Lyme disease

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LYME DISEASE
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LYME DISEASE

Section I

THE PAPER
History

Lyme Disease was first identified in Lyme and East Haddam Connecticut in 1975. Allen Steere, a Yale Immunologist and Rhumatologist, began to study the occurrence of arthritis in young children. The multisystem arthritis had the local medical establishment baffled and was initially titled Lyme arthritis. In 1978, Steere determined that the disease was caused by the *Ixodes dammini* tick commonly known as the deer tick. It took three more years to discover that it wasn't the tick which caused Lyme Disease, but a bacteria carried by the tick and classified as a spirochete.

Willy Burgdorfer, a Pathobiologist from the Rocky Mountain Laboratory in Montana, localized the *Borrelia burgdorferi* spirochete in 1981. (Steere, p. 37) It took another year for the Centers of Disease Control to recognize its diverse symptoms and to realize that the bacteria was a danger to the community. There is evidence which supports the theory that Lyme Disease dates back to the early 1900's; however, the disease never attained the epidemic proportions, nor attention, which it has today. Lyme Disease has also been labeled as erythmia migrans disease, acrodermatitis chronica atrophicans, lymphocytoma of bafver stedt, and meninogoplyneuritis (Garin-Bujadoux-Baninwarth Syndrome); nevertheless, they are all caused by the *Borrelia burgdorferi* spirochete bacteria.
Geographic Ranges

Lyme Disease is currently found throughout the United States and cases have been recorded on six continents. Epidemic areas on the east coast of the United States are Connecticut, Rhode Island, New York, Massachusetts, Maryland, and Pennsylvania. Wisconsin, Minnesota and Michigan are other infectious areas including Northern California, Oregon and in Canada from British Columbia to New Brunswick. (Spach, p. 936) Lyme Disease has not been documented in the Rocky Mountain states, Hawaii or Alaska. (Ferris, p. 3)

The Lyme Disease Foundation, the Vancouver-based BC Lyme Borreliosis Society and physicians, veterinarians and microbiologists from 15 countries met for the eighth annual scientific conference on Lyme Disease in 1995. The representatives believe there are 23 strains of Lyme Disease in the United States alone and 81 strains worldwide. (Ferris, p. 5) Globally, all of Scandinavia, Europe, Russia from the Baltic Sea to the Pacific Ocean, northern China, northern Japan, North Africa, and the east coast of Australia are also infected.

Incidence of Lyme Disease

The United States went through The Industrial Revolution which resulted in the obliteration of countless forests and natural habitats. Populations of deer and other animals became very low and the incidence of Lyme Disease was infrequent enough to be overlooked. Presently, the allocation of land to the National Parks,
environmental preservation and restoration has resulted in a regeneration of the deer population. Traditional ranchers still destroy large predators such as the wolf and mountain lion countering the balance found within the natural world. Today's strict hunting laws are more favorable towards the deer. (Barbour, p. 1611) These factors contribute to the reproduction explosion of the deer and, hence, the noticeable increase of Lyme Disease. (White, p. 171)

The expansion of Lyme Disease in the United States has not only been attributed to human factors, but also to environmental changes. In recent decades many farms have been abandoned and deciduous forests, which are beneficial to deer, have taken their place. The past ten winters have been relatively mild thus improving the survival rate of deer and other small rodents which are essential hosts for the tick. (Barbour p. 1611)

There is currently a national total of 77,612 cases of Lyme Disease in the United States. There were 8,546 cases documented in 1995 alone and New York was the state with the highest occurrence of Lyme Disease with 2,867 cases reported. (Howe, p. 10)

**Ticks**

**Tick Identification**

There are five ticks thought to carry the Lyme Disease causing spirochete: *Ixodes dammini* (northeastern US.), *Ixodes scapularis* (southeastern US.), *Ixodes pacificus* (western U.S.), *Ixodes racinus* (Europe), and *Ixodes persulcatus* (Asia). (Kiszewski, p. 19) (Oliver,
In February, 1994, two more tick species were added to the list as spirochete vectors: *Ixodes spinipalpis* (northern California) and *Ixodes angustus* (Pacific Northwest). (Baxter & Liegner, p. 581) Veterinarians have discovered three more species of ticks which may transmit the spirochete: the American Dog Tick (*Dermacentor variabilis*), Lone Star Tick (*Amblyomma americanum*), and the Rabbit Tick (*Ixodes dentatus*). (Fort Dodge Labs, pamphlet) (Janson, Your Health Section)

