Arthropod-borne disease in Canada: A clinician's perspective from the 'Cold Zone'

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Arthropod-borne diseases do not occur commonly in Canada. Nevertheless, Canadians run the risk of contracting certain infections within the country during arthropod season, as well as when travelling abroad. Therefore, it is important that clinicians are aware of the possible occurrence of arthropod-borne diseases, and consider them in their differential diagnoses. The present review is divided into two sections: arthropod-borne diseases or disease agents documented in Canada, and imported arthropod-borne diseases. The review also provides brief overviews of these diseases.

Key Words: *Arthropod-borne diseases; Zoonotic diseases*

Les maladies transmises par des arthropodes au Canada : La perspective d'un clinicien de la «zone froide»

Les maladies transmises par des arthropodes surgissent rarement au Canada. Néanmoins, les Canadiens courent le risque de contracter certaines infections au pays pendant la saison des arthropodes et quand ils voyagent à l'étranger. Par conséquent, les cliniciens doivent être conscients de l'occurrence possible de maladies transmises par des arthropodes et en tenir compte au moment de leur diagnostic différentiel. La présente revue se divise en deux parties : les maladies ou les agents de maladies transmis par des arthropodes documentés au Canada et les maladies transmises par des arthropodes importées. La revue procure également un bref aperçu de ces maladies.

As we enter the 21st century, it is clear that the battle against infectious diseases is far from being won. Internationally, in the area of arthropod-borne diseases, we continue to encounter major threats from diseases such as malaria, dengue, dengue hemorrhagic fever, Japanese encephalitis and plague. Our battle to control the important mosquito disease vector *Aedes aegyptii* has suffered a severe setback, and another very relevant vector, *Aedes albopictus*, has gained a foothold in the Americas.

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possible occurrence of arthropod-borne diseases, and consider the diseases in their differential diagnoses. A list of arthropod-borne diseases of potential interest to Canadian clinicians is presented in Table 1, and a brief summary of the incubation period and the clinical syndromes of these diseases are presented in Table 2.

The present review is divided into two sections: arthropod-borne diseases or disease agents documented in Canada, and imported arthropod-borne diseases. The diseases are described in the following order: bacterial, rickettsial, viral and parasitic. Two of the diseases listed in Table 1, Q fever and *Bartonella* infections (cat scratch disease, bacillary angiomatosis, etc), will not be discussed because their primary means of transmission is not arthropod borne.

TABLE 1: Arthropod-borne diseases of potential interest to Canadians

Disease	Microbial category	Arthropod host	Distribution
Lyme disease	Bacterial	Tick	• Southern Ontario, British Columbia, sporadic elsewhere, imported cases
Relapsing fever	Bacterial	Tick	• British Columbia
Tularemia*	Bacterial	Tick	• Canada wide
Plague	Bacterial	Flea	• Western Canada
Bartonella*	Bacterial	Louse, flea	• Potentially Canada-wide [†]
Q fever*	Rickettsial	Tick	• Canada-wide
Rocky Mountain spotted fever	Rickettsial	Tick	• British Columbia, Alberta, Saskatchewan, Ontario, Nova Scotia
Human granulocytic ehrlichiosis	Rickettsial	Tick	• Potentially in Canada [†] , imported
Endemic (murine) typhus	Rickettsial	Flea	• Potentially Canada-wide [†]
California encephalitis	Viral	Mosquito	• Canada-wide
Western equine encephalitis	Viral	Mosquito	• Western Canada
Eastern equine encephalitis	Viral	Mosquito	• Quebec, Ontario
Powassan encephalitis	Viral	Tick	• Ontario, Quebec, New Brunswick
Colorado tick fever	Viral	Tick	• Alberta, British Columbia
St Louis encephalitis	Viral	Mosquito	• Ontario, Quebec, Manitoba, Saskatchewan
Cache Valley	Viral	Mosquito	• Ontario, Manitoba, Saskatchewan, Alberta
Dengue	Viral	Mosquito	• Imported
Exotic arboviral infections	Viral	Mosquito, tick, sandfly	• Imported
Malaria	Parasitic	Mosquito	• Imported
Babesiosis	Parasitic	Tick	• Potentially in Canada [†] , imported

