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Substantial Zoonotic Bacterial Pathogen Caused Infections: A Review

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Abstract **Review Article**

Zoonotic diseases are widespread worldwide and represent an important source of infection transmitted directly or indirectly to humans. This article aimed to review the available literature on bacterial pathogens in wild and domestic animals and their significant public health concerns. The key to the transmission methods for infection with zoonotic bacterial pathogen were either by food or water borne, direct or indirect contact, aerosol inhalation, scratches or bites, animal's secretions. Although infected animals may be asymptomatic, they can transmit the infection to humans. This can also cause economic losses due to high animal mortality rates or reduced production. Regarding its impact on public health, it was concluded that zoonoses cause high morbidity of severe human infections and even serious complications worldwide.

Keywords: Zoonotic diseases, bacterial pathogens, public health.

1. INTRODUCTION

Clearly, zoonotic diseases are infections that are transmitted between vertebrate animals and humans, with or without an intermediary [1-3]. Zoonoses are a major cause of infectious disease outbreaks and deaths worldwide [4,5]. It is worth noting that they negatively affect economies and the public health system, especially in developing countries [6]. Animals are reservoir hosts for a wide variety of potential pathogens including bacterial ones [7]. A high proportion of emerging pathogens are zoonoses, particularly those of great global public health importance, such as acquired immunodeficiency syndrome [8], crimean-congo hemorrhagic fever [9], monkey pox [10], Nipah [11], Ebola [12], and COVID-19, which have originated from zoonoses [13,14]. In general, the groups most at risk for these infections include the elderly, children, and immunocompromised individuals [15]. Approximately more than 60% of infectious pathogens that cause human diseases are zoonotic, meaning that they are normally found in animals and also infect humans [16]. However, bacterial zoonoses are no less significant than viral pathogens in causing considerable mortality as recorded in ancient times, coinciding with the absence of vaccines and antibiotics [17,18]. From the above, the prevalence of bacterial zoonoses in our contemporary time remains a concern, especially in developing countries [19,20]. The purpose of this paper is to review and evaluate bacterial zoonoses and their caused infections to increase knowledge of the importance of these pathogens on health system significance.

2. SALMONELLA

In general, salmonellosis is a highly contagious food borne zoonotic disease with significant public health implications, with an estimated annual incidence of approximately one billion infections worldwide. This infection is caused by Gram-negative rod-shaped Salmonella bacteria with a tendency to adapt to the environment. Bacteria, according to taxonomical classification, of the genus Salmonella evolved from the kingdom Eubacteria. Animals can be asymptomatic carriers of serotypes, although most are pathogenic to humans. In infected animals, early pregnancy induces abortion [21].

Typhoid fever and gastroenteritis are the most common clinical manifestations of this infection in humans. It is transmitted by contaminated food, water, and vegetables and particularly in developing countries [22,23]. Poultry is also a major source of these bacteria among farm animals, along with pigs and cattl. Food-producing animals become infected through contact with wildlife, the environment, contaminated water, or feed [24] as explain in Figure (1).

