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A Review on Epidemiology and Public Health Importance of Brucellosis with Special Reference to Sudd Wetland Region South Sudan

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Abstract: *Brucellosis is one of the most important zoonotic diseases of public health implications causing socio-economic impacts on the livelihoods of the poor rural pastoralist communities and the urban population worldwide. Bovine brucellosis is one of the top five priority diseases of livestock in South Sudan. This review casts light on some epidemiological parameters and public health importance of brucellosis to enable key stakeholders to understand the magnitude of the disease in South Sudan. Of which over 85% of the population is associated with cattle directly or indirectly for improving their livelihoods and enhancing food and nutrition security. Rural people commonly contract the disease through drinking of raw milk or ingestion of improperly cooked meat from infected cattle or even aborted feti and stillbirths. Cattle are infected through ingestion of contaminated feed or water in the endemic areas. In the Sudd Wetland region of Terekeka County and Jonglei State brucellosis poses threats to socioeconomic development. Biotyping of Brucella species and One Health approach are needed to mitigate prevalence of the disease among the livestock and the rural farming communities in South Sudan.*

Keywords: *Brucellosis; Epidemiology; Cattle; Public Health; Sudd Wetland; South Sudan.*

1. INTRODUCTION

Brucellosis is a highly contagious zoonotic chronic bacterial disease of public health, wildlife and livestock importance (Glynn and Lynn, 2008). The disease is caused by ten species of the Genus: *Brucella* and distributed worldwide (Corbel et al., 1997).Susceptibility to brucellosis varies among individual animals. It depends on the animals' natural resistance, age, sex, level of immunity and environmental stress (Ahmed, 2009). Adult animals are highly susceptible to and both sexes become infected with brucellosis (Ibrahim, 1990) and that large herd size and age of cattle had a significant association with brucellosis seropositivity (Mugizi et al., 2015). Apart from humans, cattle, sheep and goats, deers, elks, dogs and pigs (CDC, 2002), brucellosis also affects camels (Teshome et al., 2003; Hegazy et al., 2004).

Brucellosis was eradicated in developed countries but its control remains unresolved in most of the developing countries (Abubakar et al., 2012). The public health implications of brucellosis in Terekeka County, Central Equatoria State South Sudan were due to the norms of the rural pastoralist communities in drinking raw milk directly from the cows' teat. Such socio-cultural complexities are most likely spread in other endemic areas (Lado et al., 2012). Bovine brucellosis causes substantial economic losses in infected cattle population culminating in a lower calving rate and decreased replacement costs as well as reduced value addition of infected cows (Mangen et al., 2002).

Although there was inadequate data on livestock-human-disease situation in Sudd Wetland region, bovine brucellosis was one of the most predominant livestock diseases in Jonglei State, South Sudan (McDermott et al., 1987). This is likely attributed to collapse of veterinary and public health services during the devastating civil war (1983-2005) in the Sudan. Pastoralists and farming communities might have perceived little knowledge of infectious diseases and the consequences of infection. Streamlining of such valuable knowledge by strengthening disease information and health education

systems appeared to be helpful in understanding the need for control measures (Smits, 2013). Consequently, understanding the epidemiology of brucellosis is imperative for providing baseline data on the host-agent-and environment relationships in certain geographical region (Schneider and Lilienfeld, 2015).This is socially desirable and economically feasible in the sense that brucellosis was identified as one of the top five priority diseases of livestock impeding sustainable development of livestock sector in South Sudan (Anon, 2010).

This review article aimed at casting lights on some epidemiological parameters and public health importance of brucellosis with particular emphasis on the Sudd Wetland region. This is essential for providing an impetus for key stakeholders and development partners to develop "One health" approach in the control of brucellosis in South Sudan.

2. EPIDEMIOLOGY OF BRUCELLOSIS

2.1. Etiology

Brucellosis is caused by the Genus Brucella that comprises a group of closely related bacteria. These bacteria are facultative intracellular, gram-negative, non-capsulated, non-flagellated and non-spore forming coccobacilli (Madigan and Martinko, 2006). The species *Br. melitensis* (three biovars) infects mostly sheep and goats; *Br.suis* (four biovars) mostly infects swine while *Br. abortus* (nine biovars) affects mostly cattle, buffalo and bison. Brucellosis due to *Br.abortus*, *Br.melitensis* and *Br.suis* were included in the second category (List B) of communicable diseases (Gwida et al., 2010). Cross-transmission could occur between cattle, sheep, goats, camels and other species (Montasser et al., 2011). The predilection site of *Br.abortus* is the reproductive organs including placenta, aborted fetus and products of parturition, and it is most likely found in the milk, semen, feces and hygroma fluids (Glynn and Lynn, 2008).

