Effects of livestock/wildlife interaction on the epidemiology of bovine tuberculosis in the Kafue Basin of Zambia

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Abstract

Bovine tuberculosis (BTB), caused by *Mycobacterium bovis* has persistently been reported in wildlife and domestic animals of the Kafue Basin without understanding the transmission patterns. In Zambia, previous reports have estimated cattle BTB prevalence at 3 to 7% based on tuberculinisation and 14 to 35% in the Kafue lechwe (*Kobus leche Kafuensis*) based on post-mortem. Although the Kafue lechwe has been suspected as a biological reservoir for cattle BTB, the transmission patterns remain unclear. Therefore, a cross-sectional study was conducted to estimate BTB prevalence in cattle reared in the interface areas of the Kafue flats (Lochinvar and Blue Lagoon) and identify associated risk factors. A control area outside the interface areas (Kazungula District) was included for comparative purposes. The comparative intradermal skin test (CIDT) was used to determine the prevalence while risk factor identification was done using a structured questionnaire. Overall individual cattle BTB prevalence was estimated to range between 0.6% and 7.4%. Results of the logistic regression analysis indicated that BTB prevalence was independently associated with type of grazing system, where cattle herds grazing in sustained close contact with the Kafue lechwe (interface herds) had the highest prevalence (11.6%), followed by the transhumance system with irregular wildlife contact (5.1%) and lastly village grazing systems with no wildlife contact (2%). Interface herds were, 18 times more likely to be BTB positive compared to village grazing system (Odds ratio = 18.1; CI 95% = 4.3-81.0); $p<0.000$) suggesting that cattle BTB occurrence was highly associated with wildlife contact. The generated TB model proved to be a very useful tool in understanding the epidemiology of BTB in the Kafue Basin. This is the first study of its kind to provide valuable insights on the possible transmission pattern of BTB in the Livestock/wildlife interface areas of the Kafue Basin in Zambia.

The study

This study focused on tuberculosis in indigenous cattle breeds in the Zambian livestock/wildlife interface areas across different cattle grazing strategies. It also explored the relationship between cattle sharing grazing land with wildlife (mainly Kafue lechwe antelopes). The study has been able to establish the levels of BTB in livestock/wildlife interface areas of the Kafue basin across different cattle grazing strategies. Identified significant risk factors associated with BTB status in Blue Lagoon, Lochinvar and Kazungula have been elucidated. In this type of set up, BTB infection was found to be prevalent in the livestock/wildlife interface areas. The observed association between area and other variables may suggest the existence of an ecological linkage. Area could be a proxy variable for other risk factors such as communal grazing and contact with wildlife. Lochinvar and Blue Lagoon, receive cattle from different places around the basin which congregate on the plains. This arrangement potentially increases the risk of between and within herd contacts and has been documented as the key risk factor for BTB status in the basin (Cook et al., 1996). However, communal grazing was also practiced in Kazungula along the Zambezi plains despite the recorded low prevalence suggesting that additional factors other than communal grazing could account for the observed differences in disease frequency.

The animal prevalence of BTB varied among the 3 grazing strategies identified in the study areas. Significant differences were recorded between those in the interface areas and those outside. Animal BTB prevalence in Lochinvar was recorded at 5.2% and Blue Lagoon 9.6%, both found in the wildlife/livestock interface areas whilst Kazungula which is outside the interface area had a prevalence of 0.8%. These findings hint on the

