DIRECT FROM CDC ENVIRONMENTAL HEALTH SERVICES BRANCH

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Prevention of Tick-Borne Diseases

Editor's Note: NEHA strives to provide up-to-date and relevant information on environmental health and to build partnerships in the profession. In pursuit of these goals, we feature a column from the Environmental Health Services Branch (EHSB) of the Centers for Disease Control and Prevention (CDC) in every issue of the *Journal*.

In this column, EHSB and guest authors from across CDC will highlight a variety of concerns, opportunities, challenges, and successes that we all share in environmental public health. EHSB's objective is to strengthen the role of state, local, and national environmental health programs and professionals to anticipate, identify, and respond to adverse environmental exposures and the consequences of these exposures for human health. The services being developed through EHSB include access to topical, relevant, and scientific information; consultation; and assistance to environmental health specialists, sanitarians, and environmental health professionals and practitioners.

The conclusions in this article are those of the author(s) and do not necessarily represent the views of the CDC.

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Lyme disease ranks among the top 10 notifiable infectious diseases in the U.S.; in 2009, state health departments reported 29,959 confirmed and 8,509 probable cases to the Centers for Disease Control and Prevention (CDC, 2010). The first line of defense in the effort to prevent Lyme disease is personal protection (Piesman & Eisen, 2008). Educational efforts, however, such as promoting tick checks, avoiding tick infested habitat, and using repellents, have had only modest success in changing behavior or actually preventing Lyme disease (Connally et al., 2009; Gould et al., 2008). The nymphal stage of the blacklegged tick, *Ixodes scapularis*, is the principal vector of the Lyme disease spirochete (*Borrelia burgdorferi sensu stricto*); it has been a focus of research on methods for tick control for prevention of Lyme disease. Some of the methods developed include the application of area-wide acaricides; applying acaricides to rodent hosts of immature ticks; and applying acaricides directly to deer, the principal hosts for the adult ticks. The least toxic agents for killing ticks include soaps and desiccants, fungi, and botanical extracts (reviewed in Piesman & Eisen, 2008). Vegetation management strategies can potentially reduce tick exposure (Schulze, Jordan, & Hung, 1995) as can eradication of deer (Rand, Lubelczyk, Holman, Lacombe, & Smith, 2004).

Despite a plethora of excellent academic research on tick control, however, the public has been slow to adopt any of these methods on a wide scale. One potential hurdle to tick control at a community level is the fact that unlike mosquito control, where mosquito abatement districts receive public funding, tick control is basically an individual homeowner or homeowner association responsibility. The amount of money individual homeowners are willing to spend on tick control, even in highly endemic Lyme disease regions, is extremely limited (Gould et al., 2008).

Targeting the pathogen within the natural reservoir or vector holds promise. Vaccines directed against the outer surface protein A (OspA) of *B. burgdorferi* have been applied to rodents either via direct inoculation (Tsao et al., 2004) or as baits containing spirochetal OspA (Meirelles Richer,

Aroso, Contente-Cuomo, Ivanova, & Gomes-Solecki, 2011). Moreover, rodent-targeted baits containing antibiotics that clear rodents and ticks of spirochetes have also been tested in the lab and the field (Dolan et al., 2011). None of these pathogen-targeted ecological approaches is to the stage yet where commercial products are available for testing.

Human-targeted approaches to blocking transmission of the Lyme disease spirochete include vaccines and antibiotic prophylaxis. An effort toward developing an OspA recombinant protein for deployment as a human vaccine was successful. Two vaccine candidates were tested in clinical trials in both North America (Sigal et al., 1998; Steere et al., 1998) and Europe (Beran, De Clercq, Dieussaert, & Van Hoecke, 2000), and a commercial vaccine became available in 1999. Although this vaccine was effective (Steere et al., 1998) and surveillance did not demonstrate adverse events tied to the vaccine (Lathrop et al., 2002), the vaccine was withdrawn from the market in 2002. The principal reason for withdrawal of the vaccine was lack of market success; however, public perceptions about the safety of the vaccine may have contributed to its withdrawal (Shen, Mead, & Beard, 2011). Antibiotic prophylactic treatment of tick bite can potentially play an important role as a method to prevent *B. burgdorferi* transmission. A large clinical trial in Westchester County, New York, an area highly endemic for Lyme disease, examined patients that had an *I. scapularis* tick removed within 72 hours of entering the trial (Nadelman et al., 2001). The efficacy of doxycycline prophylaxis was judged to be 87%, but how widely physicians practice this method is presently unknown. Thus, many approaches are available for preventing Lyme disease, but the incidence nevertheless continues to climb.

Looking forward, what is needed most is an integrated approach to Lyme disease prevention. Ecology, entomology, and epidemiology must be combined to design studies on what works in the real world to significantly reduce the incidence of Lyme disease in highly endemic communities. Toward that end, a network has been established by CDC and state health departments; this network, called TickNET, is currently conducting a multistate trial to determine whether barrier acaricide sprays on residential properties are effective in decreasing the incidence of Lyme disease in highly endemic regions of the northeastern U.S. This project may hopefully become a model for future studies on the efficacy of prevention methods for tick-borne diseases in the U.S., such as Lyme disease, human babesiosis, human anaplasmosis, Rocky Mountain spotted fever, human ehrlichiosis, tick-borne relapsing fever, Powassan encephalitis, and Colorado tick fever.

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