WEST VIRGINIA
2016 ZOONOTIC DISEASE SURVEILLANCE REPORT

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2016 Mosquito-borne Disease Surveillance Summary

Introduction

Mosquito-borne diseases, most of which are viruses, are transmitted through the bite of infected mosquitoes. Surveillance for these diseases in West Virginia (WV) focuses on four endemic arboviruses—La Crosse encephalitis virus (LAC), West Nile virus (WNV), St. Louis encephalitis virus (SLE), and eastern equine encephalitis virus (EEE)—and travel-associated diseases such as chikungunya, dengue fever, malaria, and Zika virus (ZIKV). Historically, LAC has been the mosquito-borne disease of most concern in West Virginia, with up to 40 human cases reported in previous years.

Most people who become infected with endemic with arboviral infections have no clinical symptoms; however, encephalitis (inflammation of the brain) is a potentially life-threatening complication that is often reported among infected persons who develop symptoms. Symptoms generally begin one to two weeks after a mosquito bite and include fever, headache, myalgia, meningitis, and neurologic dysfunction. There is no specific treatment available for arboviral infections.

Environmental surveillance for arboviral diseases monitors local activity in non-human species. Mosquito surveillance is important to understanding the distribution of these vectors and the diseases that they may transmit to humans. Mosquito surveillance is conducted in selected counties across the state from late spring through fall. Dead birds reported to local health departments (LHDS) can also assist public health officials in arbovirus surveillance activities. Certain species of birds (e.g. crows and jays) are more likely to become infected with WNV than other bird species and can die from infections. Additionally, horses can become infected with arboviruses resulting in clinical illness. Mosquitoes, dead birds and horses have all been used to help identify WNV and other arboviral disease activity in West Virginia.

This surveillance summary describes human cases of mosquito-borne disease and environmental surveillance—mosquito, dead bird, and horse surveillance—for arbovirus in West Virginia in 2016.

Methods

Human Surveillance

Patients with a positive laboratory test result for a mosquito-borne disease were entered into the West Virginia Electronic Disease Surveillance System (WVEDSS) for additional follow-up by the LHD where the patient resides, including an environmental assessment of case sites. All reported human cases were classified according to the national case definition for each mosquito-borne disease (wwwn.cdc.gov/nndss/script/casedefDefault.aspx) only confirmed and probable cases were included for analysis. For dengue fever and other arboviral diseases (except ZIKC), the 2015 case definitions were used to ascertain case status. For malaria, the 2014 case definition was used, and for ZIKV, the 2016 case definition was used. Confirmed and probable arbovirus cases were reported to the Centers for Disease Control and Prevention (CDC) through ArboNET. Surveillance reports were shared with public health partners throughout active mosquito/mosquito-borne disease season from July to November 2016, to provide data on vectorborne disease activity around the State. To obtain case counts and basic descriptive epidemiologic characteristics of cases, records were exported from WVEDSS for all mosquito-borne disease cases within Morbidity and Mortality Weekly Report (MMWR) Year 2016. Data were summarized using Microsoft Excel.

Enhanced passive surveillance methods were utilized to help detect human cases of mosquito-borne arbovirus infection. These methods included 1) statewide health alerts to physicians, 2) a hospital laboratory letter, 3) an email memo to LHDs with important arboviral disease information, and 4) and dissemination of equine testing and dead bird surveillance information sheets to veterinarians. During 2016, mosquito-borne disease testing of human specimens occurred through hospital and commercial laboratories. The West Virginia Office of Laboratory Services (WVOLS) performed WNV, SLE, EEE, ZIKV testing, and the Virginia Department of Health Division of Consolidated Laboratory Services and CDC conducted LAC and ZIKV testing.

Equine Surveillance

Veterinarians suspecting arboviral infection in horse patients were asked to submit serum specimens to WVOLS. Specimens were forwarded to the National Veterinary Services Laboratory in Ames, Iowa for IgM capture enzyme-linked immunosorbent assay (ELISA) testing for WNV and EEE. A report was submitted to CDC through ArboNet for any equine serum specimens testing positive for an arboviral infection.

Dead Bird Surveillance

LHD personnel submitted oral swabs from dead birds to WVOLS for WNV, SLE, and EEE testing at the Southeastern Cooperative Wildlife Disease Study (SCWDS). A report was submitted to CDC through ArboNet for any dead bird specimens testing positive for an arboviral infection.

Mosquito Surveillance

Regular weekly mosquito trapping at three counties with historically low human cases of LAC (Kanawha, Wood, and Jackson) and three counties with historically high human case numbers of LAC (Raleigh, Fayette, and Nicholas) was conducted using CDC gravid traps and CO_2 dispersing light traps. BG Sentinel traps and aspirators were also used sporadically during the season, more often in late summer and early fall to capture the Asian tiger mosquito, *Aedes albopictus*. Semi-regular sampling was conducted in Greenbrier, Harrison, Mercer, Monongalia, Roane, and Wetzel counties. Daily mosquito specimens were returned to WVOLS in the nets of the mosquito traps and placed in a -80°C freezer. LHD partners provided additional samples from Berkeley, Braxton, Cabell, Jefferson, Kanawha, Lincoln, Marion, Mason, Morgan, Nicholas, Ohio, Putnam, and Wayne counties. All mosquito specimens were identified to species.

Mosquitoes collected from the same locality and on the same date were pooled together by mosquito genus to conserve testing resources. Only mosquitoes active from May through September were tested for arboviruses. Due to recent concerns of ZIKV and the activity of ZIKV competent mosquitoes, the invasive Asian tiger mosquito, *Aedes albopictus*, was monitored and tested separately from other mosquito species. Pools consisting of 10-50 adult female mosquitoes were tested for arboviruses (male mosquitoes do not transmit arboviral diseases). Real time reverse transcriptase polymerase chain reaction (rtRT-PCR) was used for arboviral detection. Mosquito pools were screened for WNV, SLE, LAC, and EEE. Positive and negative results were reported to CDC through ArboNET. Pooled infection rates were examined for each mosquito genus each week. The minimum infection rate (MIR) for *Culex* spp. was determined weekly. MIR is the ratio of the virus positive mosquito pools to the total number of mosquitoes in the samples.

Results

Human Surveillance

Table 1 provides a comparison of human cases of mosquito-borne diseases reported in West Virginia from 2012 to 2016. In 2016, 21 cases of mosquito-borne diseases were reported. One probable case of WNV was reported from Berkeley County. One confirmed case and seven probable cases of LAC were reported from seven counties; six were neuroinvasive cases. Seven of the cases were male and the remaining case was female. The median age was seven years (mean= 9.8 years; range= 3-33 years). Illness onset for LAC cases began in July (n=2), August (n=2), and September (n=4). Six cases were hospitalized as a result of illness. No cases of dengue fever were reported in 2016. One travel-associated malaria case was a male from Mason County reporting recent travel to Cameroon.

