Review on bovine tuberculosis and its public health importance in ambo Ethiopia.

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Abstract

Tuberculosis is a chronic, primarily respiratory infectious disease of mammals caused by the Mycobacterium tuberculosis is a chronic debilitating that occurs in cattle. The main risk factors which contribute to the acquisition of M. bovis diseases in both urban and rural human populations are poverty, malnutrition, HIV infection, illiteracy, the consumption of raw milk and others. Risk factors such as herd size, keeping herd with other livestock species, contact with other herds, annual migration dynamics, and the recent introduction of new animals to the herd, could be associated with herd positivity to tuberculosis. Transmission of tuberculosis, generally, is through the respiratory tract. No symptoms occur in the early stage of the disease that is asymptomatic. Most of the conventional methods used for detecting Mycrotuberculosis employ sputum smear and culture techniques, which is a tedious process that require skilled persons to handle the test. The emergence of drug-resistant tuberculosis (DR-TB) is becoming a major global challenge. However, no M. bovis infections have been reported in the Ethiopian wildlife population. So the objective of the present review is to review the available literature on the bovine tuberculosis and its public health importance in Ethiopia.

List of Abbreviations

BCG: Bacille Calmett Guérin
DR-TB: Drug-Resistant Tuberculosis
EIDs: Emerging Infectious Diseases
ELISA: Enzyme Linked Immunosorabent Assay
FDA: Food and Drug Administration
HIV: Human Immunodeficiency Virus
MDR-TB: Multidrug-Resistant Tuberculosis
MTBC: Mycobacterium Tuberculosis Complex
OIE: Office International Des Epizooties
PPD: Purified Protein Derivatives
PPD-A: Avium Purified Protein Derivatives
PPD-B: Bovine Purified Protein Derivatives
TST: Thiousulfate Sulphur Tranferase
WHO: World Health Organization
ZN: Ziehl-Neelsen

Keywords: Ethiopia, M. bovis, Public health.

Introduction

The name “Tuberculosis” comes from the nodules, called tubercles, which form in the lymph nodes of affected animals and the disease is characterized by the progressive development of specific granulomatous lesions of tubercles in affected tissues and organs [1-3]. A close interaction between animals and humans primarily contributes to the transmission of infectious zoonotic diseases [4-6].

Mycobacterium bovis (M. bovis) is an intracellular, non-motile, facultative, weakly Gram-positive acid-fast bacillus.

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In (agro-) pastoral settings, where cattle graze in the open, tuberculin testing and abattoir surveys [7], show a relatively low prevalence. In contrast, in intensive dairy farms that keep exotic breeds, a much higher prevalence (24%–34%) has been reported.

Bovine tuberculosisis a common zoonotic disease caused by Mycobacterium bovis which affects a wide range of animals and humans [8,9]. Cattle-based tuberculosis has become a significant infectious disease that spread between species. Bovine tuberculosis is widely distributed around the world with a significant economic impact on the livestock production sector [10]. However, in developed countries, the occurrence of human tuberculosis due to M. bovis has meaningfully declined because of mandatory pasteurization of milk together with tuberculin skin testing of cattle followed by culling/ slaughtering the infected cattle [11].

Studies showed that BTB is still common in developing countries where routine milk pasteurization is not practiced, and an estimated 10–15% of human tuberculosis incidences are because of M. bovis [12]. Testing of cattle followed by culling/slaughtering the infected cattle. Cattle are considered to be the main hosts of Mycobacterium bovis (M. bovis) although isolations have been made from many other livestock and wildlife species and transmission to humans poses a public health problem [13,14]. Diseases transmitted between humans, wildlife, and domestic animals are increasingly challenging public and veterinary health systems [15]. Similarly three-fourths of all emerging infectious diseases (EIDs) of humans are zoonotic with most originating from wildlife reservoirs. Therefore, diseases that arise from the livestock–wildlife interface are of paramount importance and must be an area of focus for public and veterinary health systems.