probable existence of a likely focus of infection around this geographical zone of the country (Sitima, 1997). However, the reasons for such spatial distribution of infection are not well known, although it is suspected that the lechwe antelope is the biological reservoir host of BTB in the Kafue Basin area (Cook et al., 1996; Pandey, 1998; Sitima, 1997). Cattle raised in the livestock/wildlife interface areas of the Kafue Flats were more likely to have a positive tuberculin reaction on CIDT than those found in Kazungula District although relatively larger herd sizes were recorded in Kazungula and the mixing of animals and other characteristics were similar to those found in the Kafue Flats, with the exception of lack of wildlife contact. Animals that were reared in the interface areas (IFH), were almost seven times more likely to have a positive test reaction than those reared in the villages (VRH) (OR=6.7). These results strengthened the earlier suggestion of an existing concentric focus of infection towards the wildlife sanctuary in the Kafue Basin as postulated by Pandey (Pandey, 1998). The Kafue Basin has been identified as an area with favourable ecological conditions for the spread of infectious diseases between livestock and wild animals due to the interaction that exists between cattle and wildlife, coupled by the favourable marshy environmental conditions (Munag'andu et al., 2006). The gregarious nature of lechwe antelopes with higher herd densities obtaining in drier seasons is thought to have had facilitated the survival of *M. bovis* in these wetlands (Gallagher et al., 1972; Siamudaala et al., 2003; Stafford, 1991). Yearly seasonal flooding may also help in the propagation of micro-organisms in the environment, while overcrowding of animals during the dry season at watering points may enhance the direct animal to animal transmission of the disease (Corner, 2006). Thus, from the biological stand point of spread and maintenance of *M. bovis*, both environmental, host and agent attributes may be regarded as being optimal in the Kafue Basin region (Corner, 2006; Zieger et al., 1998). Our results demonstrate that the unique factor to Blue Lagoon and Lochinvar is the presence of wildlife, which was highly associated with area and BTB status.

Data from this study indicated that sex had no effect on BTB status. This is in accordance with findings from other studies (Oloya et al., 2006; Omer et al., 2001). According to the biology of the disease, tuberculosis positive cattle go through a period of desensitization before and after calving and as many as 30% may give false negative reactions returning to a positive status 4 to 6 weeks later (Radostist et al., 1994). In our study less than 0.5 % of the animals had given birth within a month or two prior to being tested, which imply that the number of false negatives due to this aspect could not have an effect on the validity of the results.

Age was related to the distribution of BTB reactors across all areas and grazing strategies with low prevalence values being recorded in younger age groups and high values in older ones. These results tie up with other similar findings (Ameni et al., 2003; Asseged et al., 2000; Cook et al., 1996). Cattle of all ages are susceptible to TB, but the probability of becoming infected generally increases with age due to the proportionate increase in exposure time, with older animals being likely to have a greater risk on account of exposure period (O'Reilly and Daborn, 1995).

Results from the model indicated that body condition score, age and grazing strategy as important predictors for cattle BTB. It is likely that emaciation was an indicator of tuberculosis occurring in an animal. It is also possible that tuberculosis positive animals have poor body condition score as a result of being infected, i.e. a clinical sign that typically follows an active infection with *M. bovis* (Kazwala et al., 2001; Pritchard, 1988).

Grazing strategy apart from being a major predictor variable for BTB status, it is also a proxy variable for other risk factors. For example, interface cattle herds are known to be in constant contact with lechwe herds, previously described as sources of residual infection of tuberculosis (Cook et al., 1996; Pandey, 1998; Stafford, 1991). Interface herds are also known to be large thus facilitating for close contact within and between herds and thus favouring the transmission of respiratory diseases including tuberculosis (Radostits et al., 1994)

It was also noted that there was more than one animal per herd that gave a positive result, giving rise to a certain degree of clustering. However, these numbers were very small and it was considered very unlikely that a clustering effect would influence the results of the study. In summation, BTB is relatively high in cattle in the livestock/wildlife interface areas the Kafue Basin compared to Kazungula, raising concerns in terms of animal productivity and public health. The study further showed that old and emaciated animals raised in the interface areas where more likely to test positive for BTB. Overall, the study has been able to establish geographical area attributable differences in prevalence coupled with potential risk factors of its occurrence at animal level.

References

Ameni, G., Ameni, K., Tibbo, M., 2003, Bovine tuberculosis:Prevelance and risk factor assessment in cattle and cattle owners in Wuchale-Jida district central Ethopia. Journal of applied research in veterinary medicine 1, 1-4.

