Brucellosis in Sri Lanka: A review of the epidemiology and control strategies, and recommendations for future control strategies

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Introduction

Brucellosis is a disease reported mainly in cattle and buffaloes in Sri Lanka since 1956. Though eradication of brucellosis would be the most desired option, limited financial and infrastructural facilities and existing epidemiological and socioeconomic conditions, requires Sri Lanka to ensure that most cost-effective control options are used to control the disease. At present the control strategies are limited to serological testing of bovines, isolation of seropositives and occasional culling, and vaccination with *Brucella abortus* S19 in selected areas and state-owned cattle farms.

Objectives of project

1. Conduct a systematic review of literature on selected aspects related to the control of brucellosis.
2. Perform cost-benefit analyses to demonstrate the net benefit of effective control strategies if applied in Sri Lanka.
3. To suggest relevant future control strategies for brucellosis in humans and in animals in Sri Lanka.
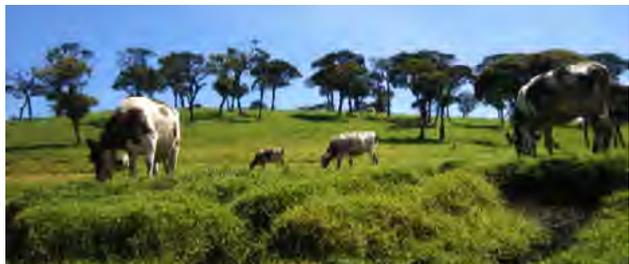

Figure 1. Cattle grazing on a farm in Sri Lanka.

Methods

Two international mentors, who were experienced in conducting systematic reviews and meta-analyses were appointed to train the group of investigators. A step-by-step training process via lessons delivered as YouTube video clips reinforced with discussions through Skype sessions, were the main modes of teaching.

The systematic review training covered the following areas: selecting the research questions suitable to be answered by performing a systematic review; developing a review protocol; performing literature search; summarizing the literature using narration; and performing meta-analyses using the software RevMan. In addition, a three-day training workshop on cost-benefit analyses was conducted by another international expert in the field of veterinary economics. Members were trained to perform cost-benefit analyses for *abortus* control options for cattle and buffalo using a preformed

spread sheet. The first step in the training was to customise the spreadsheet to suit the Sri Lankan situation by adopting locally relevant parameter values. Once the parameter values had been decided upon, multiple analyses with different parameter settings to demonstrate the cost and benefit of control strategies in different possible scenarios will be performed.

Of the many research questions that were initially formulated, four were selected as suitable to be answered through a systematic review process (Figure 2).

Q1- What is the sero-prevalence of brucellosis in cattle, buffalo and goat in Sri Lanka?

Q2- Is sero-prevalence of antibodies to *Brucella abortus* in buffaloes different to the sero-prevalence in cattle in countries with endemic brucellosis?

Q3- What is the proportion of abortion cases in cattle, buffalo and goats diagnosed with brucellosis in Sri Lanka?

Q4- What is the effect of vaccination against brucellosis on preventing abortions in buffaloes, cattle or goats?

Figure 2. The four questions that were selected to form the bases of the systematic reviews.

Systematic review protocols were developed and reviews were performed using both published and unpublished sources of data. The results of the reviews of Q1 and Q3 resulted in narrative forms of results due to inadequate numbers of local literature eligible to be summarised using meta-analysis techniques. Q2 and Q4 were completed using meta-analyses.

Results

The situation was reviewed regarding the sero-prevalence of brucellosis in cattle, buffalo and goats in Sri Lanka. Several published sero-epidemiological surveys revealed the presence of the disease in cattle and buffaloes, indicating that bovine brucellosis is an endemic disease in the country with *B. abortus* being the causative agent.

