Abstract

Mycobacterium bovis is the pathogen responsible for the zoonotic transmission of bovine tuberculosis. Bovine tuberculosis is more prevalent in developing countries, where cattle and other animals play a prominent role in daily life. An extensive literature search was performed to assess current data on Mycobacterium bovis and its effects on animals and humans in Africa. Knowledge, attitudes, and practices of the general population versus livestock-keeping population were evaluated. Due to risky behaviors, livestock keepers are at an increased risk of acquiring bovine tuberculosis. Education may be the only way to decrease the burden associated with bovine tuberculosis in Africa. McGeary A. The role of Mycobacterium Bovis in tuberculosis in Africa. Med J Therapeut Africa. 2008;1:59-62.

Keywords: tuberculosis bovine sub-Saharan Africa Mycobacterium review

Introduction

Bovine tuberculosis (TB), a zoonotic disease transmitted from animals to humans,(1) is particularly prevalent in sub-Saharan Africa. Mycobacterium bovis (the bovine tubercle bacillus) causes the progressive development of lesions in the lung tissue, lymph nodes, and elsewhere in infected animals or humans.

Wildlife infected with M bovis poses a threat to both domestic livestock and humans. Humans can be infected with M tuberculosis or M bovis.(2) The spread of bovine TB in developed countries is controlled; however, bovine TB is more easily spread in developing countries where wildlife, particularly buffalo, roams free and cattle are a part of daily life. Transmission of M bovis from cattle to humans is possible, and likely results from the cattle's living or slaughtering conditions. When cattle are bred for the market, they are kept near homes while they are fattened before sale. Once sold, cattle are often slaughtered, and the butchers do not protect themselves against mycobacterium or other infectious agents. Butchers use their bare hands on the carcasses, which may be diseased and serve as a host for M bovis.(3)

Many humans are not aware of the risk factors associated with the transmission of bovine TB, and living conditions often promote the zoonotic spread of disease. Lack of knowledge has been documented in interviews of residents that focus on their knowledge, attitudes, and practices regarding bovine TB. Zoonotic transmission of bovine TB is likely and should be addressed through education and prevention programs. Herein, this paper will focus on the prevalence of bovine TB mainly in Tanzania, Uganda, and Nigeria, as well as the pathogen's effects on wildlife and humans.

Methods

This review evaluates the threat of M bovis by expanding upon published studies and data to reveal the burden associated with bovine TB in Africa. Livestock keeping was evaluated in Tanzania to determine if knowledge, attitudes, and practices put humans at risk for acquiring bovine TB. In order to determine the burden of bovine TB in sub-Saharan Africa, an extensive literature search was performed on PubMed. Search terms included, but were not limited to: bovine tuberculosis; bovine AND tuberculosis; tuberculosis AND bovine AND Africa; livestock keeping AND Africa; livestock keeping AND tuberculosis; mycobacterium; mycobacterium bovis; M bovis; bovine tuberculosis AND Tanzania; bovine tuberculosis AND sub-Saharan Africa; cattle AND tuberculosis; M bovis AND Africa; zoonosis; zoonotic tuberculosis; and bovine tuberculosis AND Uganda.

Results

Bovine TB is most common in cattle in Africa, but can infect all warm-blooded animals.(2) Similar strains of M bovis can be found in neighboring cattle herds, which may be a result of importing and exporting cattle among African countries.(3) M bovis is transmitted to humans via ingestion of unpasteurized milk, poorly heat-treated meat, and

<table>
<thead>
<tr>
<th>Practice</th>
<th>General population</th>
<th>Livestock-keepers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drinking milk</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fresh or sour</td>
<td>98.2</td>
<td>98.3</td>
</tr>
<tr>
<td>Drinking tea milk</td>
<td>88.1</td>
<td>95.5</td>
</tr>
<tr>
<td>Drinking goat milk</td>
<td>20.8</td>
<td>23.4</td>
</tr>
<tr>
<td>Hot milk (fresh and sour)</td>
<td>79.6</td>
<td>83.1</td>
</tr>
<tr>
<td>Frequency</td>
<td></td>
<td></td>
</tr>
<tr>
<td>During wet season</td>
<td>Weekly/monthly</td>
<td>Weekly/monthly</td>
</tr>
<tr>
<td>During dry season</td>
<td>74.8±25.6</td>
<td>72.5±24.7</td>
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<tr>
<td>Meat or meat products</td>
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<tr>
<td>Eating habits</td>
<td>76.6</td>
<td>62.3</td>
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<tr>
<td>Cooked meat/meat products</td>
<td>54.7</td>
<td>41.7</td>
</tr>
<tr>
<td>Eating wild animal meat</td>
<td>Monthly-6-monthly</td>
<td>Monthly-6-monthly</td>
</tr>
<tr>
<td>Frequency eating meat</td>
<td>89.0</td>
<td>87.5±24.7</td>
</tr>
</tbody>
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Table 1. Risk factors associated with the transmission of bovine TB.(5)
bushmeat. The pathogen can also be transmitted during close contact with infected animals. In cattle infected with bovine TB, lesions generally develop in the following tissues: medial retropharyngeal, parotid, tracheobronchial, mediastinal, caudal deep cervical, and subiliac lymph nodes; palatine tonsil; or the lungs, Figure 1. However, M bovis has been detected in cattle that did not express infection through lesions, and TB infections can be detected by a number of symptoms besides lesions.(4)

