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Review Article

Review on: Tick-Borne Zoonotic Diseases and its Implication for One Health Approach

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Abstract

This article concerns to ticks and ticks as vectors of pathogen, their detection methods and controlling mechanism having a major focus on 'One Health' principle against tick and tick born pathogens. In general ticks divide as soft (Argasids) and hard (ixodids). Argasids ticks do not possess a dorsal shield orscutum and they have multi-host life cycles that is two or more nymphal stages each requiring a blood meal from a host and feed rapidly (for about an hour) then dropping off the host. Species of Argasids having importance of transmission of human's pathogens were Argas, Ornithodoros, Carios and Otobius. However, the ixodids (hard) ticks, attached to their hosts for up to several days for feeding. They transmit a variety of pathogens, including viruses, bacteria, rickettsiae, helminthes, and protozoans, all of which are able to cause damage to livestock production and human health. Several tick born disease detection was focused on physical examination, history of exposure to tick, early evaluation and recognition of clinical finding through different diagnostic tools. As many tick born pathogen have no vaccine, so controlling of tick infestation line with acaricides and the acarcides have its own drawback due to resistant pests and an environmental contaminant. Conducting a research activities on alternatives use of acaricides is strongly represented by tick's infection vaccines by considering a more economical and environmentally safe strategy. However, the only protection in case of vaccine availability for pathogens and healthcare workers need to be more aware on correct tick removal, recognition of potential infection, rapid control and treatment. Indeed knowledge of the complex nature of tick's life cycle and epidemiology of tick-borne diseases with respect to One Health framework is crucial for its integral professional profile.

Keywords: Human Pathogens; Tick; Tick-Born Disease; One Health

Introduction

The prevalence rate of tick and Tick-Borne Diseases (TBDs) globally has been increased due to outdoor activities of human beings, changes in demographics, climate, and utilization of land which is resulting of emerging, re-emerging of infectious and zoonotic diseases [1]. Ticks are the second most successful disease vector following mosquito's globally; their successfulness as a disease vector is attributed to their wide distribution, being obligate hematophagous ectoparasite of human, domestic and companion animal [2]. Most of the continents have more than 900 ticks species and every country has at least one species [3]. Ticks are known to transmit a considerable number of pathogenic organisms, such asprotozoans, rickettsiae, spirochetes, and viruses (*anaplasmosis, babesiosis, borreliosis, ehrlichiosis*, *rickettsiosis,* etc) and the most crucial vector of humans and animals [4]. They are also responsible for blood loss, tick worry, damage to hides, skins, and the injection of toxins [5-6]. Most of the tick-borne diseases are zoonotic and increasing globally. The contact between arthropod vectors with humans and animals leading the emergence of infectious disease agents through the enhancement of their potential to reproduce and

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spread World Health (WHO), Food and Organization (FAO) and Organization for des epizotic [7]. About 75% of emerging infectious diseases were zoonoses; nearly 60% of human tick-borne diseases are zoonoses [8]. Human tick-borne diseases have become crucial of interest since the discovery of Lyme borrelios is two decades ago [9].

The concept of One Health is derived from World Health Organization (WHO); which is mainly related to development strategies against tick infestations and Tick Borne Disease (TBD) control in humans and animals. One heath as a tool for integrated approach between ecologists, environmentalists, microbiologists, physicians, public health professionals, vector biologists, veterinarians, and agriculturalists to overcome tick and other vector-borne zoonotic diseases [8]. At the same time, there is a need for specific research and control programs within international organizations such as World Health Organization (WHO), World Organization for Animal Health (OIE), Food and Agriculture Organization (FAO), Centers for Disease Control and Prevention (CDC), and European Center for Disease Prevention and Control (ECDC), 2004) looked-for to fight TBDs based on the "One Health Initiative" concept [10]. The aim of the paper was to review tick-borne human diseases, their detection methods, controlling mechanism and to highlight the use of a "One Health" doctrine in control of tick-a borne human diseases.

Tick in Relation to Transmission of Human Pathogens

Among arthropod vector, ticks transmit different infectious agents between humans and animals. The importance and awareness of the impacts of tick-borne diseases are gradually increasing. Significantly, the frequency of emerging vector-borne zoonotic disease has increased during the last ten years [11]. Epidemiologically some of most commonly reportedly human tick-borne diseases are Lyme disease, tularemia, granulocytic anaplasmosis, Ehrlichiosis, Crimean-Congo hemorrhagic fever, tick-borne encephalitis and Tick borne rickettsioses [12].

