Lyme Disease Control in Face of Tick Phobia

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Lyme disease, the subject of recent public awareness and fear, not only can be controlled through medical means but also can be effectively prevented with environmental techniques and common sense safety precautions. Understanding the origin of the disease and its carriers will aid physicians in calming patient fears and reinforcing preventive measures.

There is no question that "Lyme disease hysteria" is out there.[1] The media have made it clear that the disease is spreading and its incidence increasing. During 1988, Lyme disease was reported in 43 states, but 92 percent of the cases came from eight states: New York, New Jersey, Pennsylvania, Connecticut, Massachusetts, Rhode Island, Wisconsin and Minnesota.[2] To prevent human transmission of the disease, unfounded fear should be channeled into constructive strategies. The complex biological interactions involved in Lyme disease transmission leave it vulnerable to many points of attack.

Understanding the life cycle of the deer tick, *Ixodes dammini*, has great value in preventing spread of the disease by this, the major vector of the disease-causing spirochete *Borrelia burgdorferi*. The usual two-year life cycle is analogous to the majority of tick species. As it progresses from egg to larva to nymph and finally to mature adult form, each tick form requires a blood meal. After mating and feeding, the adult female lays its eggs in the spring. The eggs hatch into barely visible larva. They climb onto hosts, take their first blood meal, and drop to the ground where they emerge as nymphs in a few weeks. Nymphs, more mobile than larva, actively feed on a variety of animal hosts, probably during the following spring and summer (especially May through early July). The nymph, whose small size makes it difficult to spot, is the form of the tick that most often bites man and is responsible for the majority of B. burgdorferi transmission. After engorging, the nymph drops off its host and molts into the adult form. Adult ticks, which also bite man and transmit disease, prefer white-tailed deer as hosts year-round, even on warm winter days. Most ticks will reach adult form by fall, when the cycle begins again. Because mating does not dictate death some may survive until the next year.

Likely hosts

Of the three major tick vectors of borreliosis worldwide, the one responsible for most cases of Lyme disease in the eastern U.S. is I. dammini, the eastern deer tick. On the West coast, borreliosis is transmitted by I. pacificus and in Europe, I. rinicus transmits the disease. A variety of arthropods have been shown to carry the Lyme disease spirochete. In one study from a highly endemic area in Connecticut, 18 species of ticks, mosquitoes, horse flies, and deer flies harbored B. burgdorferi as demonstrated by indirect fluorescent antibody stains.[3] None of the common dog ticks, *Dermacentor variabilis*, which also bite people, were found to be infected. Although several non-ixodid ticks were found to harbor B. burgdorferi, only the lone star tick, *Amblyomma americanum*, is suspected of being a vector in some disease foci.[4] In other arthropods which harbor the spirochete, the organism may be short-lived, and the potential for insects such as mosquitoes to serve as vectors is unknown.

Vertebrates that can act as host species for I. dammini include at least 29 species of mammals and 49 species of birds.[5] Only 12 of these mammal species were shown to be infected with the adult ticks.

In highly endemic areas, two vertebrate hosts have emerged as critical for maintenance of the tick population: white-tailed deer and mice. The common white-footed mouse is frequently infected by immature I. dammini and serves as the most important reservoir for B. burgdorferi. Mice, which show no signs of disease and remain infectious to ticks for life, are more easily infected by and able to transmit the spirochete than other host animals.[6] Thus, the prescence of other vertebrates competing for ticks may actually decrease transmission of the disease. White-tailed deer serve as the food source for large numbers of adult ticks, and deer abundance is linked to the survival and distribution of I. dammini. Other important species, especially in a suburban setting, may include chipmunks, grey squirrels,

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raccoons, opossums, skunks and domestic pets.[7]

Birds, which appear to be important hosts for larval and nymph forms, not only serve as tick host but can be infected by B. burgdorferi,[8] making it the only species of Borrelia known to infect both mammals and birds. The potential for birds to widely and rapidly disseminate ticks and spirochetes makes Lyme disease more refractory to control. Birds may make B. burgdorferi accessible to competent arthropod vectors that otherwise would not come in contact with the organism.

