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Review Article

Review on the prevalence and economic importance of camel tuberculosis in Ethiopia

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Abstract

Camel tuberculosis is a chronic disease, which is portrayed by the development of granulomas, essentially in the respiratory tract and related lymph nodes, from which the mycobacteria are discharged and contaminate other susceptible animals. Camel tuberculosis has public health implications, especially in pastoral areas of Ethiopia due to the communities having the habit of consuming raw milk and its products and those who do have consistent or day-to-day contact with their camels. In the pastoral areas of Ethiopia, the camel is the spine of their everyday life and extraordinarily adjusted to cruel conditions camels are for the most part raised in Afar, Somali, and Oromia (Borena, Kereyu and Guji). Camels have a high contribution to the economic development of the country. The pastoral community utilized camel products, such as milk and meat, and used camels for various purposes for example, for transportation, drafting, ploughing land, festivity and rivalry as in dashing. In most parts of Ethiopia, camel milk is accepted as a treatment for gastritis, asthmatics, stomach inconvenience, HIV, Hamot (kar), tuberculosis, fever, urinary issues and hepatitis. Among significant illnesses, tuberculosis is one of the principles, which influence camel's Health and has a zoonotic impact. In addition to this, the etiological agents are transmitted to humans through an aerogenous route from those animals with active cases in the herd. The infection has been reported from several parts of pastoral areas of the country essentially dependent on tuberculin tests and abattoir inspections. Therefore, attention should be given to the control of tuberculosis in livestock; public health education on the zoonotic importance of the disease or awareness creation and the national tuberculosis control needs to consider the one health approach and further epidemiological studies should be undertaken.

Introduction

Tuberculosis (TB) is a chronic contagious tuberculous disease that has a zoonotic impact and economic potential worldwide OIE [1]. TB remains one of the most prevalent and devastating diseases of man and animals caused by the Mycobacterium tuberculosis complex. While birds and wild animals participate in the epidemiological cycle of the disease as vectors [2]. In Africa, a dromedary population of about 15 million accounts for about 74% of the world, and of these, 60% are found in East African countries (Somalia 6.2 million, Sudan 2.8 million, Ethiopia 1.7 million, and Kenya 0.9 million) [3]. The clinical signs of tuberculosis in camelids are wasting, anorexia, respiratory distress, enlargement of superficial lymph nodes, recumbency and eventually death will occur. Clinical signs are often associated with extensive respiratory pathology, and, surprisingly, overt respiratory distress is sometimes not observed in animals with severe lung lesions. Animals are occasionally found dead with no previous clinical observations [4]. The diagnosis of TB in camel depends mainly on the pathology and detection of pulmonary, lymphatic, mastitic and miliary tubercles as well as serology and tuberculin skin tests as screening tests whereas microscopy, culturing and molecular approaches have a confirmative diagnostic impact [5]. Tuberculosis is a reportable disease in many countries and, where this is the case, control is the subject of statutory regulation, with the culling of infected animals. Treatment of infected animals is, therefore, not usually attempted, although there are some reports of anti-Tb drugs being used in captive wild animals (Thoen, et al. 2009). Tuberculosis is prevalent in camels, and it indicated a higher TB prevalence of 13% in camels a more recent study in Ethiopia abattoirs indicated a

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similar prevalence of 10% based on the identification of gross lesions in apparently healthy dromedaries [6].

Therefore, the objective of my graduate seminar is.

- To indicate zoonosis of camel tuberculosis
- To show information on the epidemiology of camel tuberculosis
- To highlight some possible approaches for camel tuberculosis control

Genus mycobacterium

The genus Mycobacterium belongs to the kingdom of bacteria, phylum Actinobacteria, order Actinomycetales and family Mycobacteriacae (Quinn, et al. 2004). The generic name, Mycobacterium was introduced by Lehman and Neuman in 1896. The organism was named so because of the mold-like pellicular growth of these organisms in a liquid medium. Myco means fungus and bacterium means bacteria (Bhatia,1994). The mycobacteria are most closely related to the genera Rhodococcus and Nocardia and all three genera have similar cell wall types but comparatively, Mycobacteria have characteristics of slow growth rate (Quinn, et al. 2011). In contrast, these microorganisms are not readily stained with the gram-staining method and are considered weakly gram-positive (Gyles, et al. 2010).

