Approach to assess the economic impact of bovine tuberculosis in Ethiopia

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Abstract

Bovine TB is prevalent in Ethiopian cattle and represents a serious zoonotic risk. However, extensive epidemiological data in the human and livestock sector are lacking. Create a dynamic transmission model of disease between animal and human, as a prerequisite for economic analysis of the most profitable intervention to control BTB in Ethiopia. Study on-going (2005-2010), epidemiological (prevalence, risk factors) and cost (human and livestock) data are collected in eight sites over a period of four years and fed into a compartmental trans-sectoral framework that simulates disease transmission. Different intervention scenarios will then be simulated in the model. The most profitable intervention to control BTB in Ethiopia has to be assessed as well as the cost sharing scheme between the public health and agricultural sectors. It has been postulated that a test and slaughter policy would have a negative economic impact in Ethiopia. Alternatives need to be assessed. [*Ethiop.J.Health Dev.* 2008;22(Special Issue):135-138

Introduction

Tuberculosis is distributed worldwide and is one of the most important public health concerns, especially in sub-Saharan Africa. The disease is responsible for the death of more people each year than any other infectious disease: nearly 8 million new cases and 2 million deaths are reported annually (1). Nearly 2 million TB cases occur each year in sub-Saharan Africa alone, and the role played by cattle pathogen *M. bovis* in the rising epidemic of tuberculosis, fostered by HIV in Africa, is largely unknown (2).

Cattle are considered to be the main hosts of *M. bovis*. However, the disease has also been reported in many other species, including human beings, domesticated animals and wildlife (3).

The epidemiology of *M. bovis* is well documented in many countries and control and elimination strategies have long been implemented in the developed world by a policy based on systematic slaughter of infected animals, meat inspection in abattoirs and milk pasteurization. However, BTB is still widely distributed and largely uncontrolled in developing countries, which are unable to support the costs of test-and slaughter policies and where BTB is often neglected and viewed as secondary to the huge problem posed by the more readily transmissible human disease caused by *M. tuberculosis* (4).

Very little systematic data on the extent of BTB either as a veterinary or as a human health problem are available in Ethiopia. BTB is endemic in cattle in Ethiopia; the disease has been reported from different regions (5, 6). However, the prevalence of the disease is not well established on a national level and large pastoralist communities in the country have been omitted. Over 80 % of the Ethiopian population is rural and live in close contact with cattle in areas where BTB is not controlled at all. These communities are exposed to direct contact with their animals and consume unpasteurized milk and milk products as well as raw meat. In addition of being a zoonotic threat, BTB is also an economical and financial burden to society but its cost has rarely been assessed (10) and is largely unknown for Africa.

The aims of this study are to compile large scale and long term epidemiological field data on BTB to create a dynamic animal-human transmission model, which is a prerequisite to simulate intervention strategies to control the disease in Ethiopia. In addition, the impact of BTB is assessed in terms of public and private costs in both the livestock and human health sectors. Field data collection is still ongoing. We present here the approach to estimate the cost of BTB to society and potential benefits of interventions.

Method

A cattle-human compartmental transmission model will be developed to simulate the transmission of BTB between animals (wildlife & cattle) and humans (fig 1). Differential equations are formulated for each compartment and parameters estimated with field data. The parameters consist of demographic data (birth and death rates) and disease transmission data (contact rate, risk factors). BTB transmission can then be simulated as well as the effect of different intervention strategies.

Field data are collected over a period of four years from eight different geographical sites in Ethiopia: the Northern highlands (Gondar, Woldia), the Rift Valley (Butajira), the West (Gimbi), the South (Jinka/Hamer), the South-East (Bale Mountains) and Sellale. The following data are collected: field prevalence of BTB in cattle (intradermal PPD testing), abattoir prevalence of BTB, prevalence of BTB in humans, productivity parameters in cattle, cost of animal and animal products (regional, seasonal and annual variation), cost of TB in humans, risk factors of disease transmission and socio-anthropological parameters.