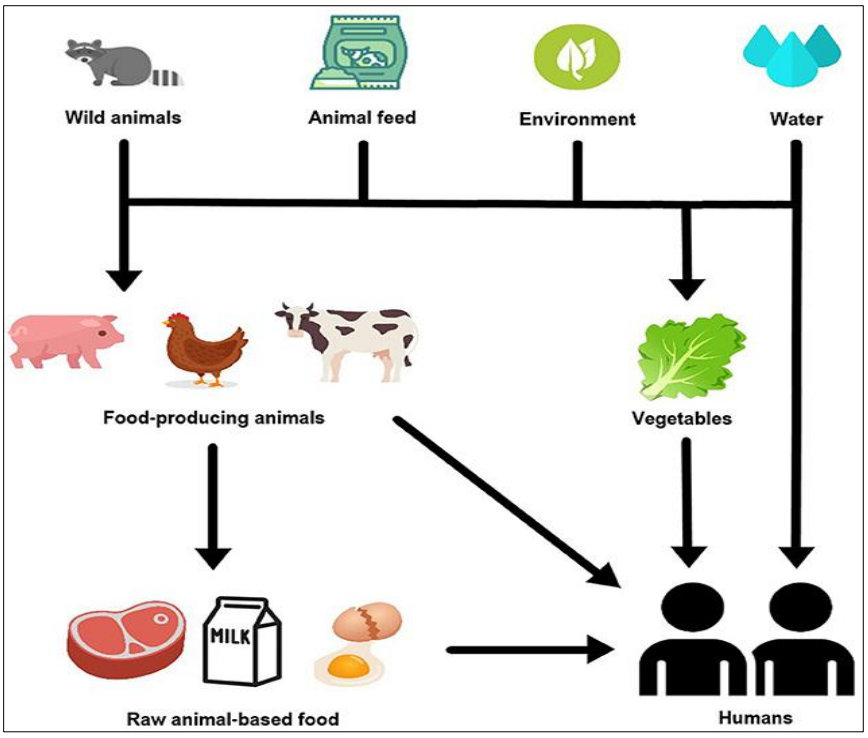

Figure 1: Transmission of Salmonella between humans and animals [25]

3. Anthrax

Anthrax is a serious infectious disease affects in wild and domestic herbivores including cattle, dogs, and horses. It can be transmitted to humans through zoonotic pathways as exposure to infected animals tissues and contaminated products (Figure 2). It caused by spore-forming bacteria called Bacillus anthracis, which secrete many toxins responsible for their clinical features [26].

Also, it releases several potent toxins, which contribute to the disease's clinical manifestations. This infection can manifest in three various forms: cutaneous, gastrointestinal, or inhalational. In addition to its health implications, anthrax has been recognized as a potential agent of bioterrorism, further heightening concerns about its impact on public health and safety. Vigilance and proper measures are crucial in preventing and managing outbreaks enters in bioterrorism [27].

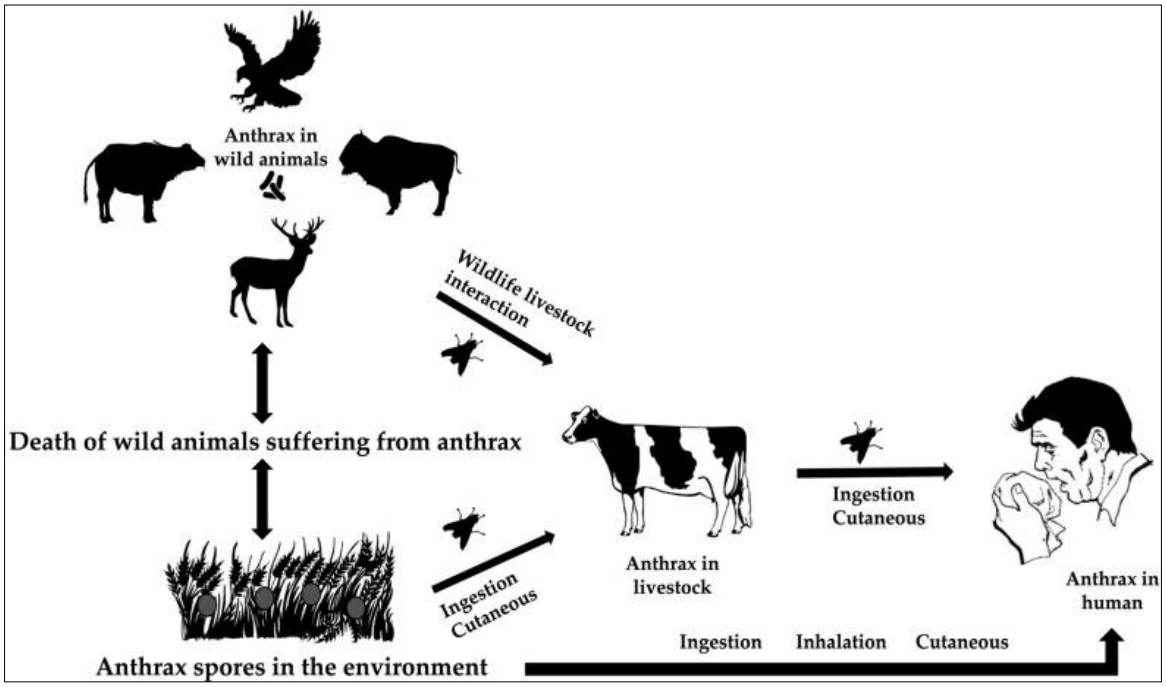

Figure 2: Mode of anthrax transmission [28]

