



Emerging Tick-Borne Arboviruses: Powassan virus, Heartland virus, and Bourbon virus

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Introduction

Ticks are blood-sucking parasites that live on the external surface of vertebrates. They depend completely on a blood meal from vertebrates for their development and reproduction. Most importantly, ticks can acquire or transmit pathogens like bacteria, viruses, and protozoans from or to the host. *Ixodes scapularis* (the blacklegged tick; figure 1) and *Amblyomma americanum* (the lone star tick; figure 2) are common ticks in Virginia; their presence is attributed to favorable environmental temperature, humidity, and the abundance of wildlife. While most diseases transmitted by tick display flu-like symptoms, tick-borne viruses can have much more life-threatening symptoms, and do not respond to the same antibiotic treatments that would normally be used to treat other tick-associated diseases such as Lyme disease. In recent years, blacklegged ticks and lone star ticks have been incriminated for transmitting rare, but fatal viral pathogens -- Powassan, Heartland, and Bourbon viruses, each capable of causing damage to vital body organs and even death.

Powassan virus

Powassan virus (POWV), the causative agent of Powassan virus encephalitis disease, is transmitted by the **blacklegged tick** (see Fig. 1). This tick can be found across Virginia and is more concentrated up the western edge of the state. Adult ticks are typically less than 3 mm in length with dark to dark-brown legs. Females typically have orange to red coloration on their [scutum] lower back. POWV is named after Powassan County, Ontario, Canada where it was first detected in a fatal human disease

case in 1958 (Dupuis II *et al.*, 2013). Infected individuals usually display symptoms of fever, fatigue, body aches, and vomiting. In addition, POWV infection can cause severe abnormalities to vital body organs including the brain and the spinal cord, within 1-4 weeks of transmission from an infected tick bite. In the USA, 125 cases of POWV infection were reported between 2008 and 2017, primarily from the Northeastern and Great Lakes regions, with one case reported in Virginia in 2009.



Figure 1. Female blacklegged tick (Alexandra Cumbie, VT Entomology)

There have been no additional reported cases in Virginia, however POWV is increasing nationwide, and vector-borne disease researchers at Virginia Tech are surveying wildlife and ticks for evidence of previous exposure or isolation of POWV. Most POWV disease cases usually occur in the late spring, early summer, and mid-fall corresponding with when the harder-to-detect nymphal ticks, less than 2 mm in size, are most abundant and trying to feed.

There is a 12% fatality rate observed for POWV human disease cases in the United States, which include former North Carolina Senator Kay Hagan who died in 2019 with POWV disease complications after being exposed to ticks while hiking. Nearly half of all survivors of POWV infection experience longer-term neurological sequelae.

Heartland virus

Heartland virus (HRTV) is transmitted by the **lone-star tick** (see Fig. 2), which is found predominantly east of the Blue Ridge Mountains of Virginia at elevations below 1800 ft. Lone-star tick adults are brown to tan; females have a single white pigment spot on their back. HRTV was first detected in 2009 in two separate cases involving Missouri farmers, initially suspected as ehrlichiosis due to presentation of similar symptoms of reduced platelets and white blood cells in the body (Staples *et al.*, 2020). As of January 2021, more than 50 cases of HRTV disease cases have been reported from states in the Midwest and Southern United States. Infected individuals usually show symptoms of fever, fatigue, body aches within two weeks of infection, and illness onset. Although HRTV is not currently a notifiable disease and no cases have yet been identified in Virginia, the wide presence of the lone-star tick, serological evidence from Virginia wildlife, and confirmed cases of HRTV infection in neighboring states highlight the need for awareness that this virus is potentially in Virginia.

Bourbon virus

Bourbon virus (BRBV) belongs to a group of viruses called Thogotoviruses and is also transmitted by the **lone-star tick** (Savage *et al.*, 2017). BRBV was first detected in 2014 in a fatal human case in Bourbon County, Kansas. Only two other BRBV disease cases have been reported in the United States; one in Missouri and one in Oklahoma. As yet, there have been no cases of BRBV in Virginia, however the presence of the lone-star tick vector, and antibody evidence in wildlife, together suggest that this tick-borne virus is circulating in the Commonwealth. Disease symptoms include fever, fatigue, body aches, and vomiting. Just like HRTV infection, BRBV-infected patients also display reduced platelets and white blood cells in the body.

Diagnosis

Medical diagnosis of Powassan, Heartland, and Bourbon virus is usually based on a history of

exposure to tick bites and laboratory tests to confirm the diagnosis. Common laboratory tests include measurement of virus-specific IgM antibodies in serum or CSF, plaque reduction neutralization tests, and RT-PCR.



Figure 2. Female lone-star tick (Alex Cumbie, VT Entomology)

Treatment

Because these viral infections are not caused by bacteria, they cannot be treated with antibiotics. Specifically, there are no treatments or vaccines for these tick-borne viruses. Supportive therapies are usually adopted to improve patient conditions. See your medical doctor if you suspect that you have a tick-transmitted disease.

Avoiding exposure to ticks

Prevention of tick bites is the key method to avoid these tick-borne viruses. Ticks are active year-round. **Blacklegged tick** adults are active throughout the winter, while their nymphs are most prominent April-June. Both life stages are usually found in wooded and brushy areas. The most active period of **Lone-star ticks** in Virginia occurs primarily between April and September. All life stages of the are active in the spring and summer, and they are usually found in wooded areas with thick underbrush, grasslands, and edge habitat.

When going outdoors, ensure to wear EPA-registered tick repellent with a minimum of 20-30% DEET on the skin and 0.5% permethrin on clothing. Use only as directed and do not apply permethrin directly on the skin. Additional protective measures including tucking pant legs into socks, performing

regular tick checks, and showering once home. Ticks on clothing can be killed by use in a dryer on a hot setting.

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