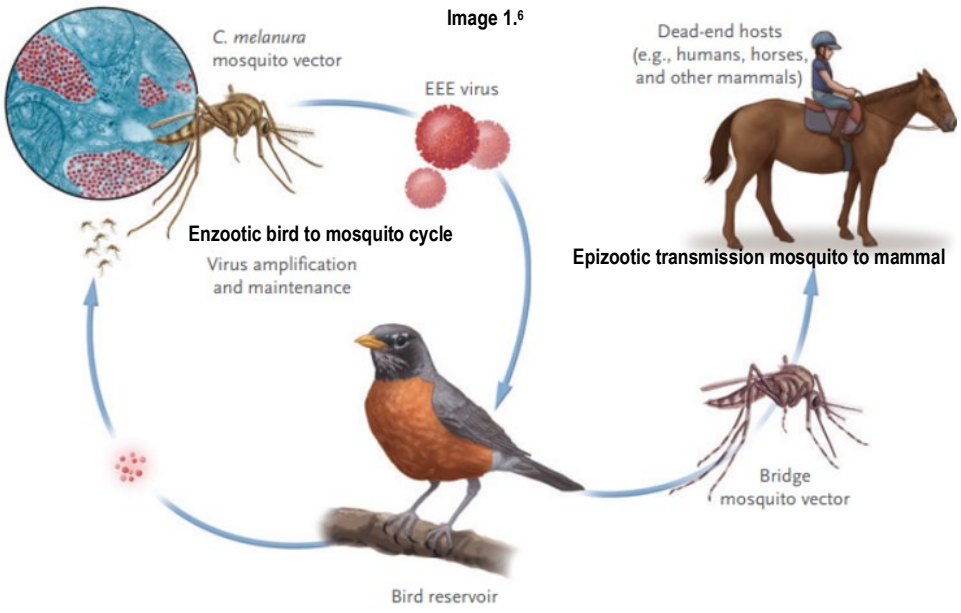
CONNECTICUT MEDICAL ASSISTANCE PROGRAM
DEPARTMENT OF SOCIAL SERVICES
&
ACENTRA HEALTH
QUARTERLY NEWSLETTER

Eastern Equine Encephalitis (EEE)

Eastern Equine Encephalitis (EEE) is an RNA arthropod-borne virus (arbovirus) transmitted via mosquito bite.[1,2] Endemic to North America, EEE is found in freshwater hardwood swamps primarily in the Northeast, Great Lakes, and Gulf Coast regions of the United States. EEE is typically contained within an enzootic bird to mosquito cycle between passerine (tree perching) birds and the mosquito species *Culiseta melanura (C.melanura)*.[3] *(Image 1)*[6] Although EEE has been found in 35 mosquito species, *C.melanura* is the primary enzootic vector that maintains the cycle between birds and mosquitoes.[4,5] While EEE has been found in more than 200 bird species the American robin, wood thrush, tufted titmouse, and black capped chickadee are considered the main amplification hosts of EEE in the Northeast and their migratory patterns are thought to spread the virus farther than mosquitoes travel.[4,5,6] EEE can periodically spill over from the bird to mosquito cycle and infect "dead-end hosts" such as horses and humans via bridging vectors, or mosquitoes that feed on both mammals and birds *(Image 1)*.[6] The most common bridging vectors of epizootic transmission in the Northeast are *Coquillettidia perturbans, Aedes canadensis, Aedes sollicitans,* and *Culex salinarius*.[7] Dead-end hosts are called such because viral transmission stops with them, they can be infected but do not transmit EEE back to mosquitoes due to the low volume of virus in their blood.[6,7] Other hosts can include pheasant, turkey, quail, reptiles, and amphibians. Amphibians are thought to contribute to enzootic transmission, especially in Florida, potentially maintaining a critical reservoir of EEE during the winter months.[2,5,7]

