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Hardi Fattah Marif
 Department of Clinic and
 Internal Medicine, College of
 Veterinary Medicine,
 University of Sulaimani,
 Sulaimanyah, Kurdistan
 Region, Northern Iraq.

Brucellosis: Its impact and cost effective control strategies in Mongolia

Hardi Fattah Marif

Abstract

Brucellosis is a disease caused by a group of pathogenic bacteria in the genus *Brucella*, which primarily infect animals. Brucellosis is known as one of the most common emerging and re-emerging infectious diseases in both medical and veterinary sector. Within about 76 animal threats brucellosis has a crucial effect on impoverished people. According to The World Organization for Animal Health (OIE), the most significant control strategies for brucellosis are elimination of infected animals by test-and-slaughter, vaccination of young animals combined with the elimination of infected animals, vaccination of only young animals, mass vaccination of both young and adult animals and treatment by heating of milk for human consumption without doing any action in animal populations. However, vaccination Schemes is the only possible control strategy in Mongolia. As it has been revealed in a study, the actual vaccination costs were US\$ 8.3 million and the overall benefit was US\$ 26.6 million, so the actual benefit was US\$ 18.3 million in Mongolia.

Keywords: Brucellosis, Mongolia, vaccination, OIE, *Brucella*.

1. Introduction

Brucellosis is one of the most common zoonotic infectious diseases in the world (Ariza, Bosilkovski *et al.*, 2007) [2] and it is an emerging and re-emerging threat to veterinary and public health (Abdullayev, Krcalick *et al.*, 2012) [1]. Developing countries are often disproportionately affected resulting in major economic losses, while at the same time imposing heavy losses on the health of population. Countries most heavily burdened by the disease are Mediterranean countries, the Arabian Peninsula, Indian subcontinent and Central and South America (Peeridogaheh, Golmohammadi *et al.*, 2013) [8], as well as Central Asia, Middle East and Sub-Saharan Africa (Abdullayev, Krcalick *et al.*, 2012) [1] (Figure 1). It has been stated that out of 76 animal diseases and syndromes, brucellosis has a greater impact on impoverished people and lies within the top ten (Dean, Crump *et al.*, 2012) [4]. Although vaccination efforts and food safety standards have reduced the disease in many countries, it has been estimated that there are approximately half million of new cases of the disease worldwide annually. Brucellosis in republic of China including Inner Mongolia was highly endemic until 1970s, and then significantly decreased until the mid-1990s (Zhang, Guo *et al.*, 2010) [11]. Incidence of brucellosis has substantially increased in China since 1995, and the Inner Mongolia Autonomous Region is the most severe endemic area. The fact that the continuing existence of human (and animal) brucellosis extends beyond medical and veterinary duties and encompasses political factors goes to show that the eradication of the disease will not be an easy task for the future (Pappas, Papadimitriou *et al.*, 2006) [7].