**Tick Biology**

The body of a tick is divided into two parts, the cephalothorax and the abdomen; there are no other obvious divisions. Like other arthropods, the dorsal surface is covered with a sclerotized shield or carapace called the scutum; in male ticks it covers the entire dorsal surface. In females the carapace is only on the anterior surface, allowing for abdominal expansion while ingesting blood. (Spach, p. 936 & Barnes, p. 538) The ventral side is completely covered with protective plates. (Barnes, p. 540) The adult tick has four pairs of legs which have six segments apiece indicating it is of the class Arachnida (spider). It has no antennae and its first pair of appendages are modified for feeding and contain tarsal sense organs. (Barnes, p. 494 & 538)

**Tick-Borne Diseases**

Lyme Disease is not the only tick-borne disease, concern should be practiced for any tick. There are over 800 species of ticks, of them 100 types are believed capable of carrying diseases caused by
bacteria, viruses, rickettsiae or protozoa. (LDF web-site) Babesiosis (malaria like and often fatal), Colorado tick fever, Rocky Mountain spotted fever (most prevalent in the eastern US), ehrlichiosis (spotless Rocky Mountain fever), tick-borne relapsing fever, tularemia (rabbit fever) and Lyme Disease are the most common tick-borne diseases. (LDF web-site) (Hoskins, p. 325)

Life Cycles

Ixodes Tick Life Cycle

The Ixodes family of ticks has a two year developmental life cycle which begins in the early spring. During the first spring the larval tick or "seed" tick crawls out from the plethora of eggs. It quickly finds a host usually the white-footed mouse, Peromyscus leucopus. The tick engorges itself with blood throughout the summer and drops off in the fall to molt and seek shelter for the winter.

The second spring the tick emerges as a nymphal tick and actively seeks another host, preferably the white-footed mouse; although it may feed on rabbits, squirrels, dogs or even humans. During the second summer the tick again engorges itself and later drops off to pursue the white-tailed deer Odocoileus virginianus. The white-tailed deer is the ticks primary choice of hosts and hereon it feeds and mates. Ultimately, in the fall the female drops off and lays numerous eggs. The male remains on the deer and continues to mate with other females. The cycle begins again the following spring. (Steere, p. 39)
There are other important hosts which play an active role in the tick life cycle including the Dusky-Footed Wood Rat, *Neotoma fuscipes*, in California and the California Kangaroo Rat, *Dipodomys californicus*. Lizards of the southwest, migratory birds and other animals are also utilized by ticks. (Schwan, p. 3097)

Scientists have explored population levels of deer and mice in relation to the prevalence of ticks. The result of one study concluded that there were more ticks in areas where there were a greater number of deer. The population of small rodents, especially the mouse, were the same thus having little effect on the incidence of Lyme Disease. (Gray, abstract) There is a direct correlation between the rate of reproduction of vertebrate hosts (deer) and the prevalence of Lyme Disease. (Ginsburg, p. 380)

**Spirochete Bacteria Life Cycle**

The spirochete, the bacteria which causes Lyme Disease, is also an active part of the tick's life cycle and requires numerous hosts for survival. The spirochete finds humans as a dead end since they do not actively pass it on to other organisms. The first host, the white-footed mouse, may unconsciously carry the spirochete. The mouse and other wild animals are not effected by the spirochete; however, they can pass the spirochete onto progeny and unaffected ticks. The spirochete-positive nymhal tick actively feeds on its second host, the unaffected white-footed mouse, thus infecting that mouse and any other ticks which actively feed on it. The engorged spirochete-positive nymhal tick will then infect a third host probably the white
tailed deer, dog, or human. This is the period in which the spirochete enters society. (Steere, p. 39)