Zoonotic mycobacterium

Zoonotic TB principally due to *M. Bovis* is not only considered a neglected zoonotic disease (NZD), it is one of the neglected tropical diseases (NTDs) and is a disease of major public health concern (FAO-IUATLD-OIE-WHO, 2017; WHO, 2017a). Zoonoses are defined as diseases naturally transmitted from vertebrate animals to humans and vice-versa (Reverse zoonoses). In general, zoonotic TB is among NZDs affecting mainly the poor and marginalized communities disproportionately. (Okello, et al. 2014) have further described NZDs as politically neglected endemic Zoonotic diseases, which are under-reported and inadequately prioritized in many developing countries. Zoonotic TB is caused by *M. Bovis* or *M. caprae*; however, *M. Bovis* is the most common zoonotic disease transmitted from animals to humans than zoonotic TB is caused by other zoonotic members of the *M. tuberculosis* complex (MTC) species (Bapat, et al. 2017).

Tuberculosis due to *M. Bovis*in humans is often associated with manifestation in sites other than the lungs (extrapulmonary) that may include the gastrointestinal tract and lymph nodes of the neck (FAO-IUATLD-OIE-WHO, 2017). Zoonotic TB has a high economic impact due to costly eradication programs in livestock and trade barriers. It also has serious consequences for the movement of animals and their products, biodiversity, public health and the livelihoods of camel-rearing communities (Jemal, 2016). In sub-Saharan Africa, the interface between wildlife, livestock and the HIV/AIDS epidemic has resulted in a cycle of infection and re-infection (Hardin, et al. 2011).

Tuberculosis in camels: The important species in animals include *M. tuberculosis*, *M. Bovis*, *M. paratuberculosis,* and *M. avium* and the susceptibility of different host species depends on exposure route, virulence, and dose (Thoen, et al. 2014). The species members of MTBC that have been isolated from tissue lesions and milk of camelids include *M. tuberculosis, M. Bovis, M. pinniped, M. caprae, and M. microti* (Garcia-Bocanegra, et al. 2010). Atypical mycobacteria such as M. kanasi, M. aquae, *M. chelonae*, *M. fortitum, M. marinum*, *M. scrofulaceum*, *M. xenopi*, *M. simiae*, *M. szulgai*, *M. kansasii*,

M. leprae, *M. avium,* and *M. smagmatis*have also been isolated as causative agents of camel TB (Muller, et al. 2013). Besides, reverse zoonosis involving infection with *M. tuberculosis* has been reported in camels (Thoen, et al. 2014). The frequent routes of transmission of tuberculosis between animals are respiratory through proximity and gastrointestinal tract due to contaminated water, feed and pasture (Kaneen, 2004). The disease in animal populations may occur as outbreaks or endemic infections and human-to-livestock transmission through genitourinary tuberculosis has been documented (Good, 2011).

Epidemiology of zoonotic mycobacterium: According to the WHO global TB report 2017, new human cases of zoonotic TB globally were estimated at 147,000, with 12,500 deaths (FAO-IUATLD-OIE-WHO, 2017; WHO, 2017b). Diagnostic limitations are contributing to the continued underestimation of the true dimension of zoonotic TB. Besides, apart from cattle and *M. Bovis*, other animal species and MTBCs such as *M. caprae*can contribute to zoonotic TB (Perez-Lago, 2014). The WHO has classified TB due to *M. Bovis* as one of the neglected zoonotic diseases and despite a renewed focus on this disease, documentation remains scanty. The levels of *M. Bovis* in humans have a wide variation and are estimated at between 0.4-10% based on sputum samples, despite its extrapulmonary preponderance (Malama, et al. 2013). It is most important in developing countries, where it is associated with cervical lymphadenopathy, and intestinal and chronic skin TB, while in developed countries cases are mostly pulmonary, gastrointestinal, or cervical lymph node involvement (Ayele, et al. 2004). An abattoir-based epidemiological study of tuberculosis in dromedaries in eastern Ethiopia in which 293 dromedaries were examined, found a prevalence of tuberculosis-compatible lesions of 12.3%, in which *M. tuberculosis* was isolated in 13.6% of those having *Mycobacteria* isolates (61%) [7].

