



TICK ASSOCIATED DISEASES

Kirby C. Stafford III, Ph.D. (October 2002)
Connecticut Agricultural Experiment Station
123 Huntington St.-Box 1106, New Haven, CT 06504
Phone: (203) 974-8485, Website: www.caes.state.ct.us

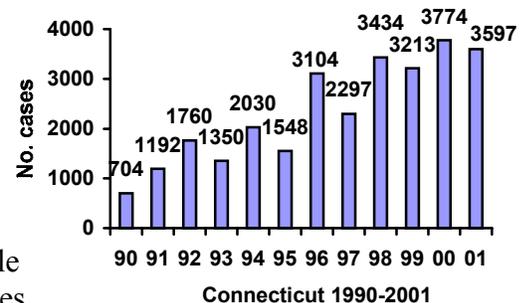
Data on disease incidence courtesy the Connecticut Department of Public Health
410 Capitol Ave, MS#11EPI, P.O. Box 340308, Hartford, CT 06134-0308
Phone: (860) 509-7994, Website: www.state.ct.us/dph

Lyme Disease

Lyme disease is caused by the spirochete *Borrelia burgdorferi*, a corkscrew-shaped bacterium. It is associated with the bite of certain *Ixodes* ticks, particularly the blacklegged tick, *Ixodes scapularis* (commonly known as the deer tick). This disease was first recognized in a group of arthritis patients from the area of Lyme, Connecticut in 1975. The emergence of Lyme disease is associated with reforestation and increased white-tailed deer populations and populations of small animal hosts. Deer are the principal hosts for adult *I. scapularis*. White-footed mice, chipmunks, and birds are important hosts for the larval and nymphal stages.

There were 132,438 cases of Lyme disease reported to the Centers for Disease Control and Prevention (CDC) from 1991 through 2000, with 12 states from the northeast, mid-Atlantic, and Wisconsin and Minnesota accounting for 95% of the 17,730 cases reported in 2000.

In Connecticut, the number of reported Lyme disease cases has steadily increased from a few hundred in the mid-to late 1980s to 3,773 cases for 2000 and 3,597 cases for 2001, a rate of 105.6 cases per 100,000 population. In the past several years, around one-third of the cases have been in Fairfield County. The number of cases and incidence of Lyme disease by town is available at the Department of Public Health's (DPH) web site and the result of tick testing is available on the Experiment Station's website. The number of Lyme disease cases reported may represent only 10 to 20% of the diagnosed cases.



Signs and symptoms of Lyme disease . . .

Localized infection - Approximately 70 - 80% or more of patients develop a red rash (erythema migrans or EM) within 2 to 32 days (typically 8 or 9 days) after the tick bite. The rash gradually expands over a period of a week or more. Rashes vary in size and shape, and may occur anywhere on the body, although common sites are the thigh, groin, trunk, and armpits. Many rashes reach about 6 inches in diameter, but some can be 8-16 inches or more in size. The rash often remains red, but swelling, blistering, scabbing or central clearing may occur, resulting in a "bull's-eye" appearance (photo courtesy Pfizer Central Research). The rash may be hot to the touch, but it is usually not painful. Mild nonspecific, flu-like symptoms may be associated with the rash. In most cases, symptom onset occurs during the summer months when the nymphal stage of *Ixodes* is active. Lyme disease affects all age groups, but the greatest incidence has been in children under 14 years and adults over 40 years of age. There may be no early symptoms in some cases.



Disseminated infection - The course and severity of Lyme disease is variable. Days or weeks after the bite of an infected tick, multiple rashes, migratory joint and muscle pain (also brief, intermittent arthritic attacks), debilitating malaise and fatigue, neurologic or cardiac problems may occur. Early neurologic symptoms develop in about 15% of untreated patients and these can include paralysis of facial muscles (Bell's palsy), meningitis (fever, stiff neck, and severe headache), and radiculoneuropathy (pain in affected nerves and nerve

roots, can be sharp and jabbing or deep). A year or more after the tick bite in untreated or inadequately treated individuals, symptoms of persistent infection may include numbness or tingling of the extremities, sensory loss, weakness, diminished reflexes, disturbances in memory, mood or sleep, and an intermittent chronic arthritis (typically swelling and pain of the large joints, especially the knee). Approximately 50-60% of untreated patients develop arthritis and about 10% of these will progress to chronic arthritis.

