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Review Article

A Review on Bovine Brucellosis and Its Public Health Significance in Ethiopia

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Summary

Brucellosis is economically important zoonotic bacterial disease caused by the genus Brucella. Brucellosis occurs worldwide, except for few countries that have been successfully eradicated. The Aborted fetus, fetal membrane and uterine discharges are considered as the major source of infection. Bovine brucellosis is mainly transmitted to animals by ingestion of contaminated feed and water, by contact with infected aborted fetus, fetal membrane and genital discharges and by artificial insemination from infected bulls. The bacteria are preferentially localized mainly in the reproductive tract of pregnant animals and consequently cause late abortion, retained fetal membrane and infertility, whereas orchitis and epididymitis are seen in males. The overall studies of bovine brucellosis in Ethiopia range from 1.1% to 22.6% and 0.05% to 15.2% in intensive and extensive management systems respectively. Brucellosis is mainly transmitted to humans through the consumption of unpasteurized dairy products, occupational case direct contact with infected animal and their discharges. The prevalence of Bovine brucellosis depends on the standards of environmental hygiene, animal husbandry practices and species of the causative agent. Brucellosis has been widely reported from cattle in Ethiopia. This requires formulating effective control strategies are needed that includes surveillance to identify infected animals, prevention of transmission to non-infected animals and removal of the reservoir to eliminate the source of infection.

Keywords: Animal, Brucellosis, Economic Zoonosis, Prevention of Health, And Infections.

1.Introduction

Ethiopia has the largest livestock population in Africa with an estimate of 65 million cattle, 40 million sheep, and 51 million goats 8 million Camels 49 million Chickens and 11.1 million equines However, the country has not used this resource effectively owing to various limitations. Animal disease, management problems, poor genetics, and nutritional deficiency are among the foremost impediments to cattle production in the country Among the infectious diseases, Brucella infection is widely prevalent and causes extensive anomic losses, and brucellosis is one of the most serious zoonotic diseases in Ethiopia [1].

The introduction of higher-yielding cattle breeds is one of the major strategies to increase milk production in the country. However, brucellosis is the main challenge to the development of dairy farming in different parts of Ethiopia, since the disease causes reproductive inefficiency and pregnancy loss in cattle. Brucella infection causes huge financial losses and community health concerns in countries around the world, including Ethiopia [2-5].

Brucellosis is one of the economically important diseases of livestock caused by members of the genus Brucella. The disease is characterized by reproductive disorders such as abortion, stillbirth and birth of weak offspring in females and orchitis and epididymitis in male animals causing transient or permanent infertility. The genus Brucella currently comprises six classical species primarily affecting domestic animals and rodents including B. meltiness of small ruminants, B. abortus of cattle, B. suis of pigs and hares, B. ovis of small ruminants, B. canis of dogs and B. neotomae of desert wood rats; and six novel species identified from marine mammals (B. penippedialis and B. ceti), red foxes (B. vulpes), baboons (B. papionis), a human breast implant (B. inopinata) and rodents While Brucella species are host-adapted to preferred hosts, they are capable of infecting other species for instance, B. abortus, which is host-adapted to cattle, can infect small ruminants and wildlife . Camels are known to be infected by both B. melitensis and B. abortus when they are reared in close contact with small ruminants and cattle respectively [6-8].

Brucella abortus, B. melitensis, and B. suis are the major causes of bovine brucellosis. The disease is known to cause abortion in the last stage of pregnancy, followed by retention of the fetal membrane and infertility in succeeding pregnancies in cattle. Office International des Epizooties

(OIE) declares brucellosis as multiple species disease, infection and The etiological agent of bovine brucellosis is a Gram-negative coccobacillus, Brucella abortus and occasionally by Brucella melitensis and Brucella .Human brucellosis is popularly known as undulant fever, Crimean fever, Mediterranean fever, remitting fever, Maltese fever, goat fever, Gibraltar fever and bovine brucellosis is called as contagious abortion or Bang's disease. Brucella species are among those pathogenic bacteria which have propensity to those pathogenic bacteria which have propensity to adapt to new host and they can either be naturally transmitted to their primary hosts by direct or indirect contact or sometimes inadvertently to other susceptible hosts Mixed farming of cows, buffaloes, sheep and goats has increased the risk of brucellosis where small ruminants act as primary hosts for B. meltiness and cattle as spillover host [9-11].