Table 1. Human cases of mosquito-borne disease in West Virginia from 2011 to 2015*.

Disease	# (%) of Cases† (2012)	# (%) of Cases† (2013)	# (%) of Cases† (2014)	# (%) of Cases† (2015)	# (%) of Cases† (2016)
LAC	14 (56)	11 (69)	2(28.6)	4 (57.1)	8 (38.1)
WNV	9* (36)	1 (6)	0(0)	0 (0)	1 (4.8)
Malaria	2 (8)	2 (12.5)	2(28.6)	2 (28.6)	1 (4.8)
Dengue	0 (0)	2 (12.5)	1(14.3)	1 (14.3)	0 (0)
EEE	0 (0)	0 (0)	0(0)	0 (0)	0 (0)
SLE	0 (0)	0 (0)	0(0)	0 (0)	0 (0)
Chikungunya	0 (0)	0 (0)	2(28.6)	0 (0)	0 (0)
Zika	-	-	-	-	11 (52.4)
Total	25 (100)	16 (100)	7(100)	7 (100)	21 (100)

**Does not include positive viremic blood donors †Includes only cases classified as confirmed or probable*

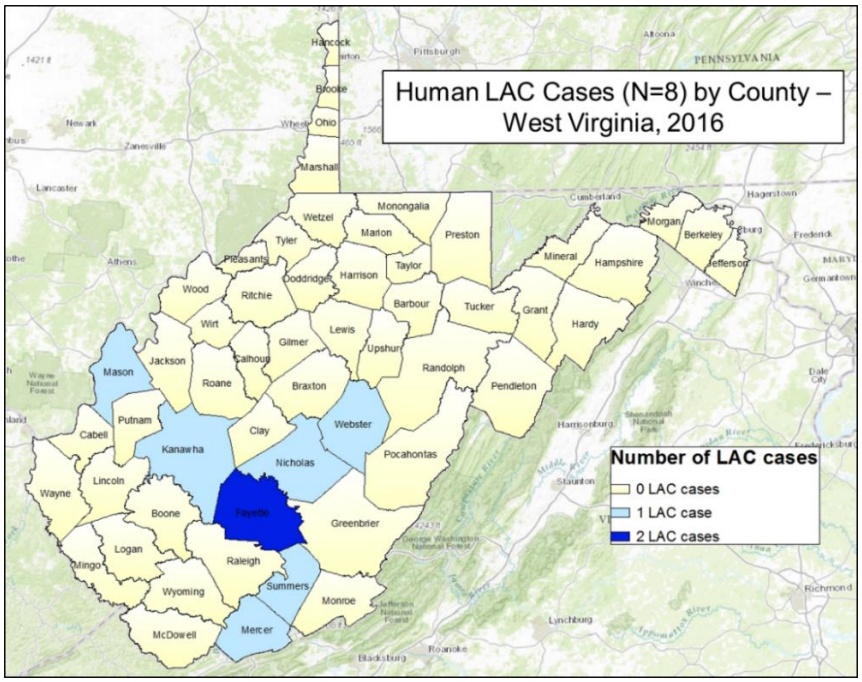

Figure 1. Distribution of human LAC cases reported in West Virginia in 2016.

Equine Surveillance and Dead Bird Surveillance

One equine serum specimen from Mineral County tested positive for WNV. Six dead birds were submitted to WVOLS for arboviral disease testing in 2016; three were insufficient for testing while the other three tested negative for arboviral disease.

Mosquito Surveillance

Active adult mosquito sampling was conducted from May 24, 2016 to November 8, 2016. A total of 16,545 adult mosquitoes was collected during mosquito surveillance season, of which 393 mosquito pools were tested for arboviruses. Table 2 shows the total number of mosquitoes collected by species. The right column shows diseases known to be transmitted by that species.

Table 2. Mosquito species collected during 2016.

Mosquito Species	Number of Mosquitoes Collected (%)	Major Vectors in Endemic Disease Transmission Cycle
Culex pipiens/restuans	6,863 (41.48)	WNV, SLE, EEE
Culex erraticus	5,176 (31.28)	
Aedes albopictus	2,256 (13.64)	LAC
Aedes japonicus	641 (3.87)	LAC
Aedes vexans	573 (3.46)	
Aedes trivittatus	445 (2.69)	
Aedes triseriatus	145 (0.88)	LAC
Anopheles punctipennis	101 (0.61)	
Psorophora ferox	76 (0.46)	
Uranotaenia sapphirina	54 (0.32)	
Aedes canadensis	40 (0.24)	
Other (Anopheles quadrimaculatus (37), Coquilletidia perturbans (34), Aedes spp. (20), Anopheles crucians (19), Aedes cinereus (16), Orthopodomyia signifera (10), Anopheles spp. (6), Culex spp. (6), Culex territans (6), Toxorhynchites rutilus septentrionalis (6),Psorophora columbiae (4), Psorophora spp. (4), Anopheles walkeri (2), Aedes atropalpus (1), Anopheles barberi (1), Orthopodomyia alba (1), Psorophora ciliata (1), *Psorophora cyanescens* (1)	175 (10.58)	
Total	16,545 (100)	

Figure 2 shows a map of counties where adult mosquito surveillance (N=22) occurred in the State. Positive WNV pools were found in five (22.7%) counties. Eleven (2.8%) of the 393 total mosquito pools tested positive for WNV. Four (36.4%) were collected from Kanawha County, three (27.3%) from Wayne County, two (18.2%) from Cabell County, one (9.1%) from Mason County, and one (9.1%) from Nicholas County. The first WNV-positive pool consisted of *Culex pipiens/restuans* active in Cabell County on July 6, 2016. The last WNV-positive mosquito pool contained *Culex pipiens*/*restuans* was collected from Kanawha County on September 22, 2016. In *Culex* mosquitoes, WNV activity began to increase in August (MMWR Week 33) and reached its peak in September (Figure. 2). LAC, EEE, and SLE were not detected in any mosquito pools in 2016. Samples from Ohio County were insufficient for arboviral testing.

