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Brucellosis: A Highly Infectious Zoonosis of Public Health and Economic Importance

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Abstract

Brucellosis, a highly infectious, neglected, foodborne zoonotic disease, is caused by consumption of unpasteurized milk or undercooked meat of infected animals origin, or direct contact with the discharges. It is the most common re-emerging significant disease globally, and causes a significant human morbidity in endemic regions of the world. Globally, around 500, 000 cases of human brucellosis occur each year. The disease is responsible to cause an estimated economic loss of US dollars 344 billion to the livestock industry. Brucellosis in human beings is especially caused by *B. abortus, B. melitensis, B. canis*, and *B. suis*. Since brucellosis affects animals all over the world, people who always work with animals or come into contact with infected animal's blood or other discharges are at higher risk of contracting the disease. Human-to-human transmission of the infection is uncommon; some such instances have happened through breastfeeding, trans-placental transmission, and blood transfusion. The clinical signs of the disease comprises fever, sweating, malaise, anorexia, headache, arthralgias, and back pain. There are three most important laboratory methods for the diagnosis of brucellosis consisting of microbiological, serological, and molecular techniques. The standard treatment for acute brucellosis in adult humans requires a combination therapy of different antibiotics. It is crucial to impart health education to the public to consume only the pasteurized milk, and take care in handling and disposal of foetus, placental membranes, and uterine discharge. Additionally, one health approach including veterinary, medical, environmental, and other related professionals should collaborate to control brucellosis, a life threatening bacterial disease of global importance.

Keywords: Brucellosis, Economic Importance, Public Health, Zoonosis

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1. INTRODUCTION

Brucellosis also known as Bang's disease", "undulant fever", "Mediterranean fever" or "Malta fever" is a highly contagious re-emerging zoonotic disease of public health and economic importance and is caused by several species of *Brucella* [1, 2]. Disease is almost consistently transmitted by direct or indirect contact with infected animals or their products/secretions, and affects both sexes and people of all age groups [2]. Brucellosis is one of the neglected zoonotic diseases in the world, especially, countries with low-income being affected more [3, 4].

Brucellosis first came to the attention of British medical officers in the 1850s in Malta during the Crimean War, and was referred to as Malta fever. Jeffery Allen Marston (1831-1911) described his own case of the disease in 1861. The causal relationship between organism and disease was first established in 1887 by David Bruce. The agent that Bruce identified was classed as a coccus. In 1897, Danish Veterinarian Bernhard Bang isolated a bacillus as the agent of heightened spontaneous abortion in cows, and the name "Bang's disease" was assigned to this condition. At the time, no one knew that this bacillus had anything to do with the causative agent in Malta fever [5, 6].

Maltese scientist and archaeologist Themistocles Zammit identified unpasteurized goat milk as the major etiologic factor of undulant fever in June 1905 [7]. In the late 1910s, American bacteriologist Alice C. Evans was studying the Bang bacillus and gradually realized that it was virtually indistinguishable from the Bruce coccus. The short-rod versus oblong-round morphologic borderline explained the leveling of the erstwhile bacillus/coccus distinction (that is, these "two" pathogens were not a coccus versus a bacillus but rather were one coccobacillus) [8].

The Bang bacillus was already known to be enzootic in American dairy cattle, which showed itself in the regularity with which herds experienced contagious abortion. Having made the discovery that the bacteria were certainly nearly identical and perhaps totally so, Evans then wondered why Malta fever was not widely diagnosed or reported in the United States. She began to wonder whether many cases of vaguely defined febrile illnesses were in fact caused by the drinking of raw (unpasteurized) milk. During the 1920s, this hypothesis was vindicated. Such illnesses ranged from undiagnosed and untreated gastrointestinal upset to mis-diagnosed. Febrile and painful versions, some were even fatal. This advance in bacteriological science sparked extensive changes in the American dairy industry to improve the food safety. The changes included making pasteurization standard and greatly tightening the standards of cleanliness in milk houses on dairy farms. The expense prompted delay and skepticism in the industry [8].