The direct economic impact of the disease is associated with loss of replacement stock, reduction in milk production and culling of valuable reproductive age animals further constraining herd expansion. In countries like Ethiopia, where the export of live animals is one of the sources of foreign exchange earnings, brucellosis hinders access to lucrative international markets. Where market accesses are permitted, the requirements by importing countries of testing every individual animal at export quarantines and rejection of those testing positive, further adds up to the economic loss. Brucellosis is also one of the significant zoonotic diseases affecting 0.83 million individuals worldwide, annually. In Ethiopia, a country with an estimated population of 112,078,730 60.9 million Heads of cattle, 31.3 million sheep, 32.7 million goats 1.2 million camels and 11.1 million equines. serological studies conducted so far demonstrated that the disease is endemic across greater areas of the country. However, no official figures are available both for livestock and human brucellosis. Only the presence, absence or suspected statuses of the disease during the various years between 1996 and 2019 in livestock and humans had been reported to the World Organization for Animal Health. No control strategy including vaccination is so far been implemented against brucellosis in any of the livestock species in Ethiopia. Studies conducted to estimate the prevalence of brucellosis in the country were conducted by individual researchers, in research organizations or higher education institutions. But they were fragmented and are limited in space, time and scope; as a result, there is a need for summarizing such data to make them useful in understanding the disease burden and its distribution at a national level to devise appropriate intervention strategies. Then the objective of this review is to illustrate the potential predictors and the disease's spatial distribution pattern along the bovine and describe the public health impact. Finally, it suggests the way forward with a contextual intervention strategy to reduce the economic and public health impact of bovine brucellosis in Ethiopia [12-25].

Etiology:

Bovine brucellosis is usually caused by Brucella abortus, less frequently by B. melitensis, and rarely by B. suis. However; humans, sheep, goats, and other domestic animals can also be infected by Brucella abortus. Cattle are infected with B. suis and B. melitensis when they graze together with infected pigs, goats, or sheep. Each Brucella species tends to infect a particular animal species and they have a predilection for both female and male reproductive organs in sexually mature animals. The target organs and tissues of Brucella species are placenta, mammary glands and epididymis in animal reservoir host Brucella organism persist in targeted organ of the reservoir host and Persistent (lifelong) infection is a characteristic of its facultative intracellular organism, with shedding in reproductive and mammary secretions [26-30].

Characteristics of Brucella Organism

They are Gram-negative, aerobic, facultative intracellular rods or coccobacilli, which lack capsules, endospores or native plasmids. The bacterium has a diameter of 0.5–0.7μm and has 0.6-1.5μm length, partial acid fast with oxidase, catalase, nitrate reductase and urease activity. The Brucellae are able to survive freezing and thawing, but are susceptible to most of the common disinfectants. The bacterium remains viable in environment for months especially in cool and wet conditions. Pasteurization can effectively kill Brucella in milk.A total of six classical species (Table 1) and seven novel Brucella species have been recognized from a wide spectrum of susceptible hosts. Species affecting terrestrial animals are seven in number including B. abortus, B. melitensis, B. suis, B. ovis, B. canis, B. neotomae and B. microtia two other species, B. ceti and B. pinnipedialis affect marine mammals (Foster et al., 2007). B. papionis isolated from baboons and B. vulpis from red foxes were also added to the list of genus Brucella. Seven biovars have been recognized for B. abortus, three for B. melitensis and five for B. suis. Rest of the species has not been characterized into biovars. The recovery of distinct Brucella strains from marine mammals and human beings recently indicates the significance of zoonotic transmission [31-45].