Lyme Disease

The bacteria *Borrelia burgdorferi* spirochaete is the causative agent of Lyme disease in human [13]. The disease is extremely severe illness with associated symptoms of recurrent arthritis, mood impairment, facial muscle paralysis, even meningitis or encephalitis heart, and central nervous system [14]. It is transmitted by the bite of *Ixodesscapulari s*tick species. Eight legged nymphal stages play a major role in the transmission of spirochaete to humans [15]. Blacklegged ticks of larva and nymphal stage can feed from mammals, birds, reptiles, and amphibians (disseminate infected ticks to large distances) then ticks need to have a new host at each stage of their life [16]. *Borreliais* not transmitted by transovarial transmission, however each generation of tick must feed on infected reservoir hosts to obtain the bacteria and Bactrerium transmission occur from stage to the other stage via blood meal and become molted [16]. Adults mainly feed on larger animals in the wild, which are not the competent reservoir hosts *Borreliaburgdorferi* spirochetes [17]. Diagnosis of Lyme disease start from a review of patient health history which includes looking for reports of tick bites or residence in an endemic area following with physical examination looking for the presence of rash and other symptom of Lyme disease [18]. Testing during early localized infection is not recommended [19]. Detection of this disease was performed by two methods which is Enzyme-Linked Immunosorbent Assay (ELISA) test and Western blot test. The Enzyme-Linked Immunosorbent Assay (ELISA) test can detect B.burgdorferi antibody but the test has a limitation of false-positive result, it's not used as the sole basis for diagnosis [20]. If the ELISA test is positive and the area not endemic the confirmed by Western blot test method [20]. In tick endemic area prevention and control of Lyme disease was avoid getting bitten, via wearing of pants and socks in areas with lots of trees and when you touch fallen leaves and wear a tick repellent on your skin and clothing that has DEET, lemon oil, or eucalyptus even more use the chemical permethrin on clothing and camping gear then bath 2 hours after coming inside. In addition; look for ticks on your skin, and wash ticks out of your hair then put your clothing into a hot dryer to kill whatever pests might be on them. Indeed, use a tick control product on your pet to prevent and vaccinating them against Lyme disease also the choices of controlling tools [18].

Babesiosis

A global emerging zoonosis of human disease caused the genus *Babesia; Babesiamicroti*, *B. divergens,* and *B. duncani* are the causative agents and itis also an economically crucial disease of cattle [1]. Humans can be exposed to sporozoite which is the causative agent via blood meal and undergo asexual reproduction whereas male and female gametes are differentiated and fused through the sporogony cycle [21]. The disease mainly infects human red blood cells and clinical manifestation happen due to there is multiplication parasite in the red blood cell [4]. Well recognized transmission occurs between humans was blood transfusion [22]. The life cycle of *babesia microti* involves two hosts, primarily in white footed mouse and in tick genus Ixodes; tick is the definitive host in this cycle. The mouse acquires sporozoite (infective form) through blood meal after sporozoite entersinto erythrocyte and undergoeasexual reproduction (budding) and then the parasite differentiated into male and female gametes [22].

Several methods have been employed for identification of this parasitic infection that is, microscopic detection, culture, serological tests, and molecular technique [23]. The recommended preventive strategies were avoidance of tick bite/exposure particularly for immunosuppressd or splenectomized person since infection is fulminant [24]. The risk of exposure was reduce by covering exposed area with clothes, tucking of pants in shoes, skin application of various acaricides and wearing light colored and permethrin-impregnated clothes then careful examination for ticks in body after travel, particularly in children and pets were recommended to prevent tick exposure/bite [25]. Preventing of human babesiosis was done through screening of blood donors using a combination of IFA and PCR method of test [26]. Currently, no vaccine is available for the prevention of babesiosis.

Tularemia

Is transmitted to humans by dog tick (*Dermacentor variabiis*), the wood tick (*Dermcentor*) and the lone star tick (*Amblyommaamericanum*); bacterium Francisella tularemia was motile and rod-shaped [27-28]. Tularemia varies in its method of acquisition, presentation, severity and the diseases how a clinical sign of skin ulcer fever, exhaustion, weight loss, sore throat, nausea, vomiting, abdominal pain, intestinal ulcer, redness, pain, and discharge in the eyes, swollen glands, dry cough, respiratory difficulty, chest pain, meningitis then later develops a glandularulcer, pneumonia and serious complications diarrhea [29-30]. *F. tularensis* is organism of fastidious which requires enriched medium for growth. Conventionally, cysteine glucose blood agar has been the growth medium of choice. However, enriched chocolate agar (cysteine heart agar supplemented with 9% heated sheep red blood cells (CHAB) and nonselective buffered charcoal yeast extract agar also support the growth of the organism and may be used for isolation [31-32]. The guidelines Centers for Disease Control and Prevention (CDC), recommend that the use of CHAB once growth on the general microbiological agars, such as sheep blood agar, chocolate agar, and Thayer-Martin agar, which are routinely used in laboratories. For the isolation of bacteria from clinical specimens, indicates the pathogen to be present [31-33]. The effective preventing measure tularemia in humans is using vaccination [34-35]. In the absence of an effective vaccine, antibiotics are the only available treatment or therapy, and the need to monitor for the appearance of antibiotic-resistant variants strains remains critical [36-28].

