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Ticks and Tick-Borne Pathogen Importance for Public Health

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Abstract
The current review was established to display, for professional people, the tick species, tick geographical distribution, and the pathogens that are transmitted by these ticks, leading to the incidence of a wide range of diseases that have different levels of severity, from low to high fatal diseases, such as Crimean–Congo hemorrhagic fever virus (CCHFV). Ticks are important vectors that can transmit various pathogens, such as viruses, and basically those can cause neurologic and hemorrhagic health problems, such as Crimean–Congo hemorrhagic fever virus. The best way to protect and treat patients infected with tick-borne pathogens is to identify tick species and their feeding duration, and this will help understand the best treatment procedures.
Keywords: Crimean–Congo hemorrhagic fever virus, Ticks.

Introduction

The most of vector-borne illnesses in North America, Europe, and Asia are delivered by ticks. Ticks are to blame for the majority of instances of vector-borne illness in the United States. Perhaps the most common illness transmitted by ticks in the northern hemisphere is Lyme disease. There are roughly 300 000 instances of Lyme disease identified in the United States each year, according to two surveys (1,2). This estimate is around 10-fold larger than the quantity of reported incidents. Lyme disease may be one of the most frequent infectious illnesses in the United States, based on these estimations. As many as 10,000 instances of tick-borne infections are recorded each year, even though the true number is likely much higher (3).

Tick-borne illnesses have a substantial economic burden, which is only becoming worse year after year. In 2002, the estimated cost of treating individuals with Lyme disease only in the United States were USD $8172 per patient, which is equivalent to USD $11 838 in 2019. More than $500 million is estimated to be spent each year by the Centers for Disease Control and Prevention (CDC) depending on the 42 743 cases recorded in 2017. Patients with post-treatment Lyme disease syndrome may have to pay even more (4). One-fourth of Lyme disease patients get public assistance or disability assistance, which places a significant financial burden on society. The hotel and tourist business in the endemic regions is subjected to extra economic expenses that are large but difficult to measure (5). Lyme disease's impact on public health isn't limited to the United States. Several European governments have spent tens of millions of euros treating Lyme disease, according to a recent thorough assessment.

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The total public health burden of all illnesses transmitted by ticks is still largely unquantified (6,7).

Aside from human tick-borne illnesses, veterinary tick-borne diseases have the potential to be devastating, particularly for those living in underdeveloped nations (8). At an expected cost ranging from $13.9 billion to $18.7 billion USD, 80% of the planet's cattle herd is at risk of contracting a tick-borne illness. About 1.3 million cattle died from theileriosis (68%), babesiosis (13%), and anaplasmosis (13%), in Tanzania, a country where the economic damages caused by tick-borne illness have been measured (9). Ticks are now attracting the interest of a wider spectrum of public health specialists due to the growth in tick populations and the rising prevalence of illnesses transmitted by ticks. This review aims to outline the most recent achievements in tick-borne illnesses, with a focus on newly identified or emerging diseases globally that constitute a public health issue (10).

There are different species of ticks that transmit diseases to humans, such as species from the genera; *Ixodes*, *Haemophysalis*, *Hyalomma*, *Rhipicephalus*, *Amblyomma*, etc. Table (1) shows some details about diseases transmitted by these tick species and the regions where these diseases are currently present (11).

Table 1: Tick species and tick-borne microbial diseases

Tick-borne viruses			
Disease	**Tick species**	**Regions**	**Spread type**
Encephalitis	*Ixodes ricinus* and *I. persulcatus*	Middle east, Asia, and Europe	Widespread
Encephalitis (Powassan)	*I. scapularis* and *I. cookei*	USA, Canada, and Russian	Elevating even it is rare
Omsk haemorrhagic fever, Kyasanur Forest Disease, and louping ill	*Ixodes, Dermacentor*, and *Haemophysalis* sp.	Middle east, Asia, and Europe	Elevating even it is rare

