“A One-Health Review of Vector-Borne Zoonotic Diseases in Veterinary Workers and Animal Owners”

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Abstract:

This review examines the link between chronic diseases and vector-borne zoonotic infections among veterinary workers and animal owners. It addresses occupational risks, transmission dynamics, and the growing burden of zoonotic diseases within the One Health framework. Key insights include increased risk factors, diagnostic challenges, and the importance of interdisciplinary collaboration to combat these threats. The review underscores the need to integrate human and animal health strategies to protect professionals and the public from zoonotic diseases.

Introduction:

Vector-borne zoonotic diseases are a significant occupational hazard for veterinary workers and animal owners. This review aims to assess the epidemiological risks and diagnostic challenges posed by these diseases, emphasizing the need for a One Health approach. Transmitted by infected arthropods such as fleas and ticks, vector-borne zoonoses not only threaten animal health, but also pose significant risks to the humans who care for them. This review delves into the complex relationship between chronic diseases in humans and vector-borne infections. It highlights the increased risk of transmission of zoonotic diseases to

veterinarians and animal owners, examines the increasing incidence of these diseases, explores the animal reservoirs and vectors involved, discusses the challenges in detection and reporting, and underscores the importance of a One Health approach in mitigating these risks and safeguarding both human and animal health.

Occupational Health Risks in Veterinary Medicine

Chronic illness is a widespread yet often overlooked issue among veterinary professionals, impacting their physical and mental well-being, career longevity, and job satisfaction. Studies reveal that veterinarians are at increased risk of chronic diseases due to factors such as long working hours, physical and emotional stress, workplace injuries, and exposure to infectious zoonotic diseases [1–4]. The high levels of stress experienced by veterinarians can either trigger new chronic conditions or exacerbate existing ones. Struggling to balance health needs with work demands, many veterinarians face burnout, dissatisfaction, and, in some cases, leave the profession altogether [1,2].

Research shows that veterinarians and veterinary workers are two to four times more likely to die by suicide than the general population [5–7]. Suicide risk is particularly high among people suffering from chronic psychological or cardiac disorders, or with multiple health conditions, including chronic pain and fatigue [8–10]. Addressing chronic disease in veterinary professionals is crucial not only for their well-being but also for the sustainability of the profession. There is a compelling need to evaluate and collect solid data on the incidence of veterinarians leaving the profession or committing suicide due to chronic physical or psychological illnesses, as some of these cases may be related to undiagnosed infectious diseases.

Chronic Diseases and Vector-Borne Zoonoses

Chronic inflammatory diseases have been recognized as the most significant cause of death in the world today, with more than 50% of all deaths being attributable to inflammation-related diseases such as ischemic heart disease, stroke, cancer, diabetes mellitus, chronic kidney disease, non-alcoholic fatty liver disease (NAFLD) and autoimmune and neurodegenerative conditions [11]. The World Health Organization (WHO) ranks chronic diseases as the greatest threat to human health [12]. Chronic diseases account for 74-86% of all deaths worldwide and, in Europe, contribute to 77% of the disease burden and 80% of health expenditures [13]. Common chronic diseases include cardiac, pulmonary, neurological, metabolic (diabetes), and psychological disorders (e.g. depression, anxiety disorder,...), as well as those causing chronic pain disorders [14]. In general, approximately one in three adults suffers from multiple chronic diseases [14].

Patients with chronic conditions such as fibromyalgia, chronic fatigue syndrome, long COVID, and chronic Lyme disease often experience a wide range of symptoms affecting psychological, neurological, gastrointestinal, immune, cardiac, vascular, and musculoskeletal systems [15–19]. Increasing scientific evidence suggests that infectious agents play a larger role in the development of chronic diseases than previously recognised [20–24]. Infections can induce an inflammatory response in the body and there is growing evidence that chronic inflammation can result in chronic conditions such as diabetes, cardiovascular disease, autoimmune disorders, cancers, fibromyalgia and chronic fatigue syndrome [11,20,25].

Vector-borne infections, particularly those transmitted by fleas, ticks, and other biting arthropods, are increasingly linked to chronic diseases, especially to those diseases with an

inflammatory component and/or aetiology [20,21,26,27]. According to a 2016 World Health Organization (WHO) report, vector-borne diseases account for over 17% of all infectious diseases and cause more than one million deaths annually [28]. Many of these diseases are transmitted as co-infections involving multiple bacteria, viruses, or parasites [27,29,30]. In the United States alone, a study identified 19 different tick-borne pathogens [31]. Among the most notable vector-borne pathogens associated with chronic illness are *Borrelia burgdorferi* [32–36], the causative agent of Lyme disease, non-Lyme *Borrelia* species, and *Bartonella* species [37–41].