Reforestation of the northeastern U.S. and the last century's deer population explosion are major forces behind the current Lyme disease epidemic. Patches of wooded areas may concentrate hosts and parasites, perhaps explaining high rates of disease in small local foci. In theory, the greater the area of transition zone between forest and field, the greater the population of animals and number of species that can be supported in a given area.

Man's contribution to the prevalence and spread of Lyme disease is described by author Joel Lang: "There is one other crucial component of Lyme disease ecology besides the spirochete, the tick, and the deer. This other species also prefers to live quietly on abandoned agricultural land. It is called the suburbanite. As many scientists and health officials are fond of pointing out, two acre zoning is perfect for Lyme disease."[2] Inherent in this statement is the supposition that the trend can be reversed by human action.

Beyond precautions

In addition to "common sense" precautions to preventing Lyme disease infection (see page), other methods of halting its spread are being tested. But if the use of common control strategies is widespread, people will perhaps not have to rely upon toxic compounds or other en-

Effective precautions

Avoiding ticks is largely a matter of common sense. High risk locales have been relatively well identified. Rural habitats, including areas of thick brush and long grass, provide many places for questing ticks to lie in wait. It is particularly risky to tramp through these areas in early to mid-summer when the number of voracious nymphs is at its peak.

1. Wear protective clothing, and inspect for ticks frequently.

2. If ticks do attach, identify and remove them as soon as possible. Ticks attach by means of a barbed harpoon-like mouthpart called a hypostome. Engorgement with blood is a slow process, taking nymphs an average of 5 days and adults 9.3 days.[9] But because infected I. dammini do not immediately introduce an inoculum of bacteria sufficient to cause disease, removal of attached ticks within 24 hours will prevent disease in most cases. Even after 48 hours, only about 50 percent of ticks transmit disease-causing B. burgdorferi.[10]

3. Remove ticks with forceps, with as little physical trauma as possible to the tick itself. The aim is to prevent transfer of or contact with any tick fluids which may contain the spirochete.

4. Chemical repellents applied to clothing and skin may be effective, and their use is certain to be more thoroughly investigated and promoted. Two main chemical agents in use are N,N- diethlymetatoluamide (deet) and permethrin. Deet, the active ingredient in most commercial repellents used for mosquitoes and flies, appears to deter ticks as well. Permethrin, used in repellents for mosquitoes, ticks, and chiggers, is a synthetic pyrethroid that acts as a pesticide by killing ticks on contact.[9] It is only licensed for use on clothing, not skin. Some commercial repellents that are essentially pure deet may be even more effective. A study shows that cotton impregnated with permethrin and made available for mice to incorporate into bedding material reduced the risk of human infection by 82 percent,[6] and drastically reduced the number of ticks and infested mice. More importantly, a year later, less than half as many nymphs could be found, and these were less likely to carry the spirochete. Tubular dispensers of treated cotton are now available commercially, although this system is expensive.

5. Homeowners can help manage other natural tick hosts by clearing brush, eliminating nesting sites near homes, not feeding wild animals, and avoiding extensive bird feeding.

6. Inspect domestic pets and most farm animals often and do not allow them to roam free. Pets should wear tick collars and can be treated with sprays or baths of pesticides and repellents. Intimate pet contact with owners underscores their potential role in human Borreliosis.

vironmentally dangerous precautions.

Treating deer with a chemical agent had such disappointing results that a full scale study was abandoned. Practical problems, as well as the fact that deer may be eaten by people, may limit the use of repellents or acaricides on hosts to mice.

Though presticide use is controversial because of potentially detrimental environmental effects, three presticides effective against ticks are available to homeowners: carbaryl (Sevin), chlorpyrifos (Dursban), and diazinon.[9] Exposed ticks are most vulnerable to these, but many ticks, especially immature forms, may be protected by vegetation, soil, or hosts.

