

Tick-Associated Diseases: Symptoms, Treatment and Prevention

Alice Anderson and Elizabeth Chaney

ABSTRACT

According to the Centers for Disease Control and Prevention (CDC), there are eleven tick-associated diseases prevalent in the United States. Most commonly diagnosed are Lyme disease, anaplasmosis (ehrlichiosis) and babesiosis, with Lyme disease being the most common vector-borne disease in the country. In southeastern states, studies have shown the prevalence of southern tick-associated rash illness (STARI), which is similar to Lyme disease. Healthy People 2010's 14-8 objective is to reduce Lyme disease, with a "44 percent improvement" by the year 2010. A key component for success of this objective is to provide the public with important information that can yield early detection or prevention against tick-associated disease, such as Lyme disease. Additionally, awareness of signs, symptoms and how to protect oneself from tick-borne illnesses is critical for individuals living in regions where these diseases are most prevalent. Therefore, the purpose of this paper is twofold: (1) to convey the signs, symptoms, and clinical tests for early detection of Lyme disease and STARI, and (2) to provide guidelines and discussion of some treatment controversies for health educators to utilize in educating the public on personal protection against tick-associated illnesses.

Anderson A, Chaney E. Tick-associated diseases: symptoms, treatment and prevention. *Am J Health Educ.* 2009; 40(3):183-189. This paper was submitted to the Journal on October 17, 2008, revised and accepted for publication on February 24, 2009.

INTRODUCTION

According to the Centers for Disease Control and Prevention (CDC),¹ there are 11 tick-associated diseases prevalent in the United States. The most commonly diagnosed diseases are Lyme disease, anaplasmosis (ehrlichiosis) and babesiosis, with Lyme disease being the most common vector-borne disease in the country. In 2007, 27,444 cases of Lyme disease were reported, which resulted in a national average of 9.1 cases per 100,000 persons. The states with the most reported cases are Connecticut (incidence rate = 87.3), Delaware (incidence rate = 82.7), New Hampshire (incidence rate = 68.1), Massachusetts (incidence rate = 46.3)

and Maryland (incidence rate = 45.8).² Approximately 20,000 new cases are reported every year, and the northeastern, north central, and Mid-Atlantic states continue to exceed the average reported number.³ In the southeastern states, studies have shown the prevalence of a condition known as southern tick-associated rash illness (STARI), which is similar to Lyme disease.⁴ Additionally, recent reports have shown an increasing number of Ixodid ticks in the Midwest and in extreme northeastern states.⁵ Although these states are most notably the ones with the higher incidence rates of Lyme disease and STARI, individuals residing in all states should be aware of and know how to protect

themselves from these diseases.

Bloodstream infections, such as Lyme disease and other tick-borne illnesses, significantly impact the direct and indirect costs of health care. According to cost data presented by *Healthy People 2010*, these infections add approximately \$3,517 to hospital bills for the infected patient. For Lyme

Alice Anderson is an assistant professor in the Department of Health Education and Promotion at East Carolina University, Greenville, NC 27858; E-mail: andersonal@ecu.edu. Elizabeth Chaney is an assistant professor in the Department of Health Education and Promotion at East Carolina University, Greenville, NC 27858.



disease cases, if the illness is diagnosed in the early stages, it amounts to about \$174 in direct costs for medical treatment. However, with a delayed diagnosis of the illness, costs incurred can range from \$2,228 to \$6,724 per patient, in the first year of treatment.⁶ Clearly, an early diagnosis is essential, for many reasons, but in a time when health care costs are soaring for most Americans, it is critical for individuals to understand how to recognize the signs and symptoms of these tick-associated diseases.