However, the new hygiene rules eventually became the norm. Although these measures have sometimes struck people as overdone in the decades since, being unhygienic at milking time or in the milk house, or drinking raw milk, are not a safe alternative. In the decades after Evans's work, this genus, which received the name *Brucella* in honor of Bruce, was found to contain several species with varying virulence. The name "brucellosis" gradually replaced the 19th-century names Mediterranean fever and Malta fever [9]. In 1989,neurologists in Saudi Arabia discovered "neurobrucellosis", a neurological involvement in brucellosis [10, 11]. Moreover, these obsolete names have previously been applied to brucellosis [9, 12, 13].

2. BRUCELLOSIS – ENVIRONMENTAL PUBLIC HEALTH IMPACTS

Brucellosis remains one of the most important zoonotic bacterial diseases in the world. In people, brucellosis is related to a broad spectrum of signs, and may on occasion be fatal [2, 14, 15]. The disease is affecting domestic animals, human beings, and wildlife. It is the slow growing, gram negative, small coccobacilli bacteria of the genus *Brucella* capable of surviving and multiplying inside epithelial cells, placental trophoblasts, dendritic cells, and macrophages [16, 17]. The capability of the microorganism to invade, continue to exist for long durations of time, and multiply inside host cells is vital for the illness causation. Brucellosis is recognized as the most common re-emerging zoonotic disease of global distribution [18, 19]. The disease in human beings in mainly caused by *B. abortus*, *B. melitensis* and *B. suis*. Worldwide, *B. melitensis* is the most prevalent species causing human brucellosis, owing in component to difficulties in immunizing free-ranging goats and sheep [2, 20].The purpose of this book chapter is to delineate the public health and economic importance of brucellosis, a major disease of global concern.

2.1. *Brucella* – Infectious Zoonosis Characteristics

Brucella is small, gram negative coccobacilli, aerobic, non-motile, non-spore forming, and facultative intracellular bacterium [5]. The genus *Brucella* is categorized under the phylum Proteobacteria, class Alphaproteobacteria, order Rhizobiales, and family Brucellaceae. Genomes of *Brucella* species range between 3100-3300 kb of DNA in two circular chromosomes, with size of 0.6 × 0.6 to 1.5 ìm [21, 22]. *Brucella* species include *Brucella suis*, *Brucella ovis*, *Brucella abortus*, *Brucella melitensis*, *Brucella canis*, *Brucella neotomae, Brucella ceti*, *Brucella inopinata*, *Brucella microti, Brucella pinnipedialis, Brucella papionis*, *Brucella vulpis* and other strains without standing in nomenclature [22, 23]. From these species, six of them including *B. melitensis*, *B. abortus*, *B. suis*, *B. canis*, *B. ovis*and *B. neotomae* are considered classical species of causing disease, with the first four (*B. melitensis*, *B. abortus*, *B. suis* and *B. canis*) are pathogenic to humans. *Brucella abortus* and *B. melitensis* are related with most of the reported diseases in humans in the sub-Saharan Africa.

Brucella species are naturally host-specific, but in some circumstances, some strains cause multi-host infections. *Brucella melitensis* and *B. suis*, for example, cause caprine/ovine and porcine brucellosis and can also infect cattle [24, 25]. *B. abortus* is less virulent than *B. melitensis* and is primarily a disease of cattle. *B. melitensis*is the most virulent and invasive species; it usually infects goats and occasionally sheep. *B. suis* is of intermediate virulence and chiefly infects pigs. *B. canis* affects dogs. Symptoms include profuse sweating and muscle and joint pain and profuse sweating. Brucellosis has been recognized in animals and humans since the 20th century [5].

The bacterium can survive almost exclusively in infected hosts with preference for localization in intracellular compartments of phagocytic, reticuloendothelial, and specialized epithelial cells [26]. They produce enzymes including catalase, oxidase, nitrate reductase, and urease (except *B.ovis*); fail to produce indole; are non-hemolytic; do not liquefy gelatin; and have negative on Voges-Proskauer and methyl red tests [22]. Most (again except *B. ovis*); consume glucose as source of energy. *Brucella* species have been classified as potential agents of bioterrorism, because they may be spread by aerosol, and there is no human vaccine [1, 27].