Despite this importance cross-species transmission is one of the least studied aspects of disease ecology [16]. One such pathogen is Mycobacterium bovis, the causative agent of tuberculosis in cattle and most other mammals, wild or domestic. Importantly, its remarkably broad host range includes humans [17].

Objective

- To review the available literature on the bovine tuberculosis and its public health importance in Ethiopia.

Literature Review

Definition, global and national burden of tuberculosis

Tuberculosis is a chronic, primarily respiratory infectious disease of mammals caused by the Mycobacterium tuberculosis (MTB) complex, a group of closely related bacteria that include M. bovis responsible for TB in cattle and other mammals, including, occasionally, people. Cattle are the natural hosts of M. bovis, but nearly all warm-blooded animals, including goats, deer, pigs, camelids, and badgers, are susceptible to the infection. Tuberculosis has a broad range of animal hosts that complicates the eradication of tuberculosis in different animal species [18,19].

Tuberculosis (TB) is one of the top 10 causes of death worldwide as well as being the leading cause from a single infectious agent (more than HIV/AIDS). According to 2018 global estimates, there were an estimated 10 million new cases of TB and 1.2 million TB deaths in 2018. The high prevalence of TB is always a critical public health problem in China: China has the second-highest number of cases of TB in the world right after India, with 866,000 identified cases in 2018 [20].

Tuberculosis is a well-known poverty-related disease, usually related to the disadvantages of socio-economic status. In particular, among those who come from rural and poor districts, the scarcity of health resources and poor economic conditions place them in a more serious situation [21]. Delayed and repeated visits to clinics before diagnosis, the over-prescribing of drugs, and prolonged treatment are common [22]. Patients bear too much economic burden which precludes them from further adhering to treatment and results in treatment failure [13].

Etiology

Bovine tuberculosis is a chronic bacterial diseases, Gram-positive, acid-fast bacterium. This pathogen belongs to the Mycobacterium tuberculosis complex, a group of genetically closely related mycobacteria [23-25]. Mycobacterium tuberculosis, Mycobacterium bovis, Mycobacterium bovis BCG, Mycobacterium canettii, Mycobacterium africanum, Mycobacterium pinnipedii, Mycobacterium microti, Mycobacterium caprae, the dassieand the oryx bacillus, and the recently discovered Mycobacterium mungi are closely related species that form the M. tuberculosis complex (MTBC) [26-29]. Mycobacterium tuberculosis and M. bovis are the most important species in the complex which commonly cause human and animal tuberculosis (TB), with concomitant negative consequences for human and animal health and economic costs [30].

Mycobacterium tuberculosis is a nonmotile, non-spore-forming, obligate aerobe, the acid-fast bacillus that often appears beaded or unstained using Gram stain. Like all mycobacteria, it is distinguished by its ability to form stable mycolate complexes with arylmethane dyes (carbolfuchsin, auramine, and rhodamine) [31,32].

Epidemiology

Geographically, M.bovis is distributed worldwide. According to the Worldwide Animal Health Information Database of OIE [33], 91 out of 182 countries reported the presence of BTB infection in cattle during the 2015–2017 period. In Africa, 30 of 59 countries reported the presence of the disease in the same period. The disease is also widespread in Central and South America, parts of Asia, and Middle East countries. While BTB has been controlled successfully in most developed countries through the implementation of test-and slaughter schemes, meat inspection at abattoirs, and pasteurization of milk, BTB remains a problem in some developed countries (e.g., UK, Ireland, New Zealand) [1], and in most developing countries where the practice of control programs are either at an early stage or non-existent [34,35].

