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The effectiveness of parallel gamma-interferon testing in New Zealand's bovine tuberculosis eradication programme

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ABSTRACT

In bovine tuberculosis (bTB) eradication programmes, especially where prevalence is low, sensitivity of testing in infected herds must be maximised to reduce the possibility of recrudescence of prior infection and the risk to other herds via animal movement. The gamma-interferon (γ-IFN) assay applied in parallel with intradermal tuberculin testing has been shown to increase test sensitivity. The aim of this work was to substantiate this effect in the field.

A retrospective observational study was conducted on 239 New Zealand cattle breeding and dairy herds with bTB infection between 1 July 2011 and 1 September 2015 to evaluate the outcomes of new policy introduced in 2011. The investigation defined the number and proportion of reactors (animals testing positive and slaughtered) found with lesions of bTB in intradermal caudal fold testing (CFT) and parallel γ-IFN testing, at the breakdown test or first whole herd test after breakdown, WHT(1), and at the final or projected final whole herd test, WHT(F).

Parallel γ-IFN testing was used in 26.8% of the 239 herds at WHT(1), and 430 animals in 49 herds were deemed reactors. One hundred and sixty (37.2%) of these reactors from 32 herds were found to have bTB lesions, despite having been negative to caudal fold testing. These 160 infected animals accounted for 29.6% of all infection found at WHT(1).

At WHT(F), parallel γ-IFN testing was conducted on 93 herds and detected a total of 122 reactors in 49 herds, in addition to those found by CFT. Twenty-one of these reactors, from 13 herds, had bTB lesions at slaughter, accounting for 67.7% of all reactors found with bTB at WHT(F). Eleven of these 13 herds would have had their movement restrictions revoked based on a negative herd CFT alone, and could potentially have caused outward transmission of bTB to other herds, as well as experiencing recrudescent breakdowns.

We conclude that γ-IFN testing in infected herds, in parallel with intradermal tuberculin testing, is a valuable tool in a bTB eradication programme, as it enables higher test sensitivity at both herd and animal level. The use of the γ-IFN test over a risk cohort early in a breakdown assists in removal of early infection and some cases of anergy to intradermal tuberculin testing. Parallel γ-IFN with compulsory slaughter of reactors should be considered in breeding and dairy herds in conjunction with tuberculin testing before movement control is revoked, and will assist in achieving TB freedom on a herd level and nationally.

1. Introduction

Bovine tuberculosis was introduced to New Zealand by cattle imports with settlers in the mid-1800s. By the 1950s, the disease had become widespread in both the North and South Islands. Voluntary test-and-slaughter schemes failed to eradicate bTB, and in 1967 infection was identified in Australian brushtail possums, *Trichosurus vulpecula* (Ekdahl et al., 1970). Possums