2.2. Epidemiological characteristics

Brucellosis is an important bacterial zoonotic zzonois, which affects animals all over the world. Infections with *B. melitensis* occur most frequently in Mediterranean countries, in Latin America, and in Asia including India [2]. The disease due to *B.melitensis* seen in Europe is either caused by milk products imported from these countries or occur in travelers. *Brucella abortus* infections used to be frequent in central Europe, but the disease has been practically disappeared due to elimination of *Brucella* infested cattle herds [3]. In many parts of the world, brucellosis continues to be, or is re-emerging as, a significant zoonosis [26]. In low-income countries, the disease is often underreported, and there is little or no effective control, resulting in major health, economic, and livelihood burdens [4].

2.3. Risk Factors

Risk factors include production systems, agro-ecological zones, husbandry practices, contact with wild animals and management factors. People who always work using work animals or come into contact with infected animal's blood are at higher risk of brucellosis. Examples include dairy farmers, veterinarians, ranchers, slaughterhouse workers, microbiologists and hunters. Additionally, individuals who live in countries that do not have effective public health and animal control measures or those who travel to or import unpasteurized dairy products from these areas, occupational risk for workers and laboratory personnel have the chance to be contracted by the disease [1, 4, 28].

2.4. Source of Infection and Route of transmission

Brucellosis is a significant zoonosis particularly transmitted from cattle, sheep, goats, pigs, and camels via direct contact with blood, placenta, fetuses or uterine secretions, or through intake of infected raw animal products (specifically unpasteurized milk and soft cheese) [2, 29]. The genus *Brucella* consists of three medically important species including *B. abortus*, *B. melitensis*, and *B. suis*, besides some of others. These three species are the causative organisms of conventional zoonoses in farm animals and wild animals, particularly in cattle (*B. abortus*), goats (*B. melitensis*), and pigs (*B. suis*). These microorganisms also can be transmitted from diseased animals to people, inflicting a uniform clinical picture, so-referred to as undulant fever or Bang's disease [3].

Ingestion, direct touch through breaks in the skin and airborne infection (laboratories and abattoirs), typically affecting consumers of uncooked milk and derivatives, farmers, butchers, veterinarians and laboratory workers. Brucellosis is caused by numerous species of gram negative facultative intracellular bacteria of the genus *Brucella* that may be transmitted to people by means of direct animal contact or their products; so it is an occupational threat to the ones involved in certain professions [2, 30]. As a result of, there is intense human suffering from brucellosis, which may additionally cause substantial financial losses in endemic areas [25, 31].

Human-to-human transmission of the ailment is uncommon; some such instances have happened through breastfeeding, trans-placental transmission, and blood transfusion [25, 32]. *Brucella* species are taken into consideration because the most common laboratory-acquired pathogens [33]. Some transfusion transmitted infections and one case of transmission by using bone marrow transplantation have been detected [34].

2.5. Pathogenesis and Clinical Signs

The organism invades the body either through the mucosa of the upper intestinal, and respiratory tracts, or via lesions within the skin, and then enter the sub-serosa or sub-cutis. From there they may be transported through microphages or macrophages, in which they can continue to exist, to the lymph nodes, in which a lymphadenitis develops. The pathogens then disseminate from the affected lymph nodes, at the start lymphogenously after which hematogenously, eventually achieving the liver, spleen, bone marrow, and different reticuloendothelial tissues, inside the cells of which they are able to live on or even multiply.

The granulomas usual of intracellular microorganism expand. From those inflammatory foci, the bacteria can enter the bloodstream intermittently, whenever causing one of the ordinary febrile episodes, which normally occur within the evening and are followed by means of chills. The incubation length is one to four weeks. *B. melitensis* infections are characterized by means of extra severe clinical symptoms than the opposite brucellosis [3, 35].