Mycobacterium bovis combines one of the widest host ranges of all pathogens with a complex epidemiological pattern, which involves interaction of infection among human beings, domestic animals and wild animals [27,29,36,37]. However, only little is done particularly in developing countries on the epidemiology of this organism and the epidemiological requirements for its control. The M. bovis is transmitted from animal to man through ingestion of the unpasteurized dairy product, milk of infected cattle, and undercooked meat which was recognized as a major public health problem [38]. Infected cattle are considered a possible source of infection as they shed a significant amount of M. bovis through droplet nuclei into the environment and may act as a source of intra herd transmission [39]. The main source of infection is untreated smear-positive PTB patients. It typically affects the lungs (PTB) but can also affect other sites as well (extra PTB) [24]. Infectious organisms can be found in respiratory secretions, feces, milk, urine, vaginal secretions, semen, and draining lymph nodes [40].

Source of infection: The M. bovis is transmitted from animal to man through ingestion of the unpasteurized dairy product, milk of infected cattle, and undercooked meat which was recognized as a major public health problem [41]. Infected cattle are considered a possible source of infection as they shed a significant amount of M. bovis through droplet nuclei into the environment and may act as a source of intra herd transmission [42]. The main source of infection is untreated smear-positive PTB patients. It typically affects the lungs (PTB) but can also affect other sites as well (extra PTB) [24]. Infectious organisms can be found in respiratory secretions, feces, milk, urine, vaginal secretions, semen, and draining lymph nodes [43].

Modes of transmission: Organisms can survive for long periods in moist conditions or organic matter. Spread from the dam to children through the feeding of milk from animals with TB of the udder is also possible [43]. The disease is a significant zoonosis that can spread to humans, typically by the inhalation or the ingestion of unpasteurized milk [44,45]. Tuberculosis is transmitted by respiratory route when a patient is coughing or sneezing, and one strain of TB, Transmission of tuberculosis, generally, is through the respiratory tract. Infectious organisms can be found in respiratory secretions, feces, milk, urine, vaginal secretions, semen, and draining lymph nodes. Occasionally abdominal involvement is observed, suggesting that ingestion may be a possible route of transmission. Tuberculosis can spread either directly (animal-to-animal), particularly by aerosol, or indirectly (via infective material, for example, manure, urine, bedding, contaminated feed, and water). In case of intestinal route or ingestion through the buccal mucosa, pharyngeal mucosa, and intestinal mucosa the organism may enter into the animal body. It is also through the congenital route but is the less common mode of acquiring infection [46-50].

Risk factors

In humans: The risk of M.bovs is high among populations living in poverty, low socioeconomic groups, low income, immune-suppressed (including AIDS), and extreme age (old age and children) groups, a certain ethnicity, migrants, and those exposed to animals (Mycobacterium bovis). The risk of M.bovs transmission also increases with the intimacy and duration of contact with the infectiousness [51-53].

Animal level: Animal level risk factors are cattle breeds, genetic resistance, physiological state of the animal, age, sex, stress, concurrent infection, immune status, and body condition score (BCS) [54,55]. Several past and recent studies have shown that susceptibility to bovine TB can vary between cattle breeds with suggestions that indigenous zebu cattle are more resistant to BTB than exotic breeds [56]. Genetically improved cattle may suffer more severely from deficient housing and malnutrition and thus be more prone to infection [57-60]. One of the main animal risk factors identified by numerous studies in both developed and developing countries is the age of animals. The duration of exposure increases with age [6].

Animals might get infected at a young age, but only express the disease clinically when they are adults. Mycobacteria can remain in a latent state for a long period before reactivation at an older age. Furthermore; as animals become older (above 5 years), the immune response also gets depressed; as a result, animals commonly show a lower reaction to tuberculin tests [51]. Gender-linked factors are probably related to management practices or behavioural habits; Males have potentially more contact with other herds during breeding, which may increase their risk [32]. Animal's resistance to tuberculosis is reduced by a shortage of feed and/or unbalanced diet, attributable to a deficiency of proteins, minerals, and vitamins in the diet [10].