*The disease may have an arthropod-borne association, but it is not necessarily the main means of transmission to humans; [†]Reflects speculation by the author

TABLE 2: Arthropod-borne diseases and accompanying clinical syndromes of potential interest to Canadian clinicians

Disease	Incubation period (days)*	Clinical syndrome
Lyme disease	3 to 30	• Early disease – erythema migrans, myalgia, fever, arthralgia, lymphadenopathy; late disease – arthritis, encephalopathy
Relapsing fever	4 to 18	• Fever, fatigue, chills, myalgia, arthralgia
Tularemia	3 to 21	• Fever, chills, myalgia types: ulceroglandular, glandular, oculogranular, oropharyngeal, typhoidal, pneumonia
Plague	2 to 7	• Types: bubonic (febrile illness, regional lymphadenitis buboes), septicemia, pneumonia, meningitis
Bartonella	3 to 38	• Trench fever, bacillary angiomatosis, bacteremia, hepatitis, endocarditis, chronic lymphadenopathy, cat scratch disease
Q fever	14 to 39	• Fever, chills, fatigue, myalgia, hepatitis, pneumonia, encephalitis
Rocky Mountain spotted fever	2 to 14	• Fever, myalgia, malaise anorexia, exanthem
Human granulocytic ehrlichiosis	3 to 16	• Fever, malaise, myalgia, anorexia, seizure, coma
Endemic (murine) typhus	8 to 16	• Fever, chills, myalgias, diarrhea, exanthem
California encephalitis	5 to 15	• Febrile illness, encephalitis, possible respiratory involvement
Western equine encephalitis	5 to 15	• Fever, encephalitis, occasional respiratory symptoms
Eastern equine encephalitis	3 to 10	• Fever, encephalitis, anorexia
Powassan encephalitis	8 to 34	• Fever, encephalitis, respiratory distress, lethargy
Colorado tick fever	3 to 14	• Fever, lethargy, myalgia, exanthem meningoencephalitis
St Louis encephalitis	4 to 21	• Fever, malaise, encephalitis
Cache Valley	Unknown	• Implicated in congenital defects of the central nervous system
Dengue	3 to 15	• Febrile illness may be biphasic with rash, hemorrhagic fever, shock
Exotic arboviral infections [†]	3 to 18	• Fever, encephalitis, arthralgia, hepatitis
Malaria	12 to 30 [†]	• Fever, chills, headache, shock, renal failure, encephalitis
Babesiosis	7 to 42	• Fever, chills, myalgia, arthralgia, fatigue

*Use as a guideline only. The incubation periods cited in the literature tend to vary greatly for certain diseases. [†]Examples of possible arbovirus infections include West Nile encephalitis, Japanese encephalitis, Ross River fever, Sandfly fever, tick-borne encephalitis and Rift Valley fever. [‡]Some strains may have a protracted incubation period of eight to 10 months

ARTHROPOD-BORNE DISEASES OR AGENTS DOCUMENTED IN CANADA

Lyme disease

Lyme disease is the most common vector-borne disease in the United States, and clearly warrants attention from Canadian clinicians. Two major tick vectors of Lyme disease, *Ixodes scapularis* and *Ixodes pacificus*, have been documented in Canada with endemic sites in southern Ontario and parts of British Columbia, respectively (1). In addition to the tick populations that reproduce in Ontario and British Columbia, adult *I. scapularis* have been detected sporadically in all provinces from Newfoundland to Saskatchewan (1,2).

Lyme disease begins as a localized infection that may spread and result in acute, subacute or chronic manifestations involving one or more organ system. An erythema migrans rash and symptoms which may include fever, malaise, headache, mild neck stiffness, arthralgia and fatigue, generally characterize localized early disease. Disseminated disease involving the skin, joints, heart and nervous system may occur.