Brucellosis is a systemic infectious disease in which any organ or system of the body can be affected. The incubation time of *Brucella*, the time from exposure to the bacteria to the start of clinical signs, is usually about 2-4 weeks (ranges between 1-8 weeks and sometimes even longer). The initial clinical signs of the disease comprises fever, sweating, malaise, anorexia, headache, arthralgias, and back pain. In most cases, an undulant fever pattern can be detected. Mild lymphadenopathy, splenomegaly, or hepatomegaly may also be encountered. In more serious cases, it involves the central nervous system signs including meningitis, encephalitis, and the cardiovascular system signs including endocarditis and pericarditis [2, 23].

The disease may observed with a broad range of clinical indications, such as weakness, fatigue, chills, myalgia, weight loss, abdominal pain, vomiting, diarrhea, nausea, constipation, cough, bronchitis, insomnia, colitis, ileitis, pneumonia, jaundice, epistaxis, and orchitis [2]. In some cases; involuntary movements of limbs, only joint pain, burning feet or ischemic heart attacks are observed. Certain complications like osteomyelitis, spondylitis, endocarditis, and meningo-encephalitis are also observed. Earlier studies described weakness in greater than 90% of the cases; and more than 70% of cases presented with chills, and sweating [17, 28].

2.6. Diagnosis

The signs and symptoms in human brucellosis are not unique and consequently, laboratory confirmation obligatory to make an unequivocal diagnosis of ailment [2]. There are three most important techniques for the diagnosis of brucellosis consisting of microbiological, serological, and molecular techniques [36]. Diagnosing brucellosis includes culturing the blood, liver, or bone marrow for *Brucella* organisms. A positive culture alone does no longer characterize brucellosis, in view that people who have been treated for the disease may also retain to harbor *Brucella* organisms for numerous months. Confirmation of brucellosis, consequently, includes a culture positive for *Brucella* bacteria in addition to evidence of the feature signs and symptoms and records of feasible contact with infected milk or different animal products. Microbiological technique remains a gold standard confirmatory diagnostic approach [17, 31].

During isolation of the organism from biopsies or blood in cultures, it should be incubated for the duration of four weeks. Hence, the laboratory must therefore be informed of the tentative diagnosis. *Brucella* are usually isolated based on various metabolic characteristics, and the presence of surface antigens, which are detected using a polyvalent *Brucella*-antiserum in a slide agglutination test reaction. Special laboratories are also designed to differentiate the three most pathogenic *Brucella* species. Antibody detection can be done using the agglutination reaction according to Gruber-Widal in a standardized method to differentiate the bacteria. In uncertain cases, the complement binding reaction and direct Coombs test can be applied to gain a serological diagnosis [3, 34].

More importantly, several other serological tests have been widely used for diagnosis of *Brucella*, and these include Rose Bengal plate test (RBPT), Standard tube agglutination test (STAT), complement fixation test (CFT), enzyme linked immunosorbant assay (ELISA). RBPT was originally used for screening of animals for *Brucella* infections; but, it is used for the diagnosis of human brucellosis [2, 33]. Serological tests are mostly used to conduct various epidemiological researches and diagnostic purposes, but there is no exactly perefect serological test. However, the diagnostic performance and discriminative ability of a test can be examined by comparing the sensitivity and specificity of various tests analytically. Thus, the diagnostic performance of a test can be seen by comparison with standard reference test and detected using latent models. Besides these, molecular test including polymerase chain reaction (PCR) based identification and typing, fluorescence polarization assay (FPA) is also important diagnostic tools [37, 38]. Brucellosis must be differentiated from other infectious diseases, such as typhoid fever, malaria, influenza, Kala azar, rheumatic fever, leptospirosis, tularaemia and tuberculosis [2].