Diagnosis . . .

Consult a physician if you suspect Lyme disease. In the absence of an EM, Lyme disease may be difficult to diagnose because its symptoms and signs vary among individuals and mimic those of many other diseases. Conversely, other arthritic or neurologic diseases may be misdiagnosed as Lyme disease. A diagnosis of Lyme disease is made on signs, symptoms, history, and supporting laboratory data. A blood test to detect antibodies to Lyme disease spirochetes can aid in the diagnosis of the disease. Some newer tests for the serodiagnosis of Lyme disease appear to be more sensitive and specific for antibodies to *B. burgdorferi*, but tests should not be used as the sole criterion for a diagnosis, especially during the early stages of the disease. Antibodies can usually be detected 3-4 weeks after infection. Negative results do not necessarily exclude Lyme disease, but reliability of the test does improve in later stages of the disease. Patients are known to have detectable antibodies for years after successful treatment (i.e. absence of clinical symptoms).

Treatment . . .

Lyme disease is treated with several antibiotics, including tetracycline, doxycycline, amoxicillin, penicillin, cefuroxime, or ceftriaxone. Early treatment can prevent the later symptoms of Lyme disease from developing. Oral antibiotics are effective in treating most cases of Lyme disease. In some cases, antibiotics may be given intravenously. Patients treated in the early stages of the disease usually recover completely. Full recovery is possible for patients treated in the later stages of the disease but resolution of symptoms may take weeks or months. Persistent signs and symptoms after treatment have been reported in some patients, though the cause(s) are unclear and controversial. Possible reasons for treatment failure include coinfection with another tick-borne pathogen or unrecognized involvement of the central nervous system at the time of initial treatment. People can be re-infected and develop Lyme disease with subsequent tick bites, requiring another course of treatment.

Human Lyme disease vaccine . . .

A human Lyme disease vaccine, LYMERix™, containing recombinant outer-surface protein A (OspA) of the spirochete (*B. burgdorferi*) was available from GlaxoSmithKline. Approved by the Food and Drug Administration (FDA) in December 1998, the vaccine was taken off the market by the manufacturer in February 2002 because of declining sales. In clinical trials, vaccine efficacy was 49% after 2 doses for those with definite Lyme disease and 76% after the third dose. Protection in an immunized individual was provided when levels of antibody to OspA in the blood were high enough to neutralize the spirochetes inside the feeding tick before transmission occurred. Protection in vaccinated individuals will wane after a year or two. Without a booster, protection against Lyme disease in previously vaccinated people will be low to nonexistent.

Lyme disease in animals . . .

Dogs, cats, horses, and cows can also contract Lyme disease. Lameness, fever, reduced appetite, and a reluctance to move are the usual symptoms in these animals. Animals are treated with antibiotics. Canine vaccines are available. Consult your veterinarian about the prevention and treatment of Lyme disease in your animals. The extent to which pet owners may be at increased risk of tick bite is unknown. Animals may carry ticks into the home, or outdoor activities with animals may increase the exposure of pet owners to ticks and their habitat (photo courtesy Pfizer Central Research).