Anaplasmosis

Is a crucial tick borne disease of both human and animal and it causes an emerging granulocytic anaplasmosis in human. It is a zoonotic disease of bacteria in the order of Rickettsiales. Anaplsmaisan intracellular pathogen; manifested by febrile systemic illness, hematological abnormalities, and lymphadenopathy [11]. Tick acquire infection during blood meal on infected reservoir host. Therefore transovarian transmission does not exist between female tick and their progeny. Transmission happens by a male one-host tick after repeated feeding on reservoir host and can transfer the infection between hosts [37]. For example, *Amblyomma*species can transmit, African tick-bite fever, a spotted fever group rickettsiosis caused by *Rickettsia africae*, present in many countries sub-Saharan Africa, as well as in the Caribbean region [38]. Detection of anaplasmosis is trhough conventional method using, light microscopy of freshly prepared stained blood smears (Giemsa) for diagnosis in acute phase of the disease. This is rapid, inexpensive and the best way for directvisualization of bacteria before start of antibacterial therapy but less sensitive at lower bacteremia [39]. Serological method of test in carrier or chronic stage was higher in sensitivity and specificity as compared to the conventional microscopy but less sensitive during acute stage. So in late stage of the disease specialized laboratory tests may include Indirect Immunofluorescence Assays (IFA) conducted on the fluid portion of an affected individual's blood (serum) [40-41]. Control of *Anaplasma* comprising of controlling arthropod vectors, enhancing host resistance against ticks, vaccination, sanitary/hygienic measures chemoprophylaxis and chemosterilization [42].

Ehrlichiosis

Is a disease similar to bacterial illness that affects humans and animal commonly associated with fever, headache, fatigue, and muscle aches; the symptoms were mild and never seek medical attention but septic shock, meningoencephalitis or Acute Respiratory Distress Syndrome (ARDS) was the life-threatening cases of ehrlichiosis [43]. Human infections with the bacterium are mainly afforded by dogs' high companionship to human beings. Ehrlichiosis is a tick-transmitted bacterial (*Ehrlichiacanis*) disease of dogs**.** Other species with public health and veterinary importance include *Ehrlichiaruminantium* known for causing Heart water or cowdriosis [44]. Clinically these infections are difficult to diagnose, due to nonspecific symptoms with other diseases [45]. In the laboratory Ehrlichiosis diagnosed by direct identification of intracytoplasmic morulae in leukocytes upon examination of stained blood smears [46]. Serological tests have been used as the tests of choice, but antibody titers typically do not develop in the first week of acute clinical ehrlichiosis [47]. Several PCR-based diagnostic assays have been developed and used for the laboratory diagnosis of ehrlichiosis [47-45].

Crimean-Congohaemorrhagic Fever (CCHF)

is also a viral disease causing tick-borne zoonosis and is transmitted by ixodid ticks, particularly belonging to the *Hyalomma*genus. Crimean-congohaemorrhagic fever is a major public health concern in Africa, the Middle East, the Balkan, Greece, Turkey regions of Europe, and Western Asia [48]. Unlike African Swine Fever (ASF), CCHF has a diversity of domestic animal reservoirs, such as cattle, sheep, and goats [49]. Tick contact with viraemic animal and contact with infected body fluids/blood was the main modes of transmission of CCHF and manifest with noticeable symptoms of a high fever, headache, fatigue, myalgia, and nausea [50]. Detection of CCHF, include Reverse Transcriptase (RT)-PCR, Immunofluorescence Assay (IFA), antibody (IgG, IgM) and antigen-capture ELISA, and virus isolation [48]. Vaccines that use for veterinary may be an alternative or complementary approach to human vaccines [51]. CCHF vaccines for livestock play an important role in preventing human infection by controlling exposure during animal slaughter, as well as interrupting the vector cycle during tick feeding [52].

