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Zoonotic Importance of Bovine Tuberculosis in Ethiopia: An Overview

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ABSTRACT

Bovine tuberculosis (BTB) is an important zoonotic disease that affects both domestic animals as well as humans in many countries of the world. The disease is caused by *Mycobacterium bovis,* which is responsible for 10–15% of human tuberculosis cases. BTB poses an occupational health hazard to the cattle owners, butchers, animal attendants, and veterinarians. The source of infection is exogenous and the respiratory tract is considered the chief portal of entry of the organism. The mode of spread of bacteria is aerogenous. BTB is endemic in Ethiopia, and it is mostly transmitted to people through the consumption of unpasteurized contaminated milk. Miliary tubercular lesions, chronic cough, blockages of the airways, alimentary system, or blood vessels, and lymph node enlargement are all symptoms of tuberculosis. Single intradermal or comparative intradermal tuberculin tests are useful delayed-type hypersensitivity tools for diagnosing tuberculosis in live animals. It is also employed in tuberculosis eradication programs and international trade activity. Vaccination of calves with an attenuated BTB strain known as Bacillus of Calmette and Guerin, as well as testing and culling, is significant measures in the prevention and control of BTB in endemic areas like Ethiopia. The proper pasteurization of milk before human consumption is a significant measure to reduce the public health risk posed by BTB.

Keywords: Bovine, Ethiopia, *Mycobacterium bovis,* Public health, Tuberculosis, Zoonotic disease

INTRODUCTION

The transmission of infectious zoonotic diseases between animals and humans is generally facilitated by close contact between them.[1] *Mycobacterium bovis* causes bovine tuberculosis (BTB), a zoonotic disease that affects a wide range of animals and humans.[2] Tuberculosis in cattle has become a major infectious disease that has spread between species. BTB is found all over the world, and it has a considerable economic impact on the livestock production sector.[3,4] It has been identified as the most common cause of human zoonotic tuberculosis.[5]

Human tuberculosis caused by *M. bovis* has decreased significantly in developed countries as a result of pasteurization of milk and tuberculin skin testing of cattle, followed by culling/ slaughtering of infected cattle.[6] However, it still poses a public health concern to both humans and animals in developing countries, notably in Africa. This is because 82% of the human population and 85% of the livestock population live in areas, where BTB is widespread.[7] According to studies, BTB is still prevalent in underdeveloped countries, where routine milk pasteurization is not practiced, and *M. bovis* is responsible for 10–15% of human tuberculosis cases.[8,9]

Despite its zoonotic potential, research into *M. bovis* in both animal and human populations remains minimal in underdeveloped countries, notably in Africa. Several factors, such as social unrest, political uncertainty, the associated cost of testing programs, wars that result in human and animal displacement, and a scarcity of skilled expertise in the field, all had a significant impact on the disease investigation and public health implications.[10] BTB is highly widespread disease in Ethiopia's cattle population among African countries. According to study, results in Ethiopia utilizing intradermal tuberculin tests, the prevalence of BTB varies between 0.8% and 78% in free-range rural farming systems with mostly Zebu cattle and intensive systems with exotic and crossbreed cattle, respectively.[11,12]

Few studies have also shown that because the disease is zoonotic, it can spread from animal to human and *vice versa*.[13,14] Many other researchers have shown many potential risk factors contributing to the spread and persistence of BTB in poor countries. Eating habits, educational status, demographics, living style, socioeconomic status, culture, the presence of other immunosuppressive disorders, and sharing a home with animals are just a few of these factors.[4,13,15] In Ethiopian communities, unpasteurized raw milk is preferably consumed than boiled milk due to its accessibility, convenience, good taste, and reduced cost. The public health concern posed by BTB is mostly linked to the consumption of *M. bovis*-infected unpasteurized dairy products. Closed human-animal contact is also considered a potential risk factor for the disease.[16,17]

The distribution of BTB in livestock in Ethiopia is not well known. However, in some of areas, there is a scarcity of information on the current status of the disease. Thus, the objective of this communication is to present an overview on the BTB in Ethiopia.