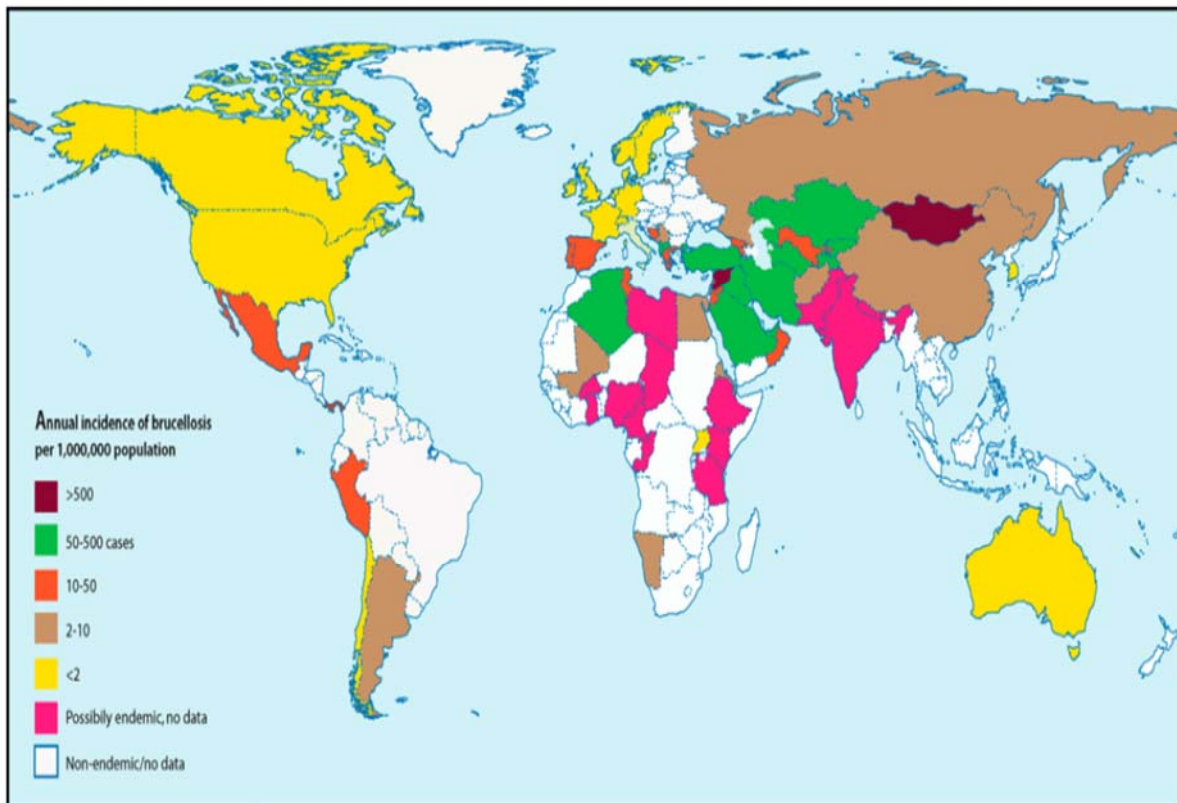
2. The Causative Agents, Risk Factors and Clinical Signs

Brucellosis is caused by a group of pathogenic bacteria in the genus *Brucella*, which primarily infect animals. The primary causative agents in humans are *B. abortus* (cattle), *B. melitensis* (sheep and goat), *B. suis* (swine) and *B. canis* (dogs) (Roth, Zinsstag *et al.*, 2003) [9]. This disease can be transmitted to humans either through consumption of unpasteurised milk and other dairy products or by coming into direct contact with infected materials during animal husbandry or meat processing (Abdullayev, Krcalick *et al.*, 2012), [1] and direct contact with infected placentas or aborted foetuses (Dean, Crump *et al.*, 2012) [4]. It has been shown that the main risk factors associated with brucellosis are occupations, such as agriculture worker, shepherd, butcher, slaughterhouse worker, and cattle dealer (Zhang, Guo *et al.*, 2010) [11].

Correspondence
Hardi Fattah Marif
 Department of Clinic and
 Internal Medicine, College of
 Veterinary Medicine,
 University of Sulaimani,
 Sulaimanyah, Kurdistan
 Region, Northern Iraq.

Brucellosis may cause subclinical, acute, sub-acute or chronic infection in which the symptoms can be continue for greater than twelve months (Young 1995) ^[10]. The main clinical symptoms are fever, sweating, head ache, anorexia, fatigue, arthritis, hepatomegaly, splenomegaly and neurological sings (Aypak, Altunsoy *et al.*, 2012) ^[3], and can

also cause neurological complications, endocarditis and formation of abscess in bones and testes. In addition, there is an economic cost as those infected are affected so that they cannot undertake normal daily activities (Peeridogaheh, Golmohammadi *et al.*, 2013) ^[8].