During the review, the overall prevalence of brucellosis in cattle was summarized as 4.5-5.5%, whereas it was 3.5-4% in buffaloes. Prevalence

was considerably higher in certain populations of animals, particularly in the North Central, North Western and Eastern provinces where the cattle are mostly raised under extensive management system. A few cases of caprine brucellosis due to *B. melitensis* were reported in the 1980s; however, none of the published reports available indicated that *B. suis* was causing infections in the country.

Table 1.Categories of parameters and the items used for economic cost-benefit analyses of brucellosis control strategies in Sri Lanka.

Demography	Human population; Adult female cattle; Annual calving rate; Proportion of female offspring; Number of female offspring each year; Initial prevalence of infection in adult female cattle; Annual culling rate; Annual replacement rate
Animal wastage costs	Annual incidence before vaccination; Abortion rate in new infections in cattle (the only effect is in the first year of infection); Opportunity cost of abortion (US$)
Costs associated with Strain 19 vaccination program	Strain 19 vaccine cost per dose; Cost per numbered ear tag; Average cost per vaccination for veterinarian to travel to farm and village and administer vaccine; Total average cost of vaccination per animal
Costs associated with a Test-and-Slaughter program	US$ loss due to testing and slaughtering; Cost ear tags; Average cost for collection of blood and serological diagnosis with selected test (RBPT & CFT protocol)
Public health wastage	Cost of a DALY for one year; Duration of average DALYs; Proportion of cases that are chronic; Proportion of reported cases requiring in-patient treatment; Average cost for in-patient treatment; Proportion of reported cases requiring out-patient treatment; Average cost for out-patient treatment; Annual incidence of human cases before interventions; Number of human cases per year before interventions; Incidence of human infections per 1000 infected animals
Diagnostic test performance	Sensitivity; Specificity
Discount rate	Discount rates

The meta-analyses of the systematic review on differences of the sero-prevalence of antibodies to *B. abortus* in buffaloes and cattle, found that there was no significant difference between prevalence of cattle and buffaloes (Prevalence Ratio (PR) = 1.03, 95% CI=0.89–1.18, p=0.22), as reported from studies in Asian countries with endemic brucellosis. Asian studies that were included in the review showed negligible clinical or methodological heterogeneity. The prevalence of brucellosis in buffaloes and cattle was not significantly different (PR=1.07, 95% CI=0.88–1.30, p=0.74) when studies which had used ELISA diagnostic methods were pooled.

Available literature on the incidence of abortions in cattle and buffaloes revealed that brucellosis is the most common infectious cause of bovine abortion in Sri Lanka. Systematic review and meta-analyses of the studies on the effect of vaccination against brucellosis for preventing abortions in buffaloes, cattle or goats confirmed the protective effect of vaccine (OR 0.16, 95%CI=0.09–0.29). No major methodological or statistical sources of heterogeneity were found.

Cost-benefit analysis for *B. abortus* control in cattle and buffalo is being conducted at present. The parameters to be included in the estimations are shown in Table 1.

Discussion

The systematic reviews indicate that brucellosis is endemic in the country with higher prevalence in selected locations. Many gaps were found in the epidemiological data on brucellosis. Particular note was made about the non-availability of data regarding human brucellosis in the country. Gaps were also noted within the information related to existing control strategies.

The systematic reviews confirmed the effectiveness of the bovine vaccine which is available in the country.

Lessons learned

The project enhanced One Health collaborations between human health and animal health sectors. Building of capacity of investigators to use epidemiological tools and techniques, and strengthening the evidence related to brucellosis control policy were the other lessons learned in this project.

Recommendations

The main recommendation from the project activities so far, is to generate the essential information on human brucellosis situation in the country. An analysis of notified cases of "pyrexia of unknown origin" is recommended to be taken up in the near future.

Of the control options available, the analysis so far has indicated that the relevant control option for the country would be essential vaccination of heifers to bring the prevalence of bovine brucellosis to a pre-determined low level. Testing and slaughtering of positive animals is recommended to be the second phase of control. More definitive suggestions will be made at the end of cost-benefit analyses.

Acknowledgments