Lyme disease is a multisystem disorder, “caused by the spirochete *Borrelia burgdorferi* and is transmitted to humans by the bite of infected blacklegged ticks.”^{3(p.573)} Symptoms of the disease can range from fever to sustained heart and nervous system problems. STARI, on the other hand, is similar to Lyme disease, and has been linked to bites from *Amblyomma americanum* (lone star) ticks living in southeastern states, but researchers have failed to provide evidence that STARI is more than a self-limiting skin condition.⁴ Either way, the rising trends of these types of bloodstream infections, regardless of severity level, indicate the urgency for better public education on signs, symptoms and personal protection. Additionally, *Healthy People 2010*'s 14-8 objective for the nation is to reduce Lyme disease, with a “44 percent improvement” by the year 2010.⁶ A key component for success of this objective is to relay important information that can yield early detection or prevention against Lyme disease. Therefore, the purpose of this paper is twofold: (1) to convey the signs, symptoms, and clinical tests for early detection of Lyme disease and STARI, and (2) to provide guidelines and discussion of some treatment controversies for health educators to utilize in educating the public on personal protection against tick-associated illnesses.

SYMPTOMS/CLINICAL TESTS

The CDC recognizes that early detection of Lyme disease is “important to resolve current signs and symptoms, eliminate *B. burgdorferi* infection, and prevent later complications.”^{1(p.22)} In most individuals, diagnosed with Lyme disease (70-80%), a

red rash, that tends to expand across the surface of the skin, appears within 2-32 days after the tick is removed or detached. The site of the tick bite, where the rash originates, is referred to as the primary erythema migrans (EM). The rash serves as a main clinical marker for early detection; however, the rash may go unnoticed in some. According to the CDC, to be considered as early disease, the rash should be > 5 cm in diameter, and it must be 2.5 inches or greater in diameter to be considered a surveillance case; however, it is important to note that the surveillance measurements should not be used to diagnose cases.^{1,7} These measurements can result in problems with diagnosis and treatment, and is the foundation of one, out of several, controversies that private Lyme disease foundations cite, regarding treatment issues.⁸

If the rash is spreading at a rate of ½ to ¾ inches each day, then it is a sign for early Lyme disease; however, a hypersensitivity reaction can occur with a tick or insect bite that can disappear within 24-48 hours. Rashes, from tick-borne illnesses, can occur anywhere on the body, and are typically red, with a defined center. In approximately 5% of cases, the rash can be accompanied by swelling and scabbing. Additionally, symptoms such as muscle pain, fever, fatigue, headache, chills and neck stiffness occur in about 80% of cases.¹

The symptoms of tick-borne illnesses can worsen as time progresses. Days or weeks after the initial tick bite occurs, muscle pain, debilitating fatigue, and cardiac and neurological problems can arise. In 10-15% of cases, neurological problems occur, due to lack of early detection.¹ The most common problems, as a result, are Bell's palsy, meningitis and radiculoneuropathy (pain in affected nerves).¹ Four to 10 percent of untreated patients experience Lyme carditis, which involves intermittent atrioventricular heart block. Lyme arthritis (chronic arthritis), joint swelling and numbness within extremities can occur, as well. It is important to note that symptoms are case-specific, and can vary in severity; however, there is no way of knowing in advance how an

individual will react to exposure to the disease. Therefore, it is imperative that health educators communicate risks and how to detect and prevent these types of diseases to the public.¹

Erythema migrans (EM) are also present with bites of *A. americanum* ticks, and have been reported in cases of STARI in several southeastern states.⁹ Although the effects and natural progression of STARI are not completely clear, it is imperative that health educators do not exclude the possibility of chronic conditions, associated with this illness, when communicating risks to the public.

Clinical tests are needed to confirm a Lyme disease case and if an individual suspects Lyme disease (or any tick-associated illness), a physician should be consulted. In some cases, an EM rash may not be present; therefore, the disease may be difficult to diagnose; however, antibodies to spirochetes can be detected through a blood test. Physicians can detect the antibodies to the bacteria that cause Lyme disease 3-4 weeks after the onset. A time span between initial tick contact and test results can be ineffective in early detection. Therefore, many public health organizations suggest newer tests, such as a two-stage serological test, which is a sensitive screening method for Lyme disease.¹