Animals infected with M bovis have low-grade fever, chronic intermittent hacking cough and associated pneumonia, breathing difficulties, weakness and loss of appetite, emaciation, and swelling of superficial body lymph nodes (adenitis).(1) In contrast, the most common symptoms of TB in humans are cough (green, yellow, and sometimes bloody sputum in the mornings), night sweats, low energy and fatigue, decreased appetite, shortness of breath, and chest pain.(5)

Post-mortem autopsy of infected cattle typically reveals the following conditions: tuberculous granuloma in the lymph nodes of the head, lungs, intestine, and carcass; active lesions in the center of lymph nodes; inactive lesions that may be calcified and encapsulated; nodules on the pleura and peritoneum; lesions in the lungs, liver, spleen, or kidneys; bronchopneumonia; firmer and enlarged udder, particularly rear quarters; and lesions in the meninges, bone marrow, and joints.(1)

Transmission of M bovis occurs via the respiratory route and the ingestion of contaminated products, such as milk.(1) In buffalo, TB typically manifests itself as a respiratory infection, whereas in cattle, it is an alimentary infection. Buffalo naturally remain close in their herds, and this closeness facilitates the transmission of M bovis through inhalation of infectious droplets.(6) Calves can be infected from a mother's milk, constituting a secondary source of infection.(1) When animals are killed by predators, infectious organisms can spread and be transmitted from open wounds through mud or water to neighboring animals.(6)

**The Impact of Bovine TB in Africa**

Animals

A total of 176 households were investigated in a cross-sectional study of human and bovine TB infections in the Monze District of Tanzania. Overall, 2,226 cattle from 176 households were tested for bovine TB of which 7.4% were positive. Of the participants who owned cattle, 10 households included a human TB infection within the past year. Households with a previous human TB infection were 6 times more likely to house an animal infected with bovine TB than households that did not report a previous human TB infection.(7)

The Ruwenzori National Park, Uganda, is home to about 18,000 Wild Cape buffalo. North of the Maramagambo Forest, buffalo were examined post-mortem: a random sample (n=52) and a selected thin sample (n=64).(5) Of the 52 randomly selected buffalo, 10% were infected, and of the 64 selected thin buffalo, 38% were infected. Post-mortem examinations of the 52 randomly selected buffalo (mean age of 13.1 years) revealed that 9.6% had tuberculosis microscopic lesions. Of the 5 buffalo, lungs were affected in 4, and pleura in 1; 3 buffalo's bronchial and mediastinal nodes had fibrocæseous granulomata; 1 had 2 lesions in its liver; 1 had a caseous abscess in its cervical nodes; and 1 had lesions that remained in the retropharyngeal and cervical nodes. The 64 thin buffalo (mean age of 11.6 years) were specifically selected based on poor body condition. Of the 64 buffalo, 38% (n=24) were tuberculous buffalo. All infected buffalo had lesions in the thoracic cavity, 10 had infections that affected the thorax, and 20 had lesions in the bronchial/mediastinal lymph nodes. In this population, TB prevalence increased with age until 14 years then decreased due to the life span of the animals. Additionally, post-mortem examinations revealed that the lungs were affected in 23 buffalo; the pleura was affected in 13; 6 had pericarditis and pericardial adhesions; 11 had lesions (diffuse, nodular, and peritonitis) in their abdominal cavity; 1 had tuberculous metritis; and 1 carcass’ lymph nodes were affected (precapular glands had multiple small, fibrocæseous foci). Overall, 29 humans were reported having TB. Lesions were found most often in the thoracic cavity (28 of 29 buffalo), suggesting that the infection is transmitted by inhalation. Each year, TB kills approximately 1,800 buffalo in the park.(6)

TB prevalence was evaluated in 4 transhumant (areas with seasonal migration of livestock and the people who tend to them) districts in Uganda. There were 30 superherds (1,522 cattle) in the nomadic transhumance cattle rearing group (Karamoja region) and 7 herds (342 cattle) in the fixed-transhumance group (Nakasongola district).(8,9) Herd-positive status was determined if there was at least 1 reactor in a superherd/herd (intradermal skin test was done on 50 cattle per superherd/herd). Intradermal skin tests revealed that 60% (95% CI, 41.4-79) and 14.3% (95% CI, -20.7-49.2) of the nomadic transhumance and fixed-transhumance groups, respectively, were tuberculin-positive.(8)