Table 1. Primary tick-borne pathogens, their vectors, and targeted organ systems

Tick-Borne Disease	**Pathogen**	**Vector**	**Primary Organ Systems Affected**
Lyme Disease	*Borrelia burgdorferi*	*Ixodes* ticks (black-legged tick)	Neurologic, cardiovascular, musculoskeletal
Rocky Mountain Spotted Fever	*Rickettsia rickettsii*	*Dermacentor* ticks (American dog tick)	Neurologic, cardiovascular
Anaplasmosis	*Anaplasma phagocytophilum*	*Ixodes* ticks (black-legged tick)	Hematologic, systemic
Ehrlichiosis	*Ehrlichia chaffeensis*	*Amblyomma americanum* (Lone Star tick)	Hematologic, systemic
Babesiosis	*Babesia microti*	*Ixodes* ticks (black-legged tick)	Hematologic, systemic
Bartonellosis	*Bartonella henselae*, *Bartonella bacilliformis*	Fleas, ticks	Neurologic, cardiovascular, systemic
Borrelia-induced Relapsing Fever	*Borrelia spp.*	Soft ticks (e.g., *Ornithodoros*) and hard ticks (e.g. *Ixodes*, *Ambylomma*)	Neurologic, hematologic, systemic
Tick-Borne Encephalitis	Tick-Borne Encephalitis virus	*Ixodes* ticks (black-legged tick)	Neurologic
Powassan Virus Disease	Powassan virus	*Ixodes* ticks (black-legged tick, groundhog tick)	Neurologic
Tularemia	*Francisella tularensis*	*Dermacentor* ticks (American dog tick)	Respiratory, systemic

Tick-Borne Disease	Pathogen	Vector	Primary Organ Systems Affected
Southern Tick-Associated Rash Illness (STARI)	Unknown	*Amblyomma americanum* (Lone Star tick)	Dermatologic, systemic

Table 2. Primary flea-borne pathogens, their vectors, and targeted organ systems

Flea-Borne Disease	Pathogen	Vector	Primary Organ Systems Affected
Cat Scratch Disease	*Bartonella henselae*	Fleas (from cats)	Neurologic, systemic
Bartonellosis	*Bartonella henselae*, *Bartonella bacilliformis*	Fleas (especially from cats and dogs)	Neurologic, cardiovascular, systemic
Plague	*Yersinia pestis*	Fleas (primarily from rodents)	Respiratory, systemic
Murine Typhus	*Rickettsia typhi*	Fleas (from rats, mice)	Neurologic, systemic
Flea-Borne Typhus	*Rickettsia felis*	Fleas (various species)	Neurologic, systemic

Zoonotic Risks for Veterinary Workers and Animal Owners

Veterinary workers and animal owners face heightened risks of contracting zoonotic diseases due to their close and frequent contact with animals[38, 42-44, 72]. Both domestic and wild animals can serve as reservoirs for diseases, including dogs, cats, horses, and livestock, as well as wildlife such as squirrels and bats [36,41,44–46]. Understanding the complex interactions between animal reservoirs and parasite vectors is crucial for effective disease prevention and control. Veterinary workers' occupational exposure to infected fleas, ticks, and other biting arthropods further increases the likelihood of transmission.

Companion animals like dogs and cats can harbour various vector-borne pathogens, such as *Borrelia spp*., *Bartonella spp*., and rickettsial agents, which pose a risk of zoonotic disease transmission to humans [2,40,42,44,47,48, 72]. Although these pets may not always show symptoms,

they can silently carry infections that are transmitted to humans through vectors such as fleas and ticks [38,42–44,49].

Veterinary professionals and pet owners are particularly at risk of being exposed to these pathogens through bites, scratches, or contact with bodily fluids, potentially acting as bridge hosts that facilitate the spread of diseases [50,51].

In veterinary clinics and animal shelters, the risk of exposure to vector-borne pathogens is always present. Documented cases have shown that veterinarians may experience symptoms such as headaches, fatigue, paraesthesia, fever, and back pain following suspected transmission of *Bartonella* spp., with symptoms resolving upon antibiotic treatment. *Bartonella* spp. have been isolated from biological samples collected from veterinary workers, underscoring the frequent exposure faced by professionals [3,41]. Due to the growing range of *Bartonella* species in pets, it is crucial to increase awareness and implement protective measures to reduce the risk of co-infections with other persistent bacterial pathogens [3,41,42,44].