Table 1: A Six Classical Brucella Species

Strain	Principle Host	Other Hosts	Symptoms	Transmission	Human Disease
Brucella abortus	Cattle	Sheep, goats, pigs, horses, dogs, humans, wild ungulates	Abortion after 5 Months	Ingestion, some venereal	undulant fever-control with antibiotics
Brucella melitensis	Sheep goats. Buffalo	cattle, pigs, dogs, humans, camels	Later term abortion, weak young, mastitis	Ingestion	Malta fever: can be fatal in human
Brucella ovis	Sheep		(goats)		
Brucella suis	Pig	cattle, horses' dogs, humans reindeer, caribou	most often effects rams, rare abortions	ingestion and venereal	extremely deadly in human
Brucella canis	Dogs	Humans	abortions at 40-60 day	Venereal	mild disease in humans
Sources: Int. J. Adv. Res. Biol. Sci. (2023). 10(4): 140-158					

Source of Infection

The concentration of the bacteria is highest in pregnant uterus. The aborted fetus, placental membranes or fluids, and other uterine discharges were considered as major source of infection. Infected animals also shade organisms in milk which serve as source of infection for the new born. Contaminated feed can spread the infection from infected pasture over long distance. Invading Brucella usually localize in the lymph nodes, draining the invasion site, resulting in hyperplasia of lymphoid and reticule endothelial tissue and the infiltration of inflammatory cells. Survival of the first line of defense by the bacteria results in local infection and the escape from the lymph nodes in to the blood. During bacteriamic phase, bones, joints, eyes and brain can be infected, but the bacteria are most frequently isolated from supra-mammary lymph nodes, milk, iliac lymph nodes, spleen and uterus. In bulls, the predilection sites for infection are also the reproductive organs and the associated lymph nodes. During the acute phase of infection, the semen contains large number of Brucella but as the infection becomes chronic, the number of Brucella excreted decreases. However, it may also continue to be excreted for years or just become intermittent [46-50].

Transmission

Brucellosis is typically transmitted to other cattle by direct or indirect interaction with diseased cattle discharges the spread of brucellosis in cattle occurs through the ingestion of contaminated feed and drinking water contaminated by the bacteria that are present in massive amounts in birth products and discharge. Moreover, cattle typically lick their fetuses and newborn calves which can have very high levels of bacteria and are the major source of infection. Brucella infection can also be transmitted by feeding pooled colostrum to newborn calves. Brucella infection is rarely spread through sexual contact in cattle. However, artificial insemination has been shown to spread the infection from infected cattle to healthy cattle. Humans acquire Brucella infection via the ingestion of unpasteurized milk or milk products. Interaction of the mucosal abrasions with the fluid or tissues of aborted fetuses of diseased cattle can also be a source of disease in humans. Work-related contact with cattle or their products is the major risk, for human brucellosis. Abattoir, farm, and laboratory workers as well as veterinarians, known risk groups for Brucella infection in the herd animals, the infection can be due to introduction of an infected animal that subsequently gives birth or aborts a fetus, whereupon pasture or water becomes contaminated by these excretions. Transient disease such as abortion can also develop following administration of a live Brucella vaccine, particularly the B abortus vaccine strain 19. The organisms have been recovered from fetal and manure samples that remained in a cool environment for longer than 2 months. However, exposure to sunlight kills the bacterium within a few hours, and the organism is susceptible to many common disinfectants [51-65].

Epidemiology of Brucellosis

Geographical Distribution of Brucellosis:

Brucellosis is endemic in many developing countries and is caused by Brucella species that affect man, domestic, some wild animals and marine mammals The majority of human and animal brucellosis is found in sub-Saharan Africa with large pastoral communities has been recorded at herd level, within-herd level and individual animal level .The persistent

disease was observed in most countries in the Sahel, with Ethiopia, Chad, Tanzania, Nigeria, Uganda, Kenya, Zimbabwe and Somalia reporting brucellosis in humans attributed to domestic cattle, camels, goats and sheep calculated an estimated seroprevalence of 16.2% with in cattle in sub-Saharan African.. It is more prevalent in developing countries and considered to be a serious health problem due to lack of effective public health measures, domestic animal health programs, and appropriate diagnostic facilities. Furthermore, the situation is also worsened by the resemblance of the disease with other diseases leading to misdiagnosis and under reporting. The management systems as well as ecological conditions greatly influence the spread of brucella infection [66-87].