2.7. Treatment

In human beings, brucellosis resulting from *B. abortus* is a moderate disease that resolves itself without remedy. However, the disease resulting from

B. melitensis and *B. suis* may be chronic and excessive [3].

The standard treatment for adult acute brucellosis requires a combination therapy of doxycycline (200 mg/day orally) and rifampicin (600 - 900 mg/day orally) for 6 weeks, or the combination of doxycycline (100 mg twice/day orally for 6 weeks) with streptomycin (1 g/day intramuscularly for 2-3 weeks) or a combination of doxycycline (100 mg twice a day orally for 6 weeks) plus parenteral administration of gentamicin (5 mg/kg body weight for 7 days). In mild cases, tetracycline at the dosage rate of 500 mg/12 hourly given orally for two weeks showed encouraging results [2, 37].

2.8. Control and Prevention Measures

Even though control and prevention of brucellosis infections depends on prevention of exposure to the pathogen, it is not as such important to isolate infected persons since the disease is not communicable between humans. Currently, no commercial vaccine is available to immunize the high risk groups [3].

In nations wherein eradication in animals (via vaccination and/or removal of inflamed animals) is not viable, prevention of human infection is based on raising recognition, food-protection measures, occupational hygiene and laboratory protection. A totally essential method to the control of brucellosis this is gaining increasingly more popularity around the world in current years is the only health technique to manipulate and prevent human and animal brucellosis requires multidiscipline efforts due to the fact neither veterinarian alone nor physician alone couldn't perform all techniques of manipulate [14, 22].

Therefore, it requires participation of different subject and farmers for powerful manage especial in developing countries in which most people are stay toward animals. In the one health framework, veterinary, medical, environmental, and allied specialists collaborate collectively with the aim of identifying feasible danger factors for this infection and layout a suitable method to combating the contamination. Because of an infectious, contagious and international wide spread form of an essential zoonotic disease that reasons direct and direct financial deterioration. Specifically in growing international locations where the animals are maximum economic source, it requires collaboration of society to control the disease [1, 28].

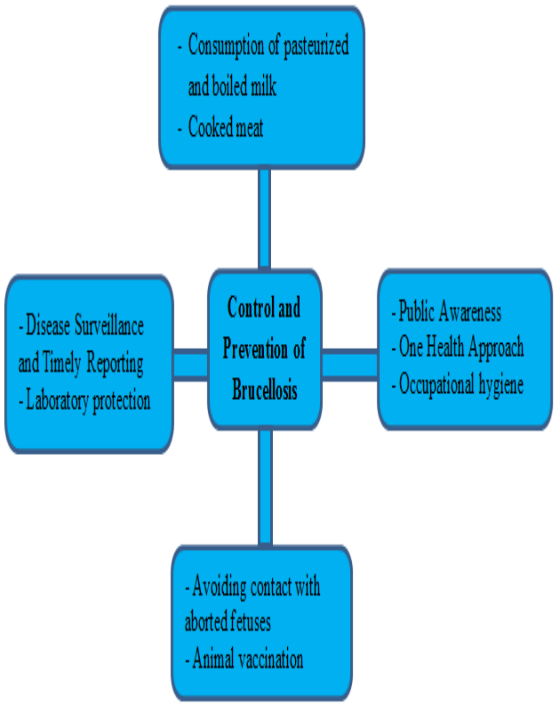

Figure 1. Measures to be taken for the prevention and control of brucellosis.

Certain measures, which include ingestion of boiled milk, pasteurized dairy products and cooked meat, use of shielding clothing through high danger groups, energetic surveillance of *Brucella* contamination, and manipulate of sickness in animals and educational programme of public to increase awareness approximately zoonotic importance of brucellosis are suggested to mitigate the prevalence of this widely general bacterial disease. In figure 1 are presented measures to be taken for the prevention and control of brucellosis. Even though some of vaccines are employed for immunization of animals, hitherto, no suitable vaccine against human brucellosis is available. Consequently, honest tries need to be made to increase safe, strong, potent and low cost vaccine, which can be afforded by means of negative resource countries [2, 33].