**Borrelia Spirochetes**

There are several human spirochete diseases which have correlating affects on the human body including syphilis, leptospirosis (from contaminated water), relapsing fever (another tick-borne infection), fusospirochetal diseases (trench mouth) and Lyme Disease. Spirochetemia is present in all the diseases and is characterized by infiltration via the skin or mucous membranes as the portals of entry into the body. Early in the course of infection, there is a wide dissemination of bacteria through tissue and body fluid. Traditionally there is one or more stages of the disease often with periods of remission. Analogous with most spirochete diseases there are skin irritations, and neurologic and cardiovascular manifestations, whereas Chronic Arthritis is unique to Lyme Disease. (Schmid, abstract)

**Spirochete Identification**

There are numerous species of the *Borrelia burgdorferi* spirochete which are the zoonotic human pathogens for Lyme Disease, for example: *Borrelia burgdorferi* sensu stricto (United States), *Borrelia garinii* (Europe), *Borrelia afzelii* (Europe), and *Borrelia japonica* (Japan). (Schwan, p. 3096) (Postic, web-site) These differences may account for the clinical variations found throughout the world. (Steere, p. 37)
Spirochete Biology

A spirochete is a non flagellated microorganism, slender and wavy in shape, and often helical in structure. It is a member of the Family Spirochaeraceae. (Dox, Melloni, & Eisner, p. 445) Its size ranges from 20-30 micrometers in length and .2-.3 micrometers in width. It has a flexible cell wall in which several fibrils are wound. The fibrils have flagella, 7-11 in number, which are called endoflagella. Like most spirochetes they are motile due to flexion and rotation of the endoflagellar filaments. They reproduce and divide by transverse fission. (Sherris, pp. 427)

The *Borrelia burgdorferi* spirochete is normally found in the saliva of the tick as well as in the digestive tract. "*Borrelia burgdorferi* lives in the midgut of the tick where it accumulates near the brush border and in the interstitial spaces between the epithelial cells." (Burgdorfer, p. 172) It then passes through the gut wall and has been found in the central ganglion, malpighian tubules, salivary glands and the genital system of the tick. (Burgdorfer, p. 174) The tick is not directly effected by the bacteria, but simply retains and transfers it to all of its hosts.

Transmission of Lyme Disease

Scientists have discovered that a non-affected tick acquires the spirochete from an infected host the same day it attaches; however, it takes 3-5 days for the tick to be infectious to other hosts. After 48 hours of attachment the transferal of the *Borrelia burgdorferi* spirochete is certain. It has also been shown that ticks which have
been feeding within a 48 hour period can be removed from one host and reattach to another. A dog, for example, transports ticks into the house and the tick in turn crawls onto the other residents. Cases such as this have been documented, although generally a tick prefers not to be interrupted while feeding.

An experiment done on laboratory mice concluded that it took at least 36 hours for the victim to become infected with the *Borrelia burgdorferi* spirochete. (Shih, p. 2879) However, when an infected tick was removed from one host and placed on a second host the spirochete was transferred within the same day (24 hours). There is evidence that transferal occurs within eight hours of reattachment; this indication demonstrates that partially fed ticks tend to pass the spirochete infection more rapidly than the non-fed tick. (Shih, p. 2880)

**Tick Bite**

Studies have shown that ticks do not tend to travel more than 40 cm from the original egg mass. The tick's action exhibits an ambush approach to a host not an active predatory search for one. (Stafford, Abstract) The primary means of transmission of Lyme Disease is through the tick bite. (C.D.C., Web-Site) The tick will burrow into the skin and after 24 hours the exchange of fluids occurs. (Shih p. 2878) After transmission the bacteria travel through the body via tissues, digestive, lymph and/or vascular systems. It has been found that the bacteria actually hides within cells and within intracellular niches. Spirochetes have been discovered in blood cells, fibroblasts, macrophages, endothelial cells,
neurons and Langerhan's cells thereby seeking a safe haven in cells which are designated to trigger an auto immune response. (Burrascano, p. 10) Moreover, the *Borrelia burgdorferi* spirochete secretes a glycoprotein which coats and encapsulates itself. This ability actually impairs the immune system's recognition of a foreign body and blocks antibiotic penetration. (Burrascano, p. 10)

**Other Additional Spirochete Carriers**

In areas where ticks are uncommon there have been recorded cases of *Borrelia burgdorferi* infection, implying that ticks are not the only carriers. The Texas Department of Health believes that fleas are capable of transporting the *Borrelia burgdorferi* spirochete. There have been articles in the New England Journal of Medicine stating that a wide variety of insects, including biting flies and mosquitoes, harbor *Borrelia burgdorferi*; however, they may not effectively transmit the spirochete. (Fort Dodge, pamphlet) There is still no conclusive evidence supporting this hypothesis. There are many variables which may account for the documented cases including traveling into infected areas or being visited by people and their pets who live in epidemic locations and happen to transport a tick.

