Tick-Borne Disease Reference Handbook

For Long Island and the Northeast

The Regional Tick-Borne Disease Resource Center

Stony Brook Southampton Hospital

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Tick-Borne Disease Reference Handbook

Second Edition

Contents

Photographs and illustrations on pages 2, 3, 4, 5, 6, 14, 26, 28, 35, 36, and 45 are courtesy of the Centers for Disease Control (CDC).

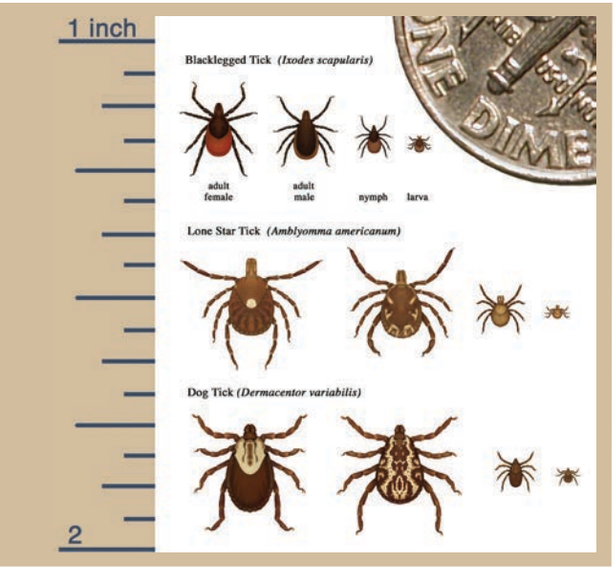
1. Ticks in Our Midst

Introduction

In Suffolk County, there are four tick species that are of public health importance and that are responsible for the transmission of a variety of tick-borne pathogens. Three of these species are the **blacklegged (deer) tick** *(Ixodes scapularis)*, the **lone star tick** *(Amblyomma americanum)*, and the **American dog tick** *(Dermacentor variabilis)*. Each species is capable of transmitting pathogens that cause human disease.

Life Cycle

A tick life cycle has four stages: the egg, the larva (plural larvae), the nymph, and the adult (male and female). The larval, nymphal and adult stages actively quest (search) for hosts for blood feeding or reproduction. For all tick species, the larva and nymph require a blood meal for development to the next life-cycle stage. The adult female requires a blood meal for egg production. In Suffolk County, tick life cycles typically take two years and the type of host will vary with the tick species and stage. All stages of the blacklegged (deer) and lone star ticks will attach to humans, while only adult American dog ticks will bite humans. Ticks are most active during the spring and summer months, and adult blacklegged (deer) ticks are active during the winter months when the temperature is above 40°F. Therefore, the risk of tick bites is continuous throughout the year in Suffolk County.



Ticks acquire human pathogens (i.e. bacteria, viruses or protozoa) from an infected host (i.e. reservoir host) during the blood meal. These pathogens are in the host's blood and enter the tick gut during feeding. If the particular tick species is a competent vector for the pathogen ingested, the tick will be able to pass it to the next host in the subsequent blood meal.

Blacklegged Tick

(Ixodes scapularis)

Other name: deer tick

The blacklegged (deer) tick can transmit a variety of pathogens including *Borrelia burgdorferi* (Lyme disease), *Anaplasma phagocytophilum* (anaplasmosis), *Borrelia miyamotoi* (Borrelia miyamotoi disease), *Babesia microti* (babesiosis), and Powassan virus disease. The greatest risk of being bitten exists in the spring and summer but adult ticks will be actively searching for a blood meal in the fall and winter when the temperature is above 40°F. All stages of the blacklegged (deer) tick bite humans.

Lone Star Tick

(Amblyomma americanum)

This tick species is more common in the South with an expanding northern range including Suffolk County. The lone star tick transmits various pathogens including *Ehrlichia chaffeensis* and *E. ewingii* (human ehrlichiosis), *Francisella tularensis* (tularemia), Heartland virus, Bourbon virus, and southern tick-associated rash illness (STARI). This tick species is active from early spring through late fall. It is a very aggressive tick and all stages bite humans. Lone star tick saliva can be irritating, with redness and discomfort at a bite site, which does not necessarily indicate an infection. Also, an allergic reaction associated with the consumption of red mammalian meat (i.e. alpha-gal meat allergy) has been reported in humans bitten by lone star ticks.

Ticks in Our Midst *- continued*

American Dog Tick

(Dermacentor variabilis)

Other name: wood tick

The American dog tick can transmit *Francisella tularensis* (tularemia) and *Rickettsia rickettsii* (Rocky Mountain spotted fever). Adult male and female ticks will bite humans. Larval and nymphal stages do not bite humans but feed primarily on rodents. The greatest risk of being bitten occurs during spring and summer.

Asian Longhorned Tick

(Haemaphysalis longicornis)

Other names: cattle tick (New Zealand); bush tick (Australia)

This tick is indigenous to eastern Asia and is now an invasive species to the United States. The first tick specimens were collected in Suffolk County in 2018. These ticks are found in a variety of habitats, including meadows, and grassy areas near forests. They will bite humans, pets, birds, livestock and wildlife. Fortunately this tick appears to be less attracted to human skin than other native tick species. Invasive Asian longhorned ticks can reproduce without mating. This is called parthenogenesis, and means that female ticks do not need males to fertilize their eggs. In the US, it is still unknown the role this species has in the transmission of pathogens to animals or humans. Research is ongoing.

Groundhog Tick

(Ixodes cookei)

Other name: woodchuck tick

The groundhog tick can transmit Powassan virus disease. All life stages feed on a variety of mammals including groundhogs (i.e. woodchucks), skunks, squirrels, raccoons, foxes, domestic animals and humans.

Larval Lone Star Ticks Versus "Chiggers"

During the mid to late summer, Suffolk County residents often complain about being bitten by "chiggers" which results in numerous itchy red bites. It is believed that these bites are the result of **larval lone star ticks** and not "chiggers." Although both "chiggers" and larval lone star ticks are about the same size and have six legs, there are some differences. A comparison of these two organisms shows that "chiggers" are larval trombicular harvest mites *(Eutrombicula alfreddugesi)* that typically become active in spring, after a rain event, since "chiggers" require a moist environment. However, "chiggers" have never been identified on Long Island. Larval lone star ticks *(Amblyomma americanum)* typically are active from approximately July through October and are less susceptible to desiccation (drying out) so a moist environment is not needed. The evidence that the complaints of "chigger bites" are caused by larval lone star ticks, and not "chigger" mites, is mostly circumstantial, but very compelling. All specimens submitted by Suffolk County residents and analyzed at our entomology lab have been identified as larval lone star ticks, not "chiggers."
(See photo in Chapter 16 Alpha-gal Allergy).

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2. Anaplasmosis

The Organism

Anaplasmosis is transmitted by the **blacklegged (deer) tick (Ixodes scapularis).** This tick also transmits the agents that cause Lyme disease and babesiosis. More than 2,900 cases of anaplasmosis have been reported to the CDC between 1994 and 2005, with the annual number of cases of anaplasmosis exceeding that of ehrlichiosis at an estimated annual incidence of 1.6 cases per million in the United States. The reservoir for *A. phagocytophilum* is primarily small mammals such as the white-footed mouse *(Peromyscus leucopus)*. In humans, anaplasmosis usually affects Caucasian males (95%) with a median age of 51. The peak incidence is during June and July.

Symptoms

Symptoms usually present during the first week after a tick bite, between four and nine days. The clinical presentation includes fever, headache, leukopenia (reduction of white cells in the blood), thrombocytopenia (low platelet count) and elevated liver enzymes. Rash is uncommon. This disease is very similar to ehrlichiosis, but milder. It also can present similarly to *Borrelia miyamotoi* infection. Approximately 5 to 7% of patients require intensive care. Inflammatory markers such as C-reactive protein and procalcitonin (PCT) are usually elevated.

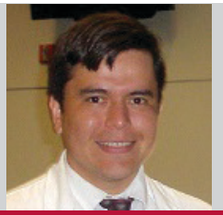
Anaplasmosis is transmitted by the blacklegged (deer) tick in the Northeast and Central United States.

Diagnosis

The diagnosis of anaplasmosis requires both a compatible clinical history and laboratory evidence of infection. Antibodies may be negative at the beginning of the infection. Specifically, the IgM antibody may be negative at the onset of illness, because not enough time has passed for the patient's immune system to develop antibodies. Thus, the best test for an early diagnosis is the detection of the DNA of the bacteria in the blood using a PCR test. After two to three weeks of disease, laboratory evidence of infection includes a single IgG antibody titer of at least 256.

Treatment

Patients usually respond well to a seven-to-ten day course of doxycycline, 100 mg orally, twice a day. Doxycycline should be taken with one to two glasses of water and taken in upright position to prevent esophagitis (inflammation of the esophagus) and other gastrointestinal symptoms. Doxycycline is usually well-tolerated. Immediate and complete removal of attached ticks is critical for prevention of transmission and infection.



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3. Babesiosis

The Organism

*Babesia microti i*s a zoonotic hemoprotozoa transmitted by the **blacklegged (deer) tick** *(Ixodes scapularis)* in the Northeast and Central United States. The parasite invades and kills red blood cells. Babesiosis is a blood infection with many similarities to malaria (see photograph of the parasite in blood cells). The first case of human babesiosis on Long Island was reported in a patient from Shelter Island in 1977. Since then this disease has remained frequent on Long Island.

The ratio of reported Lyme disease to babesiosis cases in the Long Island region is one of the highest in the Northeast.