3. IMPACT ON PUBLIC HEALTH AND ECONOMY

In endemic regions, human brucellosis has critical public health consequences. Brucellosis is an infectious zoonosis and an economically critical infection of people and farm animals with a global distribution. It is a main veterinary and human public health problem in maximum parts of the world. The incidence of brucellois is greatly decreased in the advanced world due to powerful vaccination based totally managed packages, however, it remains an uncontrolled trouble in high endemic regions of Mediterranean, Middle East, Africa, Latin America, and parts of Asia [2,33].

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Brucellosis has a detrimental health problem each for animals and people as well as financial implications for individuals and groups [28]. It is an occupational hazard with the ones specifically at risk consisting of laboratory workers, veterinarians, abattoir workers, farmers, and animal keepers either residing in near proximity with animals or dealing with aborted fetus and animal products that contaminated by *Brucella* organism [2, 39]. Brucellosis remains an economically important and significant zoonosis. It is an infectious disorder affecting a wide variety of species of animals and humans with an expected half of a million human instances stated yearly from world [2, 40, 41]. Brucellosis causes an economic losses of US Dollar 344 billion to the livestock industry [2]. Annual financial losses due to bovine brucellosis in Latin America is around US Dollars 600 millions [2].

3.1. Other Animals Related to Public Health and Economic Impact.

Moreover, other animals related to public health and associated economic impact from brucellosis is presented below [5]. These should be taken into account for proper surveillance and good operation for cleaning of farms, associated particular building facilities, sanitary infrastructures that grow or host such animals. Species infecting domestic livestock are *B. abortus* (cattle, bison, and elk), *B. canis* (dogs), *B. melitensis* (goats and sheep), *B. ovis* (sheep), and *B. suis* (caribou and pigs). *Brucella* species have also been isolated from several marine mammal species (cetaceans and pinnipeds). For the case of cattle, *B. abortus* is the principal cause of brucellosis in cattle. The bacteria are shed from an infected animal at or around the time of calving or abortion. Once exposed, the likelihood of an animal becoming infected is variable, depending on age, pregnancy status, and other intrinsic factors of the animal, as well as the number of bacteria to which the animal was exposed [42].

The most common clinical signs of cattle infected with *B. abortus* are high incidences of abortions, arthritic joints, and retained placenta. The two main causes for spontaneous abortion in animals are erythritol, which can promote infections in the fetus and placenta, and the lack of anti-*Brucella* activity in the amniotic fluid. Males can also harbor the bacteria in their reproductive tracts, namely seminal vesicles, ampullae, testicles, and epididymes.

For the case of dogs, *B. canis*, is the principal cause of brucellosis in dogs. The causative agent of brucellosis in dogs, *B. canis*, is transmitted to other dogs through breeding and contact with aborted fetuses. Brucellosis can occur in humans who come in contact with infected aborted tissue or semen. The bacteria in dogs normally infect the genitals and lymphatic system, but can also spread to the eyes, kidneys, and intervertebral discs. Brucellosis in the intervertebral disc is one possible cause of discospondylitis. Symptoms of brucellosis in dogs include abortion in female dogs and scrotal inflammation and orchitis in males. Fever is uncommon. Infection of the eye can cause uveitis, and infection of the intervertebral disc can cause pain or weakness. Blood testing of the dogs prior to breeding can prevent the spread of this disease. It is treated with antibiotics, as with humans, but it is difficult to cure [43].

For the case of aquatic wildlife *B. ceti* is the principal cause of brucellosis in aquatic life. Brucellosis in cetaceans is caused by the bacterium *B. ceti*. First discovered in the aborted fetus of a bottlenose dolphin, the structure of *B. ceti* is similar to *Brucella* in land animals. *B. ceti* is commonly detected in two suborders of cetaceans, the Mysticeti and Odontoceti. The Mysticeti include four families of baleen whales, filter-feeders, and the Odontoceti include two families of toothed cetaceans ranging from dolphins to sperm whales. *B. ceti* is believed to transfer from animal to animal through sexual intercourse, maternal feeding, aborted fetuses, placental issues, from mother to fetus, or through fish reservoirs.

