Sanitarian Training: Vector Control

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West Virginia Department of Health & Human Resources
Charleston, WV
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Objectives

- Introduction to arthropods directly associated with human health in West Virginia
- Provide techniques used to control medically-important arthropods
Medical Entomology: The study of arthropods that directly affect the health of humans
Human Medical Problems

- Mite & Louse Infestations
- Lyme Disease
- Yellow Fever
- Leishmaniasis
- Encephalitis
- Filariasis
- Chagas Disease
- Dengue Fever
- Malaria
Human Cases Per Year

- Sleeping Sickness: 25,000 die
- Leishmaniasis: 12,000,000 infected
- Chagas Disease: 15 – 20,000,000 infected
- River Blindness: 18,000,000 infected
- Elephantiasis: 128,000,000 infected
- Dengue: 50 – 100,000,000 infected
- Malaria: 300 – 500,000,000 infected
Mosquitoes & Public Health

- Loss of blood
- Allergic response to mosquito bites
- Annoyance
- Disease Transmission
La Crosse Encephalitis

- Pathogen: La Crosse (LAC) virus
- Distribution: Eastern United States

Most human cases occur in upper Midwest (Wisconsin, Minnesota, Illinois, Indiana, Ohio) and mid-Atlantic states (West Virginia, Tennessee, North Carolina)
La Crosse Encephalitis (cont’d)

- **Vectors**
  - *Aedes triseriatus*: Eastern treehole mosquito
  - *Aedes albopictus*: Asian tiger mosquito
  - *Aedes japonicus*: Asian bush mosquito

- All three of these species are container breeders (ex. treeholes, concrete basins, tires, buckets, children wading pools)
- Sciurid rodents, especially chipmunks and squirrels, serve as vertebrate hosts
- Transmitted from mother to offspring in eastern treehole mosquito
- Venereal transmission from males to females
West Nile Encephalitis

- Pathogen: West Nile (WN) virus
- Distribution: Africa, Middle East, Europe, India, southeast Asia, Indonesia, and continental United States of America
West Nile Encephalitis (cont’d)

- Vectors
  - *Culex* spp., esp. *Culex pipiens*, *Culex quinquefasciatus*, and *Culex univittatus*
  - Continually finding new vectors
Wild birds serve as vertebrate hosts

West Nile Virus Transmission Cycle

- Mosquito vector
- West Nile virus
- Bird reservoir host
- West Nile virus
- Incidental infection
- Incidental infection
Human Malaria

- Pathogen: *Plasmodium falciparum, Plasmodium vivax, Plasmodium ovale, Plasmodium malariae*
- Distribution: Sub-Saharan Africa to northern Africa; Middle East to Pakistan; India and Sri Lanka; parts of China and Southeast Asia; Indonesia and Philippines; Mexico through northern half of South America
Vectors: *Anopheles spp.*
- *Anopheles gambiae*
- *An. albimanus*
- *An. darlingi*
- *An. funestus*
- *An. culicifacies*
- *An. dirus*
- *An. quadrimaculatus*
- *An. freeborni*

Vertebrate Hosts: Humans
Zika Virus Disease

Zika virus

- Single stranded RNA virus
- Belongs to the virus family Flaviviridae genus *Flavivirus*
  - Yellow fever virus
  - Dengue virus
  - Japanese encephalitis virus
  - West Nile virus
- Transmitted to humans primarily by *Aedes (Stegomyia)* mosquitoes
  - Sexual transmission and perinatal transmission of the virus have also been documented
Zika Virus Transmission Cycle

Sylvatic (jungle) cycle

Epidemic (urban) cycle
Mosquito vectors of Zika virus found in the continental United States

- Yellow fever mosquito (*Aedes aegypti*)
- Asian tiger mosquito (*Aedes albopictus*)

*Aedes aegypti* and *Aedes albopictus* also transmit dengue virus and chikungunya virus.

*Aedes albopictus* is also a competent vector for La Crosse virus.
Zika Virus Mosquito Vector Distribution

Aedes aegypti  Aedes albopictus

Source: CDC
Ae. *aegypti* occurrence records, 1995-2016

Ae. albopictus occurrence records, 1995-2016

Ae. albopictus Distribution in West Virginia

Counties Where Aedes albopictus Has Been Identified – West Virginia, 2018
Aedes aegypti and Aedes albopictus feed on human blood.
Aedes aegypti and Aedes albopictus lay eggs in natural and artificial water containers near human habitat.
Aedes aegypti and Aedes albopictus will enter human dwellings.
**Aedes aegypti** and **Aedes albopictus** are active during daytime.