Ethiopia investigated the pathology of camel tuberculosis and characterized causative agents [8]. The prevalence of camel TB was 10.04 % based on pathology and the tropism of tuberculosis lesions was significantly different among lymph nodes and lung lobes. The results also showed that most tuberculosis lesions were a result of *Mycobacteria* other than the *M. tuberculosis* complex. However, [9] detected low levels of prevalence of TB amongst camels with an individual animal prevalence of 0.4% in southeast Ethiopia. In milk taken from tuberculin-positive animals, a total prevalence of 2.5 and 10.1% were found for *M. Bovis* infection and atypical mycobacteriosis respectively. A similar study in the southern highlands of

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Tanzania to determine secretion of *Mycobacterium* species in the milk of indigenous cows found 3.9% of the milk samples were positive for existence through the practice of drinking infected unpasteurized milk and inadvertently inhaling infected cough spray from infected livestock as well as from occupational exposure (Youssef, 2014).

Clinical Signs of Camel Tuberculosis: In animals, the signs of tuberculosis usually vary with the distribution of tubercles in the body. The clinical evidence of disease in chronic cases may not be manifested until the terminal stages of the disease. Enlarged superficial lymph nodes, emaciation despite good nutrition, dyspnoea, a low-grade fever, anorexia and general weakness are diagnostic (Kaneen, 2004). In animals, cases with the progressive pulmonary form of the disease may show dyspnoea with an associated cough. The clinical signs of tuberculosis in camelids may include respiratory distress, anorexia, enlargement of superficial lymph nodes, wasting, recumbency, and eventually death. Clinical signs are often associated with extensive respiratory pathology and sometimes death occurs with no previous clinical observations [2]. In humans, the common symptoms of active lung TB include cough with sputum and sometimes with blood, chest pains, weakness, weight loss, fever, and night sweats (Churchyard, et al. 2017; WHO, 2017b). TB cases lack a productive cough and 25% have no symptoms (Pai, et al. 2016).

Pathological lesion of camel tuberculosis: The distribution of lesions and the severity of the disease were established in the 91 camels with suspicious lesions. Lung lesions were detected in 43 camels with 78 camels having at least one lesion in their lymph nodes. The lesion appeared more frequently in the apical and cardiac lobes of both lungs than in the diaphragmatic lobes. similarly, the severity was greater in both the right apical and cardinal lobes. Regarding lymph nodes, mesenteric lymph nodes were found the most frequently and severely affected of all the lymph nodes 34% [6] (Table 1).

Risk Factors of tuberculosis: In conventional domesticated animal-raising systems, the different species of animals are often herded together, and watering points are common. Such livestock husbandry and management systems can be an important risk factor for animal-to-animal, animal-to-human, human-to-animal, and human-to-human M. Bovis transmission (Habtamu, et al. 2011). All species of animals including human beings, body conditions, sex and age groups are susceptible to tuberculosis-causing agents, (Ameni, 2009). The prevalence of TB in camels was relatively high in the younger and older camels than in other age group. Different authors have likewise announced in dairy cattle, especially that more seasoned animal is influenced by TB which could be because older animals have a weaker immune system [10].

The higher recurrence of the lesion in younger camels could be due to less developed immunity (Neill, 2000) [11]. likewise reports of high prevalence in old camels. Young camels can also be easily infected with higher doses of mycobacteria via colostrum from an infected camel in a similar way, as it occurs [12]. Besides, the pathogen acts as a risk factor for tuberculosis in camels and other animals. The causative

Table 1: The occurrence of TB lesions and camel carcasses in different countries.