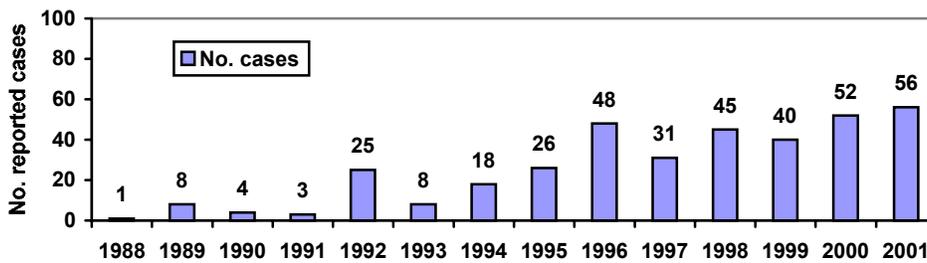
Human Babesiosis

Babesiosis is a malaria-like illness caused mainly by *Babesia microti*, a protozoan parasite of red blood cells. The protozoan is spread principally by the bite of the blacklegged tick, *Ixodes scapularis*, although cases by blood transfusion or transplacental/perinatal transmission have been reported. White-footed mice carry this parasite in nature. The majority of human cases (82%) have occurred in June, July and August¹. Signs and symptoms include fever, fatigue, chills, sweats, headache, and muscle pain, beginning usually 1-6 weeks after the tick bite. Human babesiosis has been recognized since the 1960's in parts of Massachusetts (particularly Nantucket and Martha's Vineyard), and parts of Long Island, New York. It also occurs in Wisconsin and possibly Minnesota.

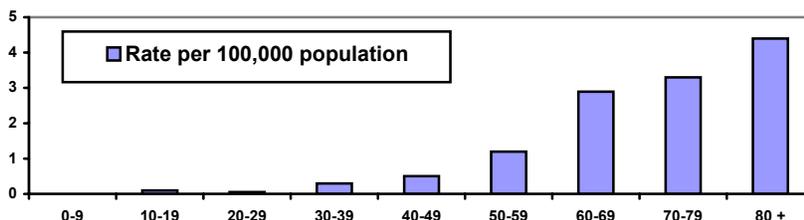
The first Connecticut case of human babesiosis was reported from Stonington in 1988. There were 8 cases in 1989 and babesiosis became a reportable disease in October 1989. A study by Experiment Station scientists in 1989 found no evidence of this pathogen in Fairfield County at that time. From 1991 through 2001, 352 confirmed cases of babesiosis were reported to the Connecticut Department of Public Health, mainly in New London County¹. In 2000, most (67.3% of 52) cases reported were still from residents in New London County. The remaining cases were reported from Middlesex (13.5%), Windham (7.7%), Hartford (5.8%), and Fairfield (5.8%) counties.

Infection usually produces no or only mild symptoms in healthy children and adults, though all ages can be severely affected. Babesiosis can be severe or fatal in the elderly, immunocompromised individuals, and people without spleens. Death has been reported in about 5% of cases. The greatest incidence of severe babesiosis occurs in those older than 50 years of age (median age of CT patients was 67 years¹). Co-infection with the agents of ehrlichiosis or Lyme disease can result in more severe or prolonged illness and overlapping clinical symptoms. Asymptomatic infection can persist for months or even years with a risk of transmission to others through blood donations. Blood donations are not accepted from people with a history of babesiosis.

Diagnosis can be confirmed from blood smears by observing the organism in red blood cells, detection of antibodies, or amplification of the disease agent's DNA by polymerase chain reaction (PCR) methods. Laboratory tests may show anemia and a decrease in blood platelets. Babesiosis in children and adults is treated with quinine and clindamycin. In recent clinical trials, a combination of atovaquone and azithromycin was effective in treating babesiosis in adults with fewer side effects. An exchange transfusion may be used in very severe cases with a high rate (> 5%) of infected red blood cells.



Number of reported cases of human babesiosis in Connecticut, 1988-2000 (Data courtesy Connecticut Department of Public Health).



Rate per 100,000 population of babesiosis by age group, 1991-2000 (Data courtesy Connecticut Department of Public Health)¹.

¹Connecticut Epidemiologist 21(3): 11-12; July 2001.