Risk Factors for Bovine Brucellosis:

The occurrence of Brucella infection is affected by a variety of factors associated with the management system, host, and environment. These include the age, sex, and breed of cattle, herd size and type, and ago ecology. Age has been stated as the intrinsic factor related to Brucella infection. A higher seroprevalence of Brucella organisms has been determined in adult cattle than in young cattle. Sexually mature and pregnant cattle are more prone to being infected with Brucella than sexually immature cattle. This is because the Brucella organism confers a response in the reproductive tract owing to the concentration of erythritol sugar, generated within the fetal tissues of cattle, which stimulates the growth of Brucella organisms. However, the higher prevalence of Brucella in adults has also been related to longer interaction with diseased cattle. This could also be vital in the herd, while not culling the positive cattle. The effect of sex on the occurrence of Brucella infection in cattle has been stated previously Female cattle are more likely than males to have Brucella infection Although this is not easy to elucidate, it may be related to the biology of the Brucella organism and tropism to the fetal tissues Because Brucella infection in males confers symptoms such as epididymitis and orchitis, the incidence in males may be lower than in females; as a result, they may be culled more quickly. However, the absence of symptoms such as abortion or metritis in non-pregnant diseased females may also mean that there is a higher prevalence in females. Moreover, brucellosis becomes chronic in non-pregnant cattle. This has important epidemiological consequences as, after the initial immune response in cattle that are symptomless carriers, the antibodies disappear from the circulation, and it can be challenging to identify them with standard serological methods. Herd size is another risk factor for Brucella infection, with the risk being highest in large herds The rise spread of brucellosis by interaction among members of the herd, the use of common grazing lands or inadequate cleaning and disinfection techniques on big farms The low incidence of Brucella infection in small herds may be related to herd and/or management Thus, small herds often graze nearby pastures, allowing interactions with other herds to be controlled, or using communal methods. A small herd can be simply managed during delivery, and cattle are frequently removed from the herd throughout parturition. This is extremely important in the case of abortion, to prevent contamination of the pasture. In small herds, substitutions are typically made by relocating animals and economic trade is uncommon. Hence, the lower rate of cattle movement reduces the chances of disease transmission. In contrast, cattle movement in large herds is common, both for replacement and for trade, thus increasing the risk of Brucella infection. Herding several species within a herd has been characterized as a risk factor for brucellosis although there is no indication of the higher susceptibility of particular species to Brucella infection. As a result, the reason for the increased prevalence of brucellosis when various species mix is unclear, but it may be related to a higher probability of being infected with brucellosis owing to various sources of the disease. Brucella infection is seldom spread from small ruminants to cattle Nevertheless, the threat to cattle on farms that also keep small ruminants suggests that some cases of bovine brucellosis may have originated from small ruminants, because B. meltiness biovar 3 has been isolated from cattle milk. Dairy cattle have a far greater probability of not only acquiring Brucella infection but also spreading it more rapidly than beef cattle. Cattle housed in small areas come into close contact with each other during feeding and milking. Dairy cattle are exposed to additional stress on farms, causing conditions that are more conducive to Brucella infection. Cattle purchase is considered as a risk for brucellosis and will increase the chance of introducing diseased cattle into the herd Most infectious disease in previously brucellosis-free herds starts with the purchase of diseased cattle from unidentified sources.

The effect of agro ecology is also recognized as a Brucella infection risk factor, with a higher prevalence in dry areas. Because of a shortage of pasture in dry areas, cattle are put out to pasture over large areas, indicating uncontrolled cattle to cattle interaction with the potential risk of transmission. In addition, transmission through aerosol inhalation of contaminated dust from fetal discharges or abortions is likely. Large herd sizes are likely to be related to intensive management systems, which are generally tougher to manage and permit closer interactions between cattle and their surroundings, which can increase the probability of exposure to Brucella organisms. In addition, the stressful conditions of an intensive production system may make cattle more prone to infections. However, an extensive production system may also increase the risk of Brucella infection. This may be related to the management of abortions, identification of diseased cattle, and interactions among cattle. Since an extensive system implies rearing many cattle over a large area and sharing common pastures, the contamination of pastures with discharges from the reproductive tract may lead to brucellosis in the herds. Risk factors relating to farming and ecological conditions that affect the spread of brucellosis include giving birth, breeding in semi-dark settings, confined areas, and high cattle populations. The intensive system is another risk factor for brucellosis. This may be related to airborne transmission of disease-causing bacteria indoors. Similarly, the seasons have an influence on animal husbandry and nutrition, principally in pastoral areas [88-100].