The Disease

Several early studies established that the main risk factors for clinical babesiosis were in elderly patients and those who have had their spleen removed. Other forms of immune dysfunction resulting from existing conditions, or from therapies for cancer, or other diseases, as well as alcoholism, can also result in severe and difficult-to-treat parasitemia (parasites in the blood) and hemolysis (rupture or destruction of red blood cells). Subclinical babesiosis, i.e. not easily diagnosable, can occur in individuals who do not have the above risk factors, and who represent a group of asymptomatic seropositives (people who test positive but have no symptoms) who can have transient parasitemia in which the presence of parasites in the blood is short term. The typical presentation of clinical babesiosis includes nonspecific flu-like symptoms, such as fever, chills, and sweats. The infection can progress to hemolytic anemia (i.e. red blood cells are destroyed faster than they can be made) as a result of the destruction of the red blood cells by the parasite. This condition can be accompanied by jaundice and dark urine. In patients with risk factors, babesiosis can be the most severe and life-threatening of all the infections transmitted by ticks.

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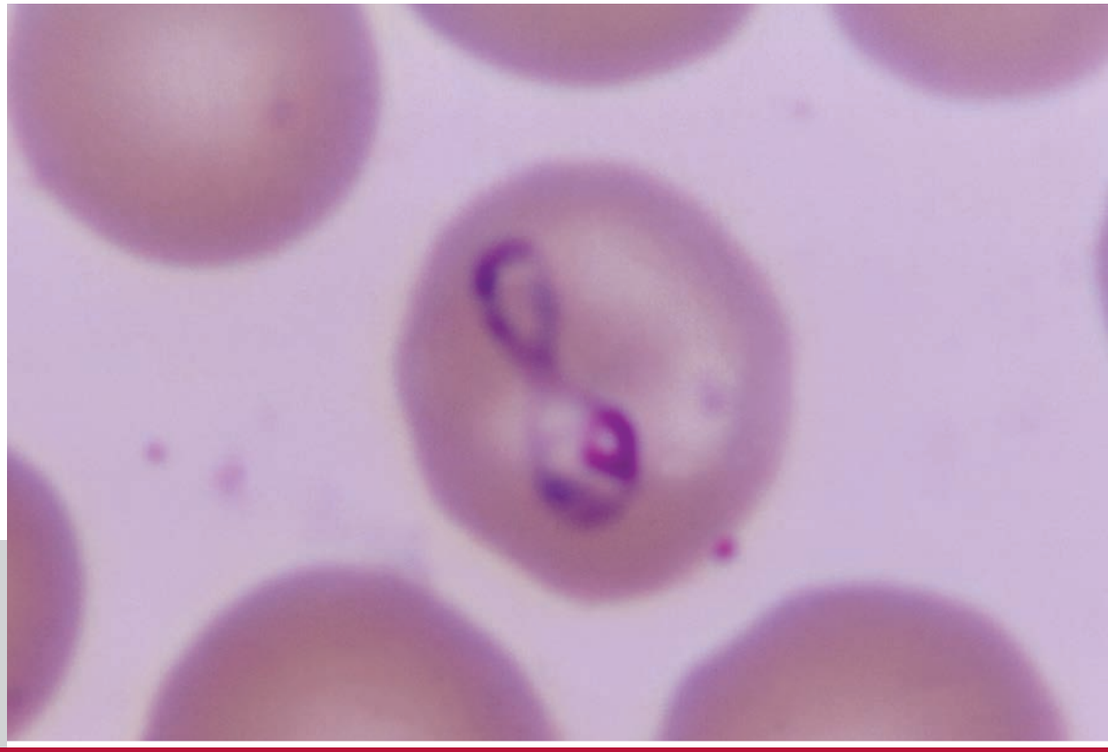
Treatment

Patients are treated with clindamycin and quinine and also with atovaquone and azithromycin. In extremely severe cases, exchange transfusions, where the infected blood cells of the patient are replaced with blood components, have given good results.

Double Infections and Prevention

Cases of babesiosis have increased markedly. The ratio of reported Lyme disease to babesiosis cases in our area is one of the highest in the endemic zones of the Northeast. Because the agents of babesiosis *(Babesia)* and Lyme disease *(Borrelia)* can both be transmitted by the blacklegged (deer) tick *(Ixodes scapularis)*, these two diseases can occur simultaneously in the same patient. Double infections represent special diagnostic challenges as the treatment for Lyme disease and for babesiosis are different. Persons with one or more of the risk factors for clinical babesiosis need to avoid tick-infested areas and be extra careful about checking themselves for ticks.



4. Borrelia Miyamotoi Disease

The Organism

New York's Suffolk County on Long Island has a population of 1.8 million people and annually reports the highest absolute number of cases of tick-borne disease in the state. In 2017, there were 523 cases of Lyme disease, 55 cases of ehrlichiosis, 31 cases of anaplasmosis, and 138 cases of babesiosis. In 2013, a series of cases in the Northeast United States first described a new *Borrelia* species, *Borrelia miyamotoi*, which caused human infection. *B. miyamotoi* is closely related to the relapsing fever family of *Borrelia spp.* (e.g. *B. hermsii*); however, it is transmitted by the **blacklegged (deer) tick** *(Ixodes scapularis)*, the same tick that transmits *Borrelia burgdorferi* (Lyme disease), as well as *Anaplasma phagocytophilum* and *Babesia microti*. In contrast to Lyme, the ticks commonly contain a low bacterial load of *B. miyamotoi*. For instance, 3 to 5% of ticks on Long Island have been found to be infected by *B. miyamotoi*, but up to 74% contain *B. burgdorferi*.

Symptoms

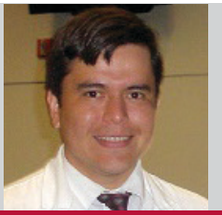
B. miyamotoi infection can clinically present during warm months as a flu-like syndrome similar to Lyme disease, anaplasmosis, or babesiosis. The most common symptoms described in Long Island patients are fatigue, fever, joint pain, muscle pain, and sometimes vomiting and diarrhea. It can also cause meningitis in patients with a low or compromised immune system. There are some studies that show that some of the long-term symptoms of Lyme disease may actually be similar to those caused by *B. miyamotoi*.

Diagnosis

The diagnosis of a *B. miyamotoi* infection is complicated by the overlap in clinical manifestations caused by other tick-borne diseases, and the need to order specific diagnostic tests that may not be familiar to general practitioners. The positivity rate of *B. miyamotoi* PCR in the Long Island area is 0.19%. Thus, for every 1000 people with an acute febrile (fever) illness after a tick bite, only two may have a positive test for *B. miyamotoi*. It is recommended that a specific test for *B. miyamotoi*, (a PCR test of the blood), be ordered if the patient has a history of a recent deer tick bite and has a febrile illness, with laboratory results consistent with a low white blood cell count, high levels of liver enzymes, and a low platelet count. This test is not recommended for people without the above symptoms, or symptoms which may be explained by other diseases.

Treatment

Patients usually respond well to a 14-day course of doxycycline, 100 mg orally, twice a day. Doxycycline should be taken with one to two glasses of water and taken in upright position to prevent esophagitis (inflammation of the esophagus) and other gastrointestinal symptoms. Doxycycline is usually well-tolerated. If the infection is proven to be in the brain by a positive PCR test via spinal tap, intravenous antibiotic may be needed.



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5. Ehrlichiosis

The Organism

Ehrlichiosis is caused by the bacteria *Ehrlichia chaffeensis* or *Ehrlichia ewingii* and is transmitted by the **lone star tick** *(Amblyomma americanum)*. The white-tailed deer (*Odocoileus virginianus*) is the main reservoir for this bacteria. The deer do not get sick, although all life stages of the tick reside on the deer. In the United States, the first human case of ehrlichiosis was reported in 1987 in a patient with fevers, low blood pressure, confusion, acute renal (kidney) failure, impaired blood clotting, and gastrointestinal hemorrhage. As a result, ehrlichiosis has become one of the most life-threatening tick-borne diseases in the U.S. Men are more frequently diagnosed with ehrlichiosis than women.

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Symptoms

Unlike Lyme disease, ehrlichiosis does not cause a rash on the site of the tick bite. The most typical presentation is fever with headaches, rigors, muscle pain and malaise. Up to 50% of patients have nausea, vomiting, diarrhea, or abdominal pain. Twenty-five percent of HME patients have a cough or other evidence of respiratory tract involvement, and 20% have central nervous system involvement, without obvious involvement of other organ systems. A laboratory report will typically show a low count of white blood cells and platelets, and a mild elevation of the liver enzymes. More than 40% of HME patients require hospitalization. Importantly on Long Island, the exploding population of the natural reservoir of *E. chaffeensis,* the white-tailed deer, and the rapid expansion in the range and population of the lone star tick, are both important ecologic factors in the continuing emergence of HME.

Diagnosis

The diagnosis of HME requires both a compatible clinical history and laboratory evidence of infection. Antibodies may be negative at the beginning of the infection. Specifically, the IgM antibody may be negative at the onset of illness, because not enough time has passed for the patient's immune system to develop antibodies. Thus, the best test for diagnosis early on in the course of the disease is the detection of the DNA of the bacteria in the blood using a PCR test. After two to three weeks of disease, laboratory evidence of infection includes a single IgG antibody titer of at least 256.