Herd level: Risk factors at herd level are herd size, types of farming practice and housing of cattle, geographical origin, history of bovine TB in the herd and human antecedent of tuberculosis in the household, contact between animals and with wildlife reservoirs, the introduction of cattle in a herd, herd movements and trading, the use of hired/shared bulls, manure and environmental persistence of M. bovis [61-65]. Under the nomadic conditions, the risk of exposure to M. bovis also increased significantly by herd contacts and increasing the total herd size. In case of wildlife direct contact or sharing of the environment with domestic cattle, the extent of the disease prevalence within the region/country or domestic animal reservoir host, herd size (wildlife densities), and the previous history of M. bovis in the wildlife populations are among the potential risk factors [51].

Clinical manifestation

In animal: Bovine TB is a chronic debilitating disease, and signs may be lacking, or vary when present. Clinical signs of tuberculosis include weight loss and mild respiratory signs. Early in the course of the disease, affected animals exhibit a deep, moist-sounding, chronic cough. As the disease progresses, tachypnea, dyspnea, and abnormal lung sound develop [66,67]. Bovine tuberculosis should be considered in cases of chronic loss of condition and appetite, reduced milk yield, and debilitating disease, with or without respiratory signs [43].

In humans: M.bovis is a chronic debilitating disease that occurs in humans. No symptoms occur in the early stage of the

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disease that is asymptomatic. However, in the late stage, there is progressive emaciation, a mild fluctuating fever, weakness, and in-appetence. When infection is present in the lung then dyspnoea, moist cough, or tachypnoea may occur a capricious appetite and fluctuating temperature are commonly associated with the disease [68-70].

Pathogenesis

The entrance of tubercle bacilli to animal body through respiratory, alimentary, genital, cutaneous and congenital routs [52]. After infection, the bacteria may localize in tissues related to the route of infection and associated lymph nodes. Miliary TB represents the most sever course of the disease with haematogenous spreading as a result of lysis of macrophages that release bacteria in to the blood from the primary foci and secondary seeding to various tissues [4]. A primary lesion or focus of infection is established following the interaction of the host and the agent at the site of entry within 8 weeks of bacterial entrance [66]. Mycobacterium bovis eludes the bacteriocidal activities of macrophages by escaping from fused phagolysosomes into nonfused vacuoles in the cytoplasma, this due to its cell wall lipids (mycosides, phospholipids, and sulpholipids). A characteristic feature of virulent strains of mycobacteria is that they form cords when they grow in a liquid culture media whereas the avirulent strains develop as clumps [71-73].

Diagnosis

In humans

Based on clinical sign: Most of the conventional methods used for detecting MTB employ sputum smear and culture techniques, which is a tedious process that required skilled persons to handle the test and consumes more time to produce the result which varies from several days to weeks. Early diagnosis of TB and drug resistance TB improves survival and by identifying infectious cases we can treat them at an early stage and reduce the mortality rate [74.75].

Tuberculin skin test: Tuberculin antigen protein derivative is injected into the patient's arm and the sensitivity reaction is noted after 48–72 hours, the reactions form the basis of Type IV hypersensitivity. The main drawback of this test is that it gives high false-positive results with Bacille Calmette Guerin (BCG) vaccinated persons and those exposed to non-TB mycobacterium. It also gives false-negative results for HIV co-infected and children. But it is used to detect latent TB along with other tests to monitor the progress of the disease [76-78].

Chest radiography: Chest X-ray (CXR) is the commonly used method to find TB, but it is done in conjunction with Thiosulfate Sulfur transferase (TST) and serological test (Interferon Gamma Release Assay Test) [79,80]. Acute pulmonary TB can be easily diagnosed with a CXR image, but TB in the extra pulmonary region cannot be diagnosed with chest radiography. This test shows more sensitivity but less specificity [68]. Therefore, relying on CXR is the possible solution for detection. The drawback of CXR is that it requires a skilled personnel to interpret the chest X-ray images [35].

Culture detection methods: Mycobacterial culture can be performed on either a solid or a liquid medium. The yield of M. tuberculosis isolated from a liquid medium (e.g., Middlebrook 7H9) is greater than that from a solid egg-based medium (e.g., Lowenstein-Jensen) or a solid agar-based medium (e.g., Middlebrook 7H11) [63].

