# Risk factors for detection of recurrent bovine tuberculosis in New Zealand cattle and deer herds 2005-2011

A thesis presented
in partial fulfillment of the requirements
for the Degree of Master of Veterinary Studies (Epidemiology)
at Massey University

Kara Dawson

2014

# Risk factors for detection of recurrent bovine tuberculosis in New Zealand cattle and deer herds 2005-2011

A dissertation presented
in partial fulfillment of the requirements
for the Degree of Master of Veterinary Studies (Epidemiology)
at Massey University

Institute of Veterinary, Animal and Biomedical Sciences

Massey University

Palmerston North, New Zealand

Kara Lee Dawson

2014

# Abstract

In New Zealand, under the national bTB eradication strategy, bovine tuberculosis (bTB) has had a sustained decrease in prevalence since its peak in 1994 at 1700 infected herds. With the success of control measures, recurrence of infection in cattle and deer herds that have previously tested to a clear status is a problem that has recently become more apparent. Uncontrolled movement of cattle and deer from these herds pose a risk to the bTB eradication strategy.

A retrospective cohort study was conducted to identify herd-level risk factors for bTB recurrence. Data were collected from 356 New Zealand cattle and deer herds that met the following criteria: (1) a culture positive case of bTB had been identified on or after 1 June 2006 (the index bTB episode), (2) the herd status had been cleared by testing that was completed by 1 November 2010, and (3) the clear status was not achieved by destocking. The outcome of interest for this study was defined as detection of a subsequent bTB episode before the end date of the study, 5 May 2011, by routine tuberculin testing or by slaughter surveillance. Herds were censored if no further bTB

episode occurred by 5 May 2011. A Cox proportional hazards model was developed to quantify the magnitude of a series of herd-level risk factors on the daily hazard of bTB recurrence. Disease control area was included in the model as a fixed effect to account for confounding.

There was a positive relationship between the daily hazard of recurrence and: (a) the number of bTB episodes in a herd prior to the first episode (HR [hazard ratio] 3.2 for two prior episodes, 95 % CI 1.2-8.5; HR 86.7 for five prior episodes, 95 % CI 13.8-580), (b) the presence of more than one bTB positive animal at the index bTB episode (HR 2.3: 95 % CI 1.2-4.3) and (c) the presence of one or more cleared test-positives at the final clearance test at the index episode. The proportional hazards assumption was violated for the latter variable so a time dependent covariate was introduced into the model to account for the variable effect of the presence of cleared test-positives at the final clearance test over time. The monthly hazard of recurrence during the first two years after clearance was significantly increased in herds with one or more test-positive animals at the final test (HR 2.8: 95 % CI 1.2-6.4), but this association was no longer significant more than two years after clearance (HR 1.5: 95 % CI 0.6-3.6).

We conclude that the presence of unresolved infection in a herd is a contributor to further bTB episodes in the first two years after clearance. TBfree New Zealand is reviewing policies to increase the sensitivity of detecting residual infection before clearance and to intensify post clearance testing and movement tracking in herds with risk factors.

# Acknowledgements

This project came about through a series of observations made by my colleague Dr Jane Sinclair in her course of work as a District Disease Control Manager for the Animal Health Board. We decided to test the hypotheses that arose from these observations, and I am deeply indebted to Jane for her insights, disease management training and support of the project in every way, including hours of assistance with data collection and in discussing the significance and implications of the results.

I am also grateful for the comments and input from Dr Mark Bosson, Senior Technical Analyst, Dr Stu Hutchings, Technical and Farm Services Manager, Dr Paul Livingstone, Research Analyst (AHB) and Dr Terry Ryan (MPI), all of whom have offered valuable insights and support for this project. Hilde Krollman assisted with data extraction for this and other projects and her assistance is much appreciated, along with others from the IT department of OSPRI New Zealand.

I also appreciate the assistance of Dr Simon More, University College of Dublin, and Dr Margaret Good, DEFRA, who have given their time and encouragement.

My sincerest gratitude to Dr Mark Stevenson, academic supervisor of this project, for many hours spent on the phone and in person assisting me with statistical evaluation, and for providing a professional viewpoint on the epidemiological inferences. I consider myself very fortunate to have had the privilege of studying at the EpiCentre and having had excellent tuition in epidemiology. I appreciate the assistance of Mark Stevenson, the Massey University travel fund and TBfree New Zealand in providing the resources to help me attend the International Society of Veterinary Epidemiology and Economics conference in Maastricht in 2012.

I am grateful for the support and interest of my husband Chris and our family, and for their patience with me as I have worked to gain new skills and knowledge.

I hope that the findings of this project will help to inform disease management policy and practice, and build on the excellent progress being made by TBfree New Zealand in eradicating bovine tuberculosis from New Zealand.

# Table of Contents

# Nomenclature

| | |
|---|---|
| AIC | Akaike's Information Criterion |
| bTB | Bovine tuberculosis, caused by *Mycobacterium bovis* |
| DCA | Disease Control Area |
| γ-IFN | Bovine gamma interferon testing of whole blood for reactivity to tuberculin |
| HR | Hazard ratio |
| NVL | No visible lesions of bovine tuberculosis at slaughter inspection |
| VFA | Vector Free Area: geographic region of New Zealand where bTB is not known to exist in the wildlife |
| VRA | Vector Risk Area: geographic region of New Zealand where bTB is known to exist in the wildlife |

# List of Publications

Dawson, KL., Bell A., Kawakami RP., Coley K., Yates G., Collins DM. (2012) Transmission of *Mycobacterium orygis* (*M. tuberculosis* complex species) from a tuberculosis patient to a dairy cow in New Zealand. *Journal of Clinical Microbiology* 50(9):3136-8

Dawson, KL., Stevenson, MA., Sinclair, J., Bosson, M. (2014) Recurrent bovine tuberculosis in New Zealand cattle and deer herds. *Epidemiology and Infection*, doi:10.1017/S0950268814000910.

# List of Figures

# List of Tables