It is difficult to determine how many cases of Lyme disease occur in Canada because this disease is not nationally notifiable, and many cases treated by clinicians as clinical cases of Lyme disease do not meet the established surveillance case definition of Lyme disease (3) and are, therefore, never reported. A survey of provinces by the Bureau of Infectious Disease, Laboratory Centre for Disease Control (LCDC), Ottawa, Ontario revealed that 287 cases of Lyme disease were reported from 1987 to 1996 – 136 of which were considered to be imported. The above numbers should be interpreted with caution and regarded as an under-representation of the true number of Lyme disease cases that occur in Canada.

Diagnosing Lyme disease can be difficult. The etiological agent is hard to demonstrate in clinical specimens; thus, serology is used most commonly as the diagnostic test of choice. However, false positive and negative serology are a problem. Clinicians should use serological tests as helpful supportive information, but should interpret these results in conjunction with appropriate clinical input and epidemiological data.

Guidelines have been recommended by the Canadian Paediatric Society for the treatment of children with localized and disseminated Lyme disease (4). Doxycycline, amoxicillin or azithromycin are extremely effective against the symptoms and complications of early Lyme disease. Intravenous antibiotic treatments, usually ceftriaxone or cefotaxime, are usually given for persistent or widespread disease, although oral doxycycline may also be effective.

Relapsing fever

Relapsing fever is a zoonotic disease that occurs in the western United States, and it has been documented in British Columbia. It is assumed to be transmitted in British Columbia by the soft-shell tick *Ornithodoros hermsii*;

cases have been recognized in West Kootenay, Kalamalka Lake and West Vancouver (1). The spirochete responsible for causing relapsing fever generally causes a febrile, septicemic disease with a sudden onset followed by a fever, an afebrile interval and numerous relapses, particularly in untreated patients. Tetracycline, erythromycin, chloramphenicol and penicillin have been used in the treatment of relapsing fever.

Tularemia

Tularemia may be contracted from blood-sucking insects – the insects account for one-third to one-half of all human infections. Other means of transmission include contact with blood or other tissue fluids of infected animals, ingestion of inadequately cooked meat from infected rabbits, animal bites, infected water or aerosol transmission (5). Of the 150 to 200 cases of tularemia reported annually in the United States, nearly 21% of the cases occur in children younger than 14 years of age (6).

Tularemia has been recognized Canada-wide. It is endemic in central and western Canada, and is less frequently reported in the eastern provinces (7). Various clinical symptoms can be observed in children, including ulceroglandular (the most common form of tularemia), glandular, oculoglandular, oropharyngeal, typhoidal and pneumonia (6). Streptomycin and gentamicin are the antimicrobial agents of choice for the treatment of tularemia.

Plague

Human plague occurs in the western United States where the bacterium *Yersinia pestis* persists in an endemic cycle involving rodents and fleas. Human infection occurs from the bite of an infected flea, from direct contact with infected mammals or their products, or from the inhalation of contaminated airborne droplets. In Canada, plague infection has been documented in Richardson ground squirrels, and in cats and dogs in southern Alberta and Saskatchewan; and *Y. pestis* has been isolated from fleas removed from rodents in Alberta, Saskatchewan and British Columbia (8,9, Leighton T, personal communication). Plague is not a high risk disease in Canada, but a suspected case involving a mink rancher in Alberta has been reported (9).

The most common form of plague is bubonic plague, but septicemic and pneumonic types also occur. Meningitis has been reported in 5% to 50% of individuals with bubonic or septicemic plague (6). Empirical treatment should be initiated promptly if plague is suspected. Streptomycin is the drug of choice, but tetracycline, chloramphenicol and sulfa drugs, especially sulfadiazine, have also been used.

Rocky Mountain spotted fever

Rocky Mountain spotted fever (RMSF) is one of the most common vector-borne illnesses in the United States. The majority of RMSF cases occur in the middle and south Atlantic states, extending westward through Ten-

nessee, Arkansas, Missouri and Oklahoma (10). The etiological agent, *Rickettsia rickettsii*, has been isolated in ticks in British Columbia, Alberta, Ontario and Nova Scotia (1). Most of the human infections in Canada have been identified in western Canada.