A study highlighted in JAVMAnews found that DNA from at least one Bartonella species was present in 28% of 114 veterinarians and veterinary technicians [3]. The true prevalence could be even higher, given the relapsing nature of *Bartonella* bacteraemia and the low sensitivity of the most used diagnostic tests for *Bartonella*. In the same study, among *Bartonella*-positive individuals, 70% reported headaches, compared to 40% of *Bartonella*-negative individuals, and 68% of *Bartonella*-positive subjects reported increased irritability, compared to 43% of *Bartonella*-negative subjects.

Drivers of Zoonotic Disease Emergence

Zoonotic diseases are on the rise globally, driven by interconnected factors such as climate change, land-use changes, and human activities [52].

Climate Change and Vector Ecology:

Climate change plays a crucial role in altering the distribution and behaviour of arthropod vectors, including fleas and ticks [52,53]. Rising temperatures, changing precipitation patterns, and habitat shifts create favourable conditions for these vectors, leading to an increase in their populations and the pathogens they carry [54]. This has resulted in the expansion of vector ranges and prolonged transmission seasons worldwide [54,55].

Globalisation and Disease Spread:

Globalisation and increased human mobility facilitate the spread of zoonotic pathogens across geographical boundaries. As people and domestic animals become more dominant globally, pathogens are under increased selective pressure to infect them [56]. Travel-associated transmission of vector-borne diseases poses significant challenges to disease surveillance and control, highlighting the need for coordinated international efforts [56].

Ownership of pets:

The increase in pet ownership worldwide, particularly in urban areas, increases the potential for the transmission of zoonotic diseases [57]. Companion animals, especially dogs and cats,

can transmit several zoonotic diseases directly or indirectly. The risk of transmission depends on factors such as vaccination status, parasite control, and exposure to other animals or specific environments [40,41].

Diagnostic and Surveillance Challenges

The accurate diagnosis and reporting of vector-borne diseases are hampered by various factors, including complex clinical presentations, limitations of diagnostic tests, and gaps in surveillance systems [50,58,59]. These challenges lead to underreporting and misdiagnosis, which obscure the true burden of these diseases.

Complex clinical presentations:

The connection between vector-borne infections and chronic diseases highlights the need to recognise the various clinical manifestations of these pathogens. Flea- and tick-transmitted diseases are well-known mimics of "non-infectious" diseases. For example, Lyme disease symptoms are frequently mistaken for chronic conditions such as fibromyalgia, chronic fatigue syndrome, autoimmune diseases, psychiatric disorders, or non-infectious rheumatologic conditions [30, 33, 39, 64–66]. Similarly, the diverse and often subtle symptoms of Bartonellosis—ranging from cutaneous and neurologic to ocular, cardiovascular, hepatic, and rheumatologic—along with low detection rates, complicate its accurate and timely diagnosis [35,36,40,41,60,61]. Additionally, the diagnostic challenge for vector-borne diseases is heightened by the occurrence of co-infections with other pathogens, complicating clinical assessments and management decisions [27,29,31,31,62,63].

Table 3. Common chronic diseases with similar symptoms to *Borrelia* infections

Organism	Common Symptoms	Common Chronic Diseases with Similar Symptoms
Borrelia burgdorferi	Erythema migrans, fever, fatigue, joint pain, neurological symptoms	Chronic fatigue syndrome, fibromyalgia, multiple sclerosis, anxiety disorders, depression, osteoarthritis, rheumatoid arthritis, muscle pain syndromes (e.g., myofascial pain syndrome)
Borrelia miyamotoi	Fever, chills, headache, muscle pain	Chronic fatigue syndrome, fibromyalgia, flu-like illnesses, anxiety disorders, muscle pain syndromes
Borrelia hermsii	Fever, chills, headaches, relapsing fever	Rheumatic fever, chronic fatigue syndrome, fibromyalgia, depression, muscle pain syndromes
Borrelia recurrentis	Relapsing fever, headache, muscle aches, chills, rash	Malaria, viral infections, chronic fatigue syndrome, depression, muscle pain syndromes

Table 4. Common chronic diseases with similar symptoms to *Bartonella* infections