2.2. Sources of Infection and Mode of Transmission

The reservoirs of Brucella species comprise cattle, goats, sheep and some wildlife (Olsen, 2013). Raw infected milk, fresh cheese and other milk products made from infected raw milk constituted the main sources of infection (Ibrahim, 1990). Humans become infected through a direct contact with animals or ingestion of animal products including raw and improperly boiled infected milk (Doris et al., 2012).Being a contagious disease the transmission is basically taken place through contact with the infected placenta and fetus, fetal and vaginal fluids from infected animals. Animals become infectious after either abortion or full term parturition (Adugna et al., 2013).As such, introduction of asymptomatic infected animals with Brucella into a herd played a pivotal role in the epidemiology of the organism (Diaz et al., 2013).

2.3. Prevalence

Several studies on bovine brucellosis have shown that the age and herd size are risk factors which play a significant role in the infection and spread of bovine brucellosis. The age of cattle and an increase in herd size might result to increasing stock density and exposure to infection, especially after abortion (Adugna et al., 2013). Cattle aged above five years had significantly higher odds of brucellosis seropositivity compared to less than three years old. Moreover, the odds of brucellosis for herds with more than 100 cattle were higher compared to those with less than 50 cattle (Sanogo et al., 2012). It appeared that the trend in the disease occurrence over the 3-year period showed that it is endemic in trade cattle slaughtered in Ibadan (Cadmus et al., 2010). Other risk factors include interactions with wildlife, communal grazing and introduction of asymptomatic infected animals into a herd (Diaz et al., 2013). In Gulu and Soroti towns of Uganda prevalences of individual animal- and herd-level were 7.5% (76/1007, 95% CI: 6.15 – 9.4%) and 27.1% (45/166, 95% CI: 20.9% 34.3%), respectively (Mugizi et al., 2015).

In Ethiopia the risk of Brucella infection to cattle was shown to increase as parity number increased, however, no significant differences in seropositivity to brucellosis among three different parity groups established (Dinka and Chala, 2009).In the Sudan prevalence of brucellosis in Bahri Province was the highest (35.2%) compared to 15.1% and 31.1% in Omdurman and Khartoum Provinces, respectively (Hamid et al., 2004). In Kuku dairy scheme Sudan 24.9% individual animal and 90% herd prevalences were reported (Angara et al., 2009). Meanwhile, in the Sudd wetlands region of Kongor Rural Council, Jonglei State an individual sero-prevalence of 25.3% was shown (Mac Dermott et al., 1987) compared to 12.7% in Western Equatoria State, South Sudan (Jok, 2013).This could be possibly explained by the large herd size in Jonglei State.

2.4. The Role of Wildlife

The Sudd Wetland region is endowed with wildlife fauna and flora, but the role of wildlife in the epidemiology of brucellosis remains unclear in South Sudan. In the United States free-roaming elk and bison in the Greater Yellowstone Area remain the only wildlife reservoirs for *B.abortus* (Elzer et al., 2002). The disease can induce abortions or stillbirth calves in livestock and wildlife. Infection takes place within and among wildlife bison, elk and cattle populations when individuals come in to contact with infected fetuses, placentas or birthing fluids (White et al., 2013). The occurrence of brucellosis in humans depends largely on the occurrence of brucellosis in an animal reservoir (Godfroid et al., 2013). The creation of new interfaces between livestock and wildlife due to human activity proved to be the most important factors in disease transmission (Bengis et al., 2002).

2.5. Geographical Distribution

Brucellosis is the most common zoonotic disease distributing at the global level. Although the reported prevalence of the disease varies globally from country to country, bovine brucellosis due to *B. abortus* is commonly disseminated worldwide (Corbel et al., 1997). Moreover, a clinical disease is still common in some parts of the Middle East, Africa, South and Central America, the Mediterranean basin and the Caribbean (Abubakar et al., 2012) and Asia including Pakistan(Abubakar et al.,2012). In South America bovine brucellosis occurs in Brazil (Poester et al., 2003) and Argentina (Samartino, 2002) .Whereas in Africa brucellosis is widely distributed including Egypt (Montasser et al.,2011), Ethiopia (Adugna et al.,2013; Dinka and Chala, 2009), Ivory Coast (Sanogo et al., 2012), Nigeria (Cadmus et al.,2010), Somaliland (Ahmed,2009),South Sudan (McDermott et al., 1987; Lado et al.,2012 ; Jok,2013), Sudan (Hamid et al.,2004; Hegazy et al.,2004; Angara et al., 2009) and Uganda (Nakavuma, 1994;Mugizi et al.,2015). It appears that there are different factors influencing the distribution of the disease at the global, regional and national levels including the stage of urbanization. In Uganda the individual animal-level and herd-level sero-prevalence tended to be higher in Soroti than in Gulu town suggesting variations in the geographical distribution of bovine brucellosis according to location, i.e. rural, peri-urban and urban (Mugizi et al., 2015).