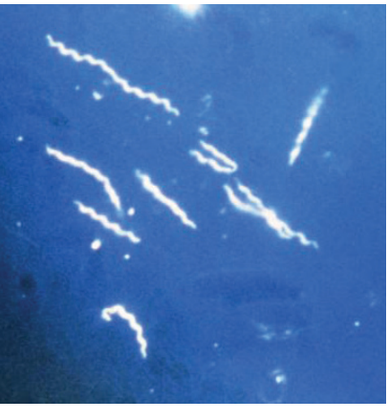
Treatment

Patients usually respond well to a seven-to-ten day course of doxycycline, 100mg orally, twice a day. Doxycycline should be taken with one to two glasses of water and taken in upright position to prevent esophagitis (inflammation of the esophagus) and other gastrointestinal symptoms. Doxycycline is usually well-tolerated. The typical response to doxycycline is rapid reduction of fever within 24 to 48 hours. Fatigue may persist for weeks or months. There is no evidence of persistent *E. chaffeensis* infection in humans, and treatment for disease beyond the acute infection is not indicated.

6. Lyme Disease

The Organism

The Lyme disease infection is caused by *Borrelia burgdorferi,* a spirochete that is transmitted by the bite of the **blacklegged (deer) tick** *(Ixodes scapularis).* The white-footed mouse *(Peromyscus leucopus)* is the dominant mammalian reservoir (where the organism resides) for this tick-borne disease. When ticks feed on infected mammals they will become infected and may then transfer the disease to another mammal or a human when they feed again in their life cycle. Lyme disease can affect the skin, joints, nervous system, and heart. Individuals who work or recreate outside, and gardeners, are at a high risk of infection. Children are especially vulnerable as they are physically closer to the ground during activities and play.



Lyme disease spirochetes

Symptoms

Early infection with *B. burgdorferi* can manifest with a "bull's-eye" rash also known as erythema migrans (EM). The appearance of a rash may occur less than fifty-percent of the time in Lyme disease infections. Ticks can transmit more than one disease to humans resulting in coinfections with Lyme disease that may include babesiosis and ehrlichiosis. Lyme disease signs and symptoms can occur three to thirty days after a tick bite. Signs and symptoms may be elusive. Predominant in spring through summer, symptoms can include flu-like symptoms such as fatigue, fever, chills, headache, muscle aches, joint pain and swollen glands. If a rash does appear, it may not always have a classic "bull's-eye" appearance. Additionally, a rash may not always be apparent in darker-skinned individuals, as it may appear as a bruise. Fever and generalized signs and symptoms may occur without a rash. The presence of a rash makes the diagnosis of Lyme easier, but the disease cannot be ruled out if a rash is not present. It is important to obtain antibiotic treatment early to prevent the complications of Lyme disease.

If Lyme disease is initially missed, later signs and symptoms can occur weeks to months after a tick bite. These symptoms can overlap in early and late Lyme disease. Symptoms include, but are not limited to, headaches, neck stiffness, visual changes, mental cloudiness, facial palsy, nerve pain (neurological Lyme), arthritis pain with swelling of a knee or other large joints (Lyme arthritis), heart palpitations (Lyme carditis), and debilitating fatigue.

In a small percentage of cases, symptoms of Lyme disease may last well after antibiotics are completed. Although sometimes called "chronic Lyme disease," this condition is properly known as "Post-treatment Lyme Disease Syndrome" (PTLDS). The exact cause of PTLDS is not yet known. Most experts believe that the lingering symptoms are the result of residual damage to tissues and the immune system that occurred during the infection. It is important for anyone experiencing ongoing symptoms to return to their medical provider for care.

Diagnostic Testing

Laboratory diagnosis includes testing of the blood for antibodies IgM (current infection) or IgG (past infection). A two-tier testing protocol is typically done. If the first test (ELISA) is positive or equivocal for antibodies, a second test (Western blot) is performed. The Western blot identifies specific bands that are the signature proteins for Lyme disease. This two-tier test for antibodies is usually negative in early Lyme disease. It may take up to one month for antibodies to develop. If an individual is treated early with antibiotics, Lyme antibodies may not develop. The spirochete, *B. burgdorferi,* that causes Lyme disease, does not remain in the blood stream very long as the organism migrates to collagen rich tissues such as into the skin, joints, heart or central nervous system. Therefore, blood cultures or PCR (Polymerase Chain Reaction) testing are ineffective diagnostic tools.

Treatment

Treatment includes oral antibiotics such as doxycycline (100mg twice daily) for 10-21-day duration. Doxycycline should be taken with food (non-dairy) to prevent GI upset. Sun safety is important to prevent sunburn. Adults who may be allergic to doxycycline, or who work outside, may be given amoxicillin. Long courses of doxycycline (more than three weeks) are not indicated for children less than eight years of age due to the potential of teeth staining. It is important to complete the antibiotic course to effectively eliminate the infection. A prophylaxis one-time dose of doxycycline (200mg) may be taken, within 72-hours of tick removal, for adults after a recognized black legged (deer) tick bite which was attached for 36 hours or more.

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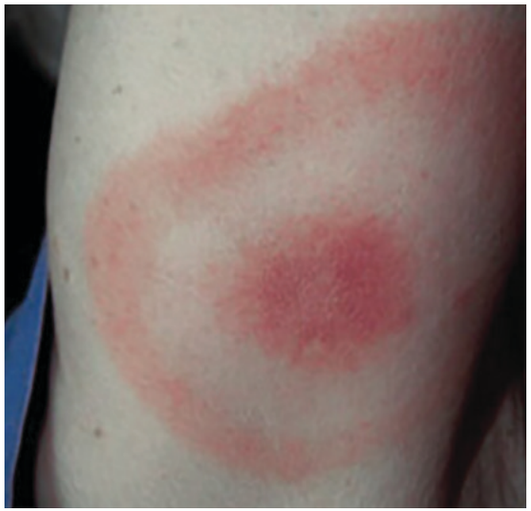
7. Erythema Migrans (EM) Rashes

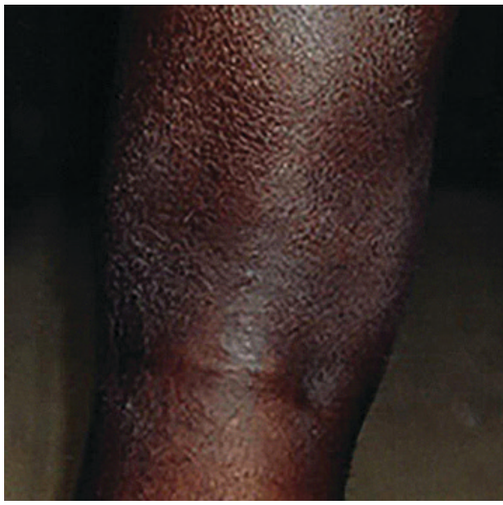
On Long Island we have found that the erythema migrans (EM) rash occurs in approximately 50% of patients with Lyme disease. At the site of the tick bite, an EM rash slowly expands in size over a few days. Some, but not all, may develop a "bull's-eye" appearance. There may also be alternate manifestations of the rash, and the rash may be warm to the touch. If early Lyme disease remains untreated, patients may develop multifocal lesions over the body as the bacteria spreads.

EM lesion, bluish hue, with no central clearing
Photo courtesy of Bernard Berger, MD



Classic EM, a circular red rash with central clearing that slowly expands
Photo courtesy of the Centers for Disease Control (CDC)

Red expanding lesion with central crust
Photo courtesy of Bernard Berger, MD



Purple rash on the back of African-American knee that can appear as a bruise and is often missed
Photo courtesy of Gary Wormser, MD

Early disseminated Lyme disease, multiple red lesions, called a multifocal rash
Photo courtesy of Bernard Berger, MD

8. Lyme Arthritis

The Organism

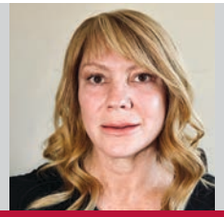
Lyme disease was first recognized in the United States in the 1970s, presenting as joint swelling (arthritis) during an outbreak in children in Lyme, Connecticut. Lyme disease is now the most common vector-borne illness in North America and Europe. The clinical manifestations of Lyme disease are divided into three phases: early localized, early disseminated, and late disease. Lyme disease can affect multiple organs, including the joints, resulting in what is termed Lyme arthritis. Lyme arthritis is the most common manifestation of late Lyme disease, occurring months to years after the exposure to *B. burgdorferi*, the causative agent of Lyme disease.

Symptoms

Lyme arthritis is characterized by joint swelling, redness, and warmth most commonly involving a single knee. Other joints including the shoulder, ankle, elbow, and wrist may be involved typically in an asymmetric pattern. Almost always, fewer than five joints are involved (including the knee). Lyme arthritis is not particularly painful, except due to pressure from a tensely swollen joint. Episodes of joint swelling tend to begin suddenly and may last for several weeks to months.

Diagnosis

Lyme disease blood testing is used to establish the diagnosis of Lyme arthritis in patients with potential exposure to *Ixodes* ticks and signs and symptoms consistent with Lyme arthritis. Because Lyme arthritis is a late manifestation of Lyme disease, all patients with Lyme arthritis will have a positive blood test for Lyme *(B. burgdorferi)*. Thus, those with negative blood tests are unlikely to have Lyme arthritis. *B. burgdorferi* DNA is detectable in joint fluid by polymerase chain reaction (PCR) in most patients with untreated Lyme arthritis; however, PCR testing of joint fluid has not been validated for widespread clinical use.



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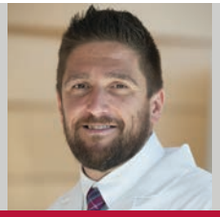
Lyme arthritis is characterized by joint swelling, redness, and warmth.

Treatment

Because antibiotic treatment of early Lyme infection is usually curative, arthritic complications have become less common. Studies of the natural history of Lyme arthritis demonstrate eventual resolution, even in the absence of antibiotic therapy, in most cases; however, the arthritis can last for years in untreated patients. Because of this, the current recommendation for treatment of Lyme arthritis is antibiotic therapy to accelerate the resolution of arthritis and prevent recurrence. In 90% of patients with Lyme arthritis 28 days of oral antibiotics (doxycycline or amoxicillin) will result in resolution of symptoms. Occasionally a second course of the same oral antibiotic, or a longer course of intravenous antibiotics, may be required.

