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Bovine tuberculosis: clinical presentation and diagnosis

Abstract

Bovine tuberculosis (TB) is a chronic disease of animals caused by a bacterium called *Mycobacterium bovis* (*M. bovis*), which is closely related to the human bacterium and avian tuberculosis. Although cattle are considered true hosts of *M. bovis*, the disease has been reported in many domestic animals and undomesticated. Tuberculosis is usually a chronic debilitating disease in cattle, but it can occasionally be acute and rapidly progressive. TB is still common in less developed countries, and severe economic losses can occur from livestock deaths, chronic disease and trade restrictions. In some situations, this disease may also be a serious threat to endangered species. Bovine tuberculosis can be controlled by test-and- slaughter or test-and-segregation methods. Affected herds are re-tested periodically to eliminate cattle that may shed the organism; the tuberculin test is generally used.

Keywords: bovine tuberculosis, *mycobacterium bovis*, domestic animals, segregation methods, zoonosis

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Introduction

Bovine tuberculosis is prevalent in animals of many developing countries whereas surveillance and control activities are often inadequate or unavailable; it is also a major zoonosis, mainly involving farm workers on dairy farms and the consumption of contaminated dairy products.

Zoonotic TB can also be considered a socio-economic disease; it has a negative impact on livestock production in developing countries through reduced production efficiency, carcass or organ condemnation and restriction of international trade.[1]

Although milk is considered as the main route for the transmission of BTB from cattle to human beings, Non-pasteurized milk is by far the most probable vehicle for the transmission of pathogenic mycobacteria.[2] An estimated 32% of the world's population, or 1.86billion people, are infected with *Mycobacterium tuberculosis*[3] and more than eight million new cases of tuberculosis disease (TB) occur each year.[4] Infections caused by *Mycobacterium bovis* are being increasingly documented as being the cause of epidemic nosocomial bursts in Paris.[5]

Polymerase chain reaction (PCR) is a sensitive and fast diagnostic tool that can be used to detect the agent in clinical samples in 48 h, but the presence of inhibitors in samples can interfere with its performance.[6,7] Tuberculosis profited from several major advances in immunopathology, diagnosis, treatment and vaccination. This pro-gress will be soon applied to improve the diagnosis (speed and reliability) and to shorten the treatment of tuberculosis.[8,9]

Many countries around the world perform the control or eradication of BTB by their official control of infectious diseases, based on test-and-slaughter policy. Additional diagnostic tests are needed to make a quick diagnosis of the disease and develop vaccines in order to prevent bovine tuberculosis.

Transmission

Animals transmit infection to each other through ingestion of urine, faeces and lymph, wound discharge, infected milk along with food and water. TB elimination programs in domesticated herds together with milk pasteurization have successfully reduced the incidence rate of TB caused by *M. bovis* among cattle and humans alike in developed countries.[10]

Transmission could have been by aerosols or contamination of fodder due to indiscriminate spitting. Milk and meat are one of the most important links between bovine tuberculosis and human beings especially children.[11,12] *M. bovis* infection in humans can occur through inhalation of infectious droplets from a live or slaughtered animal or by consumption of unpasteurized dairy or meat products from infected animals.[13,14] Vertical transmission can also occur in infected females. The uterus may serve as a portal for foetal infection and surviving calves commonly develop liver and spleen lesions.[15] People working in animal husbandry, slaughterhouse workers, veterinarians, and people in close contact with possibly-infected animals are at a higher risk for *M. bovis* infection.[16]

Pathogenesis

The genus Mycobacterium is the unique genus of the family *Mycobacteriaceae*, order Actinomycetales, class Actinomycetes. *M. bovis* is one of the members of *M. tuberculosis* complex. Current taxonomy recognizes 8 members in this group i.e., *M. tuberculosis*, *M. bovis*, *M. bovis* BCG, *M. caprae*, *M. africanum, M. pinnipedii, M. microti and M. Cannettii.*[17–20] *M. bovis* is an obligate intracellular pathogen; experimental studies have shown that it can survive under specific conditions. *M. bovis* can survive in faeces, blood, and urine from 150 to 332days at 12 to 24°C, when shielded from direct sunlight, particularly in cold, dark and moist conditions. The genome contains approximately 4000 genes, encoding different properties, potential virulence factors and antigens[21] (Table 1).

Table 1 Members of the *mycobacterium tuberculosis* complex and hosts

	Members	Main hosts
M. tuberculosis complex	*M. tuberculosis*	Human TB
	M. bovis, M. bovis BCG	Cattle and human TB
	M. africanum	Human TB in Africa
	M. canettii	Human TB
	M. microti	TB in small rodents
	M. caprae	TB in goats
	M. pinnipedii	TB in seals

Diagnosis

The global prevalence of human TB caused by *M. bovis* was estimated to be 3.1% of all human TB cases worldwide, accounting for 2.1% and 9.4% of pulmonary and extra pulmonary TB cases, respectively.[22]

To identify cattle infected with *M. bovis,* the intradermal tuberculin test is usually performed, which is based on the inoculation of *M. Bovis* antigens called purified protein derivative (PPD). Although the tuberculin skin test is highly sensitive and specific, it requires 48-72h to process, and veterinarians must be specially trained to perform the assay.