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Fig 1: Global incidence of human brucellosis in 2007.

3. Diagnosis of Brucellosis

Diagnosis of the disease can be done by laboratory confirmation based on microbiological culture, serology such as ELISA (Enzyme Linked Immunosorbent Assay) and standard agglutination tests or molecular methods. Standard agglutination test is the most common serological test, which is used for diagnosis of human brucellosis in many countries. In developing countries, laboratory personnel are at risk from contracting the infection due to contact with infected blood samples (Peeridogaheh, Golmohammadi *et al.*, 2013) ^[8].

4. Treatment of Brucellosis

Recommended brucellosis treatment regimens have not been updated by the WHO (World Health organization) in the last 20 years, although the rate of treatment failure ranges from 4.6% to 24% for the oral regimen and 5% to 8% for the oral/parenteral regimen. According to the WHO, oral regimen consists of 200mg doxycycline plus 600-900 mg rifampicin daily for a minimum 6 weeks, while the alternative oral/parenteral regimen replaces rifampicin to 15 mg/kg streptomycin daily until 2 to 3 weeks. It has been suggested by Solera and co-workers that using of gentamicin in human treatment for the first 7 to 10 days to the standard oral regimen would be useful (Franco, Mulder *et al.*, 2007) ^[6]. The main objectives of this report are to shed light on the control measures and strategies as well as its costs and impacts of brucellosis in developing countries, focusing on Mongolia as one of the highly endemic area in Central Asia.

5. Control of Brucellosis

5.1 General Effective Brucellosis Control Strategies

The World Organization for Animal Health (OIE) has developed control strategies, guidelines and recommendations for controlling of brucellosis in many Eurasian countries including Mongolia. Choosing of control strategies depends on epidemiological, economic and organizational factors present in a particular country. For example, veterinary capabilities and animal husbandry practices.

5.2 The most significant control strategies for brucellosis

1. Elimination of infected animals by test-and-slaughter: this strategy is difficult to implement as it is expensive and needs very efficient veterinary services, good laboratories, individual animal identification and epidemiological supportive services.
2. Vaccination of young animals combined with the elimination of infected animals: this method needs to differentiate between vaccinated and infected animals.
3. Vaccination of only young animals: this option can be done by the lower cost.
4. Mass vaccination of both young and adult animals: this method is relatively easy to perform and also economical. Usually using of S 19 and Rev.1 vaccines. These vaccines are very slowly excreted in milk and may also cause abortion in animals. The most significant benefit of these vaccines is rapid establishment of herd immunity.

5. Treatment by heating of milk for human consumption without doing any action in animal populations: this technique is obviously the lowest cost option, but people in contact with infected animals remain at risk (Food and Agriculture Organization, *Brucella melitensis* in Eurasia and the Middle East; 2009) ^[14].

5.3 Vaccination Schemes as the only Possible Control Strategy in Mongolia

Livestock mass vaccination is the most common and efficient control strategy in Mongolia and it will be undertaken in the next 2 years considering that at least 2-3 animal generations, i.e. 10-15 years. Two effective and inexpensive vaccines are available which Rev.1 is for small ruminants given at full dose (1 x 10⁹ CFU) by the conjunctival route, and S19 for cattle given individually at full dose (10 x 10¹⁰CFU) subcutaneously or at reduced dose (5 x 10⁹ CFU) conjunctivally (Food and Agriculture Organization, *Brucella melitensis* in Eurasia and the Middle East; 2009) ^[14].

Two vaccination schemes are applicable: First, mass vaccination of all animals every two years, including males (in the case of sheep and goats) with Rev-1 vaccine, and bovine and yak (only females) with the S19 vaccine by the conjunctival application. This is the simplest strategy that has been used successfully to control of brucellosis in many countries, and only needs the ability to locate 100% of flocks/herds and to vaccinate all animals (GUIDE BOOK for the Control of Brucellosis in the Mongolian Nomadic Husbandry System: 2012) ^[12].