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Crimean–Congo haemorrhagic fever	mainly *Hyalomma marginatum*	Middle east, Asia, Europe, and Africa	Widespread
Thrombocytopenia syndrome	*H. longicornis* and *Rhipicephalus microplus*	China, Korea, Japan	Uncommon, increasing
Heartland disease	*Amblyomma americanum*	USA	Not common
Bhanja disease	*Dermacentor* and *Haemophysalis* sp.	Africa, Asia, and Europe	Not common
Thogoto, Dhori, and Bourbon diseases	*Hyalomma*, *Amblyomma*, and *Rhipicephalus* sp.	Africa, Asia, Europe, and USA	Not common
Colorado tick fever	*Dermacentor andersoni*	Canada and some regions in the USA	Not common
Eyach disease	*I. ricinus*	Mid of Europe	Not common
Tick-borne bacteria			
Lyme disease	*I. ricinus*	Europe, Asia, and North America	Widespread
Borreliosis (relapsing fever)	*I. ricinus*	Europe, Asia, and North America	Not common
Borreliosis (relapsing fever) – tick-borne relapsing fever	*Ornithodoros* and *Carios* sp.	All continents but not in Australia	Not common
Southern tick-associated rash illness	*A. americanum*	USA (Southern and eastern regions)	Not common

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Tick-borne-*Rickettsia*			
Rocky Mountain spotted fever	*D. andersoni, D. variabilis,* and *R. sanguineus*	Western parts of the hemisphere	Widespread
Rickettsiosis	*A. maculatum*	North USA and South America	Not common
Pacific Coast tick fever	*D. occidentalis*	USA	Not common
Mediterranean spotted fever	*R. sanguineus*	Europe, Asia, Middle east, and Africa	Not common
African tick bite fever	*Amblyomma* sp.	Africa, West Indies, Oceania	Not common
Tick-borne *Anaplasma* and *Ehrlichia*			
Granulocytic anaplasmosis (Human)	*I. scapularis* and others	USA	Common
Ehrlichiosis (Human)	*A. americanum*	Eastern regions of USA	Common
Neoehrlichiosis	*Ixodes* sp.	Asia and Europe	Not common
Tularaemia	Dermacentor Ixodes, *Amblyomma*, and Haemaphysalis	USA, Canada, Asia, and Europe	Not common
Tick-borne parasites			

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Babesiosis (human)	*I. ricinus* complex	USA, China, and Europe	Common in USA but not common in other regions
Tick-borne non-pathogenic illnesses			
Red meat allergy (Alpha-gal syndrome)	*H. longicornis, A americanum, Ixodes* sp.	Globally	Not common but elevating in the incidence
Tick paralysis	A wide range of tick species	Australia, USA, and others	Not common

The Life of vectors
During enzootic cycles, tick-borne diseases travel throughout ticks and compatible vertebrate hosts, primarily rodents. To keep tick-borne organisms alive and infective in these cycles, both the vectors and the vertebrates are required to complete these life-cycles. Those microorganisms that may be transmitted between animals through the ovary of the vectors (transovarian), in which the tick acts as both a vector and a host, are an exemption to this rule. For the most part, humans do not perform any contribution in transmitting and maintaining tick-borne organisms in the cycles, apart from the tick-borne Relapsing Fever in east parts of Africa, which is triggered by Borrelia duttonii (12,13).
Argasidae (soft ticks) and Ixodidae (hard ticks) are two major groups of ticks that vary in ecological and public health significance. Fast-feeding Argasidae soft ticks (from a few minutes to an hour) may take many blood meals each stage, unlike hard ticks. It is common for soft ticks to go through many phases of development within a single moulting. Consequently, they have a smaller range of habitats (like burrows and caves) than hard ticks. Soft ticks transfer less human infections than hard ticks, which may be related to their shorter feeding periods and host-seeking behaviors (14–17).
In addition to their native habitats, ticks of the Ixodidae family may be located in suburban and urban regions as well. Based on the species and tick phase, hard ticks may feed for durations extending from 3 to12 days and exhibit a variety of host-seeking behaviors. The spreading of infections, particularly bacterial pathogens, is facilitated by continuous attaching between ticks and the hosts (11,18).
There are three phases in the life cycle of hard ticks: larva, nymph, and adult. For most tick-borne illnesses, the larvae and nymphs of the juvenile phases prey on small animals, such as

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rodents. When a tick feeds on an infected host, it picks up tick-borne microorganisms. Pathogens that thrive in their vectors are well acclimatized to their host and can survive during moulting. Microorganism survival and spread need this process, which is known as transstadial transmission. The female tick may transfer certain pathogens to their offspring via ovary, such as Rickettsia species (19–21).