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Habitat modification is another approach to Lyme disease control. In the only study of this type, Wilson evaluated the effects of burning and mowing vegetation on numbers of adult I. dammini,[13] a drastic approach applicable to a limited amount of land. Both measures are effective in reducing numbers of adult ticks for up to a year, but questions remain about the lasting effect. Fire may immediately kill ticks, perhaps preferentially killing the more exposed adults. Burning or mowing may reduce the number of tick hiding places, and increased sunlight may kill them through dehydration. But if mice and small mammals are driven out, remaining larvae and nymphs may be more likely to attach to human hosts for a short time. While frequent burning or mowing of a site should reduce the abundance of ticks in the long run, immediately after manipulation, or at some point during regrowth, risk to humans may actually rise above previous stable levels. More studies are needed to determine the optimal time to undertake habitat modification for practical uses such as the manipulation of a site to prepare for seasonal recreational activities.

Biological control of the tick vector is appealling because of limited need for continuing human invention and potential lack of detrimental effects on the rest of the ecosystem. Anecdotal evidence indicates spiders and ants may nonspecifically prey on various stages of I. dammini.[14] One insect, the small wasp *Hunterellus hookeri*, parasitizes I. dammini and has potential as a biological control agent. Originally from Europe, the wasp was introduced into the U.S. in 1926 with the hope of controlling dog tick populations on Naushon Island, Massachusetts.[6] Wasp-infected ticks seem not to be infected by spirochetes and the prevalence of B. burgdorferi in the remaining tick population is reduced.[6] Even if Hunterellus hookeri is not effective in reducing the I. dammini population, it may help reduce transmission of the Lyme disease agent. Other biological agents capable of killing ticks, inhibiting their development, or making them incompetent vectors may exist, or could be created through genetic engineering.

Host management has so far concentrated mainly on the white-tailed deer, following the direct correlation between deer and tick density.[15] But reduction of deer numbers does not always have a clear effect on tick abundance because the remaining deer may be more heavily infested; complete or nearly complete removal of deer may be effective.[9] Ticks are not very mobile and tend to be distributed by dropping off their hosts, so human use of land traversed by deer runs is inviting infection. Where deer reduction is a politically charged topic, deer could be controlled with barriers and fences on land used extensively by the public.

Physicians can help educate

In the absence of a "magic bullet" for Lyme disease, public education is necessary to bring this disease under control. But while the media have greatly increased awareness of the disease, they have often failed to educate. Public fear and anxiety result from media images of a plague-like scourge with no satisfactory treatment. Scientifically valid information is often difficult to separate from the sensational or hypothetical. Physicians must lead the way in public education by diagnosing the disease without hesitation, providing definitive treatment, and serving as sources of information.

Education must begin early, because children are especially vulnerable to acquiring the disease. A Connecticut study showed the highest incidence of Lyme disease to be among 5 to 9 year olds.[16] Children tend to play in tick infested areas, and overlook ticks on their bodies. Older children may be more refractory to using precautions. Even children highly knowledgeable about Lyme disease don't adhere to preventive measures, such as wearing protective clothing and inspecting for ticks.[16] The goal of public education should revolve around one fact: for all practical purposes, no tick bites equals no Lyme disease.

When confronted with the victim of an unspecified tick bite, a physician's reassurance with statistics may help: 1) The tick must be I. dammini (in the eastern U.S.), 2) The tick must be infected with B. burgdorferi, and 3) The tick must have been attached for a day or so to transmit the disease. These generalizations can alleviate some fears and help quell the notion that a grave prognosis necessarily follows a tick bite.

Physicians and the public working together to ensure reporting of the disease will contribute to the vital epidemiological knowledge base. Recognizing local disease patterns and ecological perturbations before they are noticed by state or federal agencies may lessen their impact.

Administration of antibiotics to individuals at high risk for the disease should be considered on an individual basis, but is not the best course. The actions of an educated public appear to have a greater prophylactic value. Those who consider themselves at high risk may actually not be. When a patient presents with no demonstrable disease, but recalls a tick bite, or perhaps multiple tick bites, the situation is more complex. Even with future development of a vaccine, it will be prudent to continue personal and environmental control measures. There are many more potential control strategies waiting to be tested, refined, or discovered.

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