4. Brucella

Brucellosis is indeed classified as a zoonotic bacterial infection, mainly affect livestock such as cattle, sheep, goats, swine, and dogs [29]. Humans also commonly become infected with this disease through various routes, such as direct contact with infected animals, consuming of contaminated animal products, or inhalation of aerosols pathogens. This infection poses considerable public health concerns, particularly in areas where livestock farming is prevalent [30,31]. The main species (Figure 3) that can cause human brucellosis include: Brucella abortus primarily associated with cattle and causes infections by consumption contaminated dairy products as well as direct contact with affected animals.

Brucella melitensis most virulent to humans, often linked to sheep and goats, and transmission typically occurs through unpasteurized milk or direct contact with infected animals. Brucella suis associated with pigs, can be transmitted by consumption of contaminated food or contact with infected materials. Brucella canis mostly affects dogs, although it can infect humans by contact with infected ones or their secretions. Human infection can happen through several routes, including the consumption of contaminated food especially raw milk and dairy and contact with infected animals or materials, even if the skin appears healthy. Factors such as handling aborted fetuses, genital secretions, or contaminated manure can also pose a risk [32].

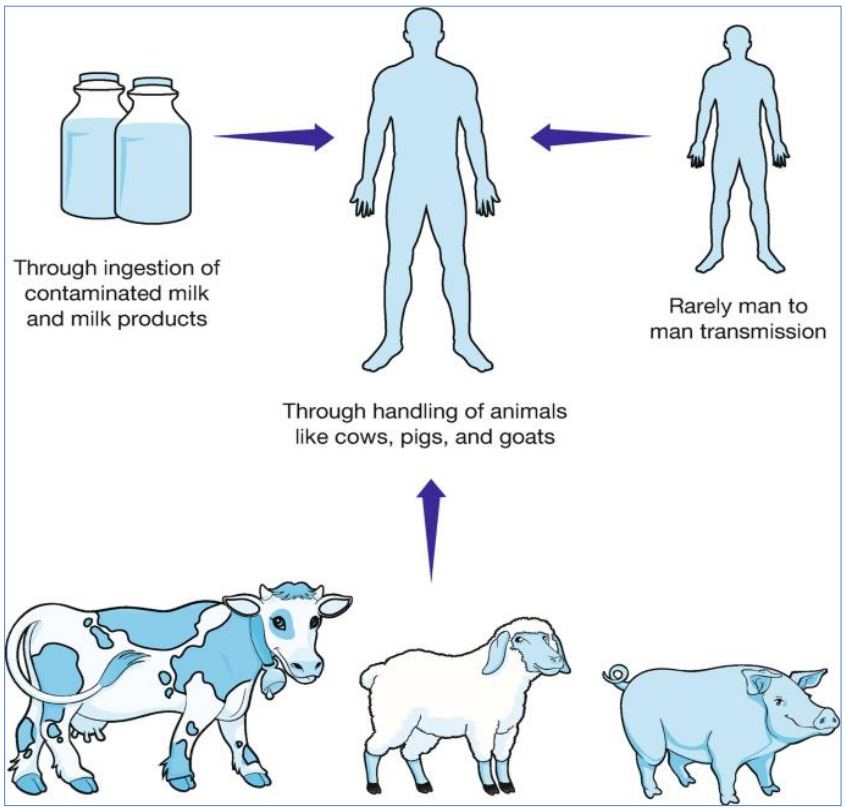

Figure 3: Transmissions of Brucellosis [33]

5. Bartonellae

Bartonella is a genus of gram-negative bacteria that belong to the clade of alphaproteobacteria. These bacteria are known for being pleomorphic, fastidious, and aerobic. Initially it believed to comprise only one species until 1993, the genus has since expanded as advances in microbiology revealed the presence of several other species, much to the interest of one health professionals due to their significant health implications. Bartonella species have garnered considerable attention from veterinarians since the late 1990s, particularly with the identification of various animal reservoir hosts. Notable species include Bartonella henselae, found in cats; Bartonella vinsonii, identified in wild canids; and Bartonella bovis, isolated from domestic cattle [34].