Hourly captures of *Ae. aegypti* landing on man

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Aedes *albopictus* are active during the daytime.

Daily dynamics of host-seeking activity in *Ae. albopictus* females from Yaoundé, Cameroon (April-July 2009)

Dengue Fever

- **Pathogen:** Dengue (DEN) virus
- **Distribution:** Southeast Asia, south Pacific, Caribbean basin, Mexico, Central and South America with epidemics in United States, Japan, Australia, Greece, and western/eastern Africa
Dengue Fever (cont’d)

- **Vector:** *Aedes aegypti, Ae. albopictus, Ae. polynesiensis, Ae. scutellaris, Ae. pseudoscutellaris, Ae. rotumae*
- **Vertebrate Host:** Human
Chikungunya

- Pathogen: Chikungunya (CHIK) virus
- Distribution: Countries in Africa, Asia, Europe, and the Indian and Pacific Oceans. Recent local transmission in North, Central, and South America.
Chikungunya (cont’d)

- Vector: *Aedes aegypti, Ae. albopictus*
- Vertebrate Host: Human
Other Mosquito-Borne Diseases

- Yellow Fever
- Rift Valley Fever
- Filariasis
- Dog Heartworm
Pest Management (Personal Protection)

- Repellent (DEET)
- Window screens
- Bed nets
- Head nets
- Reduce activity during peak mosquito activity
Pest Management (Habitat Modification)

- Land drainage
- Tire and container disposal
- Natural container elimination
- Vegetation changes in ponds
- Water-level manipulation
Pest Management (Biological Control)

- Mosquito fish
- Predatory mosquitoes (*Toxorhynchites*)
- Natural invertebrate predators
- Bacteria
  - *Bacillus thuringiensis israelensis* (Bti)
  - *Bacillus sphaericus*
Pest Management (Chemical Control)

- Light mineral oils
- Organophosphates
- Insect-growth regulators
- Pyrethrin fog sprays
Organophosphate

- Neurotoxin
- Harm non-target species (ex. humans)
- Ex. Temephos, Malathion, Naled
Oils

- Suffocate
  - Prevents air transfer into water
- Barrier
  - Mosquitoes cannot lay eggs into water
- Harm non-target species (ex. fish, amphibians)
Natural & Synthetic Botanicals

- Derived from plant products
- Ex. Pyrethrin (from Chrysanthemum)
  - Fast acting neurotoxin
  - Low toxicity to mammals
  - Low residual activity
- Ex. Permethrin, Resmethrin (Synthetic Pyrethrins)
Insect Growth Regulators

- Prevent larvae from developing into disease transmitting adults
- Specific to immature insects
- Ex. Methoprene
Pesticide Application Safety

- Read the pesticide label
- Wear appropriate personal protection
- Better to be overprotective
Mosquito Control Partners

- West Virginia Department of Environmental Protection Rehabilitation Environmental Action Plan (REAP)
  - https://dep.wv.gov/environmental-advocate/reap/Pages/default.aspx
- Tire Collection Events
- Community Cleanup Activities
Mosquito Control Partners (cont.’d)

- West Virginia Department of Environmental Protection Rehabilitation Environmental Action Plan (REAP) ‘Pollution, Prevention, and Open Dump Program’ works to reduce open dump sites in West Virginia.
Litter Control Officers have authority to control mosquito breeding sites on private and public land.

West Virginia Division of Natural Resources has authority to investigate mosquito breeding sites in containers on private property.
According to West Virginia code 16-3-6 (‘Nuisances affecting public health’), a public health officer “shall inquire into and investigate all nuisances affecting the public health within his jurisdiction” and is permitted (with judicial approval) to “restrain, prevent or abate the nuisance.”
Zika virus disease (Zika) is a disease caused by Zika virus that is spread to people primarily through the bite of an infected Aedes species mosquito. The most common symptoms of Zika are fever, rash, joint pain, and conjunctivitis (red eyes). The illness is usually mild with symptoms lasting for several days to a week after being bitten by an infected mosquito. People usually do not get sick enough to go to the hospital, and they very rarely die of Zika. For this reason, many people might not realize they have been infected. Once a person has been infected, he or she is likely to be protected from future infections. Zika has been linked to complications such as Guillain-Barré syndrome and poor birth outcomes (e.g., microcephaly) prompting additional research and studies. Because of ongoing studies surrounding these complications, suspected Zika virus cases should be reported to the local health department within 24 hours.