9. Lyme Carditis

Lyme disease is the most common vector-borne illness in the US, spread by the **blacklegged (deer) tick** *(Ixodes scapularis)* and caused by infection with the bacteria *Borrelia burgdorferi.* Although a common infectious illness that affects multiple body systems, it may uncommonly affect the heart. First described in 1977, the term "Lyme carditis" is used to describe the variety of cardiac abnormalities found in patients with Lyme disease. Although cardiac involvement is estimated to occur in 4% of patients with untreated Lyme disease, the true incidence is likely under reported.



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Symptoms

Due to widely varied clinical presentations, the diagnosis of Lyme carditis demands a high level of suspicion in endemic areas. Typically, cardiac involvement occurs weeks to months after initial infection, and most commonly manifests with AV nodal block (impaired electrical conduction between the atria in the top of the heart and the ventricles on the bottom of the heart) on electrocardiogram (EKG). Other clinical manifestations may include nonspecific symptoms such as palpitations, chest pain, or shortness of breath. Infrequently, infection may lead to inflammation of the heart (myocarditis) or surrounding tissue (pericarditis), and has been implicated as a rare cause of heart failure and sudden death.

Although cardiac involvement is estimated to occur in 4% of patients with untreated Lyme disease, the true incidence is likely under reported.

Diagnosis

Accurate diagnosis is imperative, and depends upon two sequential blood tests (Enzyme linked immunosorbent assay (ELISA), and Western blot). These tests have a poor sensitivity during the acute phase, and may be inaccurate early in the course of infection. However, since cardiac involvement is a manifestation of the later, disseminated stage of Lyme disease, those with negative blood tests are unlikely to have Lyme carditis.

Treatment

Lyme carditis has an excellent overall prognosis, and is treated with a 21-day course of antibiotics. In certain patients, hospitalization may be required for heart monitoring or temporary pacemaker for the heart. In those patients, intravenous antibiotics are recommended until the electrical conduction through the heart improves (usually within 1 week). Permanent pacemaker placement is not indicated for Lyme carditis, and there are no known long-term cardiac complications among patients whose infection has been eradicated. Future research is needed to assess whether the inflammation caused by Lyme carditis presents a risk for the development of heart failure.

10. Neurologic Lyme Disease

Lyme disease is a systemic bacterial (spirochetal) infection which targets four organs in the body: skin, joints, heart and the nervous system (both central and peripheral). After skin, neurologic Lyme disease appears to be the most common incidence. Neurological Lyme disease is curable with the appropriate antibiotics administered for the correct period of time.

There are many different strains of the Lyme bacteria which may target different areas of the body, and not all cases of Lyme disease will involve the nervous system. Size of the inoculation load may also be a factor in who develops neurologic symptoms. After a tick bite the bacteria disseminates via the skin and the blood, and then rapidly spreads to various areas, depending on the strain and an individual's susceptibility, including the nervous system. The bacteria remain in the blood for a very short time. The patient's immune system and genetic background also affect how an individual handles the inoculation with *B. burgdorferi*. Typically, there are not a large number of spirochetes present in the nervous system, and there is not marked structural tissue damage. Most symptoms are likely caused by the patient's immune response to the bacteria, and resulting inflammation.

Symptoms

A patient may have a wide spectrum of non-specific neurologic complaints such as headache, stiff neck, pain (especially in joints and muscles), fatigue, and fuzzy thinking. Most cases will present from May to October, although other times of the year cannot be discounted. Even if the patient does not recall a tick bite, just by living in an endemic area where ticks are present, Lyme disease is a consideration for anyone who develops neurologic symptoms.

After the spirochetes disseminate in the blood, there may be a facial paralysis involving the seventh cranial nerve (Bell's palsy) which can be on one side of the face or both. Typically a patient will be unable to close one eyelid and there will be tearing disturbances. Hearing may be distorted on the side of the paralysis, and also loss of taste on one side of the tongue. Generally a patient will be unable to wrinkle their forehead. Bi-lateral (both sides) facial nerve palsy increases the suspicion of Lyme disease. Twenty-five percent of suspected Bell's palsy cases in an endemic area presenting during summertime will be due to Lyme disease. Neurologic Lyme disease can also present as "viral" meningitis, with headache and stiff neck, as well as with spine pain which presents as acute pain between the shoulder blades or spinal nerve root sensory and motor abnormalities. A person who presents with spine pain during the summer months should be evaluated for neurologic Lyme disease.

Diagnosis

Diagnosis generally requires an evaluation of the cerebrospinal fluid (CSF) collected by lumbar puncture. CSF is most helpful to the diagnosis of neurologic Lyme disease, by showing increased WBCs, total protein, and intrathecal Lyme antibody production, and by helping to exclude other possible diagnoses. The vast majority of neurologic Lyme patients should be seropositive in blood. An MRI of the brain is generally normal, but a variety of lesions are reported in 25% of people.

A patient may have a wide spectrum of non-specific neurologic complaints: headache, stiff neck, pain, fatigue, and fuzzy thinking.

Treatment

Antibiotics are administered intravenously via a PICC line. Antibiotic of choice is ceftriaxone, 2 grams daily, over 30 minutes, for 21 days. This should not require hospitalization. Stony Brook Medicine has had the best results with a longer course, but 14 to 21 day courses also have been used. Oral antibiotics are generally not used for the treatment of Neurologic Lyme disease in adults in North America. All symptoms may not resolve quickly, but there should be a gradual improvement as the patient's immune response, and resulting inflammation, slowly resolve back to baseline levels. Additionally, it is recommended that a patient take a daily acidophilus (probiotic) to maintain healthy gut bacteria and avoid *C. difficile* colitis. Any GI symptoms or pain in the upper right quadrant area during treatment should be reported to your physician for evaluation (the antibiotic is excreted in bile and can cause sludge).

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11. Lyme Disease in Children and Adolescents

The Organism

Lyme disease is a bacterial infection transmitted by the bite of the **blacklegged (deer) tick** *(Ixodes scapularis)*. Approximately 500 cases are reported in Suffolk County each year, though the true number is likely much higher. Children and adolescents have similar risk factors for getting Lyme disease as adults which is based on outdoor exposures in endemic areas; though incidence is highest in 5-14 year olds, likely based on types of activities near tick habitats, forests, and tall grasses. Most cases occur in late spring and summer months. Lyme disease, due to *Borrelia burgdorferi*, presents in children and adolescents in three different stages: early disease presenting 3-30 days after a bite ("bull's-eye"/target rash or erythema migrans), early disseminated disease presenting 3-10 weeks after bite (multiple erythema migrans lesions, meningitis, carditis, facial droop), and late disease presenting 2-12 months after a bite (arthritis).

Symptoms

Sometimes the only specific symptom of Lyme disease is a single erythema migrans ("bull's-eye"/ target rash) lesion at the site of the bite. Additional nonspecific symptoms can include fevers, headaches, and muscle aches – a flu-like illness. Not infrequently, the tick and rash may not be noticed, disease may progress, with some children going on to develop multiple erythema migrans lesions, signs of meningitis, facial droop, or rarely carditis (abnormal heart rhythm) or a much later manifestation, arthritis (swelling of a joint).

Diagnosis

Early diagnosis is key. Early disease with the erythema migrans rash is a clinical diagnosis and no testing is needed. For the other forms of Lyme disease, a blood test is done for *Borrelia burgdorferi* antibodies. This begins with a screening (or first tier) antibody test and if borderline or positive, additional (second tier) antibody testing is performed on the blood sample. The second tier of tests includes early antibodies or IgM and late antibodies or IgG. This can be a Western blot (traditional testing) or part of the new commercial lab test, the modified two-tier testing (MTTT). Having clinical features suggesting Lyme disease and a certain combination of IgM or IgG, depending on the stage of the disease, determines if a patient has Lyme disease. Previous history of Lyme disease must be considered when interpreting these results.

Treatment

Treatment with antibiotics (typically amoxicillin or doxycycline) for Lyme disease is very effective. Early treatment is important, but all stages of Lyme disease can be effectively treated with appropriate antibiotics. Erythema migrans (both single and multiple lesions), meningitis, carditis, and facial palsy are all treated with between 2-3 weeks of antibiotics (depending on the illness). Arthritis requires four weeks of treatment. Children respond very well to treatment. Long term complications are rare.

Prevention

Although treatable, it is best to avoid Lyme disease entirely by preventing tick bites. Preventative measures include using insect repellents (20-30% DEET), keeping to trails when hiking, wearing long sleeves and pants, and doing regular tick checks to remove ticks immediately. If a tick is noted, remove the tick properly with tweezers. Tick identification and time of attachment are also important. It takes at least 24 hours for the *Borrelia* bacteria to be transmitted, so risk of infection decreases the earlier the tick is removed. It is important for parents to talk with their child's doctor about any concerns they have about tick bites and Lyme disease.

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12. Powassan Virus Disease


Groundhog tick

The Organism

Powassan belongs to the Flavivirus group of RNA viruses transmitted by arthropod vectors and include yellow fever, dengue, West Nile, Zika and various types of encephalitis. This particular virus was named after the town of Powassan, Ontario where it was identified in 1958 in a young boy who eventually died from the virus. There are two distinct variants of Powassan virus. The first is transmitted by the **groundhog tick** *(Ixodes cookei)* in the Eastern US, including the Great Lakes area and Canada. Lineage II (known as deer tick virus) is transmitted by the **blacklegged (deer) tick** *(Ixodes scapularis)*, and it has been identified in up to 2% of the ticks that were tested in Suffolk County in 2018 and 2019.