In terms of their impact on health, Bartonella spp. can cause bacteremia in mammalian hosts with few or no noticeable symptoms, posing a risk of transmission from animals to other animals or humans. The term bartonellosis refers to infections caused by these bacteria, with common conditions such as peliosis hepatitis, Carrison's disease, Oroya fever, and trench fever associated with them. Arthropod vectors like ticks, fleas, and lice have a critical role in facilitating the transmission of Bartonellosis among animals and humans [35]. Humans can serve as both accidental and primary hosts for various Bartonella species. Notably, some species, like B. henselae, represent zoonotic and able transmitted from infected cats to humans (Figure 4). An infection typically presents as benign regional

lymphadenopathy. After a scratch from an infected cat, papules that evolve into pustules may appear at the inoculation site within seven to eight days.

In certain cases, severe complications such as encephalitis, endocarditis, hemolytic anemia, hepatosplenomegaly, osteomyelitis, and pneumonia can also arise. Fortunately, most patients with cat scratch disease recover within a year without lasting effects. Among children, B. henselae infections may lead to arthritis and skin nodules [36]. For immunocompromised individuals, bacillary angiomatosis is one of the more prevalent clinical manifestations of bartonellosis.

This condition features chronic vascular lesions that are histopathologically and clinically similar to verruga peruana caused by B. bacilliform, such lesions are especially common in HIV patients with CD4+ cell counts below 50/mm3 [37].

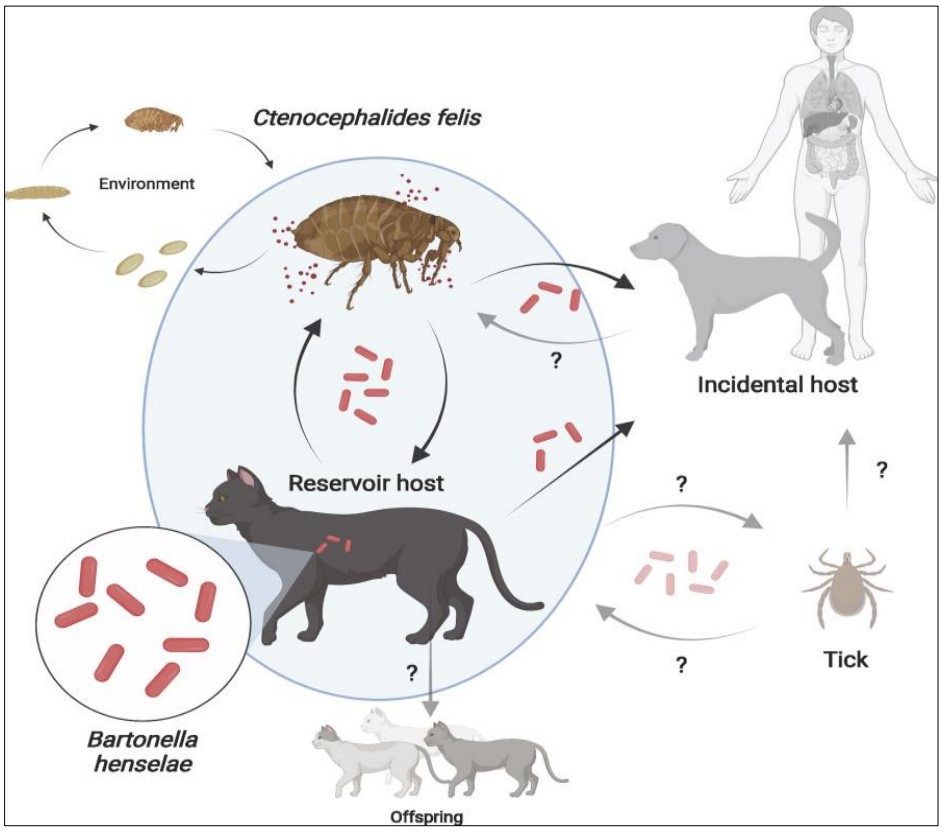

Figure 4: Bartonellosis in cats and dogs [38]

