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Bovine tuberculosis surveillance alternatives in Belgium

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ABSTRACT

Belgium obtained the bovine tuberculosis (bTB) officially free status in 2003 (EC Decision 2003/467/EC). This study was carried out to evaluate the components of the current bTB surveillance program in Belgium and to determine the sensitivity of this program. Secondly, alternatives to optimize the bTB surveillance in accordance with European legislation (Council Directive 64/432/EEC) were evaluated.

Separate scenario trees were designed for each active surveillance component of the bTB surveillance program. Data from 2005 to 2009 regarding cattle population, movement and surveillance were collected to feed the stochastic scenario tree simulation model. A total of 7,403,826 cattle movement history records were obtained for the 2,678,020 cattle from 36,059 cattle herds still active in 2009. The current surveillance program sensitivity as well as the impact of alternative surveillance protocols was simulated in a stochastic model using 10,000 iterations per simulation.

The median (50% percentile) of the component sensitivities across 10,000 iterations was 0.83, 0.85, 0.99, 0.99, respectively, for (i) testing the cattle only during the winter screening, (ii) testing only imported cattle, (iii) testing only purchased cattle and (iv) testing only all slaughtered cattle. The sensitivity analysis showed that the most influential input parameter explaining the variability around the output came from the uncertainty distribution around the sensitivity of the diagnostic tests used within the bTB surveillance. Providing all animals are inspected and post mortem inspection is highly sensitive, slaughterhouse surveillance was the most effective surveillance component. If these conditions were not met, the uncertainty around the mean sensitivity of this component was important. Using an antibody ELISA at purchase and an interferon gamma test during winter screening and at import would increase greatly the sensitivity and the confidence level of Belgium's freedom from bTB infection status.

1. Introduction

Although several European Union (EU) Member States have achieved the official bovine tuberculosis (bTB) free status (<0.1% annual herd prevalence), the possibility of a re-emergence of bTB infection cannot be excluded (EC Decision 2003/467/EC; EFSA, 2009).

Belgium has maintained the bTB officially free status since 2003 (EC Decision 2003/467/EC). Yet, sporadic outbreaks do still occur, as was recently the case in Germany and in the Netherlands (FASFC, 2010; Humblet et al., 2011; Probst et al., 2010). Belgium had 7 reported breakdowns in 2003, 8 in 2004, 5 in 2005, 8 in 2006, 5 in 2007, 12 in

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2008 and 2 in 2009. In 2010, no cases were detected (FASFC, 2010).

To date, despite the decreased prevalence following the sanitary measures implemented during the last century, *Mycobacterium bovis*, still remains a constant (re-)emerging threat for animal and public health as well as for free animal trade in Europe and worldwide. *M. bovis*, a slow-growing microaerobic bacterium, is the main causative agent of tuberculosis in cattle, and can infect a wide range of different species. If clinical signs appear, the main signs in cattle are wasting, weight loss, and fever. Because the infection does not always cause clinical signs, it might go unnoticed for several years before eventually being detected at slaughter by enlarged and/or caseating lymph nodes.

A national surveillance program according to the guidelines laid down in Council Directive 64/432/EEC and MB, 2010 was in place in Belgium for many years. This program consists of four different surveillance components (SSC), each with its own sampling – and diagnostic process. The main aim of this ongoing surveillance program is to ensure the country is below the minimum required design prevalence required to be considered free from infection. In addition, the surveillance program should enable the early detection and eradication of sporadic cases. The Belgian Federal Agency for the Safety of the Food Chain (FASFC) commissioned this study to evaluate the sensitivity of the current surveillance for bTB in Belgium and how this program could be optimized to enable efficient detection of outbreaks and maintain the bTB officially free status. Several studies have investigated the efficacy of bTB surveillance components separately, in Belgium (Humblet et al., 2009a, 2011) and elsewhere (Corner et al., 1990; Frankena et al., 2007). In the present study the different bTB surveillance components were evaluated together and for their relative efficacy.

The scenario tree methodology developed by Martin et al. (2007a,b) has been proven to be a useful tool to quantify the sensitivity of a country's surveillance system (Frossling et al., 2009; Hadorn et al., 2002; Hadorn and Stark, 2008; Knight-Jones et al., 2010; Martin et al., 2007a,b; More et al., 2009; Stark et al., 2006; Welby et al., 2009a,b, 2010). The surveillance system sensitivity is the probability of detecting an infection given the country is infected at the set design prevalence by testing all samples of the surveillance system. The sensitivity of the diagnostic test (TSe) is taken into account as well as the number of samples processed. Furthermore, the differential risk of infection for the specific risk groups in the cattle population are taken into account to quantify the benefits of targeting surveillance in those risk groups. However, when quantitative information about the key parameters affecting the differential risk of infection is not available, one needs to rely on assumptions to simulate values (Dohoo et al., 2009).

In the present study, the most representative values for the key parameters were estimated using historical data of the ongoing surveillance for bTB in Belgium. All available information regarding past outbreaks in Belgium was used to obtain quantitative values to feed the scenario tree model and obtain an output that reflected the Belgian situation, the sensitivity of its surveillance program and how it could be improved.

2. Materials and methods

Scenario tree methodology was chosen for the purpose of this study. Each event from infection to detection is represented by a node. A node has branches illustrating the possible event outcomes. Each outcome has a probability of occurrence. The combination of probabilities results in the probability of infection and detection for each limb, defined by a combination of nodes and branches, of the tree. The limbs define the different risk groups. The probabilities of detection are then combined to obtain the sensitivity of each SSC (CSe) and of the total surveillance system. Simulations are then carried out to see how changes in the current surveillance program could impact the CSe and surveillance system sensitivity, and how the surveillance program could be optimized in terms of efficiency of detection and provision of a guarantee of freedom from infection.

2.1. Belgian surveillance program

The four SSC of the current Belgian official surveillance program for bTB, in accordance with the guidelines laid down in Council Directive 64/432/EEC and the Royal Decree 17.10.2002, were:

- *Imported cattle (IMP)*: all imported cattle are tested by single intradermal injection of bovine tuberculin (ID) at import. This SSC excludes young fattening calves (FC), which are sent to slaughter at the age of 6 months.
- *Slaughtered cattle (SLGH)*: all slaughtered cattle undergo a post-mortem inspection (PM) at slaughterhouse.
- *Purchased cattle (PUR)*: all purchased cattle, except FC for veal production, are tested with ID at purchase.
- *Winter screening (WS)*: ID is carried out on:
  - all cattle older than 6 weeks from herds considered as neighbor or contact herds of a suspected or confirmed bTB positive herd, after tracing-on and tracing-back investigation;.
  - all female cattle older than 24 months which belong to on-farm 'milk-selling' herds;
  - all imported cattle, except FC for veal production, from non-bTB officially free Member States, are ID tested 3 consecutive years, during the winter period.

An animal that tested positive with ID is consecutively tested for confirmation by a comparative skin test, using bovine and avian tuberculin. Animals that test positive to this comparative ID will be slaughtered and all suspect lesions and/or lymph nodes at post-mortem examination will be tested by Ziehl-Nielsen staining and bacterial culture. In case of a positive result (isolation and identification of *M. bovis*) all animals of that herd will be slaughtered and a complete epidemiological investigation will be performed. A herd is considered free of bTB if all animals, older than 6 weeks, react negatively to the ID test 6 and 12 months after slaughtering all infected animals of a confirmed case herd, or 60 days following the introduction of (new) animals into a fully depopulated herd (FASFC, 2010; MB, 2010).

A country or region is considered bTB officially free by the EU if for 6 consecutive years, 99.9% of the herds