Typical treatment measures for a Lyme disease case involve one of several types of antibiotics. Usually, the patient is prescribed an antibiotic (such as tetracyclines, most penicillins and some cephalosporins) for approximately 14-28 days; however, a doctor may want the patient to partake in a longer treatment plan, if necessary.¹ According to the CDC, “patients treated in the early stages of the disease usually recover rapidly and completely with no subsequent complications. While a few patients (<10%) fail to respond to antibiotic therapy, retreatment is rarely needed.”^{1(p.30)} However, chronic symptoms result in controversial treatment times. These symptoms are termed Chronic Lyme Disease (CLD), which is a controversial term that is used to describe a wide array of patients with symptoms of chronic

fatigue, pain and neurocognitive disorders.¹⁰ According to treatment trials of CLD, conducted by the National Institutes of Health (NIH), no evidence has shown to support the existence of CLD from present or past diagnoses of Lyme Disease; however, the severe symptoms that some possess (fatigue, pain, neurocognitive problems) are very real for many people who have suffered from Lyme Disease or post Lyme disease syndrome (PLDS). Also, the NIH trials do not support extended antibiotic treatments for patients with symptoms of CLD, as the result may be potentially dangerous for patients, who use antibiotics without a bacterial infection present. This controversy has spurred several Lyme Disease Associations to emphasize the importance of including physician education for chronic Lyme treatment (in some form), since in their experience advanced cases are often the result of misdiagnosis or under-treatment of tick bites.⁸ However, H. M. Feder reports that the recommended extended antibiotic treatment has proven not to be effective, as shown through the NIH trials.¹¹ This information is particularly important for health educators, who are educating the public on Lyme disease, as the controversial CLD debate and extended antibiotic treatment is a topic that patients should discuss with their physician, should a tick bite and subsequent CLD symptoms occur. Patients need to understand that NIH placebo trials do not support the use of extended antibiotic treatments in the event of CLD symptoms; however, these symptoms have been cited as debilitating for many individuals.

TICK BIOLOGY AND PREVENTION

Prevention of exposure to ticks is the first line of defense against tick borne disease. In Northeastern states, where the Lyme disease tick (*Ixodes scapularis*) is a common pest, exposure and infection, year after year, is common, especially since immunity does not develop after infection. Ticks, their animal hosts (deer and white-footed mice) and backyard habitats next to woodlots are common in this part of the United States. Children and adults using outdoor

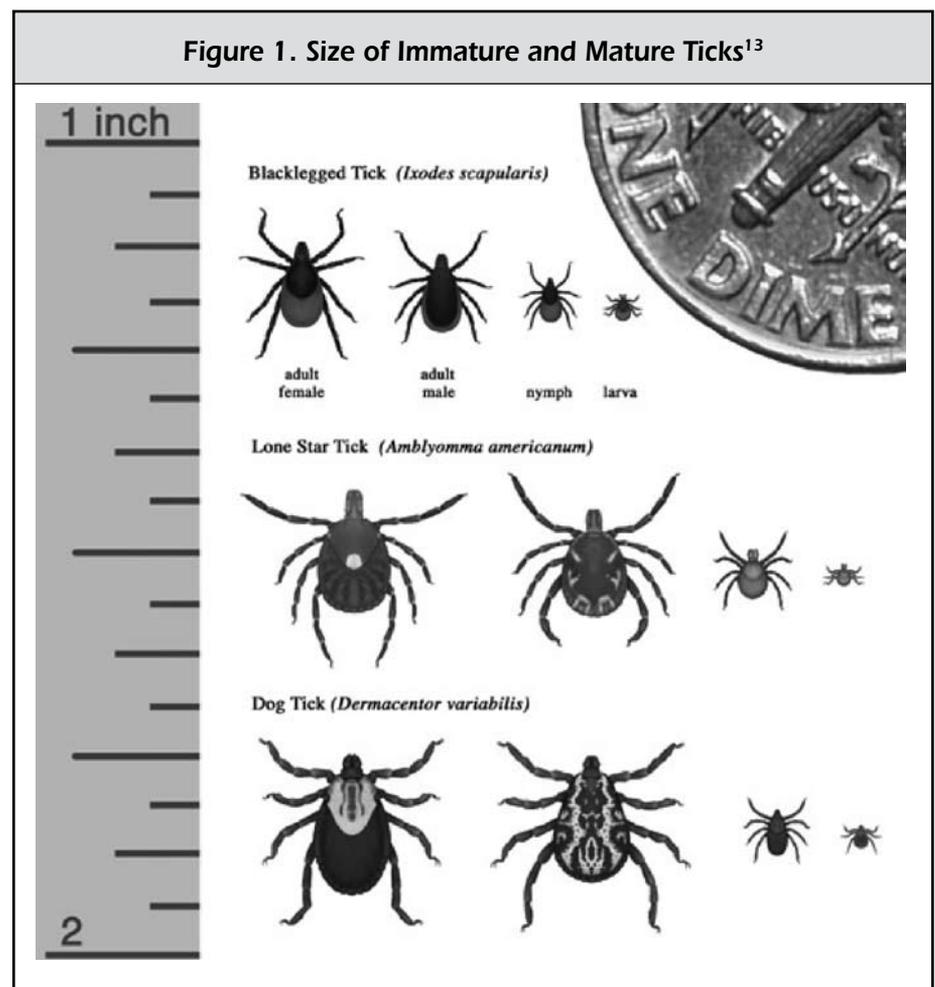
recreation areas and outdoor play areas are especially vulnerable to exposure. Exposure prevention is not always practical and tick-bite victims are often treated with antibiotics for infection prevention.