6. Listeria

Listeriosis represents a serious infects animals and humans primarily characterized with septicemia and encephalitis, also called circling and meningoencephalitis disease. It caused by facultative intracellular bacteria from the genus Listeria, and considered a foodborne zoonosis with increasing public health importance. The most pathogenic species is Listeria monocytogenes, which can be classified into four evolutionary strains. These bacteria have the ability to survive at temperatures ranging from 4 to 37°C [39]. Hyper virulent strains are often found in clinical isolates from significant outbreaks and have been distributed globally. However, the prevalence of this infection varies worldwide between foodborne listeriosis cases and clinical instances. Dietary habits and local factors play a role in the geographical diversity of this bacterium [40]. The reasons behind the higher prevalence of certain countries are still unclear, as there have been no significant differences in virulence characteristics as well as stress response among their isolates. As an environmental pathogen, it can survive and replicate outside a host but also has the potential to cause critical invasive infections in a variety of animal and humans. It has been isolated from humans, as well as from many species of domestic and wild mammals, birds, and aquatic species such as fish and crustaceans, as well as frogs, snails, ticks, and flies [41,42].

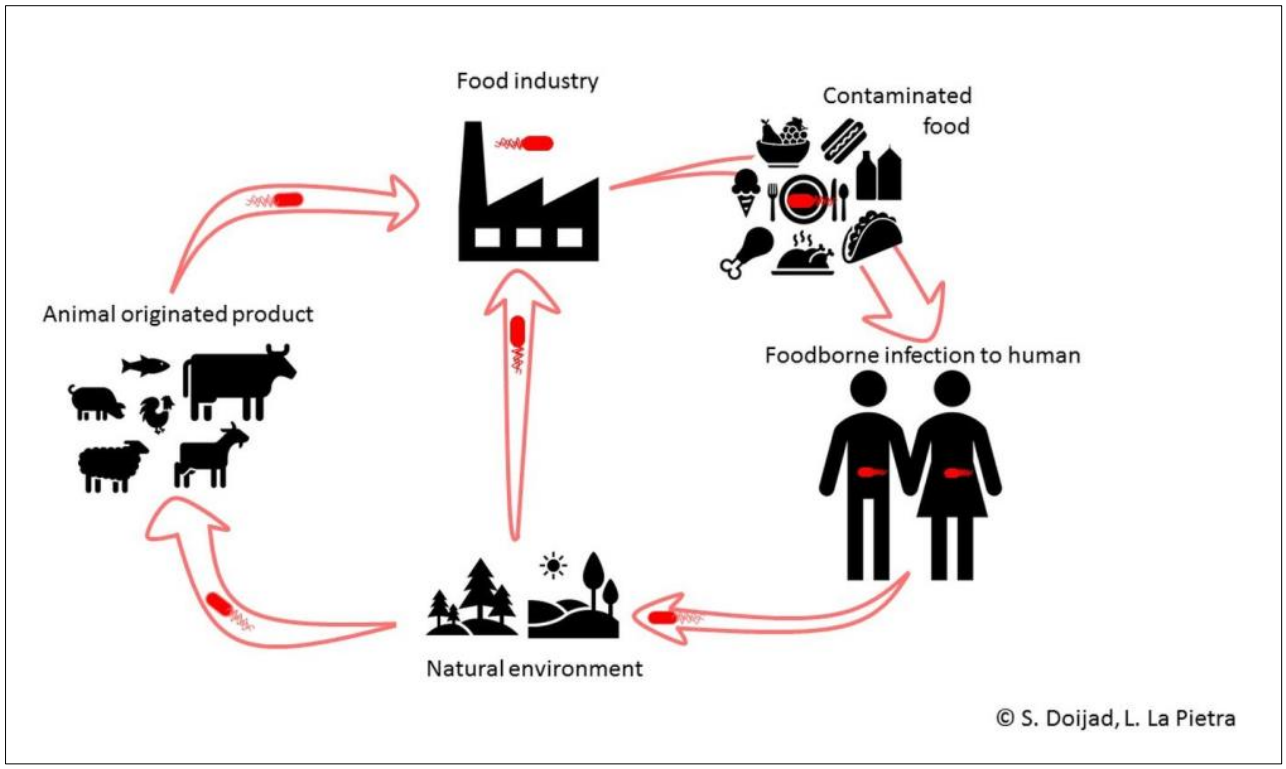

Figure 5: listeriosis transmission between domestic animal and human

7. Shiga toxin-producing E. coli