The overall prevalence of bovine TB was estimated between 46.6% and 51.4%. The high prevalence of TB could be due to the mixing of herds, introduction of new animals, and the presence of M bovis in mud holes.(8,9)

A cross-sectional study of bovine TB in dairy cattle in Asmara, Eritrea, used intradermal tuberculin tests to determine if the animal was infected. Of 1,813 cattle, 14.5% were positive reactors for bovine TB. A reactor herd was defined with at least 1 reactive animal, 30 (41.7%) of 72 randomly selected cattle
herds were reactors. When the definition of a reactor herd was defined as 2 or more reactive animals, 19 (26.4%) of 72 cattle herds were reactors. Regardless of the definition of a reactor herd, the prevalence of bovine TB in these herds was high. Risk factors for bovine TB include large herds and the presence of exotic breeds of cattle (OR = 5.70; 95% CI, 1.13-28.8).(10)

**Humans**

Idigbe and colleagues observed zoonotic transmission of *M bovis* in humans in Lagos, Nigeria. Of 2,784 humans who experienced lower respiratory tract infections, 668 were randomly selected and screened for pulmonary TB. The following mycobacterial isolates were found: *M tuberculosis*, 87 (85%); *M bovis*, 4 (4%); and atypical mycobacteria, 11 (11%). Though only in 4 humans was the *M bovis* isolate found, the presence of *M bovis* in humans is significant, as it shows zoonotic infection.(11) Similarly, a recent study of zoonotic transmission of TB strains showed that of 60 strains, *M tuberculosis* was responsible for 51 cases, *M africanum* for 6, and *M bovis* for 3.(3) *M bovis* was found on a larger scale when Mawak and colleagues examined sputum specimens from humans who were experiencing persistent bronchopulmonary infections.(12) Sixty-five mycobacterial isolates were examined: *M tuberculosis*, 40 (61.54%); *M bovis*, 15 (23.08%); and environmental mycobacteria, 15 (23.08%). Though infection with *M bovis* is not endemic, it is present and transmitted among human populations.(3)

**Knowledge, Attitudes, and Practices Regarding TB Control in Tanzania**

Knowledge, attitudes, and practices (KAPs) surrounding TB control reflect surveyed populations and their lifestyles. This is true for TB treatment regimens. Case management using the Direct-Observed Treatment, Short-course (DOTS) regimen is generally effective in treating TB. However, unknowledgeable community members may not know to seek DOTS when TB symptoms begin. This may contribute to the increasing incidence of TB in Tanzania. Proactive and early treatment of TB at the first sign of infection is crucial in reducing the burden associated with mycobacterium. A study of men and women in 6 villages in the Mpwapwa district of Tanzania found that the preferred treatment for TB was self medication. Interestingly, study participants claimed that visiting a healthcare facility was a last resort. Participants cited friends and family in the community as their sources for TB information. Considering the overall burden of TB, it is evident that TB education is lacking in Tanzania, and presumably other African countries.(13)

Mfinanga and colleagues analyzed cattle tuberculin skin tests (livestock-keeping group) and obtained information from a survey (general population and livestock-keeping group) on KAPs regarding TB control in Tanzania. Participants were defined by their lifestyle and assigned to the either general population group or the livestock-keeping group. Survey participants (n=426) lived in 27 villages of Arusha, Tanzania. Data on the following topics were obtained: pulmonary TB spread; TB adenitis: how is it acquired; can TB spread from animal to man; how is TB spread from animal to man; and TB symptoms.(5)

The majority (73.8%) of study participants were farmers or cattle keepers. Risk factors associated with the transmission of TB include consumption of uncooked meat or meat products, keeping animals in the house (OR 2.3; 95% CI, 1.1-5.0), and poor ventilation (OR 2.6; 95% CI, 1.1-6.5). Perhaps the most obvious risky behaviors for TB transmission are: keeping animals inside; milking; herding cattle; herding goats; slaughtering; handling skin; hunting; having plaster wall/mud; and moving cow dung.(5) More often, members of the livestock-keeping group partook in behaviors that increased the risk of transmitting bovine TB to a member of their family. The frequencies of risky behaviors in each group are described in Table 1.

