Epidemiology, diagnosis and vaccination control of leptospirosis in farmed deer in New Zealand

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Abstract

Leptospirosis is a bacterial zoonotic disease of global importance. It is caused by infection with pathogenic *Leptopsira* species. Leptospirosis encompasses a wide spectrum of clinical or subclinical disease in both humans and animals. In New Zealand (NZ), leptospirosis is considered to be the most important occupational zoonosis. Livestock farming plays an important role as a major occupational risk factor for human leptospirosis and farmed deer is one of the contributing factors.

Commercial farming of deer began in NZ in the early 1970s. It remains the world's largest and most advanced deer farming industry. Leptospirosis in farmed deer can cause illness and possibly sub-clinical production losses. Farmed deer also play an important role in the transmission of leptospirosis by shedding the organisms in their urine, putting both other animals and humans at risk. *Leptospira* serovars Hardjobovis and Pomona are the most commonly found serovars in this stock group. The first substantial case report of leptospirosis in farmed deer was in the 1980s but it was not until 2006 that a substantial epidemiological study of this disease in farmed deer was reported. The purpose of this research was to improve and extend current knowledge on the epidemiology of leptospirosis on mixed-species deer farms, to develop and validate a novel molecular diagnostic tool and to enhance understanding of control measures and their outcomes by means of vaccination.

A pilot longitudinal seroprevalence survey of leptospirosis on mixed-species deer farms was conducted. Results from this study revealed that leptospiral infection averaged 70% in all species on mixed-species farms in the lower North Island of NZ. Co-grazing with infected sheep and/or cattle was positively associated with deer herd serological status to both serovars Hardjobovis and Pomona which suggests the possibility of inter-species transmission. Results from this study justify further investigation of leptospirosis on mixed-species farm at the national level.

A collaborative study between Massey University and the WHO/FAO/OIE reference laboratory for leptospirosis in Brisbane to investigate for exotic serovars in farmed deer revealed seropositivity to Arborea which has never been found before in NZ. Attempts to isolate Arborea from kidney samples of farmed deer were unsuccessful and require further investigation.

Real-time PCR assay was developed and validated against culture as the gold standard for use on deer kidney tissue and urine as a research and diagnostic tool for determining infection, carrier and shedding status of deer. This research revealed that the real-time PCR assay was highly sensitive (sensitivity: 85% for kidney and 96.7% for urine) and specific (specificity: 99.2% for kidney and 100% for urine). It is a useful tool for the rapid and cost-effective detection of pathogenic leptospires in clinical samples. It can also be used to quantify the concentration of leptospires from clinical samples and identify the likely infecting serovar in NZ when adjunct with a DNA sequencing technique.

Vaccination control for leptospirosis has proven to be efficacious and likely to be cost-effective. Present research has determined the effect of a commercial bivalent leptospiral vaccine (Leptavoid-2, Intervet/Schering-Plough Animal Health Limited, NZ) on leptospiral shedding, growth and reproduction of farmed deer under NZ pastoral conditions. The study was designed to simulate an infection-free herd scenario followed by exposure to natural challenge. Results have shown the potential of vaccine to improve mean weight gain (up to 6.5 kg) and weaning rate (average 6.9%) in infected herds and prevent urinary shedding after natural challenge with Hardjobovis. It also provides the first evidence of adverse subclinical effects on deer production by Hardjobovis alone.

A pilot study to investigate the presence and localisation of pathogenic *Leptospira* in the uterus and foetus of female deer revealed evidence of a foetal infection using real-time PCR. This finding suggests a possible explanation for effects of leptospiral infection on NZ farmed deer reproduction. However, further study is required to justify this proposition.

This research has contributed significantly to understanding of epidemiology of leptospirosis in NZ farmed deer, providing objective data to assist producers in decision-making on leptospirosis control. Furthermore, this study has made available a valuable diagnostic resource for future leptospirosis studies, and has provided direction for future research into leptospirosis on farmed deer and mixed-species farms.

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Declaration

Each chapter in this thesis is set out as a paper in the style and format required of the journal to which it is in the process of being submitted to at the date of submitting this thesis. As a result, there is some repetition, particularly in the methods, and there are inconsistencies with the style and format between the chapters. Contributions to the research have been made by co-authors indicated in each chapter. However, my input was the greatest as I designed the study, undertook all the fieldwork and laboratory work, analysed the data and wrote the manuscripts.

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