EEE outbreaks occur in the summer months and have been documented in horses since the early 1800s. The first documented outbreak of EEE occurring in an equine population during the 1830s, killed 75 horses.[4] On average equine mortality due to EEE ranges from 70-90%, however, annual vaccination against the virus is widely available.[5] Human outbreaks have been documented since the late 1930s and carry a 30% mortality rate.[5] The first documented human outbreak occurred in 1938 in Massachusetts and included 38 cases resulting in 25 deaths.[2] Another large human outbreak occurred in New Jersey in 1959 with 33 laboratory confirmed cases over 8 weeks.[1,4] In 2019 a large outbreak of EEE infections occurred in the northeast with 38 cases resulting in 15 deaths.[1,3] In Connecticut, there have been five confirmed cases of EEE since 2013, four of which have resulted in death.[8] There were no documented human cases of EEE in CT during 2024 and 2025 so far, however, EEE was detected in the state via mosquito surveillance.[11] (Image 3) On average, annual infection rates in the US are low at about 8 infections per year, which is estimated to represent only 4–5% of actual human infections.[3,5] Historically, documented human cases have been rare due to the lack of people residing in low-lying swampy areas where EEE vectors thrive, but also may be due to underreporting as 95% of EEE cases are asymptomatic.[5]

Image 1.[6]



Longer, hotter summers coupled with heavy rain and mild winters are thought to provide conditions that support thriving vector activity and abundance. Human behavior such as working or recreating outdoors, clearing wetlands for suburban development, or wetland restoration may contribute to an increased risk of EEE infection. Other factors that can affect infection rates include migratory behavior of birds, zoonotic host factors, changing weather patterns, and longer mosquito seasons.[5] Historically EEE outbreaks happen in multiple year patterns after a year or years of excessive rainfall.[4] The excessive rain will pool in swamps and hardwood areas and create crypts under tree roots which support *C.melanura* larval develop-

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ment.[4] Mosquito season in the northeast typically spans from late spring into early autumn. When temperatures fall below 50° F mosquitoes are rendered inactive and mosquito season comes to an end during the first hard freeze.[8]

Approximately 5% of people infected with EEE will present with symptoms after an incubation period of about 3-10 days.[6] Initial nonspecific symptoms include fever, headache, stiff neck, malaise, weakness, nausea, vomiting, myalgia, and arthralgia.[6,9] Neuroinvasive disease often follows in symptomatic patients, which carries a high mortality rate.[1,6,9] Presentation of neuroinvasive disease can include headache, disorientation, altered mental status, difficulty speaking, seizures, meningoencephalitis, and coma.[1,2]

Neuroimaging will often show involvement of the basal ganglia, thalami, and cerebral cortex.[6] Sampling of cerebrospinal fluid (CSF) first shows neutrophil pleocytosis, followed by lymphocyte pleocytosis, high protein levels and normal glucose levels.[2,7] Patients < 15 and > 50 years of age carry the greatest risk of developing neuroinvasive disease and children have the worst outcomes and highest rates of mortality.[1,2,9] Almost all patients who develop symptomatic EEE will have chronic neurologic sequelae.[1,6,9] Lifelong consequences of infection can include cognitive deficits, long term disability, intellectual impairment, personality changes, seizure disorder, paralysis, and cranial nerve dysfunction.[2] Many survivors require long term care assistance to live and the average estimated lifetime cost is $3 million dollars.[5,7]

Infection with EEE should be considered if a patient presents with neurological illness, encephalitis, or aseptic meningitis during mosquito season.[10] If EEE is suspected, CSF testing for the virus can be performed, however, a positive result is often difficult to isolate. The gold standard for diagnosis is viral antibody testing for IgM followed by a positive plaque-reduction neutralization test (PRNT) or positive polymerase chain reaction (PCR), the latter two being specific for EEE. A positive IgM result can indicate infection with any arbovirus, therefore, if the serum sample is determined to be IgM positive, PRNT or PCR testing can confirm EEE specifically.[7,8] IgM testing is performed locally by the Connecticut Department of Public Health (CT DPH), however, PRNT and PCR tests are conducted by the Centers for Disease Control (CDC) and samples need to be shipped out to determine results.[8]