**Transovarial Transmission**

There is evidence of transovarial transmission within the body of a tick. In female ticks *Borrelia burgdorferi* was found in spaces between the oocytes and the tunica propria membranes. The eggs containing *Borrelia burgdorferi*; however, either failed to mature (the spirochetes found inside died off during oogenesis) or there was
not enough of the bacteria in each egg to have any effect.
(Burgdorfer, p. 179) Concluding that Lyme Disease is not passed onto tick progeny.

Maternal Transmission

There is great concern for pregnant women who have Lyme Disease because other spirochete diseases including syphilis have detrimental effects on the unborn fetus. (Williams, p. 504) Research has documented the presence of the antibody for *Borrelia burgdorferi* spirochete in the umbilical cord blood of humans and new borne. (Williams, p. 505) Moreover, there is clinical evidence that *Borrelia burgdorferi* is directly transmitted in the blood across the placenta and into the fetus. (Duray, p. 77) The bacteria accounts for the occurrence of a lower birth weight and neonatal jaundice. (C.D.C. Web-site) Spirochetes have been recovered from the brain, spleen and kidney tissues of stillborn and in infants with severe abnormalities. (Williams, p. 506) (Duray, p. 77)

There is no evidence that nursing Lyme Disease infected mothers transmit the infection via the milk. (C.D.C. Web-site) Researchers are currently investigating these sensitive areas.

Blood Transmission

For those who require transfusions, evidence supports the fact that the *Borrelia burgdorferi* spirochete can live in whole fresh blood found in blood banks which are kept at +4° C. Consequently, research has shown that if the temperature of the stored blood is raised to +30° C the bacteria disappears. (Baranton p. 445)
Symptoms: "The Great Pretender"

The symptoms associated with Lyme Disease can deviate and, therefore, make diagnosis on humans very difficult. Dr. Patricia K. Coyle, a neurologist at the State University of New York at Stony Brook stated at the Lyme Disease Conference in Boston, April 1996 that "besides the arthritis-like joint pain, symptoms may include depression, impaired memory, diminished ability to summon words and focus attention, lingering pins and needles nerve feelings, and loss of movement similar to a stroke." (Howe, p. 10) The location of the tick bite and the speed at which the spirochete travels and penetrates the tissues of the body determine the stage and degree of illness. Symptomatic discrepancies may be caused by genetic variations in humans and create different clinical outcomes. (Porth, p. 213)

The bacteria affects the cardiovascular system, the central and peripheral nervous systems, the reticuloendothelial and gastrointestinal systems. The disease is called "the great pretender" because it mimics many disorders including Lou Gehrig's disease, multiple sclerosis, mononucleosis and is often misdiagnosed as rheumatoid arthritis, fibromyalgia, systemic lupus, erythematous and chronic fatigue syndrome as well as numerous mild to severe psychiatric disorders. (Ferris, p. 5) (Arenofsky, p. 29) (Pachner, p. 56)

Rash (erythmia migrans)

The most probable indication of the occurrence of Lyme Disease in a human is a tick on the skin. At the tick bites location,
there is sometimes a skin rash, scientifically called the erythmia migrans, which will appear approximately 5-40 days after the bite. (C.D.C. web-site) Unfortunately, the rash only occurs 40-60% of the time. The erythmia migrans commonly appear in a bulls eye configuration with concentric rings up to twelve centimeters in diameter. The rash can also look like eczema, sunburn, hives, poison ivy, flea bites, etc., and on dark skin it can look like a bruise. (L.D.N. Web-site) It can disappear and then reappear, itch or not irritate. Skin irritation is a possible indicator of Lyme Disease, but it is an unreliable symptom.