Molecular detection methods: In 1995, the amplified mycobacterium direct test (AMTD) (Hologic, San Diego, CA) was the first nucleic acid-based amplification test (NAAT) to be cleared by the Food and Drug Administration for the detection and identification of M. tuberculosis from direct specimens. This assay utilizes transcription-mediated amplification of a portion of the 16S rRNA gene-specific to the M. tuberculosis complex to identify the organism [61].

In animal:

Based on clinical sign: Where chronic debilitating co-infections, such as CBPP (Contageous Bovine Pleuro pneumonia), trypanosomosis, and endo-parasites are prevalent, several animals were seen with enlarged prescapular lymph nodes, suggesting underlying chronic diseases [81-85]. Similarly, in an attempt to diagnose BTB clinically, Ameniet al stated that with exception of few animals that reached an advanced stage, most animals from both negative and positive herds exhibited comparable physical conditions [2]. Therefore, because of the lack of frank clinical signs and the presence of other debilitating conditions, diagnosis of BTB based on clinical examination such as auscultation and palpation of superficial lymph nodes is difficult [57].

Tuberculin skin test: Tuberculin is the name given to extracts of M. bovis, M. tuberculosis, and M. avium which are used to test animals to identify those animals previously exposed to mycobacterial infection. The common type of tuberculin is purified protein derivative (PPD) [86,87]. Aliquots of 0.1 ml of 20,000 IU/ml bovine purified protein derivatives (PPD) and 0.1 ml of 25,000 IU/ml avian PPD are injected into the dermis at these sites [48].

Enzyme linked immunosorabent assay (ELISA): The ELISA appears to be the most suitable of the antibody detection tests and can be a complement, rather than an alternative, to tests based on cellular immunity [88,89]. It may be helpful in anergic cattle. An advantage of the ELISA is its simplicity, but sensitivity is limited mostly because of the late and irregular development of the humoral immune response in cattle during the course of the disease. Specificity is also poor in cattle when complex antigens such as tuberculin or M. bovis culture filtrates are used. However, a comparison of antibody levels to PPD-B and PPD-A has been shown to be useful in increasing specificity in the ELISA [90].

Treatment and management

The emergence of drug-resistant tuberculosis (DR-TB) is becoming a major global challenge [91]. Drug-resistant tuberculosis is caused by Mycobacterium bacteria that are resistant to at least one first-line anti-TB drug [92]. Currently, DR- TB is becoming worse through the development of resistance to more anti-TB drugs. The increasing incidence of multidrug-resistant tuberculosis (MDR-TB) and extensively drug-resistant tuberculosis (XDR-TB) is a major concern for TB control programs [73]. Multidrug-resistant TB is resistant to at least isoniazid and rifampicin, whereas XDR-TB is MDR-TB, plus any fluoroquinolones and at least one of the injectable second-line drugs [93].

In 2018, there were an estimated 484,000 MDR/RR-TB incident cases worldwide, with an estimated 3.4% of new cases and 18% of previously treated cases. The major challenge of MDR-TB is its treatment, where treating and curing patients is more complicated [15]. The treatment takes a long time and it is mostly individualized and relies on the patient's condition and the decision of the clinician [26]. Unsuccessful and poor treatment outcome is common among patients treated for MDR-TB [8,33,38]. The poor treatment outcome is either failure in treatment or death during the treatment course [94].

If treatment is not initiated, a person with TB disease will infect an average of 10–15 other people every year [19]. In addition, the emergency of drug-resistant TB makes the global TB control program more difficult [95-98].

Control of bovine tuberculosis in pastoral communities, where livestock moves from one place to another searching for grazing and watering points is not easy. This situation is exacerbated during drought when nomadic tribes move and establish temporary settlements in areas where grazing land and water are available. The success of a national BTB eradication programme includes clear identification of the goals, of the policies that guide actions, and of the sequences of actions that are required within the programme to accomplish these goals. So far, BTB control in African domestic and wildlife has included culling, fencing, corridors kept free of animals. All approaches have drawbacks, ranging from inefficiency to interference with wildlife migration leading to decreased wildlife population, and even mass mortality [12].