Status of Brucellosis in Ethiopia:

Ethiopia, located in Eastern Africa, is predominantly an agrarian country with over 85% of its population engaged

in agricultural activity. Since the first report of brucellosis in the 1970s in Ethiopia, the disease has been noted as one of the important livestock diseases in the country A large number of studies on bovine have been reporting individual brucellosis zero-prevalence ranging from 1.1% to 22.6% in intensive livestock management systems and 0.05% to 15.2% in extensive management systems. Most brucellosis study report for highland agro-ecology was concentrated at urban and pre urban dairy farms. According to different authors herd level sero-prevalence ranged between 2.9% and 45.9%. The highest sero-prevalence (50%) was documented using ELISA in Dididuyura Ranch. 2.91% in indigenous Borena breed cows in Borena zone in Southern Ethiopia.

In South Eastern Ethiopian pastoral zones of the Somali and Oromia regional state herds, sero-prevalence per species which were 1.4% were reported. Another study from Addis Ababa, Ethiopia found a prevalence of 10%. A study conducted on smallholder farmers of central Ethiopia (Whale Jida district) reported a prevalence rate of 11%. he overall seroprevalence of bovine brucellosis in pastoral and agro pastoral regions of East Showa Zone, Oromia Regional State, was 11.2% by the Rose Bengal Plate Test (RBPT). This report was within the range 10 to 15% that was estimated for any assumed brucellosis seroprevalence for East Africa. According to study of bovine Brucellosis in cattle under traditional production system in North- West Ethiopia Benishangul-gumuz, among the 1,152 cattle screened for B. abortus antibodies, 14 (1.2%) tested positive by RBPT of these, 11 animals (79 %;) were confirmed positive by complement fixation test (CFT), giving an apparent seroprevalence of 1.0% in the study area .

Pathogenesis

The *Brucella* spp to cause disease requires a few critical steps during infection. Brucella spp can invade epithelial cells of the host, allowing infection through mucosal surfaces: M-cells in the intestine have been identified as a portal of entry for Brucella spp. usually through the digestive or respiratory tract, they are capable of surviving intra cellular within phagocytic or non-phagocytic host cells and replicate within the phagocyte ,then release to circulation and colonization of the bacteria in multiple tissues ,like lymphoid tissues, mammary gland and reproductive tract. Invading *Brucella* usually localize in the lymph nodes, draining the invasion site, resulting in hyperplasia of lymphoid and reticulo endothelial tissue and the infiltration of inflammatory cells. Survival of the first line of defense by the bacteria results in local infection and the escape from the lymph nodes in to the blood. During bacteriamic phase, bones, joints, eyes and brain can be infected, but the bacteria are most frequently isolated from supra-mammary lymph nodes, milk, iliac lymph nodes, spleen and uterus. In bulls, the predilection sites for infection are also the reproductive organs and the associated lymph nodes. During the acute phase of infection, the semen contains large number of *Brucella* but as the infection becomes chronic, the number of *Brucella* excreted decreases. However, it may also continue to be excreted for years or just become intermittent.

Clinical Signs

Primary clinical manifestations of brucellosis among livestock are related to the reproductive tract in highly susceptible non vaccinated pregnant cattle. The principal symptoms of *Brucella* infection are abortion in the last stage of pregnancy in female cattle and orchitis and bursitis in male