Powassan virus is quite rare. Unlike other tick-borne diseases, this virus can be transmitted in as little as fifteen minutes after a person is bitten by the tick. That is why it is extremely important not to wait, but to remove a tick as soon as possible. The CDC has reported that the number of cases of persons diagnosed with Powassan has increased in recent years.

The Disease

Disease is most often seen in children or in those older than 50 years. Symptoms may start to appear from one to four weeks after a tick bite, usually by a blacklegged (deer) tick. The person may experience fever, headache, vomiting, and weakness. These symptoms can quickly progress to an infection of the brain and surrounding membranes called meningoencephalitis, which may cause seizures and convulsions, disorientation, memory problems, movement disorders, cranial nerve palsies, loss of speech and understanding, and partial paralysis.

Diagnosis is made through signs and symptoms, a history of exposure to tick bites, and laboratory tests of blood and/or spinal fluid which are processed at selected health departments and through the CDC.

Ticks must be removed from the skin as soon as they are found as, unlike other tick-transmitted pathogens, Powassan virus can be transmitted in as little as 15 minutes.

Treatment

There is no treatment for Powassan virus disease. Supportive care will be provided in a hospital setting for help with breathing, fluids, and a reduction of swelling in the brain. There is a fatality rate of between 10 – 15%, and 50% of patients who survive will go on to have chronic or residual effects of this disease.

Remember, ticks must be removed from the skin as soon as they are found, as, unlike other tick transmitted pathogens, Powassan virus can be transmitted in as little as 15 minutes.


Blacklegged (deer) tick

13. Rocky Mountain Spotted Fever (RMSF)

The Organism

Rocky Mountain spotted fever (RMSF) is caused by the bacterial organism, *Rickettsia rickettsii*, which is carried by the **American dog tick** *(Dermacentor variabilis)*. It is transmitted through the bite of an infected tick and transmission usually takes about six to ten hours. This disease has been present on Long Island for nearly 120 years. RMSF can occur throughout the continental United States and the number of cases has risen steadily over the last 20 years. RMSF is considered rare on Long Island. Stony Brook Medicine admits one to two cases of RMSF each year.

Note: Many patients have a positive test for either IgM or IgG for RMSF, but they have no symptoms. These positive tests are likely false-positive results, and the public should be aware of this phenomena to avoid anxiety if they receive a "positive" test result for RMSF. *(See "Diagnosis" for further discussion).*

Symptoms

RMSF can be difficult to diagnose in its early stage when treatment is most effective. Early symptoms are fairly non-specific and can include a high fever, severe headache, gastrointestinal distress, muscle pain, malaise, and swelling around the eyes and the back of the hands.

The distinctive RMSF rash usually appears from two to five days after the onset of symptoms. The early-stage rash consists of small, flat, pink, non-itchy spots on the wrists, forearms and ankles and then spreads to the trunk and sometimes palms and soles of the feet. The rash can be very faint. A small percentage of patients never get a rash.

The late-stage rash, called a petechial rash, usually presents six days after onset as red dots or purple splotches. This rash is considered a sign that the disease has progressed to a later stage and is severe. A patient may experience swelling on the brain, enter into a coma, have severe respiratory distress and multi-organ failure. Left untreated, it is fatal in up to 10% of cases. People over the age of forty, particularly men, account for the highest number of cases. Children also can be of particular risk for the development of this disease and those under the age of ten represent the highest number of reported deaths. Some patients who recover from severe disease have permanent disabilities such as amputations, hearing loss, paralysis or cognitive issues.

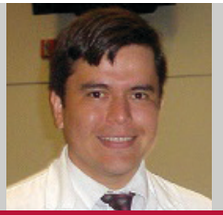
Diagnosis

Diagnosis of RMSF is made through laboratory testing of the blood and a skin biopsy of the rash to confirm the disease. However, antibiotic treatment should not be withheld pending laboratory confirmation. In a patient where the disease is suspected, effective antibiotic therapy with doxycycline should be started immediately. When started within the first five days of symptoms, a fatal outcome may be prevented. It is extremely important to seek medical attention when there are early symptoms after the bite of an American dog tick, especially if fever or other new symptoms occur after the tick bite. Most dog tick bites are benign and should not raise concern for disease, except if symptoms occur. The highest period of activity for the American dog tick is from early April to early July, and is infrequent for the balance of the year.

Note regarding a positive IgM or IgG test result for RMSF: There are people who are asymptomatic and test positive for RMSF. The vast majority of these tests are false-positive, and may occur from time-to-time in any test that measures antibodies in the blood. False-positive, (meaning the test is positive but there is no infection or disease), may occur due to several reasons. First, it is possible that some people may have a history of a tick-borne disease at some point in the past and the antibody cross-reacts with RMSF (common on Long Island). It is also possible that there is another rickettsial bacterial infection from ticks that may not yet be recognized in humans. Since there are no symptoms to treat, this will not change disease management. Also, laboratory tests are not flawless, and a simple laboratory error may have occurred. Most important in diagnosing RMSF is the appearance of symptoms, and to not wait for a positive test. Stony Brook University is presently conducting research studies to determine if other *Rickettsia* species may cause symptoms.

Treatment

Doxycycline is the preferred antibiotic for this disease and it is used to treat both adults and children. Other antibiotics have not been demonstrated to have reliably positive outcomes. Doxycycline does not cause teeth staining in children when used in short courses of treatment.



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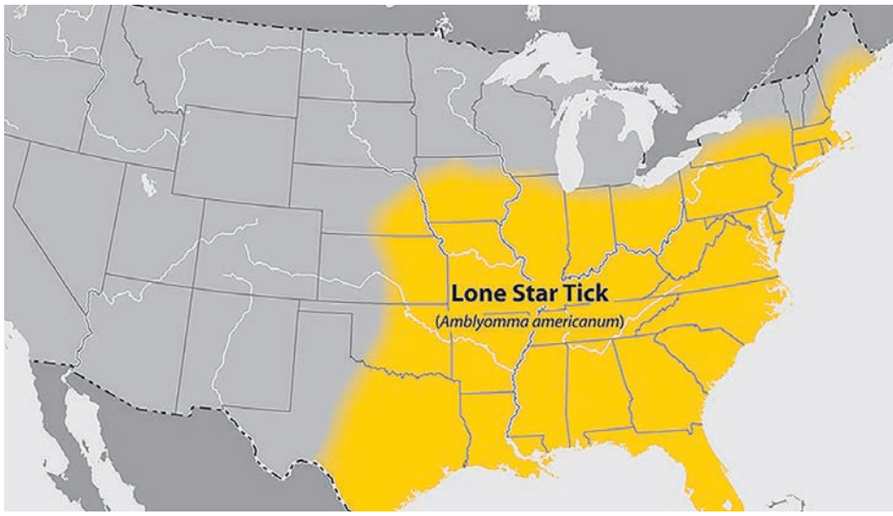
14. STARI – Southern Tick-Associated Rash Illness

What is STARI?

STARI, or Masters disease, is the abbreviation for southern tick-associated rash illness. STARI is a rash that is similar in appearance to erythema migrans, the rash of Lyme disease, but it is associated with the bite of the **lone star tick** *(Amblyomma americanum)*[1, 2]. The cause of STARI is unknown at this time. Researchers are actively seeking more information about the cause of this disease so that diagnostic tests can be developed.

Lone star ticks are not a competent vector for *Borrelia burgdorferi* (the agent of Lyme disease). *B. burgdorferi* cannot be recovered from cultures of skin biopsy specimens obtained from STARI patients, and results of acute-phase and convalescent-phase serologic assays for antibodies to *B. burgdorferi* are negative[1, 3, 4]. *Borrelia lonestari* was thought to be the cause of STARI[5], but this was not verified on a larger study[4].

Amblyomma americanum (the lone star tick).
Dorsal view of a female (A), male (B), and nymph (C) lone star tick, *Amblyomma americanum*.
Adapted from Public Health Image Library, Centers for Disease Control and Prevention.



Geographic distribution of *Amblyomma americanum* (the lone star tick).
Centers for Disease Control and Prevention, National Center for Emerging and Zoonotic Infectious Diseases (NCEZID), Division of Vector-Borne Diseases (DVBD).

The Vector of STARI

Formerly confined to the South, lone star ticks can now be found from the southern regions of the United States up the entire eastern seaboard to Maine[2, 6]. They are aggressive hunters and feeders. All stages in the tick's life cycle will bite humans, including larvae. The adult female lone star tick is distinguished by the white dot on her back. In places where both the blacklegged (deer) tick *(Ixodes scapularis),* the vector of Lyme disease, and lone star ticks coexist, people are much more likely to be bitten by a lone star tick[7].

Symptoms

The STARI rash can look very similar to erythema migrans, the rash of Lyme disease. When compared with patients with erythema migrans, STARI patients are more likely to remember a tick bite; and have a shorter time interval between the time from the tick bite to the start of the rash. The size of the STARI rashes are smaller, but the skin lesion is more circular and more likely to look like a "bull's-eye" rash (i.e. have central clearing) than erythema migrans rashes. Patients with STARI are less likely to have systemic symptoms or to have multiple skin lesions[8]. These distinctions are more apparent when comparing the groups of patients. On an individual case, it can be very difficult to differentiate between the two diseases based only on the rash appearance.