It is a toxin-producing strain of E. coli that can cause serious infection in humans when transmitted through the food chain from its animal reservoirs (Figure 6). It is well known that E. coli O157:H7 is the prototype of this bacterium causing human infections. The strains belonging to this serotype have caused foodborne and waterborne zoonotic outbreaks [43]. The phenogenotypic adherence of prototype isolates derived from beef, cattle feces, chicken, and humans have been actively studied [44].

In animals, infections by these bacteria are usually asymptomatic; however, in humans, they often present clinical symptoms such as diarrhea and hemolytic uremic syndrome typically occur when proper hygiene practices are not strictly followed, and consume undercooked food products. Cattle are known to be the main reservoir of these bacteria, pigs, beef, pork, water [45,46].

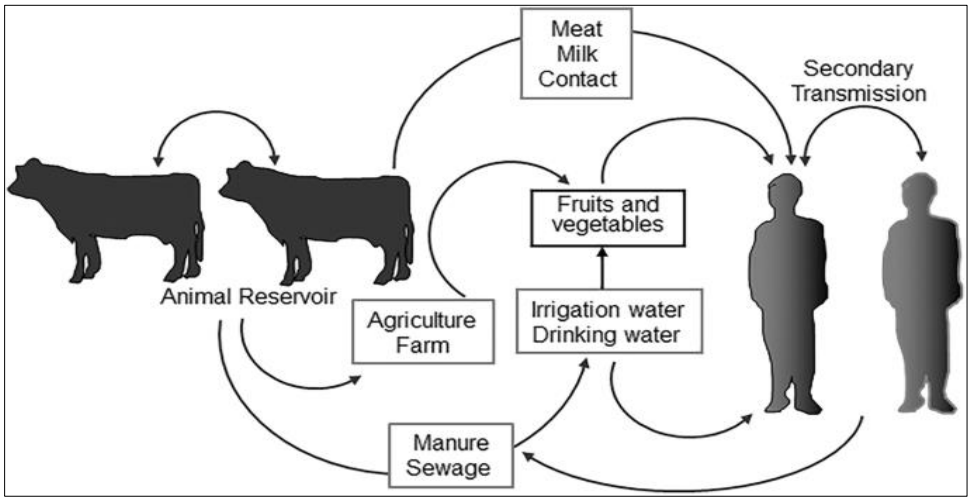

Figure 6: Shiga toxin-producing E. coli transmissions [47]

8. Leptospira

Leptospirosis is a waterborne zoonotic infection that is resurging globally and is gaining public health importance due to its high morbidity and mortality rates in both humans and animals. It is estimated to cause more than a million deaths annually. It is worth noting that this

disease is caused by bacteria of the genus Leptospira [48], and infections commonly occur via scratches or cutaneous wounds, or through handle with mucous membranes. It should be noted that a significant proportion of infected individuals suffer long-term health consequences. Pathogenic strains are a public health concern, as these bacteria typically multiply in tubules of kidneys in infected mammals and are subsequently excreted in their urine, contaminating the surrounding environment, where they can infect other living organisms [49].