Provider Responsibilities
1. Report suspect and confirmed cases within 24 hours. Supply requested clinical information to the local health department to assist with case ascertainment.
2. Arrange appropriate testing is completed for patients with suspected Zika virus infection. Testing for Zika virus should be done in coordination with the local health department, the Division of Infectious Disease Epidemiology and the Office of Laboratory Services.
3. Provide preconception counseling for women and their male sexual partners with possible exposure to Zika virus.
5. Advise pregnant women to take precautions when traveling to Zika-affected countries.

Laboratory Responsibilities
1. Report positive Zika virus testing results within 24 hours. Prompt reporting facilitates public health prevention and control activities.
2. Submit positive arboviral samples to the Office of Laboratory Services within 1 week for subsequent testing at CDC.
3. If requesting Zika rRT-PCR testing from a commercial laboratory (not the Office of Laboratory Services), retain an aliquot of the serum for Zika IgM ELISA in the event that rRT-PCR testing is negative.

Local Health Responsibilities
1. Educate the public about Zika virus, especially regarding prevention measures during travel and when mosquitoes are active. Late spring and early summer are optimal times to provide this education. A model press release is available under “Tools for Local Health Departments” at: http://www.dhhr.wv.gov/pages/disease/zhansmi/Mosquito/Pages/dhrp.aspx.
2. Educate providers and laboratories to report Zika cases within 24 hours.
3. For Zika virus infection within 7 days of onset:

State Health Responsibilities
1. Review completed case reports from local health departments within one week.
2. Report all confirmed and probable cases to CDC using ArboNET upon confirmation of case status.
3. Provide training and consultation to local health departments regarding case ascertainment and prevention for Zika infection.
4. Complete enhanced passive surveillance activities each spring. This includes release of a statewide HAN to healthcare providers, a laboratory letter, a training seminar, updates to arboviral information sheets, and release of a memo to local health departments.
5. Conduct yearly mosquito surveillance activities (see mosquito surveillance protocol). Provide regular data feedback to local health departments and public health partners during arboviral disease season (May-October).
6. Ensure that information provided to local health and the general public are up-to-date.
7. Use resources and equipment are available for laboratory testing and mosquito surveillance.
8. Work with the Office of Maternal, Child, and Family Health to ensure that pregnant women are monitored through the Zika Pregnancy Registry.
10. In the event that local transmission is identified, use GIS mapping to delineate zip code(s) where local transmission is occurring in consultation with local health departments and CDC. Share the information with CDC so that zip codes can be posted and available for blood banks at a national level.
11. Maintain contact with blood collection centers as follows: a. Pre-season: i. Compile a list of contacts

Division of Infectious Disease Epidemiology
350 Capitol Street, Room 129, Charleston, WV 25301-3715
Phone: (304) 556-5335, extension 1 Fax: (304) 556-4335 www.dide.wv.gov
Answering Service: (304) 925-9946
Local Health Responsibilities
1. Educate the public about Zika virus, especially regarding prevention measures during travel and when mosquitoes are active. Late spring and early summer are optimal times to provide this education. A model press release is available under “Tools for Local Health Departments” at: http://www.dhhr.wv.gov/oeps/disease/Zoonosis/Mosquito/Pages/Arbo.aspx
2. Educate providers and laboratories to report Zika cases within 24 hours.
3. For Zika virus infection within 7 days of onset:

Division of Infectious Disease Epidemiology
350 Capitol Street, Room 125, Charleston, WV 25301-3715
Phone: (304) 558-5358, extension 1 Fax: (304) 558-6335  www.dide.wv.gov
Answering Service: (304) 925-9946