Tick exposure is also common in Southeastern states, especially in recreational areas, such as state parks. Here, the “black legged tick” *Ixodes scapularis* is found, but it is thought that the immature ticks, which are typically the source of infection, do not usually bite humans. Other recent reports have indicated that ticks and tick borne diseases are spreading in the U.S. and around the world.^{5,12} Disease risk in the Southeast, especially in coastal areas, may be more severe due to immature and adult ticks of *Amblyomma americanum* ticks, which are a very common occurrence in early spring and summer in the area. Figure 1, provided by the CDC,¹³ indicates the relative size of immature and adult ticks.

HOW TO EDUCATE THE PUBLIC ON PERSONAL PROTECTION

The “take-home” message for health educators, from the information presented in this article, is that educating the public on the signs, symptoms and tick-associated disease prevention is critical in helping meet the *Healthy People 2010*, 14-8 objective of reducing the incidence rates of Lyme disease. Awareness of other tick-borne disease potential and of the seasonal occurrence of tick species in different regions is also important for prevention education. The best defense against these diseases is to limit exposure to ticks, which can be maximized by more specific information for each region. The CDC’s Division of Vector-Borne Infectious Diseases¹⁴ provides simple tips for personal protections.

- Avoid tick-infested areas, such as wooded areas with tall grass and leaf litter.





- Be careful and take appropriate precautions in the summer months (May, June, July), as these are the peak times for transmitted tick-associated diseases, particularly Lyme disease.

- When walking through infested wooded areas, try to avoid contact with tall grasses and leaf litter.

- Talk to local health departments about what areas to avoid.

- To keep ticks off your skin, use repellent with 20-30% DEET on all exposed skin and clothing.

- Permethrin is a repellent that can kill ticks on contact; it is available for purchase at many outdoor equipment stores.

- Wear clothing that completely covers your skin and tuck your pant legs into shoes/boots to help keep your skin from becoming exposed.

- Check your clothes and exposed skin for ticks before going indoors. Inspect yourself for ticks once you disrobe and wash all clothing in hot water. Dry clothing for at least one hour on a hot setting.

- Perform daily checks for ticks after being outdoors; make sure to inspect all parts of your body.