During the first three days of illness, patients experience fever and other constitutional symptoms; complaints of severe, intractable headaches common in older children and adults (10). Myalgias are common, and 8% to 28% of patients may have hepatosplenomegaly and jaundice. From 75% to 96% of patients have a characteristic rash, which appears between days 3 to 5 of illness. The disease may last up to three weeks if untreated. Without effective therapy, close to 25% of patients with RMSF die. Tetracycline is the antimicrobial therapy of choice for RMSF for children who are older than eight years of age. Chloramphenicol is an alternative treatment option.

Human granulocytic ehrlichiosis

Human granulocytic ehrlichiosis (HGE) was first documented in the United States in 1992. Data obtained from 1992 through 1997 from state laboratories reveal that 449 cases of HGE have been reported from the following 11 states: Minnesota, Wisconsin, Illinois, New York, New Jersey, Massachusetts, Connecticut, Rhode Island, Pennsylvania, North Carolina and California (11). To date, the author is unaware of any published case reports of HGE in Canada. However, seropositive patients have been encountered by the Zoonotic Diseases, Bureau of Microbiology Laboratory (unpublished observations). The two major tick vectors of Lyme disease, *I. scapularis* and *I. pacificus*, can be encountered in Canada (see the section above on Lyme disease), and it is reasonable to assume that HGE can be contracted in this country because the major tick vectors of Lyme disease are also capable of transmitting the etiological agent of HGE.

Clinical manifestations of HGE include fever (100% of cases), chills (98% of cases), malaise (98% of cases), myalgias (98% of cases), headaches (85% of cases), nausea (39% of cases), vomiting (34% of cases), a cough (29% of cases), confusion (17% of cases) and, rarely, a rash (2% of cases) (12). This is a severe illness; 56% of patients require hospitalization, and the fatality rate is 5%. When treated early, HGE responds very well to tetracycline, doxycycline and rifampin. Because HGE and Lyme disease have some clinical similarities, it is important to note that HGE does not respond to many antibiotics such as ampicillin and erythromycin that are commonly used to treat Lyme disease.

Murine typhus

Murine typhus, due to infection with *Rickettsia typhi*, is a flea-transmitted zoonosis with rodents as the major reservoir species (13). Murine typhus is a widespread rickettsial disease that occurs on all continents and in a variety of environments. It is common in port cities and coastal areas where commensal rodents and their ecto-

parasites are present. There is not much literature describing the occurrence of murine typhus in Canada, but diagnostic tests conducted by the Zoonotic Diseases laboratory of the LCDC have occasionally yielded positive typhus serology, possibly due to infection with *R. typhi*. The case histories of two typhus-positive patients from British Columbia are published elsewhere (14).

Symptoms of murine typhus include headache, backache, arthralgia, myalgias and fever. The fever may be extremely high and last up to two weeks with a rash that begins on the trunk and spreads peripherally. Murine typhus tends to be mild in children. Tetracycline is the preferred drug, and chloramphenicol is a possible alternative treatment.

California encephalitis

California encephalitis is caused by one of several members of the California (CAL) serogroup of bunyaviruses. Two members of the CAL serogroup, the snowshoe hare and Jamestown Canyon viruses, have been implicated as etiological agents of disease in Canada (15). These mosquito-transmitted viruses are endemic to and have a widespread distribution throughout Canada. Human disease in Canada due to CAL serogroup viruses was first documented in 1978 when four infections were diagnosed – three from Quebec and one from Ontario. In all four instances, the snowshoe hare serotype was implicated as the infecting virus. In 1981, the Jamestown Canyon serotype was shown to have caused encephalitis in an Ontario resident.

Eight of the first 11 cases of California encephalitis documented in Canada occurred in children (16) who were 10 years of age or younger. Clinical symptoms included headache, fever, vomiting and upper central nervous system involvement ranging from aseptic meningitis to viral encephalitis. There were no fatalities. Serosurveys have revealed extensive human infection by CAL serogroup viruses throughout Canada, with prevalence rates from 0.5% to 31.9%. Most likely, human disease occurs much more commonly than is currently recognized, particularly in children. Clinicians should consider California encephalitis as part of their differential diagnosis in patients who present during mosquito season with febrile illness and central nervous system manifestations.