Females usually abort only once, presumably due to acquired immunity. In general, abortion with retention of the placenta and the resultant metritis may cause prolonged calving interval and permanent infertility. In cattle, *B abortus* causes abortions, stillbirths and weak calves. The placenta may be retained and lactation may be decreased. Epididymitis, seminal vesiculates, orchitis and testicular abscesses are sometimes seen in bulls. Infertility occurs occasionally in both sexes, due to metritis or orchitis/ epididymitis. Hygromas, particularly on the leg joints, are a common symptom in some tropical countries. Arthritis can develop after long-term infections. Systemic signs usually do not occur in uncomplicated infections and deaths are rare except in the fetus or newborn. Infections in non-pregnant females are usually asymptomatic, but pregnant adult females infected with *B abortus* develop placentas, which normally causes abortion between the fifth and ninth month of pregnancy. Even in the absence of abortion, there is heavy shedding of bacteria through the placenta, fetal fluids and vaginal exudates. The mammary gland and regional lymph nodes can also be infected and bacteria can be excreted in milk [104,105].

Diagnosis

Bacteriological Diagnosis:

Isolation of the organism is considered the gold standard diagnostic method for brucellosis since it is specific and allows biotyping of the isolate, particularly if the direct examination supported by other tests. Occasionally, bacteria can be recovered from the cerebrospinal fluid, urine or tissues. Brucella spp can be isolated on a variety of plain media, or selective media such as Farrell's medium. Samples for Brucella spp isolation from cattle include fetal membranes, particularly the placental cotyledons where the number of organisms tends to be very high. In addition, fetal organs such as the lungs, bronchial lymph nodes, spleen and liver, as well as fetal gastric contents, milk, vaginal secretions and semen are samples of choice for isolation .Vaginal secretions should be sampled after abortion or parturition, preferably using a swab with transporter medium, allowing isolation of the organism up to six weeks post parturition or abortion . Milk samples should be a pool from all four mammary glands. Non- pasteurized dairy products can also be sampled for isolation. Samples of choice in slaughter houses include mammary, iliac, pharyngeal, parotids cervical lymph nodes, and spleen. Samples must be immediately sent to the laboratory, preferentially frozen at -20°C, and they must be identified as suspect of Brucella spp. Infection. Vaginal swabs, semen and seminal fluid have low numbers of viable organisms, and therefore isolation is more difficult, often resulting in false negative results. Enrichment media containing selected antibiotics can improve the sensitivity in these cases.

Serological Tests:

Several commercial serological tests are available for humans and animals (WHO, 2006) The Rose Bengal test (RBT) has been recommended as a suitable screening test at the national or local level for diagnosis of brucellosis in animals (WHO, 2006). Enzyme-linked immunoassays (ELISA) and the fluorescent polarization assay (FPA) have recently been added as prescribed tests. They are simple, but robust, tests which can be conducted with a minimum of equipment and are therefore also suitable for smaller laboratories. Further serological tests (e.g. the Combs' test, the serum or plate agglutination test and the immune-capture test) are available, and have specific advantages and disadvantages .Rose Bengal Plate Test (RBPT): Often used as a rapid screening test; the sensitivity is very high (>99%) but the specificity is disappointingly as low as 68.8%. RBPT is a rapid, slide-type agglutination assay performed on serum. The general principle of this test is the agglutination of serum antibodies with Rose Bengal dye-stained B. abortus whole cells buffered at a pH of 3.65 to inhibit nonspecific agglutinins. Due to its simplicity and low cost, it is the most common test used for brucellosis screening purposes, especially in laboratories with limited resources. However, this is of value as a screening test in high risk rural areas where it is not always possible to perform the other tests.

Milk Ring Test :

The MRT has been explained as a satisfactory and inexpensive test for the surveillance of dairy herds for brucellosis. The MRT is easy, simple and takes low time to perform. When positive test result is obtained, all animals contributing milk should be tested for seroprevalence. It detects lacteal anti Brucella IgM and IgA bound to milk fat globules (OIE, 2004). Milk that contains low concentration of lacteal IgM and IgA or that lacks the fat-clustering factors can give false negative results. Because lacteal antibodies rapidly decline after abortion or parturition, MRT, using 1ml milk, to detect Brucella antibodies in individual animal or in tank milk is strongly discouraged. In large herds (>100 lactating animals), the sensitivity of the test becomes less reliable. False positive reactions may also occur in animals vaccinated 4 months prior to testing and in samples containing abnormal milk (colostrum) or in case of mastitis [106-108].