Diagnosis

It can be a challenge to health care providers to differentiate between a STARI rash and an EM rash, as they are very similar in appearance. Diagnosis should be made on the basis of the history, geographic location and exposure to lone star tick bites. For patients in areas where both ticks are common, the only sure method of distinguishing the skin lesion of STARI from erythema migrans would be to demonstrate that the rash was associated with a lone star tick bite, for example, when the patient still has the tick. There is no blood test available to confirm STARI diagnosis at this time.

Treatment

It is not known if treatment with antibiotics is beneficial. Because this illness resembles early Lyme disease, physicians will often treat with oral antibiotics. Scientists are actively conducting research to more fully understand this disease.

Acknowledgement: This research was supported in part by the Intramural Research Program of the NIH, NIAID.

STARI Rashes.

Adapted from Centers for Disease Control and Prevention, National Center for Emerging and Zoonotic Infectious Diseases (NCEZID), Division of Vector-Borne Diseases (DVBD).

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STARI – SOUTHERN TICK-ASSOCIATED RASH ILLNESS

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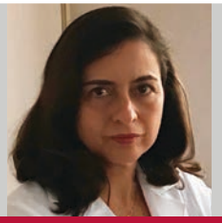

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15. Tularemia

The Organism

In the Northeast, the bacteria that causes tularemia (*Francisella tularensis*) can be transmitted through the bite of the **American dog tick** *(Dermacentor variabilis*), and the **lone star tick** *(Amblyomma americanum)*. The disease can also be contracted by handling dead infected animals (particularly rabbits), by inhalation, ingestion, and through skin contact with infected animals such as mice, squirrels, voles, rats, as well as hares and rabbits. It is not a common disease in the Northeast but cases do occur sporadically. In 2019 there were two cases seen at Stony Brook Hospital.

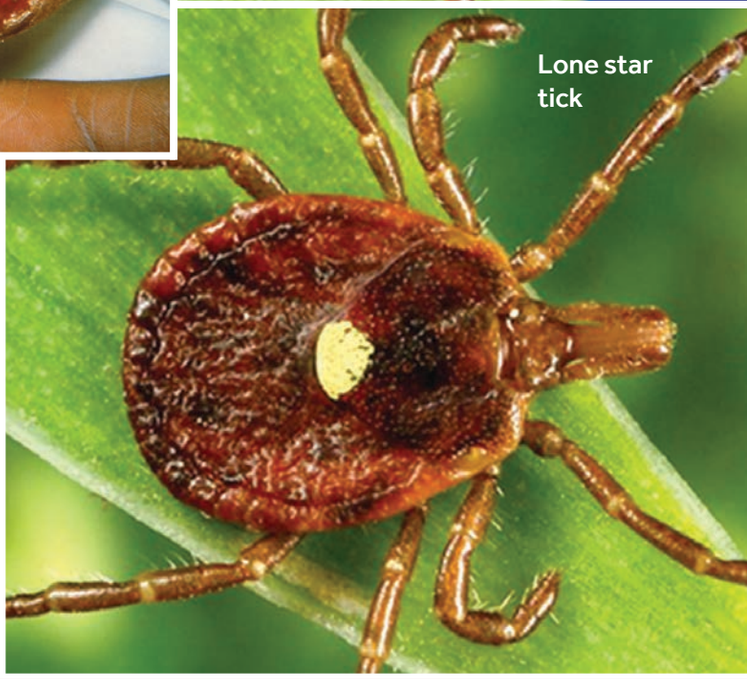
Symptoms

The incubation period can be between 3 to 5 days, but as long as 21 days. When transmission occurs by an infected tick an ulcer will often appear at the site of the bite. Symptoms can include high fever and chills, headache, fatigue, sore throat, cough, chest tightness, conjunctivitis, muscle pain, vomiting, diarrhea and abdominal pain. The diagnosis is made clinically and confirmed by an antibody test. Diagnosis will be made by the isolation of *F. tularensis* from a clinical specimen, or by the presence of antibodies.

Though most commonly contracted by the handling of dead infected animals (such as rabbits, hares, mice, squirrels, voles and rats), tularemia can also be transmitted to humans by a tick bite.

Treatment

Depending on how the bacteria was transmitted and the patient's age, medical history, and underlying health conditions, treatment with streptomycin, gentamicin or ciprofloxacin for a minimum of ten days is the preferred treatment protocol.



16. Alpha-Gal Allergy: Meat Allergy Caused by the Lone Star Tick

What Causes the Allergy to Meat?

A blood group carbohydrate (sugar) called galactose-α-1,3-galactose (α-gal) is present in all non-primate mammals. The allergy develops in response to a carbohydrate allergen, as opposed to most other food allergies, which are in response to a protein. The reaction is delayed by 3 to 6 hours after ingestion of meat (usually with a high fat content). Gelatin consumption (derived from beef or pork) may also cause allergic symptoms, and in rare cases, patients may react to large portions of high-fat dairy products or other meat by-products. Patients who develop the meat allergy have previously been able to eat meat with no problem. It is not yet known what predisposes some patients to develop this allergy.

History

Researchers at the Universities of Virginia and North Carolina have been studying patients with allergic reactions to meat. In 2011, they were able to demonstrate that patients with allergic reactions to meat had high levels of both IgE antibodies to α-gal and IgE antibodies to proteins derived from the lone star tick. The **lone star tick** *(Amblyomma americanum)* is a tick widely distributed throughout the southeastern and eastern Atlantic coast of the United States as far north as Maine. It transmits ehrlichiosis, tularemia , and causes STARI. The tick is aggressive and will actually seek out humans to bite, with the nymph and the adult females being the most aggressive transmitters of disease. The adult female is distinguished by a white dot (lone star) on her back. The saliva from this tick can be irritating, but redness and discomfort at a bite site does not necessarily indicate infection, nor does it necessarily indicate acquisition of α-gal allergy. All life stages of the lone star tick, including the larvae, have the potential to sensitize a susceptible person to the alpha-gal allergen.

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Symptoms

Patients will often awaken in the middle of the night (3 to 6 hours after eating meat) with severe itching, redness and hives over their entire body. Patients with more severe episodes may experience anaphylaxis, which is a multi-system allergic reaction that in severe cases can lead to death. Symptoms of anaphylaxis include hives or allergic swelling, abdominal cramping, vomiting, diarrhea, wheezing, shortness of breath, and loss of consciousness. A small subset of patients with this allergy will present with gastrointestinal symptoms only.

Patients who develop the meat allergy have previously been able to eat meat with no problem. It is not known what predisposes some patients to develop this allergy.

Treatment

If diagnosis of a meat allergy is suspected there is a test that can identify α-gal specific IgE in a patient's blood sample. Patients who may have been exposed to tick bites and develop allergic symptoms such as those described above should seek consultation with an experienced allergist.

17. Tick-Borne Triple Whammy

Adapted and used with permission from the East Hampton Star, May 28, 2014

As a general practitioner on eastern Long Island for 32 years, I have become habituated to tick-borne illnesses. I have had Lyme disease five times. In the summer of 2013, while my office in Wainscott saw 100 cases a week, a tick the size of a poppy seed almost killed me.

I attributed headaches on the Fourth of July to too little sleep. A different joint pain every day was from not getting enough exercise. Fits of fatigue were normal trying to accommodate the Hamptons' quadrupling population. After a week, the migratory and intermittent symptoms made it difficult to ignore the obvious Lyme.

I figured that I had been bitten by an infected **blacklegged (deer) tick** *(Ixodes scapularis)* nymph and did not get the characteristic circular or oval rash, erythema migrans. It is underappreciated that the primary culprit transmitting Lyme to humans, the blacklegged (deer) tick, has a two-year life cycle. Every spring each adult female can lay 3,000 eggs that hatch into larvae in the summer. The minuscule larvae are not infected and latch onto rodents, birds, pets or humans for their first blood meal. The larvae become infected if their hosts are infected.

In the Northeast, white-footed mice and other rodents are the primary reservoir for the bacterium that causes Lyme. After a blood meal, larvae molt into nymphs that need another blood meal before they can mature into adults. In endemic areas, 25 percent of the nymphs may be infected, and 50 percent of the adults. Female ticks, not males, transmit infections.

Knowing that many blood tests for Lyme are negative, I was glad that my antibodies were elevated. When I started taking amoxicillin and felt worse, I took consolation that this paradoxical accentuation of symptoms, a Herxheimer reaction, was common.

The second week of July was hot enough to soak my shirts with perspiration, but the clinic had air-conditioning. When patients commented on my profuse sweating and pallor, and suggested that I see a doctor, I reassured them that I had Lyme disease. Then I became too weak to work, losing a pound a day. One evening my wife asked why I put spoons in the refrigerator.

In addition to Lyme, my office also saw three to five cases of ehrlichiosis and anaplasmosis every week, from bacteria that infect white blood cells, and babesiosis, a parasite that infects red blood cells, both from blacklegged (deer) ticks. **Lone star ticks** (*Amblyomma americanum*) can also carry ehrlichiosis. Unlike Lyme, where it can take weeks or months to run out of excuses, people with anaplasmosis, ehrlichiosis, and babesiosis are acutely ill and need to be treated promptly. Rocky Mountain spotted fever also presents itself with high fevers and rash, but it is much less common and comes from the **American dog tick** (*Dermacentor variabilis*).

When a second blood test showed a drop in my white blood cells that made me susceptible to infections, low platelets that increased my risk of bleeding, and elevated liver enzymes, I recognized the stamp of ehrlichiosis. I started taking doxycycline, which covered Lyme and ehrlichiosis. But I was confined to my living room, sweating in front of a fan, writing a short list of things I wanted to do before dying.

As a physician with an inflamed imagination, I rivaled my most hypochondriacal patients, blithering with alarm. After 16 days the headache behind my left eye became so severe I thought I had a brain tumor. Bleeding gums when I brushed my teeth fueled worries of leukemia. Afraid of picking up another infection in the emergency room, I went to Stony Brook Southampton Hospital's lab, which is experienced in all tick-borne diseases.