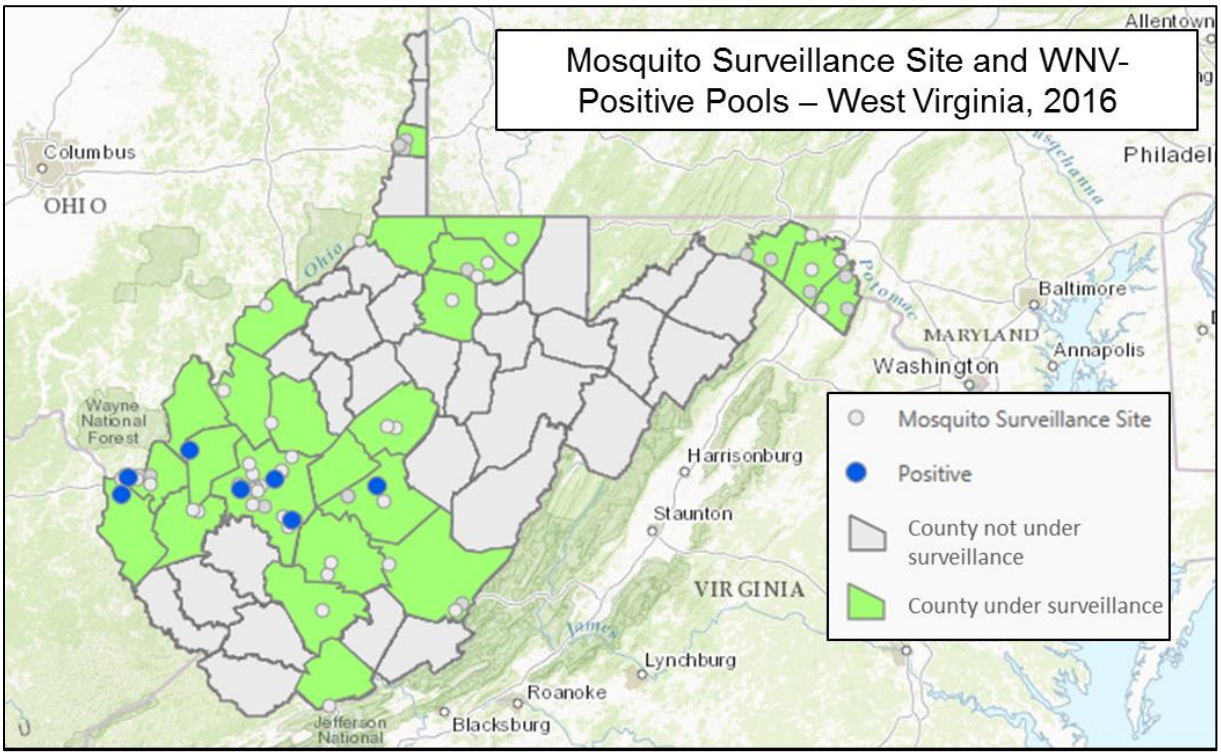

Figure 1. Counties in West Virginia where mosquito surveillance was conducted. Twenty-three counties were under surveillance in 2016. Eleven mosquito pools from five counties were positive for WNV.

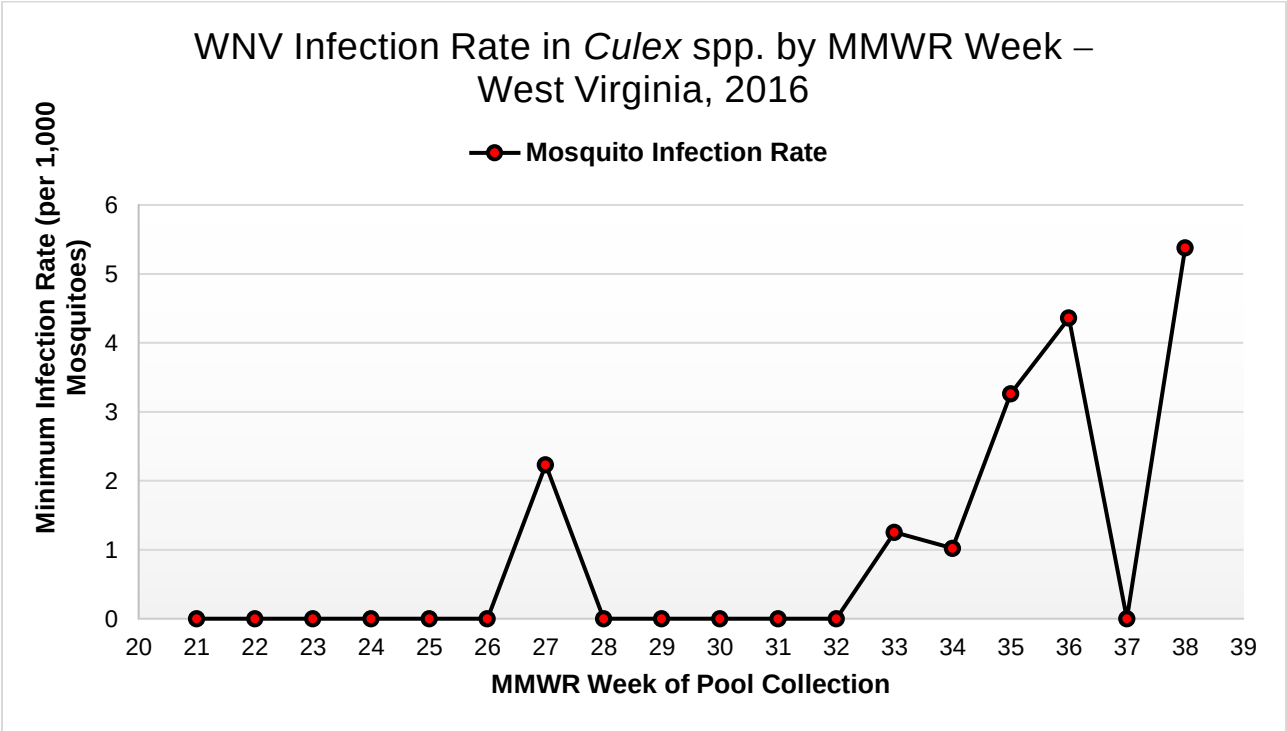

Figure 2. WNV infection rate in *Culex* spp. by week in West Virginia, 2016.

Discussion

The incidence of local mosquito-borne disease infections was very low in West Virginia in 2016 with only eight LAC cases reported (0.43 per 100,000 people) and no WNV cases reported. The majority (87.5%, 7/8) LAC cases followed epidemiologic trends previously seen in West Virginia, children under 15 years of age and in the southern region. However, one case was an adult, and two cases were from the Central Region.

Twelve imported mosquito-borne disease cases occurred in 2016, accounting for 57.1% of all mosquito-borne cases reported in the state. It is important that residents from West Virginia who travel internationally be mindful of mosquito-borne diseases endemic in their destinations, especially with the recent emergence of ZIKV in the Western Hemisphere. CDC's website for travelers' health is a good resource for this information: //wwwnc.cdc.gov/travel.