Tick-Borne Encephalitis (TBE)

Is one of the serious infectious diseases of haemorrhagic fevers in European, Asian continents and the origion of disease is viral. The disease worth particularly in Europe. Manifestation of the disease develops from uncomplicated meningitis to severe meningoencephalitis and/or myelitis [53]. This is a bacterial disease of rodent reservoirs with high medical importance, and wide distribution in the world. It cause high fever throughout the body and may even cause spotted fever syndrome in humans [54]. The Spotted Fever Group (SFG) is transmitted both by transstadial and transovarial transmission in ticks; it means tick act as vector and reservoir of Spotted Fever Group (SFG) and ticks that are free from Rickettsia can get the bacteria by feeding on rickettsemic host, co-feeding or sexual transmission [55]. The routine laboratory confirmation of the TBEV infection is based mainly on the demonstration of specific antibodies in serum (and cerebrospinal fluid), usually by highly sensitive and specific enzyme-linked immunosorbent assay [56]. Active immunization is the most effective way to prevent TBE [57].

Future Perspective of Tick-Borne Disease in Human and Animal

The biology, feeding, and life cycle of ticks and their being vector hosts for disease-causing agents have been ongoing challenges for the livestock industry [58]. To tackle tick borne disease needs further studies on tick symbionts, tick genomes, microbiomes, and microbial interactions should be desired to cure infestations by ticks and pathogens transmitted through ticks [59]. The genomes of ticks are highly complex. Moreover, it has been seen that multiple microbial pathogens are colonizing the same tick and even the same tissues, in cases. The controversy here is the type of endosymbiosis and genetics of the microbial pathogens [60]. The prospect developed due to this situation is that there shall have a probability for genetic exchange between these microbes [61]. Diagnosis is made on physical examination of host, when attached ticks are recognized and recovered. Body of tick is oval or pear shaped, rounded anteriorly, mouth parts not visible from above (except in larva), but more easily seen from the ventral view. For submission to a diagnostic laboratory, ticks should be secured in specimen tubes with or without alcohol. Tick-borne diseases also use the tick species as a reservoir or vector for pathogenic microbes [55].

The majority of zoonotic diseases are transmitted between or among animal and human hosts via consumption of flesh food from domestic and/or feral animals previously infected by disease-causing agents, consuming food and water contaminated by infected animals, human feces, or via vector arthropods [62]. The prevention, control, and management of infectious diseases demand the understanding, identification, and disruption of the complex chain of the pathogen, the vector (temporary host), and the host. The complex pattern of tick-borne diseases has called upon integrated public and veterinary health approach called the One Health approach [1]. One health approach is a new strategy in the last two decades bringing scientists, extension officers, physicians, veterinarians, and technicians and better extension services at the farm or community level together for discussion and research to tackle zoonotic diseases. In other words, the principle behind the One Health approach is the management of the recurrence outbreak of vector-borne veterinary and human diseases through launching joint research programs and referral systems in the human-veterinary health institutions [63].

Conclusion

Ticks are distributed worldwide and global climatic changes, along with social factors, influence tick's habitats and their host. The number of pathogens and the vector potential of ticks may still be undervalued, because of the complex distributions and the great diversity of tick species in diverse ecological habitats. Tick borne disease is long familiar but neglected being recognized due to their impact on human being and livestock of which become global threat. However, tick vector may increase their potential to speard bacteria, viruses, protozoa and helminthes. Such tick borne pathogens are restricted to transmission cycles involving mostly domestic animals and wildlife and/or livestock, ticks themselves. The zoonotic aspect for a specifc tick-borne pathogen may serve as the origin for its epidemiological dissemination towards new environments and this dissemination probably would require the adaptation of both the pathogen and the new vector to each other. However, such knowledge might provide clues to the further identification of tick associated pathogens, especially in epidemic areas with multiple tick species. The emergence and reemerging of tick-borne zoonotic infectious agents is becoming a global problem, therefore there is a need for existing integral surveillance and research in the long term plan for monitoring such problems. Currently, the diseases causing tick vectors are posing a health control crisis in the public - veterinary health services due to conditional relapse, their way of transmission, and the evolvement of frequent acaricide resistance. Vector and reservoir surveillance is importance method of tick control, then, there is no single ideal solution for the control of ticks, so, an integrated control approach is probably the most effective step. Much more work is required to better distinguish between ticks that carry potential pathogens and those that are competent to transmit pathogens to a host. Therefore, to overcome this challenge there is a need to have the collaboration of veterinarians, physicians, and researchers as 'One Health' approach, diagnostic tools. The collaboration areas have been in the animal sampling, ticks, and humans in diverse locations as well as detection of the pathogen by molecular and serology. Hence, constructive implementation of "One Health" with regard to tick and tick borne disease as diagnostic tools, seems crucial for its integrated professional profile.

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