Asseged, B., Lubke-Becker, A., Lemma, E., Taddele, K., Britton, S., 2000, Bovine tuberculosis:a crosssectional and epidemiological study in and arround Addis Ababa. Bulletin of Animal health production in Africa 48, 71-80.

Cook, A.J., Tuchili, L.M., Buve, A., Foster, S.D., Godfrey-Fausett, P., Pandey, G.S., McAdam, K.P., 1996, Human and bovine tuberculosis in the Monze District of Zambia--a cross-sectional study. Br Vet J 152, 37-46.

Corner, L.A.L., 2006, The role of wild animal populations in the epidemiology of tuberculosis in domestic animals: How to assess the risk. Veterinary Microbiology 112, 303–312.

Gallagher, J., MacAdam, I., Sayer, J., & van Lavieren, L.P., 1972, Pulmonary tuberculosis in free-living Lechwe antelope in Zambia. Tropical Animal Health and Production 4, 204 – 213.

Kazwala, R.R., Kambarage, D.M., Daborn, C.J., Nyange, J., Jiwa, S.F., Sharp, J.M., 2001, Risk factors associated with the occurrence of bovine tuberculosis in cattle in the Southern Highlands of Tanzania. Vet Res Commun 25, 609-614.

Munag'andu, H.M., Siamudaala, V.M., Nambota, A., Bwalya, J.M., Munyeme, M., Mweene, A.S., Takada, A., Kida, H., 2006, Disease constraints for utilization of the African buffalo (*Syncerus caffer*) on game ranches in Zambia. Jpn J Vet Res 54, 3-13.

O'Reilly, L.M., Daborn, C.J., 1995, The epidemiology of Mycobacterium bovis infections in animals and man: a review. Tuber Lung Dis 76 Suppl 1, 1-46.

Oloya, J., Opuda-Asibo, J., Djonne, B., Muma, J.B., Matope, G., Kazwala, R., Skjerve, E., 2006, Responses to tuberculin among Zebu cattle in the transhumance regions of Karamoja and Nakasongola district of Uganda. Trop Anim Health Prod 38, 275-283.

Omer, M.K., Skjerve, E., Woldehiwet, Z., Holstad, G., 2001, A cross-sectional study of bovine tuberculosis in dairy farms in Asmara, Eritrea. Trop Anim Health Prod 33, 295-303.

Pandey, G.S., 1998. Studies of the infectious diseases of the Kafue lechwe (Kobus leche kafuensis) with particular reference to tuberculosis in Zambia. Azabu University, Tokyo.

Pritchard, D.G., 1988, A centuary of bovine tuberculosis. journal of comarative pathology 99, 357-399.

Radostist, O.M., Blood, D.C., Gay, C.C., 1994, Veterinary Medicine, Eighth Edition. Bailliere Tndall, London.

Radostits, O.M., Blood, D.C., Gay, C.C., 1994, Veterinary Medicine, Eighth Edition. Bailliere Tndall, London.

Siamudaala, V.M., Muma, J.B., Munag'andu, H.M., Mulumba, M., 2003. Veterinary challenges regardding the utilisation of the Kafue lechwe (Kobus leche kafuensis) in Zambia. In: Conservation and development interventions: at the wildlife/wildlife interface: implication for wildlife, livestock and human health, Durban, South Africa, 14th to 15th August, pp. 75-80.

Sitima, A.C., 1997. Variability of Mycobacterium bovis in traditionally processed sour milk and the prevalence of bovine tuberculosis in Namwala district of Zambia. University of Zambia, Lusaka.

Stafford, K.J., 1991, A review of diseases of parasites of the Kafue lechwe (Kobus leche kafuensis). J Wildl Dis 27, 661-667.

Zieger, U., Pandey, G.S., Kriek, N.P., Cauldwell, A.E., 1998, Tuberculosis in Kafue lechwe (Kobus leche kafuensis) and in a bushbuck (Tragelaphus scriptus) on a game ranch in central province, Zambia. J S Afr Vet Assoc 69, 98-101.