Equine serum and dead bird submissions have not contributed to environmental arboviral disease surveillance in recent years. However, 2016 marked the first WNV-positive serum specimen from a horse since 2004. This may be attributed to good communication between public health and veterinary partners. Information sheets on submitting equine specimens for testing were sent to veterinarians before the start of active mosquito season. Other interventions may be necessary to promote participation.

The low arboviral activity in mosquitoes and the limited geographic distribution of infected mosquitoes resulted in few human arboviral cases in 2016. According to the WNV minimum infection rate in *Culex* mosquitoes, there was only a 'moderate' human risk of West Nile encephalitis in 2016, as defined in the '2015 West Virginia Mosquito Surveillance Plan' (www.dhhr.wv.gov/oeps/disease/Zoonosis/Mosquito/Documents/Mosquito-Surveillance). According to the plan, the risk for WNV infection in humans is moderate if there is WNV infection in some mosquito pools in the county but statewide MIR < 5/1000 *Culex* mosquitoes or statewide MIR > 5/1000 *Culex* mosquitoes for only one week. A high risk for WNV infection in humans would be preceded by a statewide MIR > 5/1000 *Culex* mosquitoes for two continuous weeks. WNV infection rates in *Culex* spp. during the 2016 mosquito surveillance season were similar to the low rates from other years when human incidence of West Nile encephalitis was low (2008-2011, 2013-2015). The low LAC, SLE, and EEE infection rate in the mosquito population meant comparatively few human LAC cases and no SLE and EEE human cases in 2015.

The Zoonotic Disease Group in the Division of Infectious Disease Epidemiology (DIDE) will continue outreach efforts related to mosquito-borne diseases across the State. In 2017, West Virginia plans to begin testing mosquito pools for ZIKV. Additionally, surveillance for *Aedes* spp. mosquitoes will again be increased in 2017 with use of mosquito ovitraps, aspirators, and additional BG Sentinel traps throughout the State that are thought to be more effective in monitoring *Aedes aegypti* and *Aedes albopictus* mosquitoes.

Links to CDC pages as well as public health literature on mosquito-borne disease can found on the Division of Infectious Disease Epidemiology Mosquito-borne Disease Webpage: www.dhhr.wv.gov/oeps/disease/Zoonosis/Mosquito/Pages/default.

Reducing the risk of mosquito-borne disease means reducing the risk of being bitten by mosquitoes:

- Be aware of the times of day when mosquitoes are most active. For many mosquitoes, peak hours are dusk and dawn. The LAC-transmitting mosquitoes are active during the day.
- Wear protective clothing such as long sleeves, pants, and socks. Use insect repellant that contains DEET, picardin, IR3535, or oil of lemon eucalyptus on exposed skin and clothing when outdoors.
- Ensure that window and door screens are intact to keep mosquitoes outside of homes. Remove breeding sites around the home (e.g. any containers that can accumulate water).
- Check with your healthcare provider when traveling abroad to learn about mosquito-borne diseases found in that area of the world.

The Zoonotic Disease Group sincerely thanks the many public health partners who contributed to mosquito-borne disease surveillance across the State. Your efforts have provided us with important information presented in this summary.

Introduction

Tickborne diseases (TBDs) are diseases transmitted by the bite from an infected tick vector. In West Virginia, tick vectors responsible for disease transmission have been identified for at least six TBDs (Table 1). Diagnosing TBDs can be challenging as some of these infections can initially produce similar, non-specific clinical symptoms (as with rickettsial diseases), while other TBDs produce highly variable symptoms (as in Lyme disease).[1] Early recognition and treatment of TBDs by healthcare providers can prevent complications from these diseases and decrease morbidity and mortality. Most TBDs, including those listed in Table 1, are reportable to public health authorities in West Virginia from healthcare providers and laboratories. The purpose of this summary is to describe the epidemiology of TBDs reported in West Virginia in 2016.

Table 1. Possible TBD by causative agent based on vectors found in West Virginia.

Tickborne Disease[a]	Agent	Tick Vector(s) in West Virginia
Anaplasmosis	*Anaplasma phagocytophilum*	Blacklegged tick (*Ixodes scapularis*)[b]
Babesiosis	*Babesia microti* and other *Babesia* spp.	Blacklegged tick (*Ixodes scapularis*)
Ehrlichiosis	*Ehrlichia chaffeensis* and *Ehrlichia ewingii*	Lone star tick (*Amblyomma americanum)*
Lyme disease	*Borrelia burgdorferi*	Blacklegged tick (*Ixodes scapularis*)
Powassan encephalitis	Powassan virus	Groundhog tick (*Ixodes cookei*)[c] Blacklegged tick (*Ixodes scapularis*)
Rocky Mountain Spotted Fever and other spotted fever rickettsioses	*Rickettsia rickettsii* (and other spotted fever group *Rickettsia* spp.)	American dog tick (*Dermacentor variabilis*) Brown dog tick (*Rhipicephalus sanguineus)* Lone star tick (*Amblyomma americanum*) Gulf Coast tick (*Amblyomma maculatum*)
Tularemia[d]	*Francisella tularensis*	American dog tick (*Dermacentor variabilis*) Lone star tick (*Amblyomma americanum*)

[a] Other TBD, including but not limited to Colorado tick fever, tickborne encephalitis, and Crimean-Congo hemorrhagic fever, may result from travel to regions where these illnesses are endemic.
[b] *I. scapularis* is also commonly referred to as the deer tick.
[c] *I. cookei* does not have an official common name. Names that have been used include the groundhog tick, woodchuck tick, and the American castor bean tick.
[d] Tularemia cases are included in the "Other ZD Surveillance Summary" since other animal species more commonly transmit tularemia to humans.

Methods

Surveillance and Case Ascertainment Methods

During the study period (2016 MMWR Year), passive surveillance was conducted for TBDs in West Virginia. West Virginia State Code 16-3-1 and 64CSR7 establish infectious disease reporting requirements for healthcare providers and laboratories. LHD conducted initial case investigations after receiving a case report or positive laboratory results for a reportable TBD. Cases were reported from LHDs to the State Health Department using the (WVEDSS).

Cases were reviewed by the State Health Department before a final case classification status was assigned. All case classifications were determined using the most current case definition for each disease or condition. Once a final case status was determined, cases were reported by the State Health Department to the (CDC) via the National Electronic Telecommunications System for Surveillance (NEDSS).

Data Extraction and Analyses

Surveillance data for confirmed and cases of each TBD for MMWR Year 2016 was exported from WVEDSS to an Excel database for analyses. County- and State-level census estimates for 2016 were obtained from the West Virginia Health Statistics Center.