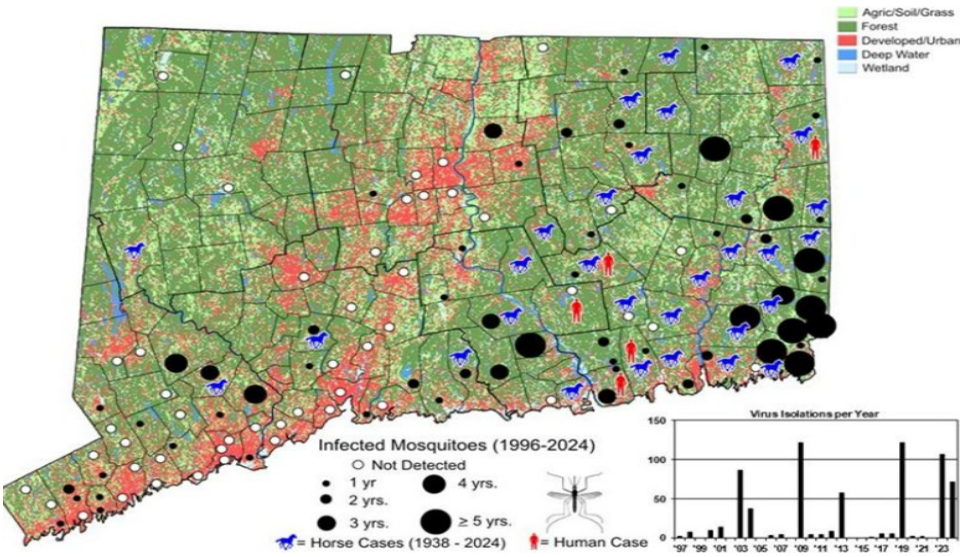
There are no current antiviral medications available to treat EEE, however, supportive measures should be started immediately when EEE is suspected regardless of testing timeline. Supportive care can include intensive care, seizure control, intravenous immunoglobulins, intubation, and ventilation.[9] Experts suggest that when an antiviral medication is developed, it is imperative that the medication be formulated to cross the blood brain barrier, where most damage and destruction occurs during infection.[6]

While vaccination against EEE is widely available in the equine population, there is no licensed human vaccine available on the market. An investigational human vaccine does exist and was first tested on volunteers in the 1960's at the United States Army Medical Research Institute of Infectious Disease (USAMRIID).[1] Additional safety and efficacy studies have been performed over the past decades and a multi series vaccine is only available to laboratory and government workers who study EEE for public health research and national security concerns. When aerosolized, the virus can be used as a potential bioweapon.[1] Due to the lack of widespread human vaccination, prevention against infection is key. Preventative measures rely heavily on federal, state, and local public health departments to monitor mosquito pods, livestock, and wildlife infections and to warn the public of impending human infection.

In 1993 the CDC published guidelines and best practices for arbovirus surveillance programs and in 2000 the CDC's Division of Vector-Borne Diseases (DVBD) developed ArboNET, a passive surveillance system of arboviruses in the US.[7] Initially developed as a response to West Nile Virus, ArboNET has expanded to surveil many other arboviruses that threaten public health, including EEE. While it may underestimate the rate of arbovirus infections due to underreporting of asymptomatic illness ArboNET is an important federal surveillance program.[10] The CDC periodically reviews, analyzes, and disseminates surveillance data to inform risk assessments to the public, as well as to national and local authorities via publications in Morbidity and Mortality Weekly Reports.[7] Due to recent funding cuts to the CDC and science based public health programs, these very important tools of surveillance and public health preventative measures may be at risk.

According to the CDC, there are two types of surveillance measures that can be conducted regarding EEE.[7] Epidemiological surveillance, tracked via ArboNET, measures human disease and infection rates. Environmental surveillance monitors

Image 2.[8] Land use map of CT, distribution and prevalence of EEE isolations from mosquitoes, humans, and horses, 1996-2024



mosquito and animal infection rates to determine when there is a risk of human exposure. Vector based surveillance monitors and documents larval, adult, and transmission activity of mosquitos to quantify a vector index (VI). An increase in VI indicates an increased risk of human infection. VI thresholds assist federal, state, and local governments in deciding when to release public facing statements regarding human risk of infection, and when to consider the use of insecticides to control the number of infected mosquitoes.[7] CT utilizes passive human and veterinary surveillance and active mosquito surveillance.[12] Mosquito trapping in CT is conducted from June through October and includes 108 collection sites.[8]

In 1997 the CT legislature passed public Act 97-289, "An Act Concerning Mosquito Control and Arial Application of Pesticides" (CT Gen Stat 22a-45b). This created the foundation for a Mosquito Management Program (MMP) detailing a framework for surveillance, public education, reduction and control of mosquito sources, and personal protection plans.[8] Multiple state departments work together to support the MMP and include the Department of Energy and Environmental Protection (DEEP), the Department of Public Health (DPH), the Department of Agriculture (DoAG), the Connecticut Agricultural Experiment Station (CAES), the Connecticut Veterinary Medical Diagnostic Laboratory (CVMDL), and Local Health Departments (LHDs).[8] Connecticut's EEE response plan is reviewed and updated annually.[8]