- If you find a tick on your body, monitor the situation closely and be cognizant of the signs of a tick-associated disease. In addition, when removing the tick, it is important to use a set of fine-tipped tweezers to get a firm grasp and pull it away from the body. Wash area with warm, soapy water and monitor the area. Do not use nail polish, Vaseline, a match, etc. to remove the tick as this causes them to regurgitate body fluids that contain pathogens.¹⁴

- After removing the tick, disinfect the infested area with rubbing alcohol or a topical antibiotic.¹

- Save the tick for a reference, in case tested is needed. "A live tick can be placed in a crush proof container with a blade of grass to keep it alive (a sealable plastic bag also will work)."^{21(p.38)} DNA of dead ticks can be analyzed; therefore, store in 70-80% ethyl alcohol (rubbing alcohol) for testing purposes.¹

In addition to the information provided by the CDC, the Infectious Diseases Society of America provides a fact sheet to be used to educate the public on practical guidelines for diagnosis and treatment of Lyme disease. See Figure 2 for the fact sheet provided by the Infectious Diseases Society (<http://www.idsociety.org/lymediseasefacts.htm>).¹⁵ This information can be used to disseminate to the public for increased awareness and knowledge about Lyme disease.

Communicating health information to the public is most successful when multi-level interventions and outlets are utilized to present the information to the public.¹⁶ For example, a one-level approach, such as a media campaign, is less successful than coupling the media campaign with community-based programs and policy changes to support engagement in the preventive behavior changes. In this case, informing the public on ways to protect against tick bites, and ultimately tick-borne illnesses, should occur in various settings (school, community, worksite and health care settings) and should use multiple health communication approaches. As with any health education initiative, health communication should be audience-centered, meaning the needs of the public should be met and all educational approaches should be tested for appropriateness and effectiveness. The segments of the population in which the education is directed should provide insight into preferred channels and formats of educational delivery.¹⁶ Utilizing the communication process, as described by Freimuth, Linnan, and Potter,¹⁷ will help guide public health educators to communicate the information on tick-borne illnesses to the public more efficiently and effectively. In brief, the communication process involves the following:

- Analysis of the audience – in this step, the health educator should conduct a needs assessment and segment the audience based on a set of criteria (i.e. demographics, behaviors, attitudes, lifestyle). Prochaska's Stages of Change Model has been shown to be a successful model to use in determining the level of readiness to change; this may be beneficial in determining the types of messages to develop for segments of the population. For example, for audience

segments who are in the "precontemplation" stage for adhering to protective behaviors against tick born illnesses, messages should be geared toward increasing their awareness regarding tick born illnesses and the importance of protective behaviors.

- Developing the health message – In this step, the public health educator should develop clear, simple and positive messages of change for the segmented population. These messages should be pilot-tested for appropriateness and effectiveness.

- Identify credible sources of information – In this step, the health educator needs to identify sources of information that the audience deems credible. This may vary, depending on the segment of the population.

- Determine the channel for communicating the information to the audience – In this step, the health educator should collect data on what channels are preferred by the audience. This is incredibly important for successful health communication, and multiple channels may be utilized.¹⁷

Responsibility VII of the CHES Responsibilities and Competencies of Health Educators indicate that health educators should "communicate and advocate for health and health education."^{18(n.p.)} In doing so, it is important that health educators communicate risks and ways to protect against these risks, when it comes to the public's health. Tick-associated diseases are preventable when individuals understand personal protection tips.

Approximately 98% of Lyme disease cases are a result of the bite of a blacklegged tick and the majority of these cases are associated with individuals engaging in activities such as, yard work, recreational play and gardening. Ticks do not drop from trees or jump onto hosts; most grasp hosts that are passing by leaf litter, tall grassy areas, etc. Relaying this information, along with the personal protection tips, provided by CDC,¹⁴ health educators can help to reduce the incidence rates of tick-associated illnesses, particularly Lyme disease, which can lead to infection within joints, the nervous system and the heart, if left untreated.



Figure 2. Infectious Disease Society of America Fact Sheet on Lyme Disease^{15(n.p.)}

Frequently Asked Questions about Lyme Disease

The following answers are based on clinical Practice Guidelines on Lyme disease developed for the Infectious Diseases Society of America (IDSA) by a panel of researchers and medical doctors who treat patients for Lyme disease.