The lack of knowledge regarding pulmonary TB is astounding, and is exemplified by a longitudinal study in Lagos, Nigeria. Late patient presentation is common and contributes to the overall burden associated with TB. However, both patient and physician delay play a role in late treatment of TB. Patient delay was defined as visiting a healthcare facility 30 days after the onset of pulmonary TB symptoms. Doctor delay was defined as more than 15 days in a healthcare facility with a referring physician. Of 141 patients, 116 (82%) tested positive for pulmonary TB, and 117 (83%) waited over a month to seek medical help after TB symptoms started. Median patient (n=117) and physician delay (n=19) was 8 weeks and 1 week, respectively, and the median total delay was 10 weeks. Patient delay only increases the number of people who serve as reservoirs of TB infection - this is true for any type of mycobacteria. (Note: Strains of mycobacteria were not reported in the results section of this abstract.) Patient education programs may help decrease the frequency of patient delay, and as a result, decrease the prevalence of TB.(14)

**Discussion**

Zoonotic diseases are an important yet understudied subject, as animals play an integral part in humans’ lives, especially in farming communities in developing countries. The transmission of an infection from an animal to human is more common in developing countries where many humans work or live in close proximity with infected animals; such is the case with bovine TB in Africa.

In cattle, 90% to 95% of mycobacteria enter the animal by respiratory routes; only 5% to 10% enter through an oral route such as through contaminated milk. Calves born to infected mothers are born with bovine TB. The pasteurization of milk was a turning point of infection is crucial in reducing the burden associated with mycobacterium. A study of men and women in 6 villages in the Mpwapwa district of Tanzania found that the preferred treatment for TB was self medication. Interestingly, study participants claimed that visiting a healthcare facility was a last resort. Participants cited friends and family in the community as their sources for TB information. Considering the overall burden of TB, it is evident that TB education is lacking in Tanzania, and presumably other African countries.(13) Mfinanga and colleagues analyzed cattle tuberculin skin tests (livestock-keeping group) and obtained information from a survey (general population and livestock-keeping group) on KAPs regarding TB control in Tanzania. Participants were defined by their lifestyle and assigned to the either general population group or the livestock-keeping group. Survey participants (n=426) lived in 27 villages of Arusha, Tanzania. Data on the following topics were obtained: pulmonary TB spread; TB adenitis: how is it acquired; can TB spread from animal to man; how is TB spread from animal to man; and TB symptoms.(5) The majority (73.8%) of study participants were farmers or cattle keepers. Risk factors associated with the transmission of TB include consumption of uncooked meat or meat products, keeping animals in the house (OR 2.3; 95% CI, 1.1-5.0), and poor ventilation (OR 2.6; 95% CI, 1.1-6.5). Perhaps the most obvious risky behaviors for TB transmission are: keeping animals inside; milking; herding cattle; herding goats; slaughtering; handling skin; hunting; having plaster wall/mud; and moving cow dung.(5) More often, members of the livestock-keeping group partook in behaviors that increased the risk of transmitting bovine TB to a member of their family. The frequencies of risky behaviors in each group are described in Table 1.

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point in the fight against bovine TB, and incidence in humans has decreased dramatically.(1)

Countries with active antiTB programs have a lower frequency of transmission of *M. bovis* from animals to humans. However, considering the burden associated with the causative *M. bovis*, public health officials should be motivated to control TB in domestic animals in order to keep humans healthy.(3) As with most infections or diseases, young children and humans with compromised immune systems are at higher risk of contracting *M. bovis*.

Mycobacteria can live outside their hosts for up to a few weeks, as they do not thrive under hot, dry, or sunny conditions; however, if mycobacteria are in a cold, dark, and moist environment, they can live and remain infectious for a longer period of time.(2) Bovine TB is linked to larger herds of animals, specifically cattle and buffalo.(7,10) Exotic breeds have a higher risk of infection.(10)

Bovine TB is a progressive disease, but not progressive in all hosts. Some infected animals and humans may have a dormant infection for many years or even a lifetime, but the disease can cause death in some hosts. During slaughter, some cattle appear to be healthy and bovine TB is not found until the animal is slaughtered. The most accurate way to slowly decrease the burden associated with bovine TB is to systematically test cattle and slaughter all infected animals so the disease is not further transmitted to other cattle or humans.(2) To decrease personal burden, livestock-keepers should regularly test their herds for bovine TB, keep a closed herd (including a replacement stock), require health records for all new cattle that are purchased, test cattle before purchase, and maintain fences to keep neighboring animals or herds from coming in contact with their herd.(2)

To decrease the burden of TB, education about transmission, symptoms, as well as appropriate treatment of the disease is needed.(13) Currently, there are no recommended guidelines for testing or vaccinating animals against bovine TB. Unfortunately, the number of bovine TB cases cannot be tracked accurately.(3)

Routine testing for *M. bovis* would provide a method for tracking the number of infected cattle. This would enable public health officials to gauge whether or not initiatives to decrease the burden of bovine TB are effective.

References