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The Epidemiology of Johne's Disease in New Zealand Dairy Herds

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Abstract

Johne's disease (JD), caused by *Mycobacterium avium* subspecies *paratuberculosis* (MAP) is a chronic, debilitating enteritis of cattle, other domestic livestock and some wildlife species. JD was first identified in the late 1800s and today it is a worldwide problem in dairy cattle. Heavily infected cows have reduced milk production, a higher risk of removal from the herd and low slaughter value. Several countries have implemented national level control strategies.

In New Zealand, JD was first reported in 1912 and today the prevalence of infected dairy herds is thought to be high. To improve our understanding of the epidemiology of JD and to evaluate the feasibility of a national control strategy, four studies were conducted.

The first study was a questionnaire based case-control study to identify associations between management practices and the occurrence of clinical JD on farms from four regions of New Zealand. The second study was on the effect of sub-clinical JD on milk production and the risk of removal from the herd in four dairy herds over four milking seasons. The effect of misclassification of disease status on productivity estimates was also studied. In the third study diagnostic test result data from the productivity study was combined with a novel Bayesian regression model to estimate performance of the ELISA and faecal culture tests as a function of covariates and utilising repeated tests on individual cows. Finally, results from these three studies were used to adapt an existing JD simulation model, 'JohneSSim', to represent the epidemiological behaviour of JD in New Zealand dairy herds. Control strategies for the disease were simulated and evaluated based on their cost effectiveness.

Of the 427 farmers responding to the questionnaire, 47% had suspected clinical cases of JD in their herd in the preceding 5 years. Only 13% of suspected infected herds had an average incidence of greater than 0.5 cases per 100 cow years at risk. The disease was not considered a serious problem by 20% of herd managers who reported the presence of disease in the preceding 5 years. The presence of Jersey cows in the herd and the purchase of bulls had strong positive associations with the presence of clinical JD. Grazing calves in the hospital paddock, larger herds, the purchase of heifers, and the use of induction were also positively associated with JD.

In the productivity study the herd-level prevalence of JD by ELISA and/or faecal culture ranged from 4.5% (95% CI 2.6–6.9) to 14.2% (95% CI 9.2–20.6). Daily milksolids production by JD positive cows was 0.8% (95% CI -6.1%–4.5%) less than that of JD negative cows. However in herd D, JD positive cows produced 15.5%, (95% CI 6.75%–24.2%) milksolids less than JD negative herd mates daily. This equates to a loss of 53kg of milksolids/305 day lactation, or NZD 265/lactation, given a price of NZD 5/kg of milksolids. In herd D only, the annual hazard ratio of removal for JD positive cows was significantly increased. It was 4.7 times and 1.4 times higher in cows older than 5 years and younger than 5 years. The results were insensitive to misclassification.

Analysis of the diagnostic test data demonstrated the strengths of our Bayesian regression model. While overall estimates of sensitivity and specificity by this method were comparable to estimates by existing methods, it showed a broad trend of increasing sensitivity in higher parity groups and higher sensitivity in early, relative to late, lactation. It also showed that estimates of prevalence may in fact decline with repeated, relative to single, testing. Our novel approach demonstrated trends that could not be shown by existing methods, but could be improved by application to a larger data set.

Simulation showed that control strategies for JD based on either test-and-cull, vaccination, breeding for genetic resistance, or removal of offspring from clinically affected cows, were not cost effective for the average infected herd. Improvement of the hygiene associated with calf management provided the greatest reduction in the within-herd prevalence of JD.

While JD is present in a high proportion of New Zealand dairy herds, the incidence of clinical cases is usually low, and most farmers consider it to be of little importance. However, JD causes significant losses in productivity in some herds. The disease would probably be best controlled on a herd-by-herd basis, given the limited success of national-scale control programs for JD in other countries. The education of dairy farmers regarding risky management practices, and the offer of a risk assessment to farmers wishing to control the disease, would provide a combination of wide reaching and targeted approaches, of low cost, for JD control.

It seems likely that JD will persist in some capacity in the years ahead, but will remain of minor concern next to major animal health issues, such as infertility and mastitis. Clarification of the effect of genetic strain on the virulence of MAP may help explain differences in the effect of the disease between herds. This knowledge could then be used to further improve the efficiency of JD control.

For Jess.

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Nomenclature

AGID	Agar gel immuno diffusion
AIDS	Acquired immunodeficiency syndrome
CFU	Colony forming units
CFT	Complement fixation test
CI	Confidence interval
CWD	Cell wall deficient
ELISA	Enzyme linked immunosorbent assay
FC	Faecal culture
ICM	Improved calf management
IEL	Intraepithelial lymphocyte
JD	Johne's disease
LAM	Lipoarabinomannan
LIC	Livestock Improvement Corporation
MAP	*Mycobacterium avium* subspecies *paratuberculosis*
MIRU-VNTR	Mycobacterial interspersed repetitive units variable number tandem repeats
MS	Milksolids
NPV	Net present value
NZD	New Zealand dollars
PCR	Polymerase chain reaction
RFLP	Restriction fragment length polymorphism
RPO	Retention pay-off
USD	United States dollars

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