What is Lyme disease?

Lyme disease is caused by an infection with a type of bacterium called *Borrelia burgdorferi*, which is principally transmitted by the deer tick (*Ixodes scapularis*). The tick typically feeds on small mammals, birds and deer but may also feed on cats, dogs and humans. Research suggests the tick has to be attached to the skin for at least two days to transmit the Lyme bacteria.

How many people get Lyme disease every year?

About 20,000 Americans are reported with Lyme disease every year.

Are there are other illnesses transmitted by deer ticks?

Yes. Although less common than Lyme disease, HGA (human granulocytic anaplasmosis, formerly known as human granulocytic ehrlichiosis) and babesiosis are associated with deer ticks. However, as with Lyme disease, not all ticks carry these diseases. HGA is an acute illness caused by a bacterium called *Anaplasma phagocytophilum* and the most common symptoms are headache, fever, chills and muscle pain. Babesiosis is a parasitic infection that affects the red blood cells and also can cause viral-like symptoms. Babesiosis usually does not cause significant symptoms in healthy people. Severe babesiosis may occur in people who are elderly or have compromised immune symptoms. Treatment for HGA or babesiosis typically includes a short course of antibiotic therapy. However, most tick bites do not cause infection and babesiosis is only found in limited areas. While it is important to take measures to avoid getting bitten by a tick, many thousands of people are bitten every year and do not acquire any disease.

Is Lyme disease found everywhere in the United States?

Lyme disease has been reported in nearly all states, but more than 98 percent of all cases are found in Coastal New England and the Mid-Atlantic States, as well as Wisconsin, Minnesota and Northern California.

What are the symptoms of Lyme disease?

The great majority of people who are infected with Lyme disease develop a large (three inches or more) circular, red rash surrounding the site where a tick attached. They may also develop non-specific symptoms such as muscle and joint aches. Infection occurs from three to 30 (average 10) days after a tick bite, but most people do not recall the bite because the ticks are small and the bite usually is not itchy or painful. Less commonly, Lyme disease can cause arthritis, facial paralysis and other neurological problems or an abnormally slow heart rate. While patients with Lyme disease may have muscle and joint aches, these symptoms usually accompany objective signs like the rash or arthritis and virtually never are the only symptoms in persons with Lyme disease who have longer-term complaints. Not everybody who gets Lyme disease will notice the characteristic circular red rash. Also, many diseases and conditions other than Lyme disease can cause similar symptoms.

How is Lyme disease diagnosed?

When the characteristic skin rash is present, Lyme disease is diagnosed clinically based on visual inspection of the patient by the doctor. For all other manifestations, Lyme disease is diagnosed based on the patient's history and the doctor's examination of the patient in conjunction with a positive laboratory test result. The most commonly used laboratory test is a blood test which determines whether the patient has developed antibodies to the *Borrelia burgdorferi* bacteria.

How is Lyme disease treated?

Treatment usually involves 10-28 days of oral antibiotics and is highly effective. When Lyme disease is diagnosed and treated quickly, 95 percent of people are cured within a few weeks of treatment.

What about the other 5 percent?

The number of people who continue to have problems is very small. Most likely, their symptoms are related to one of the following:

- They never had Lyme disease at all and received the wrong treatment for their illness
- They had Lyme disease and another infection simultaneously and were only treated for Lyme disease
- They contracted a new illness unrelated to Lyme disease but with similar symptoms
- They have again been bitten by the tick that causes Lyme disease

Continues on next page



What if patients with Lyme disease who have the characteristic rash are not diagnosed and treated?

In that circumstance the rash will resolve within about one month. However, over the course of the next months slightly more than half of such individuals will go on to develop a type of arthritis affecting the knee or other large joint, and about 10 percent to 20 percent will develop neurological problems or an abnormally slow heart rate. These patients may require up to 28 days of antibiotic therapy.