Secondly, mass vaccination and individual identification of all animals in the first year and then identification and vaccination of the replacement animals (males and female in sheep and goat and only females in case of cattle and yak) only in subsequent years. The latter strategy has also been applied in some European countries such as Spain,

Portugal and Greece. (Food and Agriculture Organization, *Brucella melitensis* in Eurasia and the Middle East, 2009). In the former strategy, inclusion of both ram and belly goat is essential, as well as Rev-1 vaccine for the successful vaccination campaign, hence to achieve of the main goal which is controlling of brucellosis (GUIDE BOOK ;2012) ^[12].

5.4 Impacts and Costs of Vaccination Programme

Mongolia is one the highest infected endemic countries of brucellosis in the world. It has been reported that the incidence rate of brucellosis is greater than 60/100 000 people. There was a reduction in individual animal prevalence, but not in flock/herd prevalence due to performing of a test-and-slaughter control programme in 1960s. Moreover, it was impossible to depopulate whole herds, as there were no disease free replacement animals (Food and Agriculture Organization, *Brucella melitensis* in Eurasia and the Middle East; 2009) ^[14].

In 1970-80s, a vaccination program was implemented using both strains S19 and Rev-1 and this successfully reduced the annual incidence of infections in humans to less than 1/10000 (Roth, Zinsstag *et al.*, 2003) ^[9]. During the 1990s there was an increase in the prevalence of brucellosis because of democratic reform and shift away from dependence of the former Soviet Union (Roth, Zinsstag *et al.*, 2003) ^[9]. In 2000 a new vaccination programme was introduced with the objection of eradicating of the disease by 2010 and an intervention study has been carried out in

Mongolia using of Rev-1 vaccine in small ruminants and found that the transmission rate of brucellosis dropped by at least 65% (Government of Mongolia, WHO. *Mongolia health sector review*. 1999) ^[13]. Indeed cost effectiveness is a cost per DALY evaded. It has been stated in a scenario that the reduction of 52% of the brucellosis incidence rate, achieved by mass vaccination, a total of 49027 DALYs would be evaded. A study estimated that the actual vaccination costs were US\$ 8.3 million and the overall benefit was US\$ 26.6 million, so the actual benefit was US\$ 18.3 million. If the costs were shared between all sectors, then the public health sector would contribute 11%, which gives a cost-effectiveness of US\$ 19.1 per DALY averted. If the private economic gain included, then the public sector would contribute 42% of the costs and the cost-effectiveness would decline to US\$ 71.4 per DALY averted.

It has been stated that the incidence of brucellosis is decreased from six cases per 10 000 to five cases per 10 000 and another study has found that this incidence dropped to only one case per 10 000 by using of ten years mass vaccination programme (Roth, Zinsstag *et al.* 2003) ^[9]. Brucellosis in cattle was ranging from 3.8% to 35% before vaccination, but now is approximately 5% to 10% in cattle and in sheep and goat is less than 2% after the vaccination program (Ebright, Altantsetseg *et al.*, 2003) ^[5].

6. Conclusion

Like many other infectious diseases, brucellosis can be controlled by vaccination control strategy. However, this would cost a lot of money. In Mongolia, two types of vaccines have been used which are Rev-1 and S19. The mass vaccination scheme has been undertaken to control brucellosis not only in Mongolia but also in some European countries including Spain, Portugal and Greece. In ten years mass vaccination program, the incidence of brucellosis decreased from six cases in only one case per 10 000. It has been shown that the transmission rate of brucellosis dropped by at least 65% by using of Rev-1 vaccine in small ruminants. The total vaccination costs in Mongolia were US\$ 8.3 million and the actual benefit was US\$18. 3 million. The eradication of brucellosis in both humans and animals is believed to be a difficult task in the future as it is beyond the medical and veterinary duties.

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