Stage I

The first stage of infection on a person is characterized by flu-like symptoms without the cough. (C.D.C., Web-site) Fever, depression, and general constitutional degradation follows. (Steere, p. 91) Conjunctivitis, interstitial pneumonia, hepatitis, hematuria (blood in the urine), splenomegaly (enlargement of the spleen) are also possible indications of first stage Lyme Disease. (Duray, p. 78)

Stage II

The second stage may involve the cardiovascular and nervous systems. (Duray, p. 69) Clinical variations include Bell's palsy, radiculoneuritis, lymphocytic meningitis, cardiac arrhythmia, myelitis, as well as migratory pain in the joints, muscles, and tendons. Continuous fatigue and general poor health may plague the patient. There are scores of diseases and complications which are associated with the second stage of Lyme Disease. Late second stage
tends to be more severe with neurological, cardiac, and arthritic complications. (Duray, p. 69)

Stage III

The third stage, (1 year or more after initial infection) chronic infection occurs in the skin, nervous system and joints. There appears subtle encephalopathy (Lyme fog) and changes in mood, memory, and sleep. Neurologically there is polyneuropathy with spinal or radical pain and/or numbness and tingling in the hands and feet. (Halperin, p. 26) Finally Chronic Arthritis with pain and swelling primarily in the knee, shoulder and wrist are specific features of Lyme Disease. (Steere, p. 91) There is "histological derangement" in the body with vascular thickening, fibrin deposits in the synovial sheaths, demylination of the mylin sheaths, and bizarre behavior of the lymphocytes and plasma cells. (Duray, p. 78)

Chronic Arthritis, or more properly termed Lyme synovitis, may be caused by the natural auto-immune response to the presence of Borrelia burgdorferi in the synovial tissues. (Duray, p. 69) Characteristically Borrelia burgdorferi doesn't attack the same joint on both sides at once and does not simultaneously affect many joints. (C.D.C. Web-site) Chronic Arthritic episodes tend to last at the most, six months and if they continue beyond that time the disease probably isn't Lyme Disease. (C.D.C., Web-site)
Testing

Numerous doctors refuse to give tests for Lyme Disease because it is in vogue for people to have the disease. Those with Lyme Disease present the ambiance of an outdoor lifestyle, health, and vigor. There are two distinct medical camps revolving around Lyme Disease. One camp believes there is misdiagnosis, media frenzy, and over-prescription of antibiotics. The other contingency concludes that Lyme Disease will reach epidemic proportions. (Habicht, p. 112)

There is no perfect test for Lyme Disease because of the variance in the symptoms and the temperament of the bacteria. Characteristically, the bacteria travel through the body tissues making isolation and testing very difficult. The average Lyme Disease patient doesn't exhibit antibodies against the *Borrelia burgdorferi* infection for at least four to six weeks after initial infection and may not develop any antibodies at all. (Ferris, p. 3)

Currently there are three tests for Lyme Disease. They are the Serologies Test, a test for antibodies; Spinal Tap, a test of the spinal fluid; and the new PCR, which amplifies and detects the bacterium's DNA sequence. (Dietrich, p. 62) (Burrascano, p. 4)

Serological tests include the Indirect Immunoflourscence Assay, ELISA and ELISA-ABS are the most common tests used; unfortunately, they are not accurate and often giving false-negative results thirty percent of the time and false-positives ten percent of the time. (Mertz, p. 474) Spinal taps are physically dramatic and are used on patients with prolonged neurological manifestations.
The experimental two-hundred dollar PCR test has had 85% success identifying patients with lyme arthritis and 100% of patients who did not. (Dietrich, p. 62) Additionally, the Rocky Mountain Laboratory of the National Institute for Allergy and Infectious Diseases has recently discovered that the specific antigens for *Borrelia burgdorferi* have also been shed in the urine of patients who have Lyme Disease. (Liegner, p. 1962) Researchers believe a test or a vaccine will be developed in the next five years.