In most parts of Ethiopia, animals are kept near dwellings and maintained under very poor management and hygienic status, thus increasing the risk of acquiring infection for animals and humans. Creating awareness among the people to meet the standard hygienic requirement and to improve husbandry practices has been described to have paramount importance in BTB control. In sub-Saharan Africa, BTB vaccination research in livestock is on-going but has shown various successes so far. In general, human tuberculosis can be effectively controlled through BCG vaccination and the employment of chemotherapy [98]. In Ethiopia, health education is practiced as one of the pivotal means to control TB through increasing awareness of the community about the disease. In pastoral areas where people have the habit of consuming raw milk and meat, public education about hygienic practices like milk pasteurization has been described to be very important [16].

Successfully eradicating the disease is dependent on the accessibility and operation of distinguishing all the infected animals. In Africa, including Ethiopia, the absence of finance generally decides the indicative strategies that can be applied, and inspection at slaughter remains the main reasonable strategy by which the infection can be analysed and its spread. In many African countries, only a small percentage of carcasses for human consumption are inspected, and most domesticated animals are slaughtered informally and are not examined by meat inspectors (professionals) [18,43].

Currently, there is no national tuberculosis control or anticipation program in Ethiopia because of principally inadequate finance, infrastructure, and human resources. An absence of awareness, by farmers and traders of a risk-based marketing system or stay away from the risk of contamination with BTB, is likewise universal and ought to be tended to while performing future control programs.

The standard control measure applied to tuberculosis is test and slaughter or abattoir. Screening of meat at slaughterhouses along with detection of slaughtered animal's herd of origin will help reduce the disease [77]. Tuberculin test is valuable in the control of zoonotic tuberculosis because early recognition of preclinical infection in animals intended for food production and early removal of infected animals from the herd eliminates a future source of infection for other animals and humans. In the case of cattle, a tuberculin test should be performed in the course of the twelve months before presentation for slaughter [25]. There is also a need for medical and veterinary professionals should cooperate in cases of a disease outbreaks [36].

Epidemiology in Ethiopia

In animals: The cattle owned by tuberculous patients had a higher prevalence (24.3%) than cattle owned by non-tuberculous owners with prevalence of 8.6%. Also noted that 73.8% and 16.7% of 42 human isolates were identified as M. tuberculosis and M. bovis and from cattle isolates 18.1% and 45.5% of 11 were found to be M. tuberculosis and M. bovis species, respectively. This showed that the role of M. bovis in causing human tuberculosis seemed to be significantly important. Moreover; in Ethiopia, exotic and crossbreeds were found to be more susceptible than local breeds to M. bovis with the manifestation of high prevalence of the disease [80]. Mycobacterium bovis also infects other species of domestic animals which are considered as spillover hosts such as sheep, goats, equines, camels, pigs, dogs, and cats. Equines and sheep are rarely infected by the disease and pigs can also acquire the infection when fed with infected milk or milk by-products [66].

Although no M. bovis infections have been reported in the Ethiopian wildlife population so far, reports from different parts of the world have demonstrated several risk factors for the presence of the disease in wildlife. Direct contact or sharing of an environment with domestic cattle, the extent of the disease prevalence within the region/country or domestic animal reservoir host, herd size (wildlife densities), and previous history of M. bovis in the wildlife populations are among the potential risk factors. The presence of the aforementioned animals in different wildlife reserves may have an epidemiological role in the spread of the disease among other wild and domestic animals [39]. On the other hand, in Ethiopia, as wildlife habitats are not fenced, there is intensive interaction between a fast-growing human

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population and livestock and wildlife competing for scarce grazing land. Wildlife and, in particular, herbivores sharing pastures with cattle might therefore be at risk for bovine TB transmission [11].