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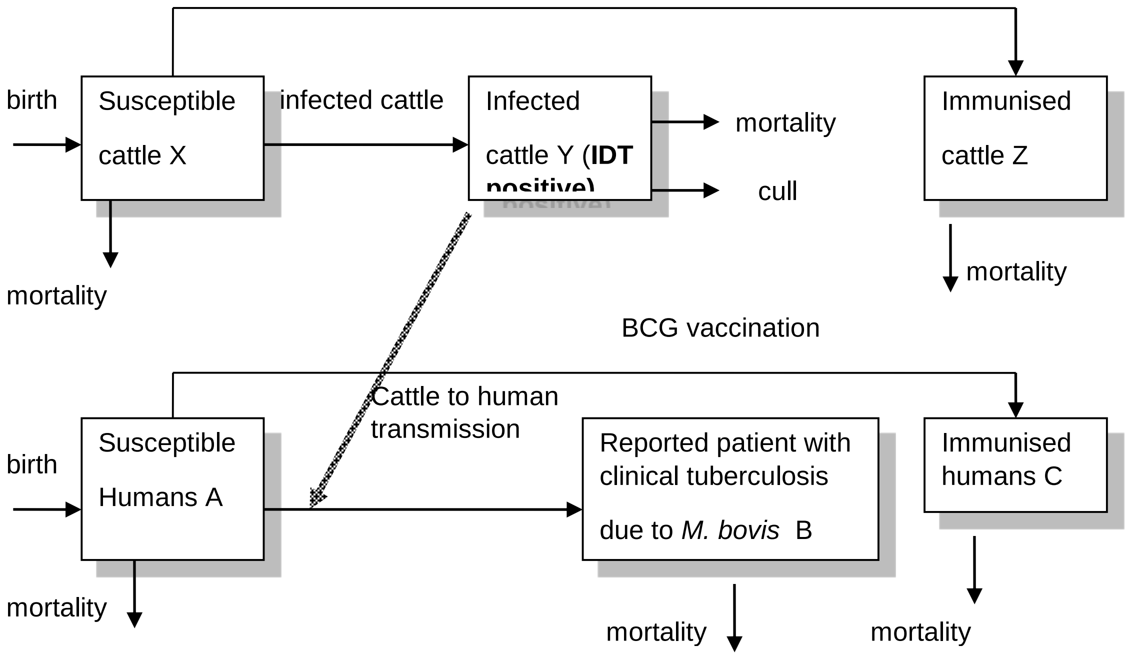

Figure 1: **Adapted model framework for joint human-animal BTB transmission in Ethiopia**

Demographic data (birth and mortality rate) in both humans and cattle are obtained from national statistics. In addition, cattle demographic data are collected from a four year productivity study, which follows 700 cattle in 21 farms, as well as from a herd structure analysis carried out in the sites where cattle PPD is performed.

The burden of disease will be assessed for the livestock sector using BTB prevalence found in the field and in the abattoirs as well as from the impact on their productivity. The burden for the public health sector will be assessed in terms of prevalence of disease in humans, cost of the disease and DALY. Data on cost of the disease will be collected directly in hospitals and health centers as well as through a patient based household survey. Data includes out and in-patient costs, therapy costs, loss of income and coping costs.

Benefits of an intervention will be computed for three different sectors:
1. The agricultural sector: the benefit resulting from the avoided losses in animals and animal products.
2. The public health sector: the benefit resulting from the avoided costs to the public health sector.
3. Private households with patients suffering from TB: the benefit resulting from (i) avoiding payment for treatment, (ii) income loss (= opportunity costs), and (iii) coping costs.
The sum of all three benefits will be considered as a benefit for the society as a whole.

Discussion
The disease has been shown in many countries to be an economical and financial burden to society due to economic losses: loss of productivity of infected animals (e.g. reduced milk yields and meat production), animal market restrictions, human health costs etc.