Organism	Common Symptoms	Common Chronic Diseases with Similar Symptoms
Bartonella henselae	Fever, swollen lymph nodes, fatigue, headache	Lymphoma, chronic fatigue syndrome, fibromyalgia, anxiety disorders, depression, osteoarthritis, rheumatoid arthritis, myofascial pain syndrome
Bartonella bacilliformis	Fever, fatigue, anemia, skin lesions	Hematological disorders, chronic fatigue syndrome, fibromyalgia, anxiety disorders, muscle pain syndromes
Bartonella quintana	Fever, headache, muscle pain, endocarditis	Chronic fatigue syndrome, endocarditis, fibromyalgia, depression, muscle pain syndromes
Bartonella clarridgeiae	Fever, lymphadenopathy, fatigue	Chronic fatigue syndrome, infectious mononucleosis, fibromyalgia, anxiety disorders, muscle pain syndromes

Infectious agents have also been implicated in triggering autoimmune responses in chronic inflammatory diseases, leading to a vast array of clinical symptoms [64]. While establishing a causal link can challenging due to the often-prolonged development time of autoimmune disorders, for certain vector-borne diseases, like Lyme arthritis, the triggering infectious event is definitively known. Lyme arthritis is a late manifestation of Lyme disease [65]. The

host immune response is crucial in this condition characterized by an excessive, dysregulated pro-inflammatory reaction that persists beyond the infection phase [49,65,66].

Diagnostic limitations:

Many of the current diagnostic tests for vector-borne diseases lack the sensitivity or specificity needed to accurately detect active infections. Serological assays may not identify infections in their early or chronic stages, while molecular techniques may be hindered by genetic variability between pathogen strains. Organisms such as *Borrelia* and *Bartonella* are known to escape detection thanks to complex mechanisms such as antigenic variation [67–69], intracellular persistence [70,71], low bacterial load [72,73] episodic bacteraemia [31,58,74], biofilm formation [75,76], latency and dormancy [77,78], and cross-reactivity [79,80].

Under-reporting and misdiagnosis:

The non-specific nature of symptoms and insufficient awareness among healthcare providers contribute significantly to the underreporting and misdiagnosis of vector-borne diseases [22,81,82].

Patients with vector-borne infections may develop symptoms across various organ systems, including musculoskeletal, neurological, cardiovascular, and gastrointestinal systems. In addition to these physical manifestations, mental and neuropsychiatric conditions such as depression, anxiety, bipolar disorder, paranoia, and eating disorders can also occur. Chronic infections have even been linked to conditions like dementia and developmental disorders, including autism spectrum disorder [39,58,60,82–85]. The broad spectrum of symptoms, often mimicking other conditions, presents a diagnostic challenge for physicians [39].

The One Health Approach in Mitigating Zoonotic Risks

Seventy-five per cent of emerging infectious diseases are zoonotic, with a significant proportion transmitted by arthropod vectors [41,86]. Addressing the complex nature of vector-borne zoonotic diseases requires a multifaceted approach, including surveillance, research, education, and collaboration. Adopting a One Health approach is essential to mitigate the risks associated with these diseases [40,41,55,87,88].

One Health initiatives foster information exchange, capacity building, and joint research efforts to tackle vector-borne zoonoses comprehensively. Collaboration between veterinarians, human healthcare professionals, testing laboratories, and environmental experts is crucial for identifying emerging threats, understanding transmission dynamics, and implementing evidence-based interventions [40,41,52,55,89,90].

Veterinary workers, as frontline caregivers, play a pivotal role in recognising and mitigating occupational risks associated with zoonotic disease transmission. They must be aware of their own risk factors and guide their healthcare providers to consider testing for zoonotic diseases if they become ill. Veterinarians also have a responsibility to educate their clients on the importance of parasite control, preventive behaviours, and timely medical intervention, empowering them to protect themselves and their animals [42,59,90]. Moreover, veterinarians play a critical role in reporting zoonotic diseases, contributing to the evidence base that supports One Health efforts to control disease [40].

Conclusion:

The increasing incidence of chronic illness among veterinary professionals, linked to zoonotic diseases, highlights the need for targeted interventions. A robust One Health approach, involving collaboration across human and veterinary medicine, is crucial for preventing zoonotic infections and protecting occupational health. Given the documented relationship between vector-borne diseases, chronic inflammation and chronic illness, further research is needed to explore the role of vector-borne infections in the health challenges faced by those who care for animals.

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