Bovine tuberculosis: a double-edged issue at the human/livestock/wildlife interface in Africa

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BOVINE TUBERCULOSIS IN AFRICA

Bovine tuberculosis (bTB) caused by *Mycobacterium bovis* is a major neglected tropical disease and there are important gaps in understanding of the epidemiology of this animal disease and zoonosis (Hotez and Kamath, 2009; El Idrissi and Parker, 2012). Its impacts can be economic, as bTB decreases the level of livestock production for both local and export markets; sanitary, as bTB can be transmitted from animal to human populations, causing severe disease and mortality; social, when livestock ownership is a source of social status in rural communities; and detrimental to biodiversity conservation, when bTB threatens wildlife populations or when disease management options consider the possibility of wildlife control. In developed countries, although bTB was once thought to be under control, the disease is re-emerging as a result of maintenance of the agent in new wild host species. In the developing world, bTB is widespread in animal populations, and the animal and human health surveillance systems are not adapted to detect the infection efficiently or to assess its real impact on both host populations (Thoen et al., 2009).

In Africa, the epidemiological situation of bTB in livestock and human populations is highly variable. In many cattle populations, the disease is chronic and largely asymptomatic until latter stages of disease. There is little information about the disease in small ruminants; although recent studies have indicated that goats in Africa are more prone to *Mycobacterium tuberculosis* infection than to bTB (Deresa, Conraths and Ameni, 2013), bTB is known to occur in goats in Europe (Napp et al., 2013). Small ruminants could therefore be an important host for the spillover of *M. tuberculosis* to humans and vice versa. The extent of this spillover is unknown because of the lack of local diagnostic capacity to detect extra-pulmonary tuberculosis (TB), the major form of bTB in humans (Durr et al., 2013); the few studies providing information on this aspect indicate absence (Tschopp et al., 2010) or low prevalence of bTB in humans (Thoen et al., 2009). The implications of a high prevalence of human immunodeficiency virus (HIV) for bTB susceptibility and prevalence in African rural populations are also largely unexplored, and human behaviour such as raw milk consumption can be an important additional risk factor. The high mammal diversity that still occurs in some areas of Africa provides additional hosts for *M. bovis*. In the Great Limpopo Transfrontier Conservation Area (GLTFCA) of southern Africa, for example, bTB has been shown to occur in more than 16 wild species (A.L. Michel, pers. comm.), but the role of each species in maintaining the...
disease is unknown or still debated, as are the impacts of the disease on different species.

The spatial extent and intensity of wildlife/livestock/human interfaces in Africa are highly variable. Interface areas range from double fences separating conservation areas (e.g. national parks) from other land-use types (e.g. communal land), to integrated mixed systems where wildlife and livestock production coexist (e.g. tourism and meat production). Some interface areas are marked by porous physical barriers, which can take the form of buffer zones around wildlife conservation areas, where human activities are regulated (e.g. wildlife hunting concessions), or environmental land-use boundaries such as rivers, which can attract wild and domestic ungulates and facilitate interactions (Kock et al., 2014). Many of these interface areas share important characteristics: they occur in semi-arid and arid areas where poor human communities with little access to human and animal health services struggle to make a livelihood from small-scale farming, environmentally constrained cultivation and the legal or illegal harvesting of natural resources (Giller et al., 2013). Limited availability of resources such as water and grazing land, especially during the dry season, promotes interactions among wildlife, livestock and human populations, increasing the risk of pathogen transmission. There is potential for these interface areas to play an important role in the epidemiology of bTB in Africa.

Across Africa, these interfaces span large tracts of land, but regional differences can arise as a result of historical and political contingencies. In western Africa, wildlife has been largely extirpated and its role in the epidemiology of bTB is probably very limited because the interface with livestock is localized around a few remaining wildlife conservation areas. In this region, *M. bovis* is therefore maintained mostly in livestock populations.

In central Africa, forest environments do not provide opportunities for intense contacts between wildlife and livestock species because forage resources are widely distributed and freely available. Although few data are available, it seems likely that these limited interface areas do not play an important role in bTB epidemiology.

In eastern Africa, *M. bovis* is endemic in wild and domestic ungulate populations (Tschopp et al., 2010), but its epidemiology in the region’s ecosystems has not attracted much interest until recently (e.g. Tschopp et al., 2010; Roug et al., 2014) and many gaps in knowledge remain. Eastern Africa has conserved extensive wildlife populations and several countries rely heavily on the wildlife industry for tourism. Expanding pastoral and agropastoral human populations in dry savannas encroach increasingly on to natural areas, but overall densities of wildlife and livestock are relatively low, except in areas of Ethiopia, where there are large cattle and wild ungulate populations.