In Argentina, the annual loss due to BTB is approximately US$63 million (4). The socio-economic impact of BTB to the agriculture and health sector in Turkey has been estimated at between 15 and 59 million US$ per year (8). Even in some industrialized countries, where BTB has been eradicated by expensive schemes for control, eradication and compensation for farmers, the disease still has a major economic impact, mainly due to the existence of a permanent wildlife reservoir that reduces the efficiency of control strategies. In the UK, where badger and other wildlife such as deer remain an important source of infection for livestock, approximately £100 million is spent annually in efforts to control the disease. In Africa, the economic losses associated with livestock infected with BTB have not been examined sufficiently or have not been studied at all (9). Since agriculture remains the backbone of many African economies, there is an urgent need to control BTB (9). However, before introducing any control and eradication program in a country, profitability of control efforts have to be assessed (cost-benefit analysis of interventions).

Many zoonoses can only be eliminated if the disease is controlled in the animal reservoirs (10). A recent study on brucellosis in Mongolia has shown that mass vaccination of animals to reduce human brucellosis was a profitable intervention for the public health and agricultural sector, if the benefits of the livestock sector are added and the costs shared between the public health and the agricultural sector (11). A similar approach will be chosen for the economical analysis of the impact of BTB in Ethiopia. Disease transmission models provide frameworks to simulate change in prevalence and disease transmission with and without interventions such as test and slaughter or vaccination (10). The disease outcome in animals and humans are needed for dynamic socio-economic assessment of different intervention strategies. Economic analysis of an intervention to control BTB should include the impact on human health costs and the impact on livestock production (12).

BTB presents a serious zoonotic threat, since the disease is prevalent in cattle. Tadelle (1988) found that in Eastern Shoa (central Ethiopia) local breeds had much lower prevalence rate (5.6%) than exotic breeds (Holstein, 86.4%) (7). In high density herds maintained under intensive farming conditions, BTB prevalence was found as high as 50% in Holstein cattle at the Holetta National Insemination Centre (*personal communication 2007*). The disease burden is difficult to assess accurately since the intradermal test prevalence in cattle might not reflect the clinical stage of the disease (e.g. anergy in advanced stage of BTB; false positive and false negative reactions of the test) and might differ from cattle breed to cattle breed (different breed susceptibility of the intradermal test, e.g. Holstein *versus* local Zebu) as well as between different management systems. The latter would imply that the burden should be estimated on the one hand for urban/periurban farming systems with intensive management and high milk production rate (urban milk market), and on the other hand for extensive farming system in rural areas of Ethiopia characterized by low milk production but important draught power of cattle for crop production.

Another difficulty faced by the current research is the low rate of *M. bovis* detection in human lymphadenitis cases. The reason for this low detection rate is still largely unknown (e.g. low prevalence of *M. bovis* in humans, sampling and/or laboratory technique) but it might affect the assessment of BTB cost to the public health sector. Alternatively, this cost can be assessed using data collected on patients with *M. tuberculosis* and then extrapolated for the impact of BTB.

Collection of detailed epidemiological data on BTB on a national level in Ethiopia over a large period of time is therefore a prerequisite before starting any control program within the country. The study of BTB requires a trans-sectoral approach since the disease has a complex epidemiology (animal-human-ecosystem) and affects different sectors of a country (public health, livestock, wildlife, ecology, economy and trade, tourism etc.).

The exact epidemiology of BTB is still largely unknown in Ethiopia, which is a country of extreme diversity (e.g. geography, ecosystem, culture and tradition, cattle breeds probably with different susceptibility to disease) and results from other African countries might not be applicable or replicated here.

Finally, from a cost and logistic point of view, it should also be investigated if the control of BTB in Ethiopia could be linked with those of other zoonosis (e.g. Brucellosis) existing in the country.

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