Larvae have a minor function in transmitting transovarial diseases, although their significance in transmitting human pathogens is negligible. Nymphs are the most harmful tick phase for humans because they are tiny, difficult to identify, and busy throughout the spring and summer, which correlates with the greatest human outdoor activity in cold areas. To begin with, an infected tick bite generally causes a non-specific fever with symptomatic features, including chills, headache, sweating, malaise, myalgia, nausea and vomiting, and arthralgias (22). Tick-borne pathogens have varying degrees of virulence and depending on the patient's immune system. Tick-borne infections may range from the non-life-threatening to the life-threatening, depending on the severity of the symptoms. In an instance, Patients with impaired immune systems may have more severe babesiosis, which commonly goes undetected in healthy people (23). Debilitating and long-lasting complications may result from Lyme disease despite the fact that it is rarely lethal. Both tick-borne encephalitis and Powasan virus may be deadly or cause long-term cognitive damage in patients (24). Detection, treatment, and prevention of tick-borne illnesses depend on tick recognition accuracy. Most tick species' larval phases carry almost no threat of humans of pathogen transmission. There are certain tick species, like Ixodes scapularis, that may carry many infectious microorganisms, but most frequently seen ticks are mainly linked with a single pathogen. There must be a precise tick species recognition and the length of tick feeding to successfully prevent Lyme disease with prophylactic antibiotic therapy (25).

Tick-borne viruses

CCHFV has a broad variety of animal hosts and humans and tick species in Eurasia and Africa. Even though CCHFV's transmission and life cycle have been extensively studied, it is still a serious emerging disease in most of its geographic distribution, where it is spread by ticks and infected animals (26). CCHFV impacts the nervous system and generates neurological illnesses before more serious hemorrhagic ones. It takes just a few days for the virus to incubate before symptoms such as severe headaches, dizziness, nausea, and vomiting appear. If left untreated or in nosocomial infections, the disease may be deadly. Ixodidae and Argasidae ticks, in which more than 30 species, have been shown to harbor CCHFV. *Hyalomma* genus is the major vector for the transmission of the virus, including *H. truncatum*, found in Africa, and *H. marginatum*, found in southern Europe and western Asia, which are two of the most common CCHFV (27).

In Iraq, CCHF is an endemic disease. In 1979, CCHF was first detected in Iraq. In 1980, a seroprevalence investigation indicated that animals, such as sheep, goats, cattle, horses, and camels were seropositive at 57.6%, 49.64%, 29.28%, 58.73%, and 23.23%, which indicates that these animals had been previously exposed to CCHFV in three separate faunal zones in

Iraq. From 1998 and 2009, there were between zero and six cases reported of CCHF every year. For the year 2010, there were a total of 11 verified and 28 suspected cases. In Iraq, a case mortality rate of 36% has been recorded among verified cases. Some nosocomial records document sporadic instances and occurrences of CCHF in Iraq, including two fatalities in 1979 (one physician and one nurse), two instances in 1992 (both doctors), and a case in 1996 (also a physician) (26–29).
Flaviviruses that are transmitted by ticks, such as tick-borne encephalitis (TBE), Asian Omsk hemorrhagic fever (AOHF), and Powassan virus, constitute a significant and significant category of viruses transmitted by tick in Europe, China, Russia, and Japan, more than 10,000 people are hospitalized each year because of these viral encephalitis and hemorrhagic symptoms. Haemorrhagic fever with fever and severe bruising and bleeding is a common sign of AOHF. The TBE is transmitted by tick species, such as *I. ricinus* L., *I. persulcatus, I. scapularis, I. pacificus* (30–32).

Conclusion

Ticks are important vectors that can transmit various pathogens, such as viruses, and basically those can cause neurologic and hemorrhagic health problems, such as Crimean–Congo hemorrhagic fever virus. The best way to protect and treat patients infected with tick-borne pathogens is to identify tick species and their feeding duration, and this will help understand the best treatment procedures.

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