3. PUBLIC HEALTH IMPORTANCE

Brucellosis is an important zoonotic disease of public health implications accounting for more than 500,000 human cases per annum worldwide (Seleem et al., 2010). In South Sudan a fraught with several potential risk factors could fuel the dissemination of brucellosis to livestock and humans (Lado et al., 2012). The traditional pastoralist's practice of assembling several herds into cattle camps with close livestock-human interactions is one of the key milestones. Moreover, poor awareness is a risk milestone to occurrence and perpetuation of brucellosis in livestock which could create human health hazards (Ibrahim, 1990). Further brucellosis risk indicators including the rampant animal herder's practice of vulval blowing, to facilitate milk letdown during cow milking (figure 1), and the practice of direct udder-to-mouth consumption of raw milk (figure 2) could exacerbate human brucellosis. Drinking of raw milk was significantly associated with brucellosis while drinking boiled milk was protective in Terekeka County (Lado et al., 2012). Hence active public health education on the benefits of boiling milk before consumption is imperative.

Fig1. *Blowing through the vulva to enhance milk letdown in one of the cattle camps in the then Terekeka County.*

Source: *Emmanuel Philip Lita, 2016.*

Fig2. *Direct sucking of raw milk from cow's teat in one of the cattle camps in the then Terekeka County.*

Source: *Emmanuel Philip Lita, 2016.*

4. DIAGNOSIS OF BRUCELLOSIS

Brucellosis is characterized by inflammation of the genital organs and foetal membrane, abortion at the late stage of pregnancy with retained placenta, sterility and formation of localized lesions in the lymphatic system and joints (Cadmus et al., 2006). A number of diagnostic tests have been used for diagnosis of the disease. Of these, a simple tube agglutination test (Gall and Nielsen, 2004) and complement fixation test (Nielsen, 2002) were extensively employed in the practice. But agglutination tests are subjected to false positive reactions due to exposure to cross reacting microorganisms. Rose Bengal Plate test (RBPT) was used for screening of brucellosis (Alton et al., 1975) and competitive Enzyme-linked Immunosorbent Assay (c-ELISA) as a confirmatory test for detection of brucella antibodies in the sera of affected animals (Portanti et al., 2006; Angara et al., 2009). It was realized that c-ELISA is efficient for differentiating vaccinal and cross-reacting antibodies to Brucella from those elicited by the natural infection in humans (Lucero, 1999) and cattle (Poester et al., 2003).

It is evident that RBPT provides more likely false positive results as such c-ELISA reduces the number of individual positive samples (Nakavuma, 1994). The gold standard test for brucellosis is based on isolation and identification of the causative bacterium by culturing. However, this requires skilled personnel in a standard biosecurity laboratory (Nielsen and Yu, 2010). Serological tests are moderately easy to perform and provide a practical advantage in detecting the prevalence of disease in large animal populations and can be used for early detection of the status of animals and they seem to be less costly (Saleha et al., 2014). However, it appears that polymerase chain reaction (PCR) and other new molecular techniques are likely to be used as routine typing and fingerprinting methods for diagnosis of brucellosis in livestock and wildlife (Godfroid et al., 2010).

5. PREVENTION AND CONTROL MEASURES

Brucellosis, due to *Br.abortus, Br. melitensis* and *Br. suis* creates an important human health threat in many parts of the world. Hence, development of safer and more efficacious candidate vaccines alone, or increased emphasis on other regulatory programme components, could have enormous impacts on mitigating the worldwide prevalence of brucellosis and the associated zoonotic infections (Olsen and Stoffregen, 2005).

Brucellosis was eradicated in Europe, Australia, Canada, Israel, Japan and New Zealand, but it remains uncontrolled in Africa, some parts of Middle East, Asia and Latin America (Abubakar *et al*., 2012). A combination of testing, vaccination, and removal of infected animals had led to such eradication as vaccination of wild animals had reduced the risk of transmission of brucellosis to humans and livestock (Davis and Elzer, 2002). Oral administration of *Brucella* strain 19 (S19) and the rough strain RB51 (SRB51) to pregnant pronghorn antelopes was unhazardous to feti. It appears that *Brucella* S19 and SRB51 rarely colonize maternal and fetal tissues of pregnant pronghorn (Elzer et al., 2002). However, the candidate vaccine, *Br.abortus* RB51 can cause placentitis and abortion in pregnant bison cows (Palmer et al., 1996). Immunization of cattle and small ruminants with *Br.abortus* S19 and *Br.melitensis* Rev. 1 poses a milestone in the control programmes against brucellosis (Godfroid et al., 2010). Live attenuated brucellosis vaccines have been developed for protecting domestic livestock against *Br.melitensis* and *Br.abortus* for several decades. Hence, development of candidate DNA vaccines may provide impetus for *Brucella* antigens to confer protective immunity in domestic livestock or wildlife reservoirs of brucellosis (Olsen, 2013).

6. CONCLUSION

Brucellosis is one of the most important priority diseases of livestock and public health importance in South Sudan. Nomadism and consumption of raw milk and under cooked meat remain unresolved. Hence, strict food hygiene and safety at slaughter houses and butcheries are essential for prevention and control of the disease. Biotyping of *Brucella* spp. is need as it provides key stakeholders with important epidemiological information for developing control strategy using one health approach. Provision of quality health education and veterinary extension services is also needed to protect livestock sector and health of the poor rural pastoralist communities in South Sudan.

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