In human: Zoonotic diseases are responsible for most (60.3%) emergent diseases of humans. Moreover, 71.8% of emerging pathogens are of wildlife origin or have epidemiologically important wildlife host [34]. Zoonotic tuberculosis is one of the many sequels of the adaptability of Mycobacterium species in different hosts. Mycobacterium bovis infections may be maintained within livestock populations and within wildlife populations, whereas human infections result from pathogen spillover from animals and very rarely from human-to-human transmission [99]. Transmissions of TB from cattle to humans mostly occur through the consumption of unpasteurized milk, eating infected raw meat, and close contact with infected animals [79]. Exposure to aerosol-borne infection with M. bovis from cattle remains highest in farmers, veterinary staff, and slaughterhouse workers [62].

In Sub- Saharan Africa, nearly 2 million tuberculosis cases in humans occur each year; yet it is unknown what role BTB plays in the rising epidemic of tuberculosis fostered by HIV/ AIDS [100,101].

Zoonotic importance

Ethiopia is among the 22 high TB-burden countries that accounts for 81% of estimated cases the tenth in the world and third in 27 Africa [92]. M. tuberculosis was suggested to be the common local practice of farmers spitting chewed tobacco directly into mouths of the cattle [3]. Cervical lymphadenitis and lupus vulgaris (chronic skin TB) are the most common presentations of a non-pulmonary M. bovis infection [70]. Pulmonary TB due to M. bovis is clinically, radiologically and pathologically identical to one caused by M. tuberculosis but it is uncommon and usually associated with animal handlers and abattoir workers [20,21]. Human TB caused by M. bovis is unusual in countries in the developed world, due to the implementation of eradication programs for domesticated animals, accounting for <1% of TB infections [59,70]. In the developing world, M. bovis is responsible for 5-10% of human TB cases but this varies between countries [54]. Limited laboratory facilities, in most developing countries, means that bacteriological diagnosis of TB infection tends to be carried out by acid fast bacillus smear examination only, so under diagnosis of M. bovis infection may be occurring [5]. Due to the effectiveness of the WHO recommended TB treatment regime against human M. bovis infections, an argument can be made that diagnosis is not necessary from a case management and therapy viewpoint [42,45].

The current increasing incidence of M. bovis in humans, particularly in immune compromized persons, has given a renewed interest in the zoonotic importance of M. bovis, especially in developing countries [59]. The role of meat and milk is the commonest source of protein to man, in the transmission of the disease remain significant. Moreover, zoonotic M. bovis infection of among dairy farm workers has been reported. Due to the grave consequences of M. bovis infection on animal and human health, it is necessary to introduce rigorous control measures to reduce the risk of the disease in human and animal populations [71]. The institution of proper food hygiene practices and stronger inter sectoral collaboration between the medical and veterinary professions is vital to the control of the disease [54,80].

Conclusion

The spread of tuberculosis from animals to humans in developing countries mostly from infected milk is a serious means of transmission that is being ignored. Food safety interventions, such as milk pasteurisation, are the best tool currently to prevent zoonotic Tuberculosis. However, as the use of unpasteurised dairy products grows globally the incidence of zoonotic TB is predicted to increase. TB is transmitted by respiratory route when a patient is coughing or sneezing and other means. The emergence of drug-resistant tuberculosis (DR-TB) is becoming a major global challenge. Control of bovine tuberculosis in pastoral communities, where livestock moves from one place to another searching for grazing and watering points is not easy. The combinations of conventional, immunological and molecular techniques are the best diagnostic tools of TB. Programs involving the eradication of the disease consist of inspection of meat at post mortem and conducting surveillance program intensively. Therefore based on the above information, the following recommendations are forwarded:

- Milk pasteurization before human consumption is very important.
- Rural dwellers should be educated on the need to boil milk before consumption since they lack infrastructure for pasteurization.
- The protective cloth should be worn during handling of the diseased human, animal, and infected carcasses.

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