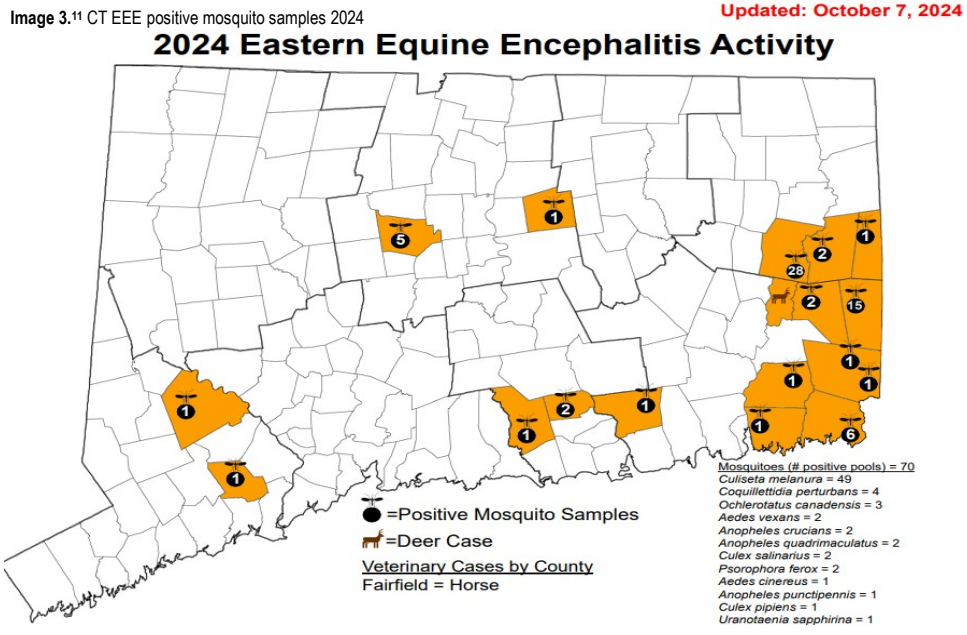
If human EEE infection risk increases to certain proportions, the Governor, in consultation with the DPH commissioner, has the authority to proclaim a public health emergency under CT Gen Stat § 19a-131a.[8] This allows the authority to implement application of chemical pesticides from the air and/or ground to control mosquito vectors, pursuant to CT Gen Stat § 22a-54(e).[8] There are two types of mosquito control measures: targeting of larva and targeting of adult mosquitoes.[7] Insecticides used must be EPA approved and potential for resistance should be considered.[7]

Measures to prevent EEE infection at the individual level can also be taken and are often part of public health messaging when there is an increased risk of human exposure to the virus. Additionally, certain people are at a higher risk of infection including people with outdoor exposure through employment or recreational activities, homeless people, people living in homes without window or door screens, and people < 15 or > 50 years of age.[7] The following actions can be taken to further decrease the risk of infection:

- Limiting time outdoors when viral activity is high
- Limiting time outdoors when mosquitoes are most active (humid stretches, dawn, and dusk)
- Avoiding spending time in or near freshwater hardwood swamps
- Use insect repellant
- Wearing long sleeved shirts and pants and/or permethrin treated clothing
- Removal of mosquito breeding ground items from residential areas (trash, debris, old tires, neglected pools with untreated water)

Due to the lack of effective treatment, prevention of this rare but lethal virus is essential. While the vast majority of infections are asymptomatic, those who present with illness have devastating outcomes. Provider awareness of mosquito season, arboviruses, and EEE specifically is crucial. Understanding the trends that drive an increase in cases is also key. Climate change is trending toward warmer winters, hotter summers, heavier rain events, and flooding which contribute to longer and more active mosquito seasons and an increased risk of vector borne diseases. Continuing to explore and consider major contributors to future outbreaks is imperative. Federal, state, and local well-funded surveillance is essential for monitoring, tracking, and identifying potential outbreaks, informing the public of risk, and implementing application of vector control measures.

Image 3.[11] CT EEE positive mosquito samples 2024



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