Human Ehrlichiosis

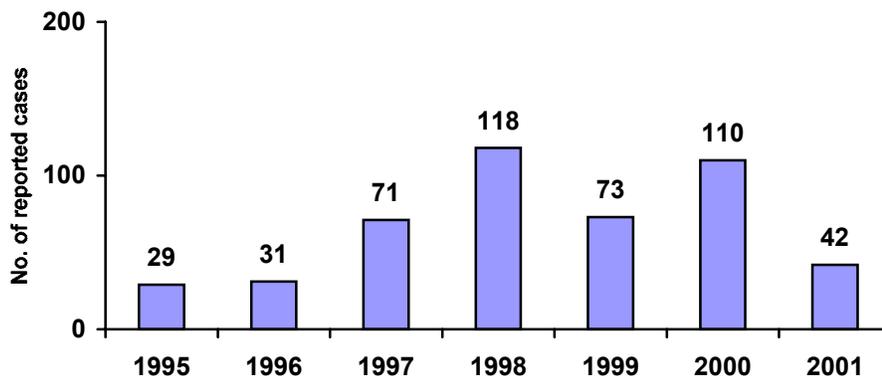
Ehrlichiosis is a disease of both animals and humans caused by several bacteria in the genus *Ehrlichia* and *Anaplasma*. Two main forms of ehrlichiosis in humans are currently recognized in the United States: human monocytic ehrlichiosis (HME), caused by *Ehrlichia chaffeensis*, and human granulocytic ehrlichiosis (HGE), caused by *Anaplasma phagocytophila*, which was recently reclassified from the genus *Ehrlichia* to the genus *Anaplasma*. Human disease caused by the recently recognized *E. ewingii* has also been reported in the south central U.S.

Human monocytic ehrlichiosis (HME) was first described in the mid-1980s. The lone star tick, *Amblyomma americanum*, is the vector for *E. chaffeensis* in south central and southeastern regions of the country where most cases of HME occur. White-tailed deer, a major host for all motile stages of the lone star tick, are a reservoir host for *E. chaffeensis*. The lone star tick is common as far north as New Jersey and Long Island, New York. It is also abundant on Prudence Island, Rhode Island. The lone star tick is uncommon in Connecticut with residents living mainly in coastal communities in Fairfield and New Haven Counties occasionally being bitten by these ticks. The DNA of *E. chaffeensis* was detected in 7.6% (of 106) and 11.5% (of 52) lone star ticks from Connecticut and Prudence Island, respectively. Human granulocytic ehrlichiosis (HGE) was first reported from Wisconsin and Minnesota in 1994. Most cases of HGE have been reported from states where Lyme disease is highly endemic. The blacklegged tick, *Ixodes scapularis* is the principal vector in the northeastern and upper mid-western states. White-footed mice, and possibly deer, are reservoirs for *A. phagocytophila*. Most cases of HGE and HME occur during the summer in May, June, and July.

Nonspecific signs and symptoms for both diseases include fever, headache, muscle pain, nausea, vomiting, and malaise. Most patients show a decrease in their white blood cell and blood platelet counts. Illness may be mild, moderate or severe and is generally self-limited, resolving in a few weeks. However, fatalities do occur and treatment should be started promptly. Doxycycline is the drug of choice for the treatment of ehrlichiosis. Although all age groups may be affected, the number of cases increases with age. The highest rates have been observed for patients 60 years of age or older. HME has been confused with Rocky Mountain spotted fever. Diagnosis can be confirmed by a serological blood test, observing the organism in white-blood cells, culturing the organism, or by polymerase chain reaction (PCR).

Ehrlichiosis is a reportable disease in only about 24 states. Both HGE and HME have been reportable diseases in Connecticut since 1995. There were 474 confirmed cases of HGE reported from 1995-2001. Cases were distributed across all eight Connecticut counties. Cases of HME in Connecticut are possible, as the DNA of *E. chaffeensis* has been detected in lone star ticks in Connecticut. In New York, both HGE and HME have been reported mainly from the lower Hudson River Valley and eastern Long Island.

A diagnosis of ehrlichiosis should be considered for patients with a flu-like febrile illness and possible exposure to *I. scapularis* ticks. Co-infections by the HGE and Lyme disease agents have been reported and may result in more severe disease and complicate the clinical presentation and diagnosis of Lyme disease.