Study areas	sample size	Sample unit	No. of positive	Prevalence (%)	Sources
Nigeria	212	Pulmonary	51	24	[22]
		Abdominal	11	5.18	
		Disseminated	9	4.25	
Kenya	1600	The right-left bronchial lymph nodes and the mediastinal lymph nodes	4	59.54	Lucas luvai, et al. 2019
		Retropharyngeal lymph nodes	0.76	12.21	
		Medial lobe	0.667	10.67	
		Left lateral and quadrate	1.098	17.58	
		lobes of the lungs			
Ethiopia	91	Parotid	13	14.3	[23]
		Mandibular	15	16.5	
		Retropharyngeal	17	18.7	
		Mediastinal	30	33	
		Left bronchial	17	18.7	
		Right bronchial	21	23.1	
		Mesenteric	31	34.1	
		Hepatic	3	3.3	
India	92	Pulmonary	15	16.3	[24]
		Disseminated	3	3.3	
		Camel, serum samples	124	67.39	
Egypt	184	Mycobacterial cultured	112	60.87	[6]

organism is moderately resistant to heat, desiccation and many disinfectants; the virulence of M. Bovis relates to its ability to survive and multiply in host macrophages (Teverson, et al. 2003). The zoonotic risk of tuberculosis is frequently connected with the utilization (ingestion) of unpasteurized milk and other dairy items infected with M. Bovis. Additionally, airborne transmission from cow to human (or the other way around) ought to be considered as a potential risk factor [13].

Pathogenesis of mycobacterium: The animals affected by tuberculosis likewise noticed that udder well-being is a contributing variable for the low quality of milk. The milk has 'sicknesses, when the udder is diseased and they said, "We want raw milk, Boiled milk is dead. Only educated people boil milk causative agents of tuberculosis through various courses of vaporized presentation, by ingestion of nourishment and water with M. Bovis regularly create essential foci in lymph tissues related to the intestinal tract. Other mycobacteria including Mycobacterium subsp. avium, Mycobacterium avium subsp. paratuberculosis, Mycobacterium intracellulare, Mycobacterium scrofulaceum, Mycobacterium kansassii, Mycobacterium fortuitum, and M. tuberculosis may induce tuberculin skin sensitivity and Aerosol exposure leads to the involvement of the lung and associated lymph nodes [14]. The phagocytes pass through the lining of the bronchioles, enter the circulation and are carried to lymph nodes, parenchyma of lungs, or other sites [15]. By this mechanism, mycobacteria survive and multiply within the phagosomes and eventually destroy the phagocytes. Mycobacterium marinum, a close relative of M. tuberculosis and M. Bovis, may lyse the phagosome and enter the cytoplasm and use actin polymerization to spread from cell to cell.

A phenomenon that has not been observed with M. tuberculosis or M. Bovis [16]. The enlargement and presence of

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macrophages in impenetrable passageways between reticular cell fibers of the lymph node provide an environment for mycobacterial growth and development of the granulomatous lesion in the node. On occasion, some phagocytized mycobacteria remain in the lung, and both lung and thoracic nodes are affected. Primary lesions often become localized in a node or nodes and may become large and firm [17].

Clinical finding: Clinical signs in infected camelids tend to be vague or non-existent. Observant owners may detect subtle changes in behavior. In some, there is a short period of illness terminating with respiratory symptoms. Other signs such as weight loss, loss of appetite, exercise intolerance, or an intermittent dry cough are not consistent. Some camelids remain in good body condition until sudden death. As there is no routine surveillance for camelids, it is for the owner or their veterinary surgeon to arrange a post-mortem examination for any dead or moribund animals. The respiratory system and associated lymph nodes are most frequently affected [3]. The lung lesions may be so extensive that it is surprising that severe pathology did not prove fatal earlier. The lesions are white or creamy and caseous. There may be military lesions or multiple foci in the lungs, and in more advanced cases, these lesions coalesce to give large areas of caseous necrosis, often involving whole lobes. By contrast, tuberculous lymph nodes are often massively enlarged and contain multiple white, cream, or yellow-tinged caseous foci and in severe cases, the whole node may be replaced by one large caseous [18].

