Journal of Infection (2015) 71, S88–S96

BIA British Infection Association

www.elsevierhealth.com/journals/jinf

Tick-borne diseases of the USA: Ten things clinicians should know

Steven C. Buckingham*

Department of Pediatrics, University of Tennessee Health Science Center and Le Bonheur Children's Hospital, 50 N. Dunlap Street, Research Tower, Room 464R, Memphis, TN 38103 USA

Accepted 21 April 2015
Available online 24 April 2015

KEYWORDS
Tick-borne diseases;
Rocky Mountain spotted fever;
Ehrlichiosis;
Lyme disease;
Anaplasmosis;
Tularemia;
Babesiosis;
Doxycycline;
DEET

Summary This article highlights critical aspects of the epidemiology, diagnosis, and management of tick-borne infections in children. Principles that apply broadly across the continental United States are emphasized, rather than details of each disease. Tick-borne infections are often confused with other, more common childhood illnesses, in part because of their nonspecific initial clinical findings and because patients are usually unaware of their preceding tick exposures. This is a problem, because delays in starting appropriate antibiotic therapy increase the likelihood of adverse outcomes from these infections, especially Rocky Mountain spotted fever (RMSF). For patients in whom RMSF is a reasonable diagnostic consideration, therapy should be started presumptively, without awaiting the results of confirmatory diagnostic tests. For both adults and children, doxycycline is the drug of choice for RMSF and other American rickettsial infections. Concerns over the potential toxicity of doxycycline in young children are unfounded. Similarly groundless is the belief in "chronic Lyme disease" as an explanation for persistent nonspecific complaints after completing antibiotic therapy for Lyme disease. Prevention of tick-borne infections rests on avoidance of tick-bites and prompt removal of attached ticks. When used appropriately, insect repellents containing DEET are safe and effective for preventing tick exposures.

Introduction

Many species of ticks are endemic to the Unites States, and some of these serve as vectors for various bacteria, parasites, and viruses that are pathogenic to humans. Summary information regarding the principal established tick-borne infections of the USA are presented in Table 1, while similar data for several emerging tick-borne infections are listed in Table 2. Detailed discussions of these infections are beyond the scope of this article. Instead, this review will emphasize key points that apply broadly to the epidemiology, diagnosis, treatment, and prevention of American tick-borne infections in children. The "ten things clinicians should know" that follow do not comprise a

* Tel.: +1 901 287 6063.
E-mail address: sbucking@uthsc.edu

http://dx.doi.org/10.1016/j.jinf.2015.04.009

Table 1 Established tick-borne infections of the USA.

Disease	Organism	Geographic distribution and vector	Prominent clinical findings[a]
Rocky Mountain spotted fever (RMSF)	*Rickettsia rickettsii*	Eastern states: *Dermacentor variabilis* (dog tick) Mountain West: *Dermacentor andersoni* (wood tick) Southwestern deserts: *Rhipicephalus sanguineus* (brown dog tick)	Fever, headache, petechial rash, hyponatremia, thrombocytopenia
Ehrlichiosis[b]	*Ehrlichia chaffeensis*	Southeastern and south-central states: *Amblyomma americanum* (Lone Star tick)	Similar to RMSF, but rash is less common; leukopenia, thrombocytopenia, elevated transaminases
Anaplasmosis[c]	*Anaplasma phagocytophilum*	Northeast and upper Midwest: *Ixodes scapularis* (blacklegged tick) Pacific coast: *Ixodes pacificus*	Similar to HME, but rash is rarely present
Lyme disease	*Borrelia burgdorferi*	Northeast and upper Midwest: *I. scapularis* Pacific coast: *I. pacificus*	First stage: fever, erythema migrans (rash) Second stage: multiple skin lesions, conjunctivitis, arthralgias, myalgias, headache, cranial nerve palsies Third stage: arthritis; encephalopathy, dementia, peripheral neuropathy
Endemic relapsing fever	*Borrelia hermsii* *B. turicatae* *B. parkeri*	Western mountains and deserts: *Ornithodoros* species	Fever, chills, relapsing course
Tularemia	*Francisella tularensis*	Eastern states: *D. variabilis* Mountain West: *D. andersoni* Southeastern and south-central states: *A. americanum*	Fever, cutaneous eschar, lymphadenopathy, pulse—temperature dissociation
Babesiosis	*Babesia microti*	Northeast, Midwest, and West Coast: *I. scapularis*, other *Ixodes* species	Fever, malaise, headache, hepatosplenomegaly, thrombocytopenia, hemolytic anemia
Colorado tick fever	Colorado tick fever virus (genus: Coltivirus)	Mountain West: *D. andersoni*	Fever, headache, leukopenia, thrombocytopenia; biphasic course

[a] Not all patients with these diseases will have all of these findings, and some may present with additional features. Many cases present simply with fever and vague constitutional symptoms.
[b] Also known as *human monocytotropic ehrlichiosis* (HME).
[c] Also known as *human granulocytotropic anaplasmosis* (HGA); previously termed *human granulocytic ehrlichiosis* (HGE).

comprehensive overview of tick-borne infections. Rather, they are intended as a starting point for clinicians wishing to learn more about this topic.

Patients are exposed to ticks more frequently than you might think

It may seem surprising, but most persons who experience a tick attachment are actually unaware of their exposure. This is because ticks, especially in their immature stages, are quite small (nymphs, for example, are only 1—2 mm in length—about the size of the head of a pin), and because they frequently attach at hair-bearing body sites and other places where they tend to escape detection. Moreover, because their bites are generally painless, most tick attachments pass unnoticed.[1] It should also be noted that many patients with tick-borne infections lack supposed epidemiologic risk factors for these infections, such as having spent time in a wooded area. Tick-borne infections occur even in urban areas and among people who have never been on a camping trip.[2] A multicenter study of 92 children with laboratory-diagnosed RMSF found that only 49% of patients reported a history of a known tick bite, while only 34% reported a history of exposure to a wooded area.[3] Thus while the historical findings of tick bite or outdoor exposure may provide useful diagnostic clues, their absence never excludes the possibility of a tick-borne illness. Underscoring this point, data from seroprevalence studies indicate that more than 10% of children in the southeastern and south-central portions of the U.S. have significant antibody titers against *Rickettsia rickettsii* and