**Treatment**

Arvid Afzelius, a physician, brought attention to the medical community with his observance of the erythmia migrans skin rash in his patients in the 1920 and 1930s. Neurologic, cutaneous and other debilitating problems were observed following the erythmia migrans. It wasn't until 1968 that the first patient with erythmia migrans in North America benefited from the administration of penicillin. (Dammin, abstract)

Treatment of Lyme Disease does not seem to follow normal procedure in the medical field. Many physicians study the patient's life-style and prescribe that (s)he keep a diary of physical and mental changes. Physicians calculate that for every one patient diagnosed with Lyme Disease ten other people are undiagnosed.

Treatment for Lyme Disease, if caught in the early stages, has very positive results and full recovery is possible. (C.D.C., Web-site) It has been clinically observed that the symptoms reoccur in four week cycles. The intensity and duration of the symptoms will
decrease with medication. A simple therapy of an oral antibiotic such as amoxicillin, tetracycline, cephalosporins (later generations) or penicillin can easily rid the patient of the bacteria. (Neu, p. 314) The drug is administered in consideration of weight, age, gastrointestinal function and the tolerance of the patient. Proper treatment also depends on the patient's use of alcohol on a regular basis, proper rest and patient compliance with the treatment. (Burrascano, web-site)

As the disease manifests, dosages of antibiotics must increase, or intramuscular or intravenous therapy may be used for long periods of time. (C.D.C., Web-page) The dangerous and irreversible result of prolonged Lyme Disease occurs when the spirochete enters the patient's synovial sheaths, nervous tissue or even passes the blood brain barrier. These are places where antibiotics can not successfully enter and the damage is irreversible. The patient may live with some days better than others. (S)he would have migratory Lyme arthritis throughout the body and continuous general fatigue. (Liegner, p. 1961)

**Veterinary Concerns**

There is a lot of speculation about the canine vaccine "*Borrelia Burgdorferi Bactrin*". As with any vaccine it is not one-hundred percent effective. Studies in vaccinated dogs have shown that dogs were protected from a direct intraperitoneal challenge of *Borrelia burgdorferi* and unvaccinated dogs succumbed to the natural symptoms of canine Lyme Disease. (Fort Dodge, pamphlet) If a dog is
vaccinated it will always test positive for Lyme Disease thus making diagnosis more complicated. (Cornell-Vet, Web site)

If infected with Lyme Disease a dog, cat or horse will display a fever, poor appetite, acute painful arthritis often accompanied by enlarged lymph nodes, kidney disease, eye problems and/or heart disease. Eventually a marked change in behavior in the animal, with possible displays of aggression or listlessness, will take place. (Cornell-Vet, Web site) Daily grooming and the use of tick collars are highly recommended for the prevention of Lyme Disease in pets.

**Effects on Children and the Elderly**

Lyme Disease has been observed in children in higher numbers than in adults because of their exploratory behavior in tick infested areas. It is difficult, however, to diagnose Lyme Disease symptoms in children since they tend to have a variety of flu-like systems from normal childhood diseases. (Hurwitz, p. 30) Until the testing procedures for Lyme Disease are perfected there is no accurate way to diagnose the disease without error. Also if the spirochete infects the tissues of a maturing fetus it is most probable that there may be some developmental problems after birth and a lifetime of pain and chronic fatigue. (Christian, p. 449) Likewise, it is difficult to detect Lyme Disease in the elderly since they exhibit natural signs of aging which mimic numerous symptoms of Lyme Disease.
Strategies for Decreasing the Existence of Lyme Disease

Exposure

The primary control strategy in preventing Lyme Disease is through precautionary measures. If people go into areas of risk they should wear light clothing to make the ticks more visible, wear long sleeve shirts and pants, and tuck their cuffs into their socks. Ticks are anti-gravitational, therefore they seek the highest point. (L.D.N., web-site) Repellents such as DDT and permathin placed on clothing have proven to repel foraging ticks. (Spielman p. 213)

After outdoor activities people and their pets should check from head to toe for ticks. They should remove ticks with a pair of fine nosed tweezers. Do not use petroleum jellies, nail polish remover or any other home remedy. If a tick is promptly removed the risk of Lyme Disease dramatically decreases. Furthermore, they should save the tick, monitor their health, and be aware of the early symptoms of Lyme Disease; and, if needed, contact the local practitioner.