Diagnosis of tuberculosis: The diagnosis of tuberculosis disease in animals is embraced into two stages. The first one is ante mortem and the second is a post-mortem examination. At ante mortem diagnosis different types of diagnosis can be undertaken, such as the single intradermal comparative tuberculin skin test, using tuberculin purified protein derivatives (ppd) extracted from M. Bovis (PPDB) and M. avium (PPDA) remains the primary official TB test for camelids. The other method of diagnosis of camel TB is clinical signs, necropsy findings, and specific immune response. In camelids, this strategy is difficult to conduct because of the lack of adequate tests for live animals [13]. A definitive diagnosis can be made only at post-mortem examination by the demonstration of typical gross lesions, followed by histopathology and confirmatory bacterial culture. Because of the chronic nature of the disease and the multiplicity of signs caused by the variable localization of the infection, the disease that occurs in a particular area must be considered in the differential diagnosis of many other diseases. The diagnosis of tuberculosis in live animals is mainly based on the tuberculin skin test demonstration of the organism in exudates or excretions from lesions of slaughtered animals [19].

Distribution of camel tuberculosis in ethiopia

Ethiopia has a high-frequency rate of TB infection and the diseases are one of the significant general medical issues in the country. The country is one of the universe's 22 countries with high TB trouble [20] (Table 2).

Ethiopia, pastoralist territories are notable for high TB prevalence where the pastoralists keep a huge number of animals as a method for occupation and endurance technique in the arid and semi-arid regions of the country. Even though the number of researchers who conducted on camel tuberculosis is limited, the origin of camels on which the research has been done is from different pastoral areas of Ethiopia [3] (Table 3).

Table 2: Prevalence of some camel tuberculosis in different regions of Ethiopia.

Study areas (Overall)	Overall prevalence (%)	Origin of camels	Sample Size	%Positive	Reference
Pastoral area of Somali and Oromia	(5.1%)	Shinillae Babille Melka Jebdu Dawe Gursum Somali	276	14	[8]
Pastoral areas Oromiya and Somali	(3.1%)	Filtu	181	5.6	[9]
		Negele	513	15.9	
Pastoral areas of Eastern Ethiopia	(12.3%)	Dire Dawa	92	11.3	[7]
		Harar	11	1.35	
		Awaday	18	2.21	
		Jijiga	172	12.15	
Pastoral areas of Oromiya and Somali	4.52%	Borana	376	16.99	[26]
		Kerayu	5	0.226	
		Menijar	39	1.76	
Pastoral areas of Oromia and Somali	8.3%	Dire Dawa	118	9.79	[27]
		Shinile	208	17.26	
		Jijiga	157	13.0	
Pastoral areas of Oromiya SE	9.82%	Borana	323	31.7	[18]
		Metahara	64	6.28	
Pastoral areas Oromiya SE	7.54%	Borana	1739	131.1	
		Metahara	331	24.95	

SE = Southern and Eastern.

Public health significance of camel tuberculosis

In Ethiopia, pastoralist areas are well known for high TB prevalence where the pastoralists keep much livestock as a means of livelihood and survival strategy in the arid and semi-arid regions of the country. Camels are the backbone of many pastoralists in the country where the habit of sharing the same dwelling and consumption of raw camel products may favor the transmission of zoonotic diseases like TB [3]. A close interaction between animals and humans primarily contributes to the transmission of infectious zoonotic diseases between them. This close contact can result in the occurrence and transmission of zoonotic disease, which is naturally transmitted between vertebrate animals and man. Zoonotic tuberculosis is an infectious the disease of domestic animals that can be transmitted from animal to human through the consumption of raw milk and meat from infected animals and directly through an erogenous route. These possible risk factors are of particular concern for many developing countries where pasteurization is limited and where people are living close to them [9]. Ethiopia ranks seventh among the world's 22 countries with high tuberculosis (TB) disease burden and had an estimated incidence rate of 379 cases per 100,000 people per year. TB caused by M. Bovis is clinically indistinguishable from TB caused by M. tuberculosis and can only be differentiated by laboratory methods. Tuberculosis as a zoonosis plays an important role among nomadic people where milk and milk products are consumed in a raw state.