Brucellosis is a reproductive disease, so has an extreme negative impact on the population dynamics of a species. This becomes a greater issue when the already low population numbers of cetaceans are taken into consideration. *B. ceti* has been identified in four of the 14 cetacean families, but the antibodies have been detected in seven of the families. This indicates that *B. ceti* is common amongst cetacean families and populations. Only a small percentage of exposed individuals become ill or die. However, particular species apparently are more likely to become infected by *B. ceti*. The harbor porpoise, striped dolphin, white-sided dolphin, bottle-nose dolphin, and common dolphin have the highest frequency of infection amongst ondontocetes. In the mysticetes families, the northern minke whale is by far the most infected species. Dolphins and porpoises are more likely to be infected than cetaceans such as whales. With regard to sex and age biases, the infections do not seem influenced by the age or sex of an individual. Although fatal to cetaceans, *B. ceti* has a low infection rate for humans [44].

In the same way for the case of terrestrial wildlife, the disease in its various strains can infect multiple wildlife species, including elk (*Cervus canadensis*), bison (*Bison bison*), African buffalo (*Syncerus caffer*), European wild boar (Sus scrofa), caribou (Rangifer tarandus), moose (Alces alces), and marine mammals (see section on aquatic wildlife above) [45, 46]. While some regions use vaccines to prevent the spread of brucellosis between infected and uninfected wildlife populations, no suitable brucellosis vaccine for terrestrial wildlife has been developed. This gap in medicinal knowledge creates more pressure for management practices that reduce spread of the disease [47].

Wild bison and elk in the greater Yellowstone area are the last remaining reservoir of *B. abortus* in the US. The recent transmission of brucellosis from elk back to cattle in Idaho and Wyoming illustrates how the area, as the last remaining reservoir in the United States, may adversely affect the livestock industry. Eliminating brucellosis from this area is a challenge, as many viewpoints exist on how to manage diseased wildlife. However, the Wyoming Game and Fish Department has recently begun to protect scavengers (particularly coyotes and red fox) on elk feed grounds, because they act as sustainable, no-cost, biological control agents by removing the infected elk fetuses quickly [48]. Purebred bison in the Henry Mountains of southern Utah are free of brucellosis [49].

The National Elk Refuge in Jackson, Wyoming asserts that the intensity of the winter feeding program affects the spread of brucellosis more than the population size of elk and bison. Since concentrating animals around food plots accelerates spread of the disease, management strategies to reduce herd density and increase dispersion could limit its spread [45]. Moreover, the effects on hunters may be at additional risk for exposure to brucellosis due to increased contact with susceptible wildlife, including predators that may have fed on infected prey. Hunting dogs can also be at risk of infection [50].

Exposure can occur through contact with open wounds or by directly inhaling the bacteria while cleaning game. In some cases, consumption of undercooked game can result in exposure to the disease [51]. Hunters can limit exposure while cleaning game through the use of precautionary barriers, including gloves and masks, and by washing tools rigorously after use [47, 52]. By ensuring that game is cooked thoroughly, hunters can protect themselves and others from ingesting the disease [51]. Hunters should refer to local game officials and health departments to determine the risk of brucellosis exposure in their immediate area and to learn more about actions to reduce or avoid exposure.

4. CONCLUSIONS

Brucellosis is an important systemic infectious disease in which any organ or system of the body can be affected. It can be transmitted from animals by direct contact or indirect contact with their products, but rarely transmitted between humans. People having direct contact with animal and animal's products have the greater chance of contracting the disease.

The disease affects the public health and economy of the developing countries by reducing production of livestock multi-directionally, and putting people under economic problems because of the cost of treatment both in humans and animals. Although brucellosis can be treated by combination of different antibiotics, prevention and control of the disease preferred nowadays. Health education of various occupational groups about the nature of disease and danger of handling infected carcass and tissues is very essential. It is emphasized that all cases of pyrexia of unknown origin in humans should be properly investigated for *Brucella* infections by employing standard laboratory techniques.

CONFLICT OF INTEREST

The authors declare that they do not have conflict of interest.

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