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July 2016
Zika Virus Disease and Zika Congenital Infection Surveillance Protocol

a. Educate the patient about the risk of transmission to others through mosquitoes
b. Request that the patient stay indoors as much as possible and avoid mosquito bites for the first week of illness.
c. Educate male patients about sexual transmission of Zika.
4. Conduct an appropriate case investigation.
d. Contact the healthcare provider that ordered the laboratory test to obtain the clinical information on the WVEDSS form.
e. If needed, contact the patient to obtain information regarding travel history.
f. In collaboration with the West Virginia Bureau for Public Health’s Vector Control Team, conduct a home visit and perform an environmental assessment to identify potential risk factors for exposure to mosquitoes.
g. Educate the patient and the patient’s family on mosquito bite prevention and other appropriate prevention messages.
h. Report all case data using WVEDSS.
5. Consult with the Division of Infectious Disease Epidemiology (DIDE) for guidance on appropriate case management and public health actions.
Environmental Assessment (cont’d)

Zika Virus Disease and Zika Congenital Infection

**Patient Demographics**

- Name (last, first): ________________
- Address (mailing): ________________
- Address (physical): ________________
- City/State/Zip: ________________
- Phone (home): ________________
- Phone (work/rel): ________________
- Alien Registration Number: ________________
- Date of Birth: ________________
- Sex: Male / Female
- Hispanic/Latino: Yes / No
- Race: ________________
- Education: ________________
- Occupation: ________________
- Employer: ________________
- Mailing Address: ________________

**Investigation Summary**

- Local Health Department (Jurisdiction): ________________
- Investigation Start Date: ________________
- Case Classification: ________________
- Report Source: ________________
- Reporter Name: ________________
- Reporter Phone: ________________
- Primary HCP Name: ________________
- Primary HCP Phone: ________________
- Exposure Period: ________________
- Onset Date: ________________

**Clinical**

- Onset date: ________________
- Diagnosis date: ________________
- Recovery date: ________________
- Zika Virus Disease (ZVD)
- Zika Congenital Infection (ZCI)

**Clinical Findings**

- Fever (highest recorded temperature: __°F)
- Rash
- Arthralgia
- Conjunctivitis
- Guillain-Barré syndrome not associated with other symptoms
- Microcephaly
- Intercurrent infections
- Congenital nervous system abnormalities
- Other: ________________

**LABORATORY**

- Detection of Zika virus or Zika virus-specific nucleic acids from specimens of serum, CSF, urine, semen, amniotic fluid, saliva, or tissue

**Vaccination History**

- Ever vaccinated for yellow fever (yes, no, unknown)
- Ever vaccinated with Japanese encephalitis (yes, no, unknown)
- Ever vaccinated with yellow fever antibodies in serum or CSF

**Notes**

*Inclusion Period: 2-7 days*
**EPIDEMIOLOGIC EXPOSURES**

Based on the above exposure period, unless otherwise specified:

- History of travel within 14 days of illness onset (if yes, complete travel history below):
  - Travel Destination (City, County, State and Country)
  - Arrival Date
  - Departure Date
  - Reason for travel

- Travel to country or region with active Zika virus transmission
- Pregnant during travel country or region with active Zika virus transmission
- Sexual contact with a person with laboratory confirmed or probable Zika virus infection
- Association in time and place with a person with laboratory confirmed or probable Zika virus infection

- Artificial water-holding containers present near residence
- Areas of standing water present near residence
- Hardwood forest present near residence
- Poorly draining gutters present near residence
- Window/door screens in disrepair or missing at residence
  - Geographic coordinates of patient residence:
    - Latitude:
    - Longitude:
    - (Indicate units: Decimal Degrees Degrees Minutes Seconds Other)

- Blood transfusion 30 days prior to onset (Date: ___/___/___)
- Organ transplant 30 days prior to onset (Date: ___/___/___)
- Case was prenatally exposed (in utero)
- Case is a breast-fed infant
- Outdoor recreational activities (e.g., hiking, camping, etc)
- Mosquito bite
- Possible occupational exposure
  - Laboratory worker (Date of exposure: ___/___/___)
  - Other occupation:

Where did exposure most likely occur? County: State: Country:

**PUBLIC HEALTH ISSUES**

- Case identified through blood donor screening
- Case donated blood products, organs or tissue in the 30 days prior to symptom onset
  - Date: ___/___/___
  - Agency/location: ___________________
  - Type of donation:
- Case is pregnant (Due date: ___/___/___)
- Case knows someone who had shared exposure and is currently having similar symptoms
- Epi link to another confirmed case of same condition
- Case is part of an outbreak
- Other:

**PUBLIC HEALTH ACTIONS**

- Notify blood or tissue bank or other facility where organs donated
- Notify patient obstetrician
- Disease education and prevention information provided to patient and/or family/guardian
- Recommended environmental measures to patient/family to reduce risk around home
- Education or outreach provided to employer
- Facilitate laboratory testing of other symptomatic persons who have a shared exposure
- Patient is lost to follow-up
- Other:
### Environmental Assessment Form

| Environmental Assessment Form | Name of Assessor: ____________________________ | Assessment Date: __________/________/______ |

### CASE INFORMATION

<table>
<thead>
<tr>
<th>Last name</th>
<th>First name</th>
<th>Middle Name</th>
<th>Date of Birth</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Home Street Address</th>
<th>City</th>
<th>Zip Code</th>
<th>County</th>
</tr>
</thead>
</table>

(Coordinates should be in decimal degrees)

<table>
<thead>
<tr>
<th>Latitude</th>
<th>Longitude</th>
</tr>
</thead>
</table>

Arboviral Disease of Concern: ☐La Crosse Encephalitis ☐West Nile Virus ☐Zika Virus ☐Other: ____________________________

### ASSESSMENT OF OUTDOOR ENVIRONMENT

- [ ] Containers holding water visible on property (If checked, indicate types of containers)
- [ ] Tires
- [ ] Pool (type) __________________
- [ ] Animal watering containers
- [ ] Flower pots
- [ ] Containers without lids
- [ ] Other: ____________________________

- [ ] Leaf litter and organic debris in yard
- [ ] Assessor noticed larvae in containers on property
- [ ] House gutters with visible debris
- [ ] Other: ____________________________

### CASE CLINICAL AND EXPOSURE HISTORY

Has the case been symptomatic within the past two weeks? ☐Yes ☐No

*If yes, indicate symptom onset date: __________/________/______*

Types of symptoms: ☐Fever ☐Rash ☐Joint pain ☐Conjunctivitis ☐Headache ☐Muscle ache ☐Encephalitis

- [ ] Other: ____________________________

Has the case traveled outside of West Virginia in the past two weeks? ☐Yes ☐No

*If yes, indicate place of travel and travel dates.*

<table>
<thead>
<tr>
<th>City</th>
<th>State</th>
<th>Country</th>
<th>Arrival Date</th>
<th>Departure Date</th>
</tr>
</thead>
</table>

### ACTIONS OF PUBLIC HEALTH OFFICIAL

- [ ] Mosquito traps were set on property
- [ ] Drained water holding containers
- [ ] Conducted treatment for mosquito larvae
- [ ] Recommended that case remain confined indoors/covered up (for symptomatic cases)

- [ ] Shared mosquito bite prevention literature
- [ ] Disposed of litter/organic debris around home
- [ ] Showed owner larval/pupa~e~ mosquitos stages
- [ ] Other: ____________________________
ENVIRONMENTAL ASSESSMENT ACTIONS AND RECOMMENDATIONS

Dear Property Owner/Occupant:

Thank you for allowing [enter health department here] to conduct an environmental assessment at your home. Environmental assessments are often used by public health officials to help reduce the spread of mosquito-borne diseases. The information collected during an assessment can be used to identify mosquito breeding sites and provide education about preventing mosquito-borne disease.

The following are recommendations or actions by public health officials during an environmental assessment of your home.

☐ Mosquito traps were set on property ☐ Shared mosquito bite prevention literature
☐ Shared disease specific literature ☐ Drained water holding containers
☐ Showed owner larval/pupae mosquito stages ☐ Disposed of litter/organic debris around home
☐ Conducted larvicide
☐ Recommended that case remain confined indoors/covered up for at least seven days
☐ Other: ____________________________________________

If mosquito traps were set on your property, public health entomologist will be available to identify the different species of mosquitoes that are living near your home and test them for endemic disease (e.g. West Nile and La Crosse encephalitis)

It is recommended that cases prevent mosquito bites by wearing mosquito repellent, staying indoors and covering up as much as possible (i.e. wearing long sleeves and pants, sleeping under bed nets) because human cases of mosquito-borne disease can spread infections to mosquitoes (usually during the first week of infection).