Veterinary Tick Submission Project

2016 marked the fourth year of the West Virginia Veterinary Tick Submission Project (WVVTSP). Veterinarians from clinics across the State (and one in Pennsylvania) were asked to mail ticks found on animal clients to the Zoonotic Disease Program. For each submission, a form that collected information about the animal host (e.g. species and home county) and date of collection was also enclosed with each submission. Tickborne disease testing history was also reported. A subset of tick specimens removed from animals was tested at West Virginia University School of Public Health.

Results

Human Surveillance

In 2016, 388 confirmed and probable TBD cases were reported from 43 counties in West Virginia (Figure 1, Table 2, and Table 3). Conditions reported included ehrlichiosis, Lyme disease, and spotted fever group rickettsioses (SFGRs). No babesiosis or Powassan virus cases were reported.

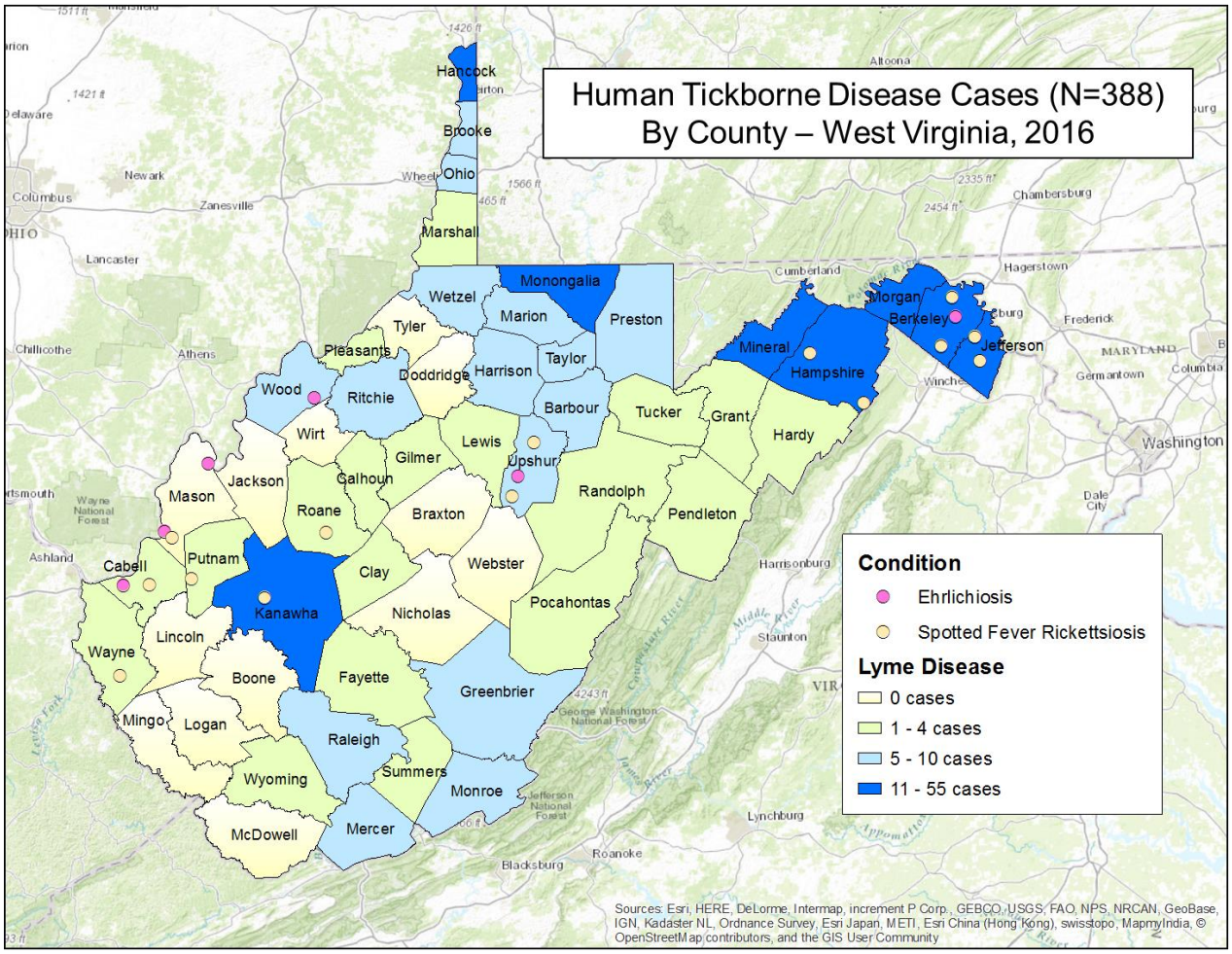

Figure 1. Counties in West Virginia that reported at least tickborne disease. Forty-three (78.1%) counties reported in at least one TBD in 2016.

Table 2. Frequency of TBDs reported in West Virginia from 2013 to 2016.

Disease Name	# of cases reported in 2013	# of cases reported in 2014	# of cases reported in 2015	# of cases reported in 2016	Incidence per 100,000 (2016)
Anaplasmosis	3	2	2	0	0
Ehrlichiosis	4	2	5	6	0.33
Anaplasmosis/ Ehrlichiosis undetermined	2	0	1	0	0
RMSF/SGFR	7	5	9	14	0.76
Lyme disease	143	136	289	368	20.0
TOTAL	**159**	**145**	**304**	**388**	**21.1**

Table 3. Frequency of counties reporting TBDs in West Virginia from 2013-2016

Disease Name	# of counties with cases in 2013	# of counties with cases in 2014	# of counties with cases in 2015	# of counties with cases in 2016
Anaplasmosis	3	2	0	0
Ehrlichiosis	4	3	4	5
Anaplasmosis/ Ehrlichiosis undetermined	2	0	1	0
RMSF/SGFR	6	5	7	10
Lyme disease	23	24	37	42
TOTAL	**23**	**24**	**38**	**43**

Six ehrlichiosis cases (one confirmed and five probable) were reported during MWWR Year 2016. Cases were reported from Berkeley, Cabell, Mason, Upshur, and Wood counties. Four cases were male and two were female. Ages ranged from 9 to 75 years of age. One case was hospitalized, and no deaths were reported. Fourteen probable SFGR cases were reported during MWWR Year 2016. Cases were reported in Berkeley, Cabell, Hampshire, Jefferson, Kanawha, Mason, Putnam, Roane, Upshur, and Wayne counties. Seven cases were male and seven were female. Ages ranged from 9 to 81 years of age. Four cases were hospitalized, and no deaths were reported.