ETIOLOGY

M. bovis is a facultative intracellular pathogen that can live and grow inside macrophages and other mammalian cells. It is acid-fast, aerobic, non-spore-forming, slow-ogrowing, and non-motile. It is a member of the family *Mycobacteriaceae* genus *Mycobacterium*. All pathogenic *Mycobacterium*, except *Mycobacterium avium*, are members of the same genetic species, the *Mycobacterium tuberculosis* complex, according to the phylogenetic analysis of their genomes.[18]

M. bovis is shown to survive best in the frozen tissue, whereas tissue preservatives, such as sodium tetraborate, have negative impacts on its viability. *M. bovis* may persist in the environment for several months, especially in cold, dark, and wet situations. The survival period varies from 18 to 332 days at temperatures ranging from 12°C to 24°C, depending on sunlight exposure. From soil or grazing pasture, there is infrequent isolation of this bacterium. It has been discovered that artificially kept samples of the bacterium can be cultured for about two years. The organism's viability is between fours and eight weeks in 80% shade, whereas it can be killed in either summer or winter.[19]

HOST AFFECTED

The most common mycobacterial disease, *M. bovis*, affects a variety of vertebrate animals of all ages, including humans. Cattle, goats, and pigs are the most vulnerable to infection.[20] In South Africa and Zambia, the African buffalo (*Syncerus caffer*) and the lechwe antelope (*Kobus leche*) have both been identified as important BTB wildlife reservoirs. African buffalo is extremely social herding animals that live in groups of several hundred. They graze on grasses or leaves or wallow in mud for most of the day. Each herd has a home range across, in which they travel throughout the year in a clumsy way.[21]

The lechwe, like buffalo, is ruminants who prefer to graze in swampy areas. In reaction to environmental conditions, they also follow local seasonal migratory patterns.[22] BTB affected Lechwe live in the Kafue Basin, which is made up of flood plains surrounding the river Kafue in central Zambia.[23]

EPIDEMIOLOGY

Tuberculosis is an infectious bacterial disease that affects a variety of mammals, including humans, cattle, deer, llamas, and other wild animals. Humans of varying ages, as well as other species, are vulnerable to infection. The disease is present throughout the world, but it is more common in Africa, Asia, and America. Tropical and subtropical countries have a high prevalence of disease.[24] Based on comparative tuberculin skin tests in different parts of Ethiopia, the prevalence of BTB in smallholder dairy farms was 6.9%, 12.9% in traditionally managed wide production systems, and 24.6% in intensive dairy farms.[25]

TRANSMISSION

In Ethiopia, animals live in the same home along with their owners, and floors and walls are painted with cow dung, which serves as the source of transmission. The probability of tuberculosis spreading to humans is increased by each of these practices.[26] Recently, there have been increasing reports of human cases due to *M. bovis*, especially in patients with HIV/AIDS.[20]

When cattle stocking density is high, transmission is most likely. *M. bovis* can be isolated from the nasal, tracheal mucus, and the lungs of most reactors with respiratory lymph node lesions. The infected cattle having the capacity to spread the disease by aerosol also. When possums transmit the disease to deer, it is predicted that *M. bovis* can travel up to 1.5 meters in aerosols created by them.[27]

PATHOGENESIS

When bacterium enters a herd of cattle through aerosolized droplets or ingestion, it becomes entrenched. The incubation period might last months or years, depending on the severity of the infection, and the immune system of the individual animal. Typically, bacteria enter a cow's respiratory system and settle in the lungs. Lung macrophages are then capable of phagocytizing the organism. After being taken up by macrophages, the bacterium replicates intracellularly as the body attempts to wall off infected macrophages with fibrous tissue, granulomas or tubercles formed. The granulomas are 1–3 cm in diameter, yellow or gray in color, spherical, and firm. The granulomas core is made up of dried yellow, caseous, or necrotic cellular debris in a cut portion. The infection can spread hematogenously to lymph nodes and other parts of the body, resulting in smaller tubercles of 2–3 mm in diameter. "Military tuberculosis" refers to the formation of these smaller tubercles. The necrotic cells at the tubercle's center are surrounded by epitheloid cells and multinucleated giant cells, all of which are encased in collagenous connective tissue. As the tubercle matures, the necrotic core of cells can become calcified.[28]

CLINICAL SPECTRUM

Humans

Feelings of sickness or weakness, weight loss, a fever, and night sweats are all common signs of tuberculosis. The chest pain, bloody coughing, and coughing up debris are other signs of pulmonary tuberculosis. The location of the infection determines the symptoms of TB disease in different parts of the body.[29]

Animals

Tuberculosis is a devastating chronic disease that affects cattle. In the early stages, the disease is asymptomatic. However, there is gradual emaciation, a mild fluctuating fever, weakness, and in-appetence in the late stages. Dyspnea, moist cough, or tachypnea may occur when a lung infection is present. The animal becomes exceedingly malnourished and develops acute respiratory distress in the final stage. The presence of a major distribution of lesions is seen in the upper respiratory tract, lungs, and tonsils in affected animals. Although some cows with severe miliary tubercular lesions are clinically normal, most suffer from unrelated progressive emaciation with other clinical signs. The disease is often coupled with a changeable appetite and a variable temperature. The affected animals become lethargic and sluggish; yet, their eyes stay bright and alert. Following calving, these general signs frequently become more apparent. Chronic cough related to bronchopneumonia is a symptom of pulmonary involvement. Coughing happens only once or twice at a time, is low, repressed and moist is easily triggered by squeezing the pharynx or by exercise, and is common in the morning and during cold weather.[30]