Confirmed cases of HGE reported in Connecticut 1995-2001 (Data courtesy Connecticut Department of Public Health and Emerging Infectious Diseases Program).

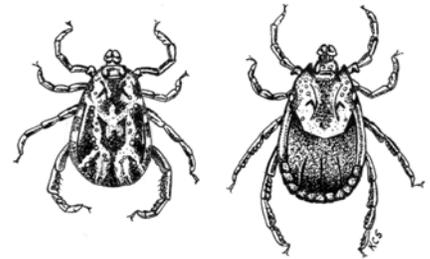
Rocky Mountain Spotted Fever



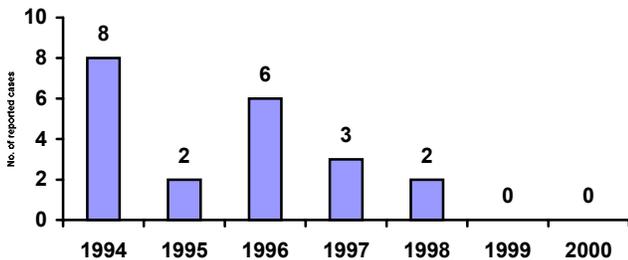
Rocky Mountain spotted fever (RMSF), caused by *Rickettsia rickettsii*, is rare in Connecticut and New England. This disease occurs throughout the United States, but most cases of RMSF are in the South Atlantic and West Central states. However, cases have occurred in New York City. In the eastern U.S., the American dog tick, *Dermacentor variabilis*, transmits *R. rickettsii*.

Far left: Female American dog tick (Photo courtesy Pfizer Central Research); Below: Adult American dog ticks (left, male; right, female).

Scientists at the Connecticut Agricultural Experiment Station found that less than 1% of 3,000 American dog ticks examined in Connecticut contained spotted fever-group organisms. Not all spotted fever-group rickettsiae are infectious to humans. Between 1983 and 1993, 27 human cases were reported to the Connecticut Department of Public Health. Seventy percent of these cases were in Fairfield and New Haven counties. Between 1994 and 1999, an additional 21 cases were reported.

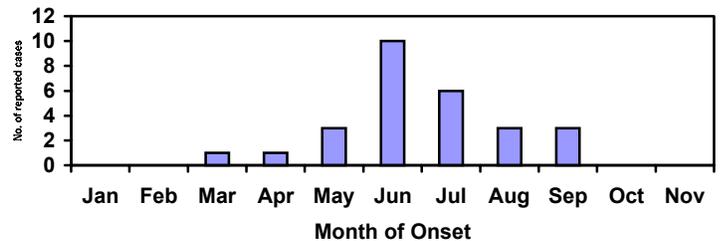


Symptoms usually appear within 2 to 9 days after a tick bite. Symptoms include sudden fever (90% of 1989 cases), headache (89% of cases), muscle pain (83% of cases), and rash (78% of cases). The rash is noticed 2-4 days after illness begins and may include the palms (50% of cases) and soles of the feet. Prompt antibiotic treatment (doxycycline is the drug of choice) for suspected cases of RMSF is important, because it can be fatal in 15-20% of untreated cases. Delays in diagnosis because of the absence of a rash or no knowledge of a tick bite could be dangerous for the patient. In recent years, about 1-4% of cases in the United States have been fatal. A clinical diagnosis may be confirmed by antibody blood tests.



Reported cases of Rocky Mountain spotted fever in Connecticut, 1994-2000. (Data courtesy Connecticut Department of Public Health).

Reported cases of Rocky Mountain spotted fever in Connecticut by the month on onset between 1983 and 1993 (Data courtesy Connecticut Department of Public Health).



Tick Paralysis

The feeding by certain *Dermacentor* ticks can cause a progressive paralysis, which is reversed upon removal of the tick. Recovery is usually complete. The paralysis is not caused by a disease pathogen, but by a toxin produced by the tick. Paralysis begins in the extremities of the body with a loss of coordination. It progresses to the face with corresponding slurred speech, and finally shallow, irregular breathing. Failure to remove the tick can result in death by respiratory failure. Most cases of tick paralysis are caused by the Rocky Mountain wood tick (*Dermacentor andersoni*) in northwestern states. The American dog tick has also been known to cause tick paralysis.