Please take time to read the mosquito-borne disease prevention literature that was provided to you. The [enter health department here] sincerely appreciates your cooperation in making public health work for you. If you have additional questions or concerns feel free to contact us at [enter health department number here].
- Loss of blood
- Tick toxicoses
- Tick paralysis
- Disease transmission
Tick-borne Diseases in West Virginia

Tick-borne diseases by causative organism(s) and presence of tick vectors in West Virginia

<table>
<thead>
<tr>
<th>Tick-borne Disease</th>
<th>Pathogen(s)</th>
<th>Tick Vector(s) Present in WV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tularemia</td>
<td><em>Franciscella tularensis</em></td>
<td>American dog tick (<em>Dermacentor variabilis</em>)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lone star tick (<em>Amblyomma americanum</em>)</td>
</tr>
<tr>
<td>Anaplasmosis</td>
<td><em>Anaplasma phagocytophilum</em></td>
<td>Blacklegged tick (<em>Ixodes scapularis</em>)</td>
</tr>
<tr>
<td>Ehrlichiosis</td>
<td><em>Ehrlichia chaffeensis</em></td>
<td>Lone star tick (<em>Amblyomma americanum</em>)</td>
</tr>
<tr>
<td></td>
<td><em>Ehrlichia ewingii</em></td>
<td>Gulf Coast tick (<em>Amblyomma maculatum</em>)</td>
</tr>
<tr>
<td></td>
<td>Panola Mountain <em>Ehrlichia</em> sp.</td>
<td>Blacklegged tick (<em>Ixodes scapularis</em>)</td>
</tr>
<tr>
<td></td>
<td><em>Ehrlichia muris</em> -like agent</td>
<td></td>
</tr>
<tr>
<td>Lyme disease</td>
<td><em>Borrelia burgdorferi</em></td>
<td>Blacklegged tick (<em>Ixodes scapularis</em>)</td>
</tr>
<tr>
<td></td>
<td><em>Borrelia mayonii</em></td>
<td></td>
</tr>
<tr>
<td>Relapsing fever*</td>
<td><em>Borrelia miyamotoi</em></td>
<td>Blacklegged tick (<em>Ixodes scapularis</em>)</td>
</tr>
<tr>
<td>Powassan encephalitis*</td>
<td>Powassan virus</td>
<td>Groundhog tick (<em>Ixodes cookei</em>)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Blacklegged tick (<em>Ixodes scapularis</em>)</td>
</tr>
<tr>
<td>Babesiosis</td>
<td><em>Babesia microti</em></td>
<td>Blacklegged tick (<em>Ixodes scapularis</em>)</td>
</tr>
<tr>
<td></td>
<td>and other <em>Babesia</em> spp.</td>
<td></td>
</tr>
<tr>
<td>Rocky Mountain spotted</td>
<td><em>Rickettsia rickettsii</em></td>
<td>American dog tick (<em>Dermacentor variabilis</em>)</td>
</tr>
<tr>
<td>fever and other spotted</td>
<td>(and other spotted fever group)</td>
<td>Brown dog tick (<em>Rhipicephalus sanguineus</em>)</td>
</tr>
<tr>
<td>fever rickettsioses</td>
<td><em>Rickettsia</em></td>
<td>Lone star tick (<em>Amblyomma americanum</em>)</td>
</tr>
<tr>
<td></td>
<td>(and other spotted fever group)</td>
<td>Gulf Coast tick (<em>Amblyomma maculatum</em>)</td>
</tr>
</tbody>
</table>

*Tick-borne disease not detected in West Virginia
• Human cases of Lyme disease and Spotted Fever Group Rickettsioses (SFGR) (including Rocky Mountain Spotted Fever (RMFS)) have been increasing in West Virginia

<table>
<thead>
<tr>
<th>Disease Name</th>
<th># of 2014 cases</th>
<th># of 2015 cases</th>
<th># of 2016 cases</th>
<th># of 2017 cases</th>
<th># of 2018 cases</th>
<th># of 2019 cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anaplasmosis</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Babesiosis</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Ehrlichiosis</td>
<td>3</td>
<td>5</td>
<td>6</td>
<td>6</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>Anaplasmosis/ Ehrlichiosis</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
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<td>RMSF/SFGR</td>
<td>5</td>
<td>9</td>
<td>14</td>
<td>17</td>
<td>20</td>
<td>26</td>
</tr>
<tr>
<td>Lyme disease</td>
<td>136</td>
<td>289</td>
<td>368</td>
<td>648</td>
<td>671</td>
<td>898</td>
</tr>
<tr>
<td>TOTAL</td>
<td>146</td>
<td>304</td>
<td>388</td>
<td>675</td>
<td>697</td>
<td>937</td>
</tr>
</tbody>
</table>