Western equine encephalitis

Western equine encephalitis (WEE) is a mosquito-transmitted viral disease that occurs in western Canada, primarily in Manitoba and Saskatchewan (15). Historically, from a human and animal disease perspective, WEE has been the most significant arbovirus in Canada. More than 1500 human symptomatic WEE infections have been diagnosed in Canada, spanning every decade from the 1930s to the 1980s. The last recorded outbreak in Canada was in 1983. The virus has been relatively quiet in North America since that time, but future outbreaks are inevitable.

The onset of illness is sudden with accompanying fever, chills, headache, nausea, vomiting and occasional respiratory symptoms (17). The spectrum of WEE infection ranges from unapparent to full-blown encephalitis, and it encompasses mild forms of illness such as fever with headache and aseptic meningitis. The ratio of unapparent to apparent infection is markedly age dependent, with disease more commonly the result of infection, particularly in infants under one year of age.

Eastern equine encephalitis

Infection with Eastern equine encephalitis, a mosquito-transmitted alphavirus, generally results in a more severe form of encephalitis. Fortunately, eastern equine encephalitis (EEE) does not occur commonly in the United States, and human disease has never been documented in Canada. Nevertheless, equine cases of EEE have been documented in Quebec and Ontario (18-20).

Subclinical infections with the EEE virus are less common than subclinical infections with the other arboviral encephalitides. The more characteristic clinical presentation of EEE is similar to that of other types of viral encephalitis but it is more severe. The prodrome of EEE typically is short, but the progression of encephalopathy is rapid and dramatic. Stupor or coma occurs in 90% of patients and seizures are experienced by 74% of patients. Approximately one-half of patients die. The incidence of EEE is highest among young children, perhaps reflecting an increased risk of being bitten by infected mosquitoes.

Powassan encephalitis

Powassan encephalitis is a rare, tick-transmitted viral disease with 27 symptomatic infections recognized in North America, including cases in Ontario, Quebec and New Brunswick (21). Proven or probable reservoirs include woodchucks, striped skunks, long tailed weasels, raccoons and snowshoe hares. Pets may serve as a medium for bringing infected ticks into contact with humans.

The disease is quite severe. Clinical manifestations include onset of fever and convulsions, prodromata such as sore throat, sleepiness, headache and disorientation, and encephalitis characterized by vomiting, respiratory distress and prolonged fever (22). Sixteen of the first 23 cases of Powassan encephalitis occurred in children who were younger than 15 years of age.

Colorado tick fever

Colorado tick fever (CTF) is a viral disease that occurs predominantly in the western United States. CTF virus is transmitted by the wood tick *Dermacentor andersoni*; squirrels and chipmunks serve as the primary animal reservoirs. Humans typically become infected while participating in recreational activities. Infected ticks have been found in Alberta and British Columbia, and one symptomatic infection has been recognized in Alberta (1).

Symptoms of CTF begin with an abrupt onset of an

influenza-like illness, including fever, malaise, arthralgia and myalgia, vomiting, headache and decreased sensorium. These symptoms may be accompanied by a diffuse macular rash. Aseptic meningitis has been observed in a small number of infected children.

St Louis encephalitis

St Louis encephalitis (SLE) is the most frequent cause of human arbovirus encephalitis in the United States. It is a mosquito-transmitted viral disease that tends to occur in one of two epidemiological patterns. Urban outbreaks occur east of the Rocky Mountains, and generally involve *Culex pipiens* - *Culex quinquefasciatus* complex mosquitoes, whereas SLE in the far western United States occurs primarily in rural regions, and it is transmitted primarily by *Culex tarsalis*.

SLE virus was isolated from a pool of *C tarsalis* in Saskatchewan in 1971 (15). Human disease due to SLE was recognized in 1975 during an unprecedented outbreak of SLE on the North American continent when 66 cases were diagnosed in southwestern Ontario, and one case each was diagnosed in Quebec and Manitoba. There has been no clear evidence of SLE activity in Canada since 1977.