Exposure should be avoided especially in the month of June or any month between May and September when the larval ticks, which contain the bacteria, are looking for their second host. (Spielman p. 216) People should avoid areas where ticks are known to be active such as the borders between forests and fields or even the edges between lawns and shrubs.
Chemical

Chemical methods have been used in the field to try to decrease the spread of Lyme Disease. Permethrin-treated cotton has been placed in biodegradable tubing and disbursed in known mouse territories. Mice in the early spring months will use this harmless substance for bedding. It repels the nymphal ticks from the nest sites thus decreasing the spread of Lyme Disease. Permethrin-treated cotton has been shown to be 99% effective, but the distribution of the tubing is a very time-consuming process. (Mather, p. 402)

Another form of chemical control is the use of acaricides. The chemical is expelled through a high-pressure, hydraulic sprayer in the fall and has been known to kill many adult ticks. (Schulze p. 204) Deer have also been carefully trapped and a tick count performed on them. Plastic discs containing rabon were then attached to the deer's ears and the animals were released. After a period of time the deer were recaptured and the ticks were again counted. There was no significant decrease in numbers of ticks; however, there were fewer ticks near the ears indicating the rabon was only locally effective. (Spielman, p. 216)

Habitat Modification:

Human behavior and habitat modification is another control method. It has been shown that ticks tend to congregate near the edges of forests and in fields of high grass. Mowing areas will reduce the number of ticks in the grasses. Staying away from the lawn-woods barrier is another defense. (Schulze, p. 207)
Removal of food stuffs such as bird seed and vegetable gardens away from the home will help deter tick laden animals. Also dismantling wood piles and stone walls which make luxurious habitats for rodents will help reduce the numbers of hosts near the home. (Ferris, p. 8) Some residents have resorted to burning the lower brush and grass land. This practice has had two different results: If complete annihilation of the brush occurs, the mice will often move indoors and closer to human contact. If the burning occurs in the early spring, during the period in which the newly developed nymphs are seeking their first host, many nymphal ticks will be destroyed.

Host Modification

The final and more controversial remedy is reduction of the afflicted deer population. The elimination of this host has shown effective reduction of tick transferal. (Spielman, p. 218) There are numerous bait and shoot programs throughout the United States. Some people tend to frown on these practices and even interfere with them, thereby creating public sympathy. This intervention may cause harm to themselves, their family and the unhealthy deer population.

Summary

Lyme Disease is a multifaceted issue which connects behavioral, environmental, legal and medical concerns. Its spread depends on deer populations which in turn are effected by the
hunting laws and the preservation of open space. The environmental groups, maybe unknowing, are advocates for the natural breeding grounds of Lyme Disease. (Schulze, p. 210)

Lyme Disease symptoms masquerade as many different illnesses, making diagnosis nearly impossible. The symptoms may appear as cardiac disorders, mental illness or chronic nervous system abnormalities. The medical establishment doesn't agree on the method of diagnosis nor the proper treatment of Lyme Disease. Testing procedures are inaccurate and costly. Many insurance companies find loopholes in the amount of coverage they are required to give.

A vaccine is on trial on 10,000 healthy volunteers who live in epidemic areas on the east coast of the United States. The results will not be known for many years. (Ferris, p. 6) It is believed that the key to finding a cure is in the work of molecular biologists. They are attempting to discover ways to interfere with the reproductive and metabolic process of the spirochete. (Liegner, p. 1962)

Like most illnesses prevention is the fundamental solution. Adhering to outdoor dress-codes and avoiding exposed areas during the peak tick season as well as the use of tick deterrent sprays is recommended. Reconfiguration of woodpiles, gardens, and lawn borders is suggested as well. There are many local and national organizations and hotlines with the most up to date information concerning Lyme Disease. (See enclosed list.)