Frequency of tick-borne diseases reported in West Virginia from 2014-2019
Lyme Disease

- **Pathogen:** *Borrelia burgdorferi, Borrelia mayonii*
- **Distribution:** Worldwide
  
  United States of America: Mainly northeastern U.S. and upper Midwest
In United States of America

- *Ixodes scapularis*: Black-legged tick (including *Ixodes dammini*: Deer tick)
- *Ixodes pacificus*: Western black-legged tick
- *Ixodes dentatus, Ixodes neotoma, Ixodes spinipalpis*
Lyme Disease (cont’d)

- Hosts of *Borrelia burgdorferi*
  - Field mice
  - Raccoon, opossum, rabbits
  - Birds
- Hosts of *Ixodes scapularis*
  - Field mice: Larvae, nymphs
  - Raccoon, opossum, humans: Nymphs
  - White-tailed deer: Adults
Rocky Mountain Spotted Fever

- Pathogen: *Rickettsia rickettsii* (and other spotted fever group rickettsia)
- Distribution: Western Hemisphere
  Found throughout U. S. except VT, HI, and AK
  Most prevalent in Appalachian country
Vectors

- *Dermacentor variabilis*: American dog tick
- *D. andersoni*: Rocky Mountain wood tick
- *D. occidentalis*: Pacific Coast tick
- ? *Haemaphysalis leporispalustris*
- ? *Amblyomma americanum*
- ? *Rhipicephalus sanguineus*
- ? *Amblyomma cajennse*
- ? *Amblyomma maculatum*
Rocky Mountain Spotted Fever (cont’d)

- Adult ticks mainly on domestic animals (dogs, cows, horses)
- Larvae and nymphs on rodents that are favored on transitional vegetation
Anaplasmosis/Ehrlichiosis

- **Pathogen:** *Anaplasma phagocytophilum, Ehrlichia chaffeensis*
- **Distribution**
  - *A. phagocytophilum*: Northeast, upper Midwest and far western U. S.
  - *E. chaffeensis*: Southeastern and southcentral U. S.
Anaplasmosis/Ehrlichiosis (cont’d)

- *Ixodes scapularis*: Black-legged tick transmits *Anaplasma phagocytophilum*
- *Amblyomma americanum*: Lone star tick transmits *Ehrlichia chaffeensis*
Other Tick-Borne Diseases

- Babesiosis
- Tick-borne Encephalitis
- Q Fever
- Tularemia
Pest Management (Large Scale)

- Pesticide
  Dipping, dust bags, power drench, pour-on, plastic collars, ear tags, permethrin impregnated cotton balls
Pest Management (Large Scale) (cont’d)

- Quarantine
- Burning or clearing vegetation
- Pasture rotation
- Elimination of deer
Pest Management (New Techniques)

- Sex pheromone and pesticide
- Insect Growth Regulators
- Tick vaccines
- Vaccines to tick-borne diseases
Pest Management (Personal Protection)

- Repellent (DEET)
- Long-trousers and light colored clothing
- Permethrin-impregnated clothing
- Self-examination
- Gentle removal of tick with mouthparts
Bed Bugs & Public Health

- Loss of blood
- Allergic to bites
- Psychological trauma
- Unsubstantiated social stigma
No diseases actively transmitted by bed bugs
- Bed bugs in different life stages existing at the same place and time
Hide in daytime in cracks, crevices, behind baseboards, bed frames, and mattresses

70-90% bed bug activity 6-8 ft. from resting surface
Surveillance with proper identification
Control Methods

Physical (Heat, Steam, Cold, Vacuum)

Barriers (Bedding covers, Seal Cracks)
Control Methods

- Insecticides
  - Liquid/Fluid Formulations (Pyrethroids)
  - Fumigants (Not Foggers)
- Diatomaceous Earth
- Insect Growth Regulators
Lice & Public Health

- Pediculosis
- Loss of blood
- Disease transmission
  - Epidemic Typhus (*Rickettsia prowazekii*)
  - Trench Fever (*Bartonella quintana*)
  - Epidemic Relapsing Fever (*Borrelia recurrensis*)
- Washing caps, bed linens, night clothing, and stuffed animals with hot water
- Powders, ointments, shampoos (humans)
  - Shampoos with permethrin, malathion or lindane
Human public health issues caused by arthropods are manageable if we understand the biology of the instigating organism.
Contact

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