Leptospirosis poses an occupational risk to individuals who handle infected animals, including livestock farmers, slaughterhouse workers, veterinarians, animal control personnel, and animal science researchers. Indirect transmission of leptospirosis generally occurs by exposed to contaminated water or soil, making it a risk for those working in sewage, waste management, construction, military, aquaculture, and farming [50]. Additionally, outdoor recreationalists, such as swimmers and hunters, are increasingly at risk due to their exposure to potentially contaminated environments. Therefore, with the continuity of outdoor activities, whether tourism or even sports, the likelihood of contracting and being exposed to leptospirosis increases [51,52].

Some species of rats are largely regarded as the primary sources of infection, they serve as subclinical hosts carriers various strains of pathogenic causative bacteria (Figure7), and they remain as commensal hosts in a persistent state of infection, shedding the pathogen at levels significantly higher than many other competent hosts [53]. Domestic dogs also serve as highly competent hosts for the pathogenic Leptospira and contribute to its spread on a global scale. Despite their close vicinity to humans, they do not significant contributors to the emergence of human leptospirosis outbreaks. Rather, they influence the disease cycle primarily through environmental contamination. Most dogs leptospirosis cases are linked to environmental factors, especially contaminated water source [54].

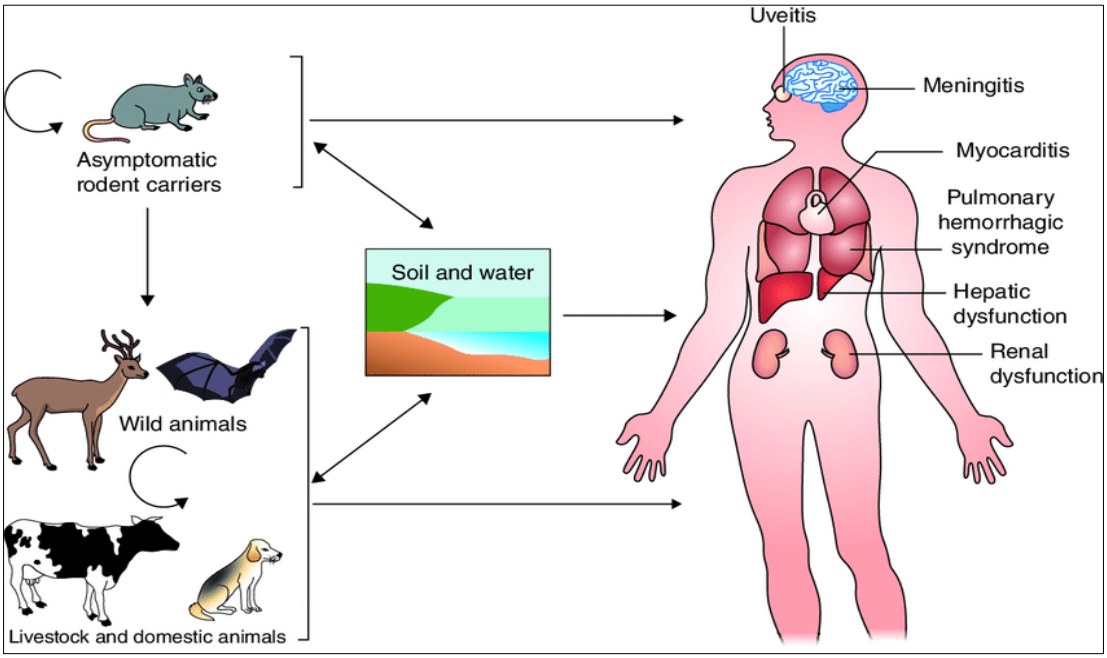

Figure 7: Transmission of Leptospirosis [55]

9. RECOMMENDATIONS AND CONCLUSIONS

From the above, it has been concluded that zoonotic bacterial infections pose a public health threat to both animals and humans, with high morbidity and mortality rates worldwide. Adopting the One Health concept for bacterial zoonoses promotes a collaborative, multi-sectorial, multidisciplinary approach to managing human and animal health interventions, and its principles can be applied in similar low-income contexts elsewhere [56-59].

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