There were 368 confirmed (n=297) and probable (n=71) Lyme disease cases reported in West Virginia during MMWR Year 2016 accounting for 94.8% (368/388) of all TBD cases reported during this period. Cases of Lyme disease were reported from 42 counties across the State (Figure 1). Berkeley, Hampshire, Jefferson, Hancock, and Morgan counties accounted for 48.9% (n=180) of cases. Twenty counties had incidence rates greater than 20 per 100,000 people based on population estimates for each county (Figure 2). Confirmed and probable Lyme disease cases ranged in age from 1 to 87 years of age. The highest proportion of cases was in the 51-60 age group (Figure 3). No deaths were reported.

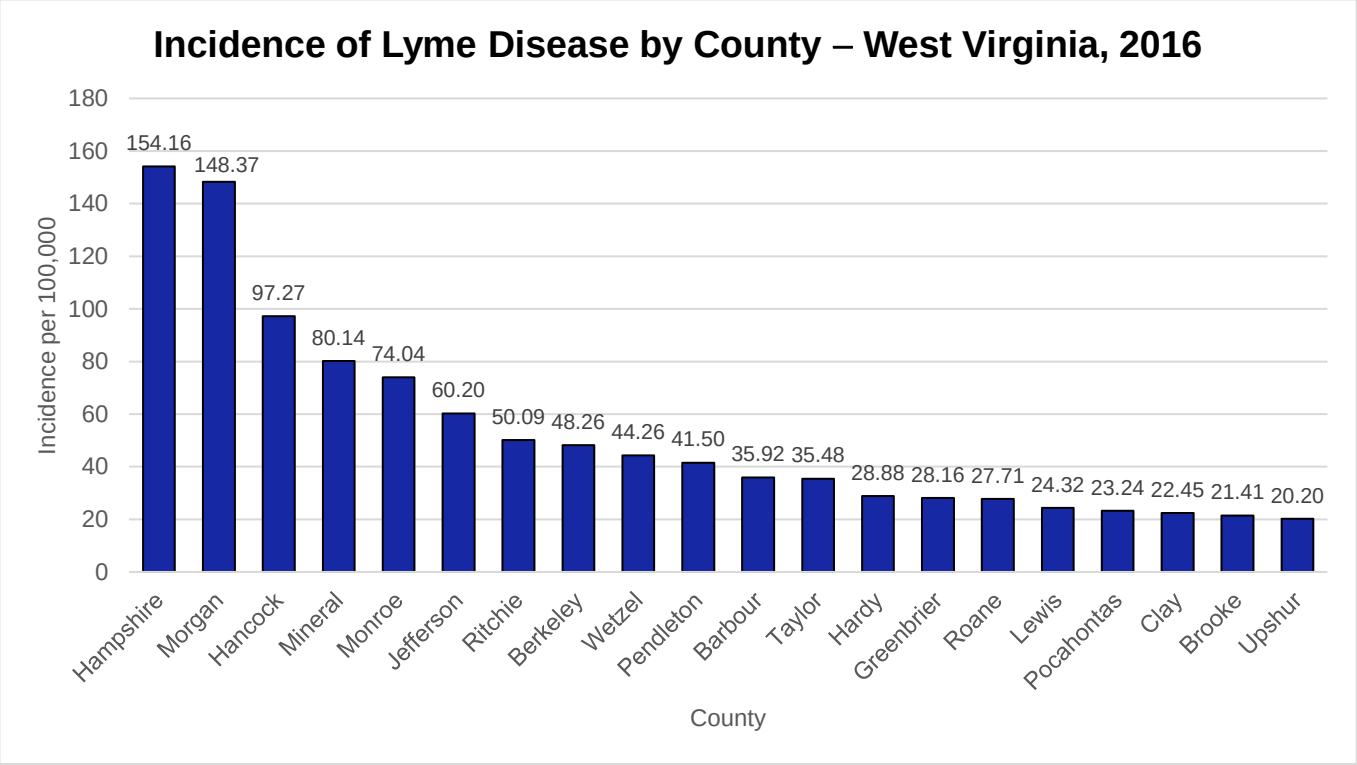

Figure 2. Incidence of Lyme disease cases by county. Estimates are based on 2016 census data for each county. Only counties with incidence rates above 20.0 people per 100,000 are shown.

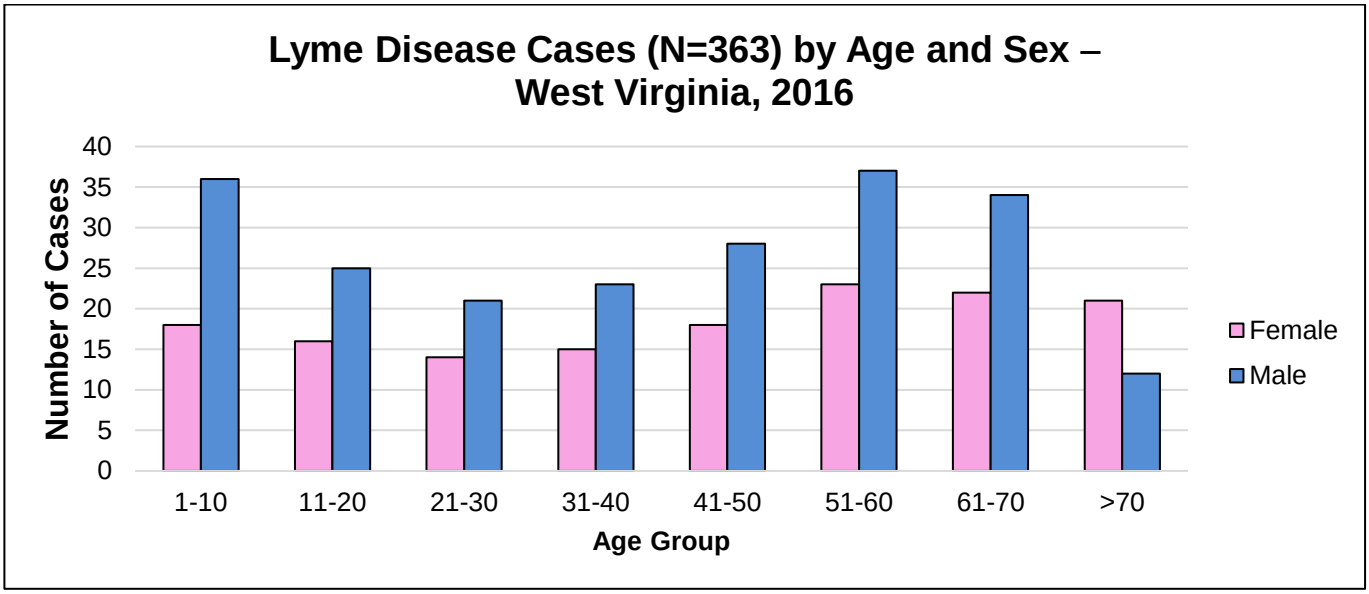

Figure 3. Frequency of Lyme disease by age group and sex during MMWR Year 2016. Note: Age and sex information was missing for five cases.