I cried when the lab called and said that there were intracellular ring forms in my red blood cells. I had three tick-borne diseases at the same time: Lyme, ehrlichiosis, and babesiosis. Babesiosis is similar to malaria and required two additional medicines, atovaquone and azithromycin.

My headache, vanishing 12 hours after taking the first dose of the new medicines, reminded me of an old adage, "There is no greater pleasure than the cessation of pain." Although I had to take the medicines for babesiosis for ten days, in addition to doxycycline for four weeks, I recovered enough to get back to work by the end of the month. I was lucky. (There is not enough space here to address chronic Lyme, or the origin of eastern Long Island's tick-borne disease endemic. We currently treat Lyme disease with three weeks of doxycycline.)

After treating tick-borne diseases for a quarter-century, I am impressed that most patients with Lyme have been easy to diagnose and treat, especially when you listen to family members or co-workers who say, "I know what you have. You're crazy! Every day you complain about a different ache and pain."

Because of the epidemic of tick-borne diseases, the Centers for Disease Control and Prevention recommends a prophylaxis of one or two days of doxycycline for patients bitten by an engorged tick. With the exception of babesiosis, doxycycline helps prevent all known tick-borne diseases on Long Island, including *B. miyamotoi*, a new spirochete in deer ticks. There is no prophylaxis for children under the age of 8 or 9 years old — doxycycline may permanently stain their teeth.

Anyone who is acutely ill with high fevers and sweats should go to the emergency room, where preliminary blood tests are available within an hour. Anaplasmosis, babesiosis, ehrlichiosis and Rocky Mountain spotted fever can be life-threatening.

Fully recovered, I am encouraged by the recent push for a Lyme vaccine, and better diagnostic tests. In the meantime, I am lengthening my short list, and checking for ticks.

Beware of nymphs!

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18. Prevention Strategies

Outdoor Activity

Avoid areas where ticks are present: tall grasses, sides of paths, woods, and shady areas under trees. Ticks love tall grass and moisture-rich environments. Let your grass get a little brown! Ticks don't fly or drop from trees. They climb tall grasses or shrubs and wait for you or an animal to brush against them. Then they'll crawl on you and find a place to attach for a blood meal.

Tick diseases can be transmitted in as little as 15 minutes, so never wait to remove a tick!

Clothing

When outdoors, always wear long pants and tuck the cuffs into your socks. Use duct tape with the sticky side out as a barrier around your socks and pants. Ticks will crawl up and get stuck on the duct tape. Also, carry a lint roller and use it to capture ticks that are crawling on your clothing. Wear light colored clothing so that ticks are more visible. Consider wearing two pairs of socks as a barrier – ticks can crawl through a single open weave. Smooth materials such as windbreakers are harder for ticks to grab onto and are preferable to a knit fabric.

Tick repellents that contain permethrin are meant to be sprayed onto clothing. Spray the clothes in a well-ventilated area and let dry before putting on. One application is usually good for 8-10 washings. Spray permethrin monthly on your shoes. Do not apply permethrin directly onto your skin!

Ticks are very intolerant of being dried out. After being outdoors, place your clothes directly into the dryer for at least 15 minutes on high heat to kill any ticks that may be present. While your clothing is in the dryer, take a shower to wash off any unattached ticks, and then do a thorough "tick check." (A shower will not dislodge any ticks that have already latched on.) Then wash your clothes and dry them as you normally would.

Clothing and camping equipment that is pre-treated with permethrin is available at sporting goods retailers as well as from work-wear clothing manufacturers. If you spend a lot of time in areas where ticks are present, either through your employment or recreation, this might be a solution for you. The repellent impregnated in the clothing fibers will last through more than fifty wash cycles. It is also possible to send your clothing away to be treated. Check online or call our Resource Center "Help Line" to find out about these resources.

Tick Checks

Tick checks are most effective when done twice a day, in the morning and in the evening. And, of course, right after coming in from the outside after hiking or gardening. Please check your children thoroughly. Ticks like to hide in warm, moist areas on the body. Pay particular attention to behind the knees, in the groin area, inside the belly button, around the waistband, armpits, behind the ears and on your head. Ticks crawl up.

Ticks will be active all year long depending on the temperature. It is important to remember that any time the temperature is 40 degrees and over, you need to do tick checks. Do not use petroleum jelly, gasoline, a lit match or anything that will agitate the tick and cause it to regurgitate bacteria into you. Use fine tipped tweezers. (see "Tick Removal")

Your Skin

Insect repellents that contain DEET are very effective when applied to the arms, legs, and around the neck. Do not use any repellent over wide areas of the body as it can be absorbed, causing toxicity. Do not use a product that contains more than 30% DEET. The concentration of a bug repellent is related only to how long the protection will last, not how effective it is at keeping bugs off your skin. Usually 20-30% DEET can provide a full day's protection.

Naturally-based repellents contain ingredients such as Oil of Lemon Eucalyptus, Picaridin, IR 3535. Always follow the instructions on the label before using any type of repellent. Oil of Lemon Eucalyptus is not recommended for children under the age of three. An analysis of the effectiveness of tick repellents can be obtained by calling our Resource Center "Help Line."

Property

Remove woodpiles, rock walls, birdbaths and feeders since these attract tick-carrying animals (mice, chipmunks, birds) that will drop ticks in your yard. Mice harbor the disease-causing bacteria and carry the ticks that are most infectious, so eliminating mice from your property is essential in reducing the population of infected ticks. Preventing deer from entering your property by erecting tall fences can be an effective prophylactic measure. A three-foot woodchip border around your yard helps prevent the spread of ticks. Consider having more wood chips than grass in your yard, and reducing shady areas. Children's play areas should be in full sun whenever possible.

Pets

Speak to your veterinarian for advice on the most up-to-date prevention measures. Often multiple layers of protection are required. Dogs are especially attractive targets for ticks and are very susceptible to tick bites and tick-borne diseases. Vaccines are not available for all the tick-borne diseases that dogs can get, and they don't keep the dogs from bringing ticks into your home. For these reasons, it's important to use a tick preventive product on your dog. Keep pets out of your bed!

Tick bites on dogs may be hard to detect. Check your pets daily for ticks, especially after they spend time outdoors. If you find a tick on your dog, remove it right away. Signs of tick-borne disease may not appear for 21 days or longer after a tick bite, so watch your dog closely for changes in behavior or appetite if you suspect that your pet has been bitten by a tick. Ask your veterinarian to conduct a tick check at each exam.

A pesticide product that kills ticks is known as an acaricide. Acaricides that can be used on dogs include dusts, impregnated collars, sprays, or topical treatments. Some acaricides kill the tick on contact. Others may be absorbed into the bloodstream of a dog and kill ticks that attach and feed. Using an acaricide can help to reduce the number of ticks in the environment and prevent tick-borne diseases. Remember, tick bites in dogs can cause a painful wound and may become infected, and it's possible for a dog to become infected with more than one disease. It will depend on the type of tick, which diseases it may be carrying (if any), and how quickly a product kills the feeding tick. Examples of topically applied products: fipronil, permethrin, amitraz.

Cats are extremely sensitive to a variety of chemicals. Do not apply any acaricides or repellents to your cats without first consulting your veterinarian!

Final Tips and Reminders

Do not let a fear of ticks ruin your summer fun! Use common sense: avoid tick-infested areas, use repellent, check for ticks often, and consider having your property sprayed.

Lugols iodine is effective as a topical treatment after a tick bite. It kills most germs and helps control itching. Apply up to six times a day for several days after a bite.

I advise patients to avoid eating beef and pork for three weeks after a lone star tick bite. It may help reduce susceptibility to alpha-gal, the meat allergy.

Could a vaccine be the ultimate in prevention? In my opinion that would be difficult, as a vaccine would need to cover all 13 strains of Lyme, multiple viruses, *Babesia* parasites, and other bacterial infections, in order to be totally protective.

Visit our website, EastEndTickResource.org for regular updates and news.

No product endorsement is suggested or implied. Products are listed as examples only and are not all-inclusive. Always consult with your medical provider, or veterinarian, for personalized medical advice.

Gerald T. Simons, PA-C, MPAS, DFAAPA
Clinical Assistant Professor
Stony Brook Southampton,
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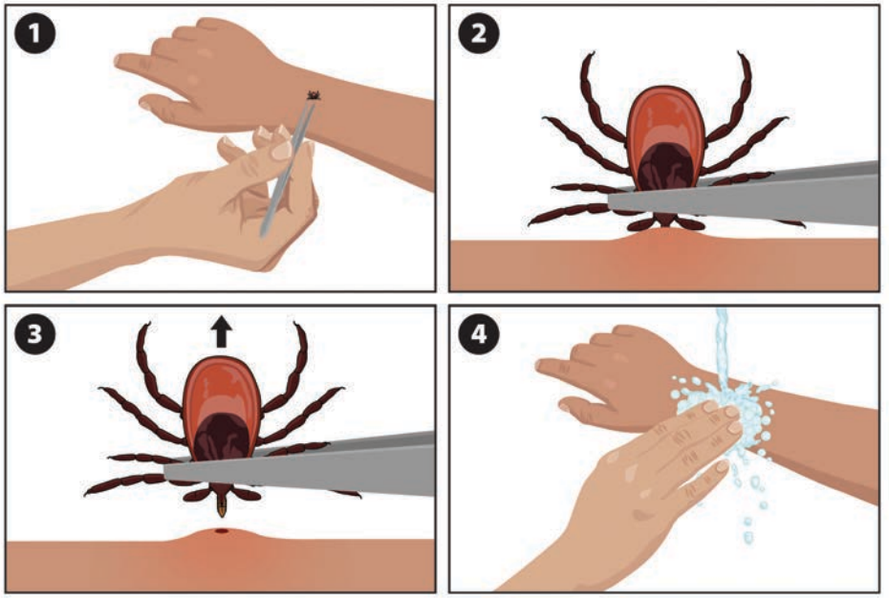
19. Tick Removal

Don't ever wait to remove a tick! But before you do, consider taking a clear and in-focus picture with your phone to help with identification of the species of tick once it is removed.