Polymerase Chain Reaction:

Polymerase chain reaction (PCR) assays can be used to detect Brucella DNA in pure cultures and in clinical specimens, i.e. serum, whole-blood and urine samples, various tissues, cerebrospinal, synovial or pleural fluid, and pus (Direct detection of Brucella DNA in brucellosis patients is a challenge because of the small number of bacteria present in clinical samples and inhibitory effects arising from matrix components. Basic sample preparation methods should minimize inhibitory effects and concentrate the bacterial DNA template [100].

Treatment

Due to the intracellular localization of Brucella and its ability to adapt to the environmental conditions encountered in its replicative niche e.g. macrophage Treatment of domestic animals with antibiotics is not usually successful. Even though, treatment failure and relapse rates are also high in humans, treatment depend on the drug combination of doxycycline with streptomycin which is currently the best therapeutic option with less side effects and less relapses, especially in cases of acute and localized forms of brucellosis A combination of doxycycline treatment (6 weeks duration) with parentally administered gentamicin (5 mg/kg) for 7 days is also considered an acceptable alternate regimen [90-100].

Prevention and Control

In Ethiopia the source of human brucellosis is direct or indirect exposure to infected animals or their products, prevention must focus on various strategies that will mitigate infection risks. There have been no national programs proposed for prevention and control of brucellosis in Ethiopia. Rather than teaching or giving awareness to population similarly, at regional levels, no strategy is in place to control brucellosis. This is largely a result of lack of facilities and budget to run such program. Moreover, many responsible bodies may not recognize the significance of brucellosis given the contradictory and sometimes low prevalence data. However, now, it is crucial to define geographical extent of the problem and then allocate resources and funds to initiate prevention and control strategies in Ethiopia and other countries with similar economic situations Based on Prevalence In areas where the disease is less prevalent (for example livestock seroprevalence of less than 1%), cull policy with compensation may be recommend. For areas with high and moderate prevalence (>5%) under well-organized farming systems, we may recommend test and segregation policy by which animals with brucellosis will be isolated and products consumed after pasteurization, with animals being disposed of properly at the end of their productive live.

Vaccination

Brucellosis is a bacterial zoonosis caused by *Brucella* spp. which can lead to heavy economic losses and severe human diseases. Thus, controlling brucellosis is very important. Vaccine against brucellosis in animals plays a crucial role in the management of the disease in animals as well as in humans. The most common *Brucella* spp., viz., strain 19, RB51 and Rev1 are widely used as vaccine strains to protect against Brucella infection and related abortions in livestock. However, their use in other susceptible animals needs further studies and requires the development of novel effective vaccines in near future. *B. abortus* strains 19 and RB51 are very efficient and common vaccines being used against bovine brucellosis. The best vaccine for the prevention of brucellosis in goats and sheep presently is *B. melitensis* strain. *B. abortus* vaccine should also be able to give cross-protection against *B. melitensis.* Aninfluenza viral vector- *B. abortus* vaccine completely protected against abortions in pregnant heifers. An excellent level of cross-protection (90-100%) in the heifers, their calves or fetuses was observed upon challenge with *B. melitensis* 16 M. Influenza viral vector-B. abortus vaccine provided equivalent protection when compared with *B. abortus* S19 vaccine These two vaccines were found to provide high degree of immunity against *B. melitensis* 16 M infection .

The economic analysis showed that a vaccination program covering the vaccination with S19 vaccine in 90% of the replacement heifers of 3–8 months of age provides excellent economic returns in a brucellosis vaccination program in bovines. *B. abortus* S19 vaccine, an intermediate rough strain, was found to be safe, immunogenic and also has the potential to be used as strategy vaccine for prevention and control of bovine brucellosis.