A wide range of clinical manifestations are evident, ranging from unapparent infection to death, but the majority of SLE infections are asymptomatic. Onset of illness is abrupt with acute onset of fever, headache, dizziness, nausea and malaise. Frank signs of central nervous system infection develop progressively and include a stiff neck, disorientation, tremulousness and unsteadiness. Patients with symptomatic infections may present with aseptic meningitis without signs of central nervous system dysfunction, particularly in the paediatric age group. Advancing age is a strong risk factor for disease and death.

Cache Valley disease

Cache Valley virus is a mosquito-transmitted bunyavirus that has been isolated in Alberta, Saskatchewan, Manitoba and Ontario (23-24). This virus has been implicated recently as an etiological agent of human congenital defects of the central nervous system (25).

IMPORTED ARTHROPOD-BORNE DISEASES

Dengue

Dengue and dengue hemorrhagic fever (DHF) are mosquito-transmitted flavivirus diseases that occur in tropical regions of the Americas, Africa, Asia and Oceania. Dengue and DHF are the world's most significant mosquito-borne viral diseases with approximately 20 million cases per annum, and they affect more than 100 countries (26). Although the major mosquito vectors of the dengue virus do not occur in Canada, cases of dengue occur in Canadians who travel abroad. From 1974 to 1996, 158 confirmed and 373 suspected flavivirus infec-

tions, almost all due to dengue virus, have been recognized by the Zoonotic Disease Laboratory, LCDC (27). These figures underestimate the number of dengue infections contracted by Canadians each year because they do not take into account figures from at least one provincial laboratory (Ontario), and many Canadians who contract dengue are, most likely, never tested.

Clinical manifestations of dengue include sudden onset of fever, headache, and joint and muscle pain. In addition, nausea, vomiting, abdominal pain and rash may occur. Dengue fever typically lasts three to seven days, but convalescence may be prolonged. DHF generally progresses along a similar initial phase as that of dengue, followed by hemorrhagic phenomena, bleeding from multiple sites and vascular collapse. Treatment is supportive, and there is no vaccine available to date.

The reader is referred to expert guidelines drafted by the Committee to Advise on Travel and Tropical Medicine (CATMAT) for advice concerning personal measures to avoid mosquitoes and issues related to medical intervention (28), <www.hc-sc.gc.ca/hpb/lcdc/publicat/ccdr/96vol22/dr2204ea.html>.

Exotic arboviral infections

Beyond dengue, many more arboviral diseases may be contracted by Canadians who travel abroad. Some illnesses manifest themselves as acute, febrile diseases and hemorrhagic fevers. Examples of fevers include Yellow, Mayaro, Chikungunya, O'Nyong-nyong, Sindbis, Ross River and West Nile. In addition, travellers may be exposed to arboviruses that may manifest themselves in an encephalitis syndrome. Examples include Japanese encephalitis, Murray Valley encephalitis, tick-borne encephalitis and West Nile encephalitis.

From 1974 to 1989, confirmed or possible imported arbovirus infections that have been recognized in Canada include Chikungunya, tick-borne encephalitis, Japanese encephalitis, Ross River and Rift Valley fever (29,30). More recently, a fatal case of West Nile encephalitis was diagnosed in an Ontario resident who returned home from New York city (31).

Malaria

Malaria occurs both in the tropics and, less frequently, in temperate zones of the world. This mosquito-transmitted, parasitic disease causes approximately one million deaths each year, mostly among children, and it is becoming increasingly difficult to treat and prevent malaria. Indigenous malaria posed an important health risk in Canada in the 19th century but gradually disappeared early in the 20th century (32). Nevertheless, malaria is a serious threat to Canadians who visit locations where malaria is endemic. For example, 1036 cases of malaria were reported in Canada in 1997; these figures are considered to be an underestimation of the true number of imported cases that infect Canadians annually.

Symptoms of malaria include fever, headache, nausea, vomiting, diarrhea, myalgias and malaise. In 30% to 40% of acute cases, the spleen is enlarged and the liver may be tender (26). Respiratory and renal failure, shock, acute encephalopathy, pulmonary and cerebral edema, coma and death may result from severe cases. Case fatality rates among untreated children and nonimmune adults exceed 10%.