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Table 3: Prevalence of camel tuberculosis by animal-related risk factors in Ethiopia.

Animal-related risk factors	Prevalence of camel tuberculosis by animal-related risk factors in No. (%) with reference							
	[11]		[27]		[23]		[8]	
Age	≤ 6 years	9 (9.68)	≤ 5 years	0	<4years	12(12.1)	1-5 yrs	1(4.8)
	≥ 7 years	29 (9.86)	6 -10 years	17(7.97)	4 - 6 years	14(7.6)	> 5-10 yr	10(6.13)
					7 - 9years	10(7.1)		
					10 - 15 yrs	19(9.6)	> 10yr	3(3.3)
			≥ 10 years	22(11.7)	16 + years	36(12.6)		
Sex	Male	2(5.00)	Male	24(7.97)	Male	45(8.4)	Male	13(5)
	Female	36(10.37)	Female	9(9.3)	Female	46(12.4)	Female	1(6.25)
Body	Poor	21(10.05)	Poor	15(15.5)	Poor	44(11.3)	Poor	2(2.3)
Cond.	Moderate	6(8.57)	moderate	13(6.13)	moderate	36(10.9)	Moderate	9(8.6)
	Good	11(10.19)	Good	5(5.7)	Good	11(5.9)	Good	3(3.6)

This is true for camel milk. Aerosol transmission may also occur as a professional hazard in agriculture and workers as well as to butcher's man, which may develop typical pulmonary tuberculosis. The incidence of pulmonary tuberculosis caused by M. Bovis in men is significant in occupational groups in contact with infected animals or their carcasses, particularly in countries where animals are kept in barns. The close contact between the owners and their animals could facilitate the transmission of the disease to man [8].

Control and prevention of camel tuberculosis

Effective control requires an understanding of the epidemiology of infection within the ecological system which can include domestic as well as wild animal species [21]. Condemnation of carcasses and organs during meat inspection, culling of infected animals, pasteurization of milk and effective disease control strategies. The test and slaughter policy is the only one assuring of eradicating TB and relies on the slaughter policy of reactors for the tuberculin test. In an affected herd, testing every three months is recommended to rid the herd of individuals that can disseminate. Disinfecting the contaminated premises, food, and water troughs is useful. Cattle under poor management were more likely to develop tuberculosis than cattle under a good management system. Feed troughs should be cleaned and thoroughly disinfected with hot 5% phenol or equivalent cresol as phenols (2% - 5%), hypochlorites (1% - 5%), alcohol (usually 70% ethanol), formaldehyde and iodophors (3% - 5%) [21,28-35].

Conclusions and recommendations

In Ethiopia, the prevalence recorded camel tuberculosis and public health importance of zoonotic importance are rare when compared to bovine tuberculosis and the economic impacts of camel Tuberculosis were not studied yet. Studies, which have been conducted in different pastoral areas of Ethiopia, indicated that the disease has a significant effect both in animals and in humans as the result of the consumption of uncooked products of camel such as milk and meat. In Ethiopia, the status of the disease was not known and people have little or no awareness of the potential risk of the disease as a zoonosis. In addition to contracting the infection by consumption of raw infected camel milk, people having close association with infected animals have a high probability of acquiring the infection. In the different pastoral areas of Ethiopia, many people only think about the medicinal value of camel meat and milk rather than thinking of potential sources of different pathogens. Based on the above conclusive remarks, the following recommendations are forwarded:

studied priority should be given to research that helps in understanding its epidemiological status to design a control strategy and awareness creation and educating of pastoral people or community awareness about the risk of animal tuberculosis transmission through sharing common shelters, consumption of animal products; and route of zoonosis are of extreme importance for effective implementation of TB control measures. Raising awareness of the people about the advantages of milk pasteurization and well cooking of meat in control measure of camel tuberculosis and the zoonotic significance of Tuberculosis in camels where the habit of consuming raw camel milk is very common in the pastoral communities.

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