The culture of milk samples is another approach to the detection of *M. bovis*, but while it provides acceptable sensitivity and specificity it is labor-intensive, with up to 6weeks required to detect positive specimens.[23] Identification of *M. bovis* in raw milk and tissue samples of domestic calves and goats from the West Bank is an important finding with economic and public health consequences.

In diagnosis of mycobacterial infections, culture is still considered the international gold standard.[22] However, due to dysgenic and slow growth characteristics, the identification of *M. bovis* by culture and biochemical methods is cumbersome and time consuming.[24] Furthermore, application of molecular techniques is expensive as it demands availability of adequate laboratory resources and trained personnel.

Lesions in cattle are most often found in organs rich in reticuloendothelial tissue, particularly the lungs and associated lymph nodes.[25] Lesions are most commonly present in the lower respiratory tract, however the upper respiratory tract and its associated tissues also displays disease in many cases (Figure 1) (Figure 2).

Bovine tuberculosis (BTB) is a disease characterized by formation of granulomatous nodules called tubercles whose locations depend largely on the route of infection. In calves, it is usually transmitted by ingestion and lesions involve the mesenteric lymph nodes Figure 3 with possible spread to other organs. In older cattle, infection is usually by the respiratory tract with lesions in the lung and dependent lymph nodes.[26]

The necropsy procedure performed after slaughtering of animals allows for the detection of gross lesions suggestive of BTB, even in apparently healthy cattle. Veterinary inspection is established as a routine procedure in most of the slaughterhouses in developing countries. The detection of infected animals is mainly restricted to the routine slaughterhouse inspection.[27] In cattle, tubercles are found in the lymph nodes, particularly those of the head Figure 4 and thorax. They are also common in the lung Figure 1, spleen, liver, heart Figure 5, kidney Figure 6 and the surfaces of body cavities. In disseminated cases, multiple small granulomas may be found in numerous organs. Lesions are sometimes found on the female genitalia, but are rare on the male genitalia.

Figure 1 Lung from a tuberculous cow showing calcified granulomas.

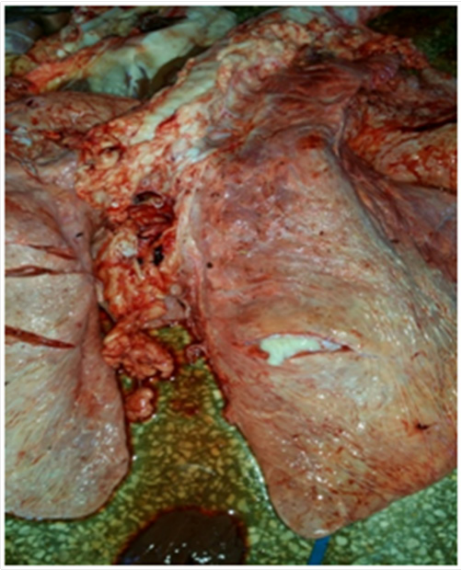

Figure 2 Lung lymph node from a tuberculous cow.

Figure 3 Lung lymph node from a tuberculous cow.

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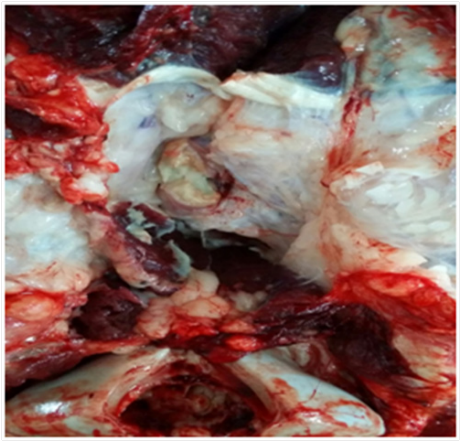

Figure 4 Head lymph node from a tuberculous cow.

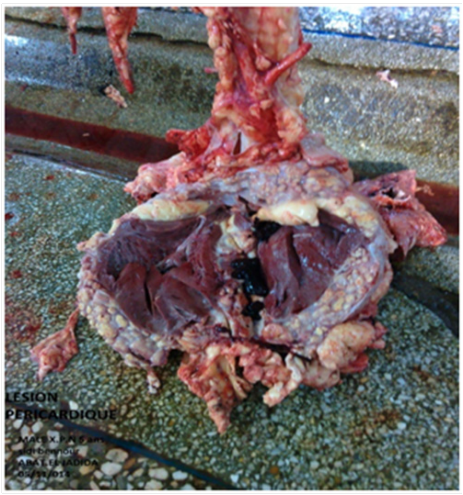

Figure 5 Cardiac lymph node from a tuberculous cow.

Figure 6 Kidney lymph node from a tuberculous cow.

A definitive diagnosis is still established by the isolation and identification of the etiological agent (*M. bovis*) from lymph nodes or lungs, obtained during necropsy or at slaughter, using a combination of traditional culture and biochemical methods, which is considered the "gold standard method".[28] These methods are laborious, unreliable and time-consuming; it may take more than 90days to grow the microorganism, and an additional 2weeks for biochemical identification. Molecular methods, especially the polymerase chain reaction (PCR) assay, are the most promising. However, the success of the PCR assay depends on the availability of intact and impurity-free DNA.[29]

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Conflict of interest

The author declares no conflict of interest.

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