Veterinary Tick Surveillance

Veterinarians from 43 veterinary clinics submitted 1,476 ticks from animal patients that were identifiable. Seven tick species were identified: *Amblyomma americanum, Dermacentor variabilis, Haemaphysalis leporispalustris*, *Ixodes cookei, Ixodes scapularis,* and *Rhipicephalus sanguineus* (Table 4). Twenty-one dogs from which at least one tick was submitted to WVVTSP tested positive for *Borrelia burgdorferi*; *Ixodes scapularis* was collected from nine positive dogs (Figure 4). Two dogs tested positive for *Ehrlichia* canis. Ticks from four cats tested positive for *B. burgdorferi.*

Table 4. WVVTSP submission data, 2016.

Species of Tick	# of ticks identified	Animal species from which tick was removed	# of counties with tick species[1]
D. variabilis	723	Feline, Canine, Human	40
I. scapularis	434	Feline, Canine, Human	32
R. sanguineus	119	Canine	5
A. americanum	109	Feline, Canine	12
Ixodes spp	59	Feline, Canine, Equine, Human	20
I. cookei	28	Feline, Canine	12
H. leporispalustris	3	Canine	2
A.maculatum	1	Canine	1
Total	**1476**	**4**	**40**

[1]Based on home county of the animal; includes counties in states bordering West Virginia.

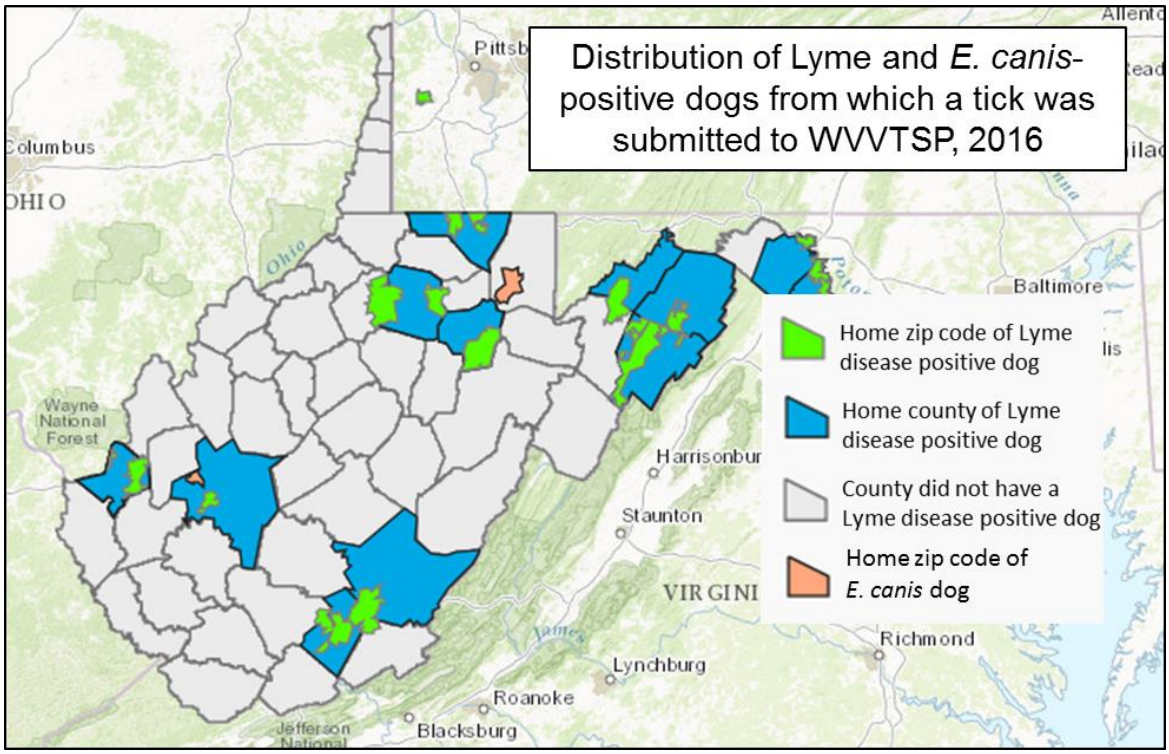

Figure 4. Distribution of dogs that tested positive for Lyme disease (n=21) and *E. canis* (n=2) by 4DX SNAP testing by county and zip code – West Virginia, 2016. Fourteen counties are represented (one county in Pennsylvania) based on the home county of the animal.

Discussion

Three human TBDs were reported in West Virginia during 2016: ehrlichiosis, Lyme disease, and spotted fever group rickettsioses. Lyme disease accounted for the majority of TBD cases (Table 2). Though the vectors of Powassan encephalitis (*I. cookei* and *I. scapularis*) have been identified in the State, there were no reports during the period. Powassan virus has never been identified in humans in West Virginia.

The reported number of TBDs increased from 304 in 2015 to 388 in 2016 (Table 2); the number of counties that reported at least one TBD increased from 38 counties in 2015 to 43 counties in 2016. Ticks were collected by veterinarians from January to December indicating that ticks are active even in cold weather.

The number of Lyme disease cases has increased greatly over the past three years from 136 in 2014 to 368 in 2016. West Virginia has a three-year average incidence of Lyme that is greater than ten cases per 100,000 making it a "high incidence Lyme disease state" as of 2017.

West Virginia borders three states with high incidence of TBDs. Maryland, Pennsylvania, and Virginia rank in the top 13 states that account for about 95% of Lyme disease cases reported annually. Quality surveillance allows for monitoring of changes in the occurrence of TBDs and identification of emerging TBDs at the local, state, and national level. Therefore, it is important to obtain timely and accurate data, including travel history, during TBD case investigations.

When compared to active tick surveillance, sentinel tick surveillance has proven to be more successful in identifying and collecting tick species. West Virginia's passive tick surveillance activities mostly involve collecting ticks from animal hosts either through veterinary submissions or from other veterinary public health partners. The number of ticks submitted by veterinarians through WVVTSP has shown an increasing trend (604 ticks in 2013 1,220 in 2014, 1,345 in 2015, and 1,476 in 2016). This "One Health" collaboration has greatly expanded knowledge of the distribution of tick vectors across the State.