Appropriate Hygienic Measures

Good hygiene and protective clothing/equipment are very important in preventing occupational exposure. Precautions should be taken to avoid contamination of the skin, as well as inhalation or accidental ingestion of organisms when assisting at a birth, performing a necropsy, or butchering an animal for consumption. Care should be taken when handling an aborted fetus or its membranes and fluids. Risky agricultural practices such as crushing the umbilical cord of newborn livestock with the teeth or skinning aborted fetuses should be avoided. Application of farm bio-safety measures: Implementation of measures to reduce the risk of infection through personal hygiene, adoption of safe working practices, protection of the environment and food hygiene. Under appropriate conditions, *Brucella* organisms can survive in the environment for prolonged periods. The proper handling and burying of abortion materials to prevent contamination of water sources and pasture is of paramount importance. Furthermore, the common practice of feeding abortion materials to dogs should be avoided as this increases the risk of transmission to other animals. It is imperative to education on risks for infection to these populations to influence behavioral practices that will reduce risks of transmission.

Pasteurization

Brucella abortus is inactivated by pasteurization and Pasteurization of dairy products is an important safety measure to prevent Human brucellosis where this disease is endemic. Unpasteurized dairy products and raw or undercooked animal products (including bone marrow) should not be consumed. Main source of transmission of *B. abortus* to human is through consumption of unpasteurized or raw milk or milk products including butter, whey, cheese, yogurt, ice-cream, etc.

Disease Spectrum in Humans

Human brucellosis is primarily caused by *B. meltiness* globally. *B. abortus*, *B. suis* and *B. canis* also cause human brucellosis worldwide Sheep, goats and their products are major sources of *B. meltiness* infection in human beings' Main source of transmission of *B. abortus* to human is through consumption of unpasteurized or raw milk or milk products including butter, whey, cheese, yogurt, ice-cream, etc.

Public Health and Economic Significance

Brucellosis, particularly B. meltiness's is thought to be one of the most prevalent re-emerging zoonotic diseases globally with an estimated incidence of more than 50,000 human cases per year The zoonotic importance of brucellosis as zoonosis is increasing owing to tremendous increase in global trade in animal products, rapid deforestation, unplanned and unsustainable development, urbanization, intensive farming, having migratory/nomadic animal husbandry and increased international tours and travel .Even the exhaustive and advanced surveillance and control measures have not been able to reduce the prevalence of brucellosis in most of the developing countries due to poor hygiene, lack of sanitation, poverty, lack of proper administration and political will . Brucellosis badly affects livestock welfare and economy. The collective economic losses are the cumulative effect of reduction in the production of milk, abortions, losses of newborn calves resulting from abortions and stillbirths, culling of brucellosis affected animals, hindrance in export and trade of animals, loss of human effort in terms of man-days wasted, veterinary and medical expenses, administrative and governmental expenses on research and control programs .

2. Conclusions and Recommendations

Bovine Brucellosis is a bacterial zoonotic disease, which has both public health and economic importance. This disease can be transmitted from infected animal to healthy one through fetal discharges, contaminated feed and water, licking of vaginal discharges or secretions or newly born infected calves in animals. In human, brucellosis can be transmitted via consumption of unpasteurized milk and cheese, direct contact with infected animal and handling of specimen that contaminated with *Brucella* species. Brucellosis is a worldwide disease both in developed and developing country even though; this disease is eradicated in developed countries with vaccination program and screening method of livestock, this disease poses serious problem in developing countries mainly African countries including Ethiopia. This disease causes abortion, delayed heat, loss of calve, infertility, reduce milk production and meat production and still birth in cattle due to absence of regular screening method and vaccination programs in most developing country mostly in sub Saharan Africa. Since brucellosis is a leading zoonotic bacterial disease that affects human health and economy due to trade ban attention must be given to control or prevent this disease in developing country through routinely screening method, regular vaccination and tackling the mode of transmission of this disease may reduce risk posed. In addition, at regional, national and international level strict regulation should be devised to control or prevent as well as to eradicate this disease. Therefore, I recommend:

- ❖ Effective control and prevention strategies should be formulated and applied.
- ❖ Public education on the source of infection and transmission of the disease as well as awareness creation should be applied.
- ❖ Implementation of control and prevention measures of brucellosis in animals, to stop human infections.
- ❖ Good hygiene and protective clothing/equipment are very important in preventing occupational exposure.
- ❖ Avoid eating or drinking unpasteurized milk, and milk product

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