Do not use petroleum jelly, gasoline, nail polish, a lit match, or other old-fashioned tick removal methods. You may annoy the tick and cause it to regurgitate bacteria into your body.

Pointy tweezers are the best tool to use, like the ones in our free tick removal kit.

Place tweezers as close to the skin as possible. Try to grab the tick's head, or just above it.



Pull upward with a slow and steady motion. Don't twist or jerk the tick. Try to avoid breaking the tick, but don't be alarmed if the head breaks off and remains in the skin. It will gradually work its way out.

Disinfect the bite area with rubbing alcohol, iodine, or soap and water. Wash your hands.

Consider saving the tick in a baggie or pill vial containing alcohol. Label the container with the date the tick was removed and the location of the tick bite on the body. Identifying the type of tick will help with disease diagnosis if symptoms later develop.

Pay attention to your health for a few weeks after a tick bite. See your health care provider if you develop a rash, and/or flu-like symptoms such as a fever, headache, muscle aches, fatigue or swollen joints.

20. Treating Your Outdoor Landscapes for Ticks

What is Natural?

Should you use an organic or synthetic insecticide?

One of the most frequent questions consumers ask us relates to the use of organic versus synthetic insecticides. Many customers, being environmentally conscious, want to protect themselves and their families from tick-borne diseases, but at the same time, want to do as little harm to the environment as possible. As in all things, there are choices to be made. Before you can make those choices you need to understand the facts. Here are some things to consider:

People assume that natural or organic pesticides are healthier, safer, and better for the environment than synthetic products. In fact, all pesticides are toxic. The suffix "cide" is Latin for killer (pesticide refers to a killer of pests). Pesticides that target ticks are called acaricides. Natural pesticides are toxic substances. Some naturally-sourced pesticides are deadlier than synthetics. For example, nicotine – which is naturally produced by species such as tobacco – helps plants defend themselves from insects but is also hazardous to other organisms, such as people. Nicotine can be deadly, even in small quantities, despite being "natural."

Natural and synthetic pesticides are both effective, but they differ in the way they work, especially in the length of time it takes to see results. We are often asked by clients to "use the strong stuff" (meaning a synthetic pesticide) after they have been frustrated by the sight of ticks on their property despite having been sprayed with a "natural" pesticide. Natural or organic pesticides both work if given enough time and patience. This sometimes requires more visits and multiple applications. Synthetic pesticides act quickly because they are designed to disrupt specific biological functions within the tick. Many customers want effective results quickly. For them, a synthetic might be the better choice.

What choice should you make?

Both natural and synthetic pesticides can be effective in controlling ticks.

What do we recommend?

Our goal as tick-control professionals is to provide the best protection from serious tick-borne diseases and conditions (i.e. Lyme disease, anaplasmosis, ehrlichiosis, Rocky Mountain spotted fever, alpha-gal meat allergy and others) as is possible. We encourage clients to choose our synthetic option because it is specific, effective, long-lasting and naturally biodegrades in the environment.

Organic products do not have residual effects on ticks. They will only kill ticks that are present.

In addition, we understand how climate change has upset our environment causing rapid changes in how ticks behave and the threat they pose to you. That is why we have developed a new granular tick-control program for the months of December through March. Ticks are now a year-round threat because they are actively questing for blood when the temperature is above 40°. There is no "winter kill" of ticks. Tick Shield, a clay-coated granular acaricide program, not only kills ticks during the winter months but stays in place to kill emerging ticks in leaf litter and mulch when spring arrives. No matter which method you choose, you can rest assured that we use all our products with caution and respect for our magnificent natural environment.

Brian Kelly, President
East End Tick & Mosquito Control
Southampton, East Hampton, Southold
www.tickcontrol.com

21. Tick Reference Table

Tick Species	Pathogen	Type of Infection	Disease
Blacklegged Tick *(Ixodes scapularis)*	*Borrelia burgdorferi*	Bacteria	Lyme disease
	Anaplasma phagocytophilum	Bacteria	Anaplasmosis
	Borrelia miyamotoi	Bacteria	Borrelia miyamotoi disease
	Babesia microti	Protozoan Parasite	Babesiosis
	Powassan virus	Virus	Powassan virus disease
Lone Star Tick *(Amblyomma americanum)*	*Ehrlichia chaffeensis / Ehrlichia ewingii*	Bacteria	Ehrlichiosis
	Francisella tularensis	Bacteria	Tularemia
	Heartland virus	Virus	Heartland virus disease
	Bourbon virus	Virus	Bourbon virus disease
	Unknown	Unknown	Southern tick-associated rash illness (STARI)
American Dog Tick *(Dermacentor variabilis)*	*Francisella tularensis*	Bacteria	Tularemia
	Rickettsia rickettsii	Bacteria	Rocky Mountain spotted fever
Groundhog Tick *(Ixodes cookei)*	*Powassan virus*	Virus	Powassan virus disease

Courtesy of Scott R. Campbell, PhD
Suffolk County Department of Health Services

22. Resources

Help Line: (631) 726-TICK (8425)

Patient Navigator
Rebecca Young, RN, BSN

Our "Help Line" nurse, Rebecca Young, fields hundreds of telephone calls from the public each year. Callers receive expert advice on tick removal and identification, help understanding laboratory results, and when appropriate, referrals to physicians and other medical professionals. Rebecca is also a popular lecturer who goes out into the community to give educational talks on Lyme and tick disease. Calls to the Regional Tick-Borne Disease Resource Center originate from all over the Northeast, the U.S. and also internationally.

Helpful Websites

www.EastEndTickResource.org

www.CDC.gov/ticks/diseases

www.TickEncounter.org

www.SuffolkCountyny.gov/Departments/Health-Services/Public-Health/Preventive-Services/Arthropod-borne-Diseases/ticks

www.tickcontrol.com

Tick Removal Kits

Our Tick Removal Kits contain all you need to be prepared for a tick bite – pointy tweezers, magnifier, first-aid supplies, and a Tick ID Card – all packaged in a kit you can hang on your backpack or put in your pocket. These kits are provided free as a public health service.

You can request a Tick Removal Kit by contacting us at Karen.Wulffraat@stonybrookmedicine.edu or by calling our Resource Center "Help Line" at (631) 726-TICK. Please provide your mailing address.

23. Advisory

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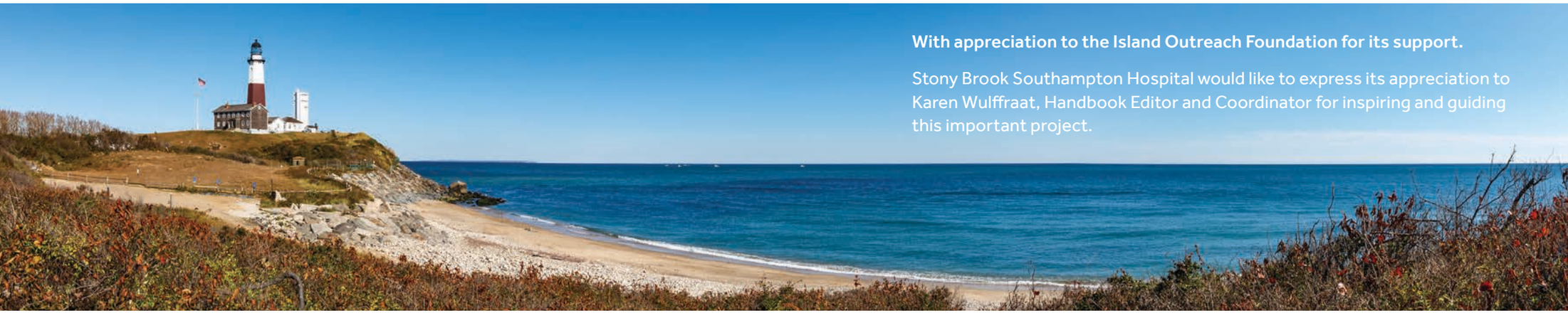

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Stony Brook Southampton Hospital would like to express its appreciation to Karen Wulffraat, Handbook Editor and Coordinator for inspiring and guiding this important project.

About the Regional Tick-Borne Disease Resource Center at Stony Brook Southampton Hospital

Since 2014, the Regional Tick-Borne Disease Resource Center has educated both the public and the medical community about the numerous tick-borne diseases prevalent on Long Island and in the Northeast. The Resource Center's popular tick disease "help line" receives as many as eight hundred calls a year from residents and visitors seeking information about ticks and the pathogens they carry, help with referrals to appropriate medical providers, information about testing, and prevention tips. The Center's educational outreach extends throughout Suffolk County bringing as many as forty-five separate educational lectures each year to libraries, civic organizations, local town governments, garden clubs, and schools. The Center also hosts full day medical symposia for physicians, inviting experts from prestigious medical research institutions to lecture on tick disease. This furthers its mission to promote collaboration among the local medical community, and helps to strengthen their ability to combat the epidemic of tick-borne disease.

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Hampton Bays, NY 11946
(631) 726-TICK (8425)
www.EastEndTickResource.org

Stony Brook Southampton Hospital