Expert guidelines have been published by CATMAT (33), and are available at <www.hc-sc.gc.ca/hpb/lcdc/malar97index.html>. The reader is referred to these guidelines for information concerning the treatment and diagnosis of this extremely serious disease.

Babesiosis

Babesiosis is a malaria-like, tick-borne illness caused by intraerythrocytic protozoa in the genus *Babesia*. The majority of cases of babesiosis in the United States occur in the northeastern United States, but cases are also encountered in the upper midwest and the west coast states. Two imported cases of babesiosis have been recognized in Canada, in Ontario and Alberta (34-35). The relevant tick vectors, *I. scapularis* and *I. pacificus*, have been documented in Canada (see the Lyme disease section above), and it is possible that locally contracted cases of babesiosis may be encountered in Canada.

Common clinical manifestations of babesiosis include fever, chills, sweats, myalgia, arthralgia and fatigue. Less common symptoms include anorexia, nausea, vomiting and headache. In contrast with other tick-borne illnesses such as Lyme disease, RMSF and tularemia, a rash is seldom noted with babesiosis. A combination of antiparasitic agents (clindamycin and quinine) has been effective in treating most patients. Exchange blood transfusion may be required in patients with very high-grade parasitemia.

Diagnostic tests for most arthropod-borne disease agents are not performed commonly in Canada. Some tests may be available in provincial public health laboratories, whereas other tests may have to be referred to the LCDC. Information concerning the health hazards for travellers in relation to many of the diseases discussed in this review are available from the Health Canada web site <www.hc-sc.gc.ca/hpb/lcdc/osh/prof_e.html>.

CONCLUSIONS

From a Canadian perspective, the burden of arthropod-borne disease is relatively low, but there is no room for complacency. The major tick reservoirs for Lyme disease, HGE and babesiosis, appears to be spreading in Ontario, and it is also showing up in many other parts of Canada where it is not currently documented to be endemic. Changing weather patterns may aid in the establishment of relevant arthropod vectors such as *A. albopictus*, and, as more and more Canadians travel, the risk of contracting arthropod-borne infections

abroad increases. The danger of having an exotic arbovirus become established on this continent was brought close to home in 1999 with the outbreak of West Nile encephalitis in New York, New York (31). It remains to be seen whether this virus will be established in the Americas and, possibly, make its way to Canada where appropriate

mosquito vectors and reservoir hosts exist to support an amplification cycle.

This brief review is intended to remind clinicians of the potential for arthropod-borne diseases to occur in the 'Cold Zone', Canada, and to urge them to consider these diseases when making their diagnoses.

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Internet addresses are current at the time of publication.

Arthropod-borne disease – Quiz

Answer the following questions by circling the letter of the correct answer(s). Answers can be found on page 236.

1. Which of the following arthropod-borne diseases would not be contracted in Canada?
 - a) Lyme disease
 - b) Dengue
 - c) Powassan encephalitis
 - d) Rocky Mountain spotted fever
 - e) California encephalitis
2. Which of the following arthropod-borne diseases is transmitted by a flea?
 - a) Plague
 - b) Lyme disease
 - c) St Louis encephalitis
 - d) Relapsing fever
 - e) Human granulocytic ehrlichiosis
3. Which arthropod-borne disease previously considered exotic to North America occurred in outbreak form in New York, New York in 1999?
 - a) West Nile encephalitis
 - b) Dengue fever
 - c) Malaria
 - d) Babesiosis
 - e) Japanese encephalitis
4. Which of the following has historically been the most significant arboviral disease in Canada?
 - a) Powassan encephalitis
 - b) California encephalitis
 - c) Western equine encephalitis
 - d) Eastern equine encephalitis
 - e) St Louis encephalitis
5. Which of the following statements is false?
 - a) Dengue fever is the most common mosquito-transmitted disease worldwide.
 - b) Tularemia may be contracted via the ingestion of inadequately cooked meat.
 - c) Murine typhus is a flea-transmitted zoonosis.
 - d) Rocky Mountain spotted fever occurs only in the western part of North America.
 - e) Diagnosis of Lyme disease may be difficult.