There are limitations to the current report. First, underreporting of TBDs in West Virginia is likely. Cases may not seek medical attention unless symptoms or clinical manifestations of disease become severe and cannot be resolved without treatment. Misdiagnosis of disease is possible due to inaccurate laboratory test results and/or provider diagnostic error. There is also the possibility of case misclassification. For example, case ascertainment for Lyme disease requires clinical, laboratory, and, sometimes, epidemiologic evidence. If information is missing, a true case may be classified as either "suspect," or "not a case." In 2016, there were 75 "suspected" cases of Lyme disease, 5 suspected SFGR case, and one suspected anaplasmosis that were not included in the analyses of this summary. This highlights the importance of obtaining quality laboratory, clinical, and epidemiologic information to ensure that appropriate surveillance is being conducted.

Prevention of tickborne illnesses focuses primarily on avoiding tick bites. A tickborne illness prevention checklist can be found on the Division of Infectious Disease Epidemiology website at: www.dhhr.wv.gov/oeps/disease/Zoonosis/Tick/Documents/Tick%20Bite%20Prevention%20Checklist.pdf. In addition, CDC provides recommendation for the prevention of TBDs, adapted in Box 1. Because ticks are more active in warmer months, it is also important to make the public aware of the risk of becoming infected with any TBD from late-spring to early-fall.

Below are CDC recommended steps for tick bite prevention:

- Be extra vigilant in warmer months (April-September) when ticks and people are most active.
- Avoid wooded and bushy areas with high grass and leaf litter.
- Walk in the center of trails.
- Use repellents that contain 20 to 30% DEET on exposed skin and clothing for protection that lasts up to several hours. Always follow product instructions. Parents should apply this product to their children, avoiding hands, eyes, and mouth.
- Use products that contain permethrin on clothing. Treat clothing and gear, such as boots, pants, socks and tents with products containing 0.5% permethrin. It remains protective through several washings. Pre-treated clothing is available and may be protective longer.
- Repel ticks with DEET or permethrin. Use repellents that contain 20% or more DEET on exposed skin for protection that will last several hours. Use products that contain permethrin on clothing. Treat clothing and gear, such as boots, pants, socks, and tents.
- Bathe or shower as soon as possible after coming indoors (preferably within two hours) to wash off and more easily find ticks that are crawling on you.
- Conduct a full-body tick check using a hand-held or full-length mirror to view all parts of your body upon return from tick-infested areas. Parents should check their children for ticks under the arms, in and around the ears, inside the belly button, behind the knees, between the legs, around the waist, and especially in their hair.
- Examine gear and pets. Ticks can ride into the home on clothing and pets, then attach to a person later, so carefully examine pets, coats, and day packs.
- Tumble clothes in a dryer on high heat for an hour to kill remaining ticks. (Some research suggests that shorter drying times may also be effective, particularly if the clothing is not wet.

Introduction

While mosquito- and tickborne diseases account for the majority of zoonotic diseases reported in West Virginia, there are other diseases that can be transmitted from animals to humans without these vectors. Table 1 shows a list of diseases and conditions under surveillance in West Virginia that are transmitted by other animals. Q fever and tularemia can be transmitted by ticks, but are more commonly transmitted by other animals.

Table 1. Lists of diseases, the associated pathogen(s), and host species.

Disease	Pathogen	Host(s)
Anthrax	*Bacillus anthracis*	Cattle, sheep, and goats
Brucellosis	*Brucella* spp.	Sheep, goats, cattle, deer, elk, pigs, and dogs
Hantavirus pulmonary syndrome	Hantavirus	Wild rodents (deer mice)
Leptospirosis	*Leptospira interrogans*	Cattle, pigs, horses, dogs, rodents, and wild animals
MERS	MERS coronavirus	Camels and bats
Monkeypox	Monkeypox virus	Rodents, prairie dogs, Gambian giant rat, and rabbits
Plague	*Yersinia pestis*	Fleas and rodents
Psittacosis	*Chlamydophila psittaci*	Parrots, parakeets, macaws, turkeys, and ducks
Q fever	*Coxiella burnetii*	Cattle, sheep, ticks and goats
Rabies[1]	Rabies lyssavirus	
SARS	SARS coronavirus	Bats (likely)
Tularemia	*Francisella tularenis*	Hard ticks, rabbits, hares, and rodents
Viral hemorrhagic fever	Marburg virus, Lassa virus, Ebola virus, Crimean-Congo virus, Rift Valley Fever, and Yellow Fever	Bats, primates, ticks, mosquitoes, and rodents

[1]WVBPH has an annual rabies report that can be accessed at: www.dhhr.wv.gov/oeps/disease/Zoonosis/Rabies/documents/surveillance/rabies-surveillance-2015.pdf.

Methods

Human Surveillance

During the study period (MMWR Year 2016), passive surveillance was conducted for reportable zoonotic diseases in West Virginia. West Virginia State Code 16-3-1 and 64CSR7 establish infectious disease reporting requirements for healthcare providers and laboratories. LHDS conducted initial case investigations after receiving a case report or positive laboratory results for a reportable zoonotic disease. Cases were reported by LHDS to the State Health Department electronically using the WVEDSS.

Cases reported by LHDS during the study period were reviewed by the State Health Department before a final case classification status was assigned. All case classifications were determined using the most current case definition for each disease or condition. Once final case statuses were determined, cases were reported by the State Health Department to the CDC via the NEDSS.

Results

One confirmed brucellosis case was reported during MMWR year 2016. The case was a male from Monroe County who reported exposure to goats, sheep, and deer. The case was not hospitalized due to illness. One probable Q fever case was reported during MMWR year 2016. The case was a male from Wirt County who reported exposure to cattle. The case hospitalized due to illness.

Discussion

Zoonotic diseases in West Virginia can come from a variety of animals and are based on the type and location of exposure to pathogen zoonotic agents. Some zoonotic pathogens require travel to specific areas of the world for a person to become infected, while others require exposure to bodily fluids or a bite from a specific animal host.

In West Virginia, most of the non-mosquito-borne and non-tickborne infections come from contact with domestic animals such as livestock and dogs. The brucellosis and Q fever cases both reported contact with livestock. High risk groups for both diseases include farm workers, veterinarians, and meat processing workers since their professions put them in close contact with animal products (e.g. unpasteurized milk) and body fluids (e.g. birth products, feces). Inhalation of the bacteria that cause brucellosis and Q fever may also lead to infection.

Most of the “other” zoonotic diseases listed on Table 2 are reportable within 24 hours or immediately since these diseases can result in severe morbidity and even mortality (e.g. rabies, hantavirus) and can be considered bioterrorism agents (e.g. anthrax, Q fever). Some “other” zoonotic diseases are not endemic to West Virginia and would only be reported if a case travel to an area where the disease was being transmitted (e.g. viral hemorrhagic fever, MERS-CoV). For information about “other” zoonotic diseases reportable in West Virginia, visit: www.dhhr.wv.gov/oeps/disease/Zoonosis/other/Pages/default.aspx.