Diagnosis

Clinical symptoms and radiographic data are frequently used to make a tentative diagnosis; however, microbiological testing is required for a definite diagnosis. Smear microscopy, culture, and phenotypic identification have all been used in the laboratory to diagnose tuberculosis. Acid-fast staining is the quickest, easiest, and cheapest technique available. However, its low sensitivity (45–80% of positive cultures) has limited its utility in BTB testing, particularly in low-incidence areas.[19]

Economic importance

Tuberculosis is found in practically every country across the globe, and it is particularly prevalent in dairy cattle and causes significant morbidity, mortality, and production losses (infected animals lose 10–25% of their productive efficiency). Tuberculosis has been declared a global emergency by the World Health Organization (WHO).[30]

About every third human of the world's population is infected with tuberculosis. Tuberculosis is extremely significant to the livestock industry's profitability since it can infect humans due to its zoonotic nature; as a result, it is a major public health concern. The World Organization for Animal Health has classified it as a notified disease (OIE). Tuberculosis also affects the international trade of animals and animal products.[30]

Public health risks

Humans can become infected with *M. bovis* through direct inoculation in rare situations.[31] Related to the animal, often described as butchers, veterinarians, and animal scientists, are an occupational risk for BTB. Because *M. bovis* is either enzootic or sporadic in much of the developing world, there is also a low risk of human-to-cow transmission by ingestion or inhalation. In terms of public health, livestock eradication programs and universal pasteurization of milk remain the mainstays in the fight against a disease spread by cows that affect humans. In locations where *M. bovis* disease in humans is more prevalent, these procedures should be supported by public education initiatives emphasizing the dangers of consuming unpasteurized dairy products.[32]

Treatment

Isoniazid, streptomycin, and para-aminosalicylic anti-tuberculous drugs like DOTS as recommended by the WHO are commonly used in the treatment of human tuberculosis.

Animal tuberculosis treatment is not a popular or cost-effective alternative in countries committed to tuberculosis eradication. If the disease requires long-term medication in humans, there is a risk of developing multidrug-resistant, extremely drug-resistant, and even totally drug-resistant bacterial strains if the treatment regimen is not followed appropriately. It is pertinent to mention that Bacillus Calmette–Guérin (BCG) vaccination, testing, and culling of calves are critical for the prevention and eradication of tuberculosis.[24]

Vaccination with BCG in animals, on the other hand, sensitizes animals to the tuberculin skin test, and vaccinated animals will, at least for a significant period post-vaccination, become test positive in the classical skin test. As a result, in many countries, including Ethiopia, test and slaughter-based control techniques based on tuberculin skin testing were preferred over BCG vaccination.[33]

Control and prevention

Ancillary diagnostic testing, such as herd testing, health surveillance, and antemortem diagnosis, which includes tuberculin testing and immunization, is successful in reducing cases of TB.[34] As soon as the initial group of reactors is removed, hygienic actions to prevent the spread of infection should be implemented. Feed troughs should be cleaned and disinfected thoroughly with a hot, 5% phenol or equivalent cresol disinfectant. Emptied water troughs and drinking cups should be disinfected in the same way. Monitoring the control and eradication program should be done regularly to take account of its success and make any necessary changes. The use of modern genotyping methods, as well as collaboration and coordination among human and veterinary health-care specialists, will eventually aid in the eradication of BTB, particularly in developing countries like India.[30]

CONCLUSION AND RECOMMENDATIONS

The transmission of tuberculosis from animals to humans in underdeveloped nations, primarily through infected milk, is a severe and under-appreciated mode of transmission. Antimicrobial treatment has been undertaken, but because long-term treatment is necessary, anti-tubercular medication is not a wise option in eradication-aware countries. The development of BTB diagnostics and vaccinations for cattle has made significant progress along with the test and slaughter policy. In human medicine, the BCG vaccine provides better protection. The following are some recommendations based on the aforesaid conclusion:

- Calves being raised as herd replacements must be fed tuberculosis-free milk, either from known tuberculosis-free animals or pasteurized milk
- Because tuberculosis is a zoonotic disease, it should be vaccinated for both people and animals
- Animals that have been imported from another state or country should be quarantined
- Pasteurization of milk before consumption is imperative.

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Authors' contributions

All authors contributed correspondingly. The final version was accepted for publishing after it was reviewed.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

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Conflicts of interest

There are no conflicts of interest.

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