There are many subsidiary issues and sincere concerns revolving around Lyme Disease. Scientists are close to developing a vaccine and discovering proper testing procedures for the bacteria.
There is definite hope for those who are suffering from Lyme Disease and for those who are yet to be diagnosed.
LYME DISEASE RESOURCES

- American Lyme Disease Foundation: 1-800-876-5963.
- Center of Preventative Medicine.
  Michael Janson, M.D., Director & Founder
  275 Mill Way, Box 732, Barnstable, MA 02630
  (508) 362-4343.
- CDC's Voice Information System: (404) 332-4555.
- Connecticut State Health Department: (203) 566-2279.
- Fort Dodge Laboratories, IA: (515) 955-4600.
- Internet: type in "LYME DISEASE"
- Lyme Disease Foundation, CT: (800) 886-LYME or
  (203) 525-2000
  43 Winton Rd., East Brunswick, NJ 08816.
- Massachusetts State Health Department: (617) 727-2700
- National Center for Infectious Diseases: (970) 221-6453
- National Institutes of Health: (301) 496-5717
- New York State Health Department: (518) 474-2011

or consult:
Coping with Lyme Disease: A Practical Guide to Dealing With Diagnosis and Treatment, by Denise Lang with Derrick DeSilva Jr., MD (Henry Holt)
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LYME DISEASE

Section II

THE EXHIBIT
It was difficult to choose which aspects of Lyme Disease should be displayed. In consideration of my spectators and possible location where the exhibit might eventually hang, I narrowed my audience to the lay public including children; however, I could not have festering erythmia migrans and complicated medical lingo. The final pieces formalized as helpful precautions, symptoms, geographical spread and life cycles. Topics which would be both informational and scientifically correct.

The construction and design of the exhibit took careful thought and experimentation. There was limited space in the gallery, consideration of post gallery use, ease of transportation and visual attraction. I chose wood because of the pleasing shadow effects, sturdiness and my familiarity with the medium.

I drew each poster on bond paper in actual size, cut out the shapes, arranged them, re-cut and organized them until they were visually acceptable. Slowly, the individual pieces formed and I united them by using similar colors, sizes and shapes.

The following list specifies the materials used:

- Two pieces of pressed masonite board  
  (4 foot by 8 foot sheets, 1/4 inch thick)
- Laytex paint (blue, cream, and brown)
- Acrylic paint for both brush and airbrush
- 1/2 inch wood screws
- Hanging hardware
- Half inch wooden balls
Preparation of the wood pieces required getting permission to use the undergraduate wood shop. There I was able to use the ban saw to cut out the pre-drawn figures. They were then sanded, painted and assembled at home.

The paint, for the larger surfaces, was mixed at Builders Square in accordance with a customized sample: half gallon of brown, half gallon of cream and a quart of dark blue. The spirochetes were airbrushed as was the green back ground behind the maps.

The vinyl letters were purchased in vast quantities from the Campus Shop. Fonts and sizes were limited because of a lack of available supplies. Hand lettering was a possibility, but too time consuming and stressful. I had attempted to find wooden letters, but to no avail. I used the computer to determine the correct spacing of the words and for spelling.

The construction of the exhibit took place in my apartment the creation then turned into a tick infested artistic experiment. The three individual poster sections were held together by screws and hung individually for ease of transportation. The lower "hands on" portion was supported by three metal hangers which were bent to a desired 45° angle with the help of Frank in the wood shop.

In conclusion, I enjoyed putting the display together and was pleased that it resulted in a successful exhibit. I wish I could have consulted with my advisers more often, but I found it complicated to lug the wood back and forth to school. I began my research in the fall, started writing during the winter and simultaneously wrote the scientific portion and constructed my exhibit. I hope this report and the display will further understanding of Lyme Disease and exhibit characteristics of the disease and its prevention in humans and their pets.
Beware

Lyme Disease has been documented on six continents and is still spreading at epidemic proportions. It affects humans and domestic animals both physically & mentally. Amazingly, the cause of this debilitating disease is no larger than the period found at the end of this sentence.
LYME DISEASE
SYMPTOMS & STAGES

STAGE 1
Skin rash.
Constitutional variations.
Flu-like symptoms.
Fatigue.

STAGE 2
Secondary skin lesions.
Migratory pain in joints.
Cardiac disorders.
Lyme Fog.

STAGE 3
Disfunction of the Central Nervous System.
Chronic arthritis.
Numbness in limbs.
Memory, mood & sleep changes.
PREVENTION

- Wear Proper Outdoor Attire
- Host Reduction
- Antibiotic Therapy
- Monitor Your Health
- Use Repellents & Insecticides
- AVOID High Risk Areas

KNOW the Symptoms
Check Family & Pets for TICKS.
Mow Lawns & Burn Brush