Tularemia

The bacterium, *Francisella tularensis*, that causes tularemia (Rabbit Fever) is transmitted mainly by the bite of several species of ticks and contact with infected animals. Highly infectious, it is also considered a potential biological warfare agent. The disease may be contracted while handling infected dead animals, eating under cooked infected meat, an animal bite, drinking contaminated water, inhaling contaminated dust, contact with contaminated materials, or bites from deer flies and horse flies. Tularemia occurs naturally throughout the United States. Most cases have been reported from the central states of Missouri, Arkansas, and Oklahoma. There has been a decline in the number of cases over the past several decades. An average of 146 cases was reported annually from 1990 to 1994. This was the last year national records were kept, although reporting has been reinstated. Reports of tularemia in New England are not common. However, there is a persistent focus of tularemia on Martha's Vineyard, an island off the coast of Massachusetts. Many cases were pneumonic and appear related to gardening or landscape activities.

Ticks associated with tularemia are the American dog tick, *D. variabilis*; lone star tick, *A. americanum*; and Rocky Mountain wood tick, *D. andersoni*. Most cases occur during the summer (May-September).

The clinical symptoms of tularemia depend upon the means of infection. With infection by a tick, an ulcer often occurs at the site of the bite with occasional swelling of the regional lymph nodes. Fever is the most commonly reported symptom. Diagnosis can be confirmed by an antibody blood test. Streptomycin or gentamicin is used for the treatment of tularemia. Tetracycline may also be used, but it is less effective and there can be relapses.

Other Tick-Associated Diseases

Powassan (POW) Virus is the only member of tick-borne (TBE) group viruses present in the United States and Canada. The principal vector is the tick *Ixodes cookei*, which feeds on a variety of small and medium-sized mammals, especially carnivores such as woodchucks, raccoons, skunks, foxes, etc., and occasionally people. Cases of Powassan encephalitis are rare and sporadic, but may be more common than previously realized. While there were only 24 known cases in North America during 1958-1994 (mainly in the eastern U.S. and Canada, of which six were fatal), four additional cases were identified in Maine and Vermont from 1999-2001 as a result of testing for West Nile Virus. The ages of these recent New England cases ranged from 25 to 70 years. Previously, the latest US case was a woman in Massachusetts in 1994. Cases of Powassan encephalitis may result in severe long-term morbidity (with a discharge from a hospital to a rehabilitation facility) and has a fatality rate of 10-15%. Patients generally have a history of tick bite, or a history of exposure to tick habitat or exposure to hosts such as squirrels, skunks, or woodchucks. Two woodchucks and two skunks at the home of a Maine patient tested positive for antibodies to POW virus. A virus similar to POW virus was isolated from two *I. scapularis*. The public health significance of this virus is unknown.

Relapsing Fever, caused by several *Borrelia* spirochetes, is transmitted by soft ticks of the genus *Ornithodoros*. This tick is found in the Western United States. Disease is characterized by cycles of high fever and is treated with antibiotics. Relapsing fever ticks are found in rodent burrows, nests, and caves. They can live for many years without feeding. Human cases are often associated with people staying in shelters or cabins infested with these ticks. *Ixodes scapularis* ticks have been found to transmit a newly discovered *Borrelia* spirochete belonging to the relapsing fever group. The public health significance of this new species of *Borrelia* is unknown.

Colorado Tick Fever, caused by a virus, occurs in mountainous areas above 5,000 feet in the western United States and Canada. There are 200-400 cases each year. Scientists believe cases are underreported. The virus is transmitted by female Rocky Mountain wood ticks. Symptoms begin with an acute high fever, often followed by a brief remission, and another bout of fever lasting 2-3 days. Other symptoms included severe headache, chills, fatigue, and muscle pain. Illness may be mild to severe. Treatment is symptomatic. Recovery takes several weeks to occasionally months.