In southern Africa, bTB at wildlife/livestock interfaces has been the focus of several studies, probably because the pathogen was introduced and spread in the Kruger National Park ecosystem in South Africa, where the implications for the conservation of wildlife and grazing land, especially during the dry season, promotes interactions among wildlife, livestock and human populations, increasing the risk of pathogen transmission. There is potential for these interface areas to play an important role in the epidemiology of bTB in Africa.

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pathogen dynamics in socio-ecosystems. The risk of bTB transmission between wild and domestic species, and ultimately to humans, is documented, but questions remain regarding the sanitary, economic and social consequences of the disease.

BOVINE TUBERCULOSIS – A NEGLECTED TROPICAL DISEASE OR NOT A PROBLEM?

Estimating the impacts of bTB on human, livestock and wildlife populations is difficult because of the chronic form of the disease. In western and eastern Africa, although bTB is endemic in cattle populations, animal and public health authorities do not consider it a priority disease. The lack of diagnostic capacities to differentiate M. bovis in humans from the human pathogen M. tuberculosis blurs the impact of bTB on human populations. A more relevant question concerns the relative impact of bTB in its hosts, as most hosts harbour communities of pathogens that can have impacts on their health and production (Caron et al., 2013). Small-scale farming communities would probably rank bTB below tick-borne diseases and other more deadly diseases of their livestock (de Garine-Wichatiksy et al., 2013b), while veterinary services generally prioritize diseases with high economic impacts, such as foot-and-mouth disease, and largely ignore bTB. In addition to descriptive epidemiology of bTB in African contexts, three areas of research could help decision-makers to assign appropriate priority to bTB surveillance or control:

- Impact of bTB on human and animal populations: What are the health and production consequences of having endemic bTB in host populations?

While the impact of bTB in cattle populations in the northern hemisphere has been documented, little information is available on African contexts (Mwacalimba, Mumba and Munyeme, 2012). Notably, the interplay among bTB, the immune system and other diseases (e.g. brucellosis, Rift Valley fever, tick-borne diseases) could increase the overall disease burden in host populations (e.g. Ezenwa et al., 2010).

- Diagnostic tools: The development of bTB diagnostic tools adapted to wildlife, livestock and human hosts could help improve field detection and discrimination between bTB infection and the presence of other mycobacteria (Chambers, 2013). A recent study investigating the relationship between the presence of Fasciola haepatica and bTB diagnosis in cattle in the United Kingdom of Great Britain and Northern Ireland highlights the need to investigate the effect of multi-pathogen conditions on bTB diagnostic sensitivity (Claridge et al., 2012).

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**TRANSLATING RESEARCH INTO MANAGEMENT AND CONTROL OPTIONS**

For countries prioritizing bTB, research on bTB epidemiology at wildlife/livestock/human interfaces can have a positive influence on surveillance and control, as surveillance systems need to be adapted to the specific situations of these interfaces. In multi-host systems, research can identify which host(s) should be sampled to detect the pathogen or to estimate its prevalence cost-effectively. Optimizing surveillance systems at these interfaces – including by taking advantage of local opportunities such as surveillance on bush meat and hunted wildlife – and adapting them to the multi-pathogen context will increase the efficiency of veterinary services in resource-limited environments. The integration of heterogeneous data from surveillance into risk analysis tools can facilitate estimation of the risk of spillover and/or spread between susceptible host populations (Etter et al., 2006). Research can also help prevent disease spillover/spillback into new host populations by offering management options for human/livestock/wildlife interfaces.
Decreasing contacts between infected and naïve hosts will limit the local spread of bTB, so adapted farming practices such as reducing the shared use of pasture and water by wild and domestic ungulates can be explored when the risk of contact is understood in the local spatio-temporal context (e.g. whether it is based on hotspots of transmission or seasonal risk of contacts). When bTB is endemic in host populations, its control or eradication is difficult, and it may be necessary to learn to live with the infection. In an endemic situation, management options will need to be identified for reducing the impact of bTB on livestock and wildlife host populations in a multi-pathogen context, and for minimizing human exposure to the pathogen. Collaboration with farmers, local veterinary services, wildlife managers and the public health sector should result in the design of socio-economically acceptable sanitary management plans to promote sustainable livestock production in African contexts. For example, the zoonotic transmission can be greatly reduced by implementing basic hygiene measures if acceptable for local traditions (e.g. boiling milk). The impact of bTB in production animals needs to be assessed: does bTB really have an impact on local production (i.e. is bTB a priority disease for local farmers)? There is room for participatory approaches that merge distinct spheres of knowledge, bringing scientific information to local communities and translating communities’ knowledge into information for the scientific community to come up with appropriate and locally acceptable control or management measures. The situation of bTB at human/livestock/wildlife interfaces is complex and can only be tackled through interdisciplinary approaches that bridge epidemiology, ecology, economics and social sciences, as recommended by the One Health and EcoHealth approaches (Pfeiffer, 2013). These approaches should aim at reducing the risk of bTB spillover to important populations, and reducing the impact of the disease on animal and humans.  

REFERENCES