Is treatment ever prescribed for someone who has been bitten by a tick, but does not have symptoms?

Routine antibiotic administration is not recommended for people who have been bitten by a tick and have no symptoms. However, one dose of an antibiotic is recommended in cases in which all four of the following are true:

- The tick can be identified as an *Ixodes scapularis* deer tick and has been attached for 36 hours or more
- Preventive treatment can be started within 72 hours of removal of the tick
- The local rate of infection of these ticks with *Borrelia burgdorferi* bacteria is 20 percent or more
- There are no contraindications to the use of the antibiotic

Can't Lyme disease sometimes become an ongoing problem?

In rare cases, people who have been diagnosed with Lyme disease and properly treated have lingering symptoms, typically generalized pain, joint pain and fatigue. These symptoms have been interpreted by some to suggest the presence of chronic *Borrelia burgdorferi* infection.

However, an extensive review of scientifically rigorous studies and papers available to date, has determined that there is no convincing biologic evidence to support a diagnosis of chronic Lyme disease after completion of the recommended treatment. There is no doubt that patients with persistent symptoms are suffering, but many report non-specific symptoms that also are associated with a number of other medical conditions. To be certain they receive the proper medical care, people who continue to have symptoms that persist after appropriate antibiotic treatment for Lyme disease should talk to their physicians about whether the original diagnosis of Lyme disease was accurate or if they may have a different or new illness.

But some people are receiving long-term therapy for Lyme disease and say it's helping. Couldn't this be true?

Long-term therapy for so-called chronic Lyme disease can involve weeks, months and even years of intravenous antibiotics. Although some people may feel better, it doesn't prove that the antibiotic cured or suppressed infection. Sometimes, the belief that a treatment is helping can be enough to make people feel better. This is called the placebo effect and it is a well-documented medical phenomenon. Antibiotics also have anti-inflammatory effects that may help alleviate certain symptoms. Or, in some cases, patients may have another infectious disease that is responsive to antibiotics.

In more than 20 years there has not been one scientifically valid study published in the peer-reviewed medical literature that proves that the benefit of long-term antibiotic treatment outweighs the risk.

What's the harm in trying the therapy?

Long-term antibiotic therapy for so-called chronic Lyme disease is not only unproven, it may in fact be dangerous. For instance, it may lead to complications related to delivery of the medicine, such as infections of the blood stream as a result of long-term intravenous administration of antibiotics. Also, use of certain antibiotics can lead to a potentially severe and sometimes deadly infection of the bowel caused by a type of bacteria called *Clostridium difficile*. Further, long-term antibiotic therapy may foster the development of drug-resistant superbugs that are difficult to treat.

What are the Clinical Practice Guidelines on Lyme disease?

The Clinical Practice Guidelines were developed by an expert panel according to widely accepted criteria for evidence-based medicine and contain updated information on the epidemiology, clinical features, diagnosis, prevention and treatment of Lyme disease in the United States. The Infectious Diseases Society of America (IDSA) believes that no guidelines can replace a doctor's judgment, but these guidelines are the best information science can provide to the wide range of physicians who might treat a patient with Lyme disease – from the family doctor or pediatrician to the specialist. Nearly 400 references of papers and studies are cited in the guidelines and many, many more that did not meet the scientific standard were reviewed.

Now available online, the 2006 Guidelines were published in the Nov. 1, 2006 edition of the journal, *Clinical Infectious Diseases*.

Who served on the IDSA guidelines committee?

The singular mission of the IDSA guidelines panel is to provide the highest quality standards for treating patients. IDSA has criteria for its guidelines panel membership: this panel included both researchers and physicians who treat patients with Lyme disease. In addition, input from a variety of sources was welcomed and evaluated.

Note: The above Fact Sheet is used with permission, copyright Infectious Diseases Society of America.



REFERENCES

1. Stafford KC. Tick Management Handbook. 2007. Available at: <http://www.cdc.gov/ncidod/dvbid/lyme/resources/handbook.pdf>. Accessed October 16, 2008.
2. Centers for Disease Control and Prevention. Division of Vector-Borne Infectious Diseases: Lyme Disease. 2007. Available at: http://www.cdc.gov/ncidod/dvbid/lyme/ld_rptdLyme-CasesbyState.htm. Accessed October 16, 2008.
3. Centers for Disease Control and Prevention. Lyme Disease – United States, 2003-2005. *MMWR Morb Mortal Wkly Rep* [serial online]. 2007; 56(23): 573-576. Available at: <http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5623a1.htm>. Accessed October 16, 2008.
4. Burkot TR, Mullen GR, Anderson R, Schneider BS, Happ CM, Zeidner, NS. *Borrelia lonestari* DNA in adult *Amblyomma americanum* ticks, Alabama. *Emerging Infect Dis*. 2001; 7:471-473.
5. Mixon, TR., Campbell SR, Gill JS, Ginsberg H, Reichard MV, Schulze TL, Dasch GA, Prevalence of *Ehrlichia*, *Borrelia*, and *Rickettsial* agents in *Amblyomma americanum* (Acari: Ixodidae) collected from nine states. *J Med Entomol*. 2006; 43(6):1261-1268.
6. U.S. Department of Health and Human Services. Healthy people 2010 (conference ed, in 2 vols). Washington, D.C.: U.S. Department of Health and Human Services; 2000. Available at <http://www.healthypeople.gov>.
7. Centers for Disease Control and Prevention. Division of Vector-Borne Infectious Diseases: Lyme Disease Symptoms. Available at: http://www.cdc.gov/ncidod/dvbid/lyme/ld_humandisease_symptoms.htm. Accessed October 16, 2008.
8. International Lyme and Associated Diseases Society. International Lyme and Associated Diseases Society (ILADS) Announces Physician Training Program. 2008. Available at: <http://www.ilads.org/files/2008/press-9-30.pdf>. Accessed October 16, 2008.
9. Kirkland KB, Klimbo TB, Meriwether RA, Schriefer M, Levin M, Levine J, et al. Erythema migrans-like rash illness at a camp in North Carolina: a new tick-borne disease? *Arch Intern Med*. 1997;157:2635-41.
10. National Institutes of Health. National Institute of Allergy and Infectious Diseases: Chronic Lyme Disease. Available at: <http://www3.niaid.nih.gov/topics/lymeDisease/understanding/chronic.htm>. Accessed December 13, 2008.
11. Feder, HM. A critical appraisal of chronic Lyme disease. *N Engl J Med*. 357:1422.
12. Süß J, Klaus C, Gerstengarbe FW, Werner PC. What makes ticks tick? Climate change, ticks, and tick-borne diseases. *J Travel Med*. 2007; 15(1):39-45.
13. Centers for Disease Control and Prevention. Tick Images. Available at: http://www.cdc.gov/ncidod/dvbid/lyme/images/TickMaster4_12.jpg. Accessed October 16, 2008.
14. Centers for Disease Control and Prevention. Protect yourself from tick bites. Available at: http://www.cdc.gov/ncidod/dvbid/lyme/Prevention/ld_Prevention_Avoid.htm. Accessed October 16, 2008.
15. Infectious Diseases Society of American. Fact Sheet on Lyme Disease. Available at: <http://www.idsociety.org/lymediseasefacts.htm>. Accessed December 14, 2008.
16. U.S. Department of Health and Human Services. Healthy people 2010 (conference ed, in 2 vols). Washington, D.C.: U.S. Department of Health and Human Services; 2000. Available at <http://www.healthypeople.gov/Document/pdf/Volume1/11HealthCom.pdf>.
17. Freimuth V, Linnan HW, Potter P. Communicating the Threat of Emerging Infections to the Public. *Emerging Inf Dis*. 2000;6(4): 337-347.
18. National Commission for Health Education Credentialing. Responsibilities and Competencies. Available at: <http://www.nchec.org/aboutnchec/rc.htm#5>. Accessed October 17, 2008.