquito fish are particularly useful for controlling mosquito species that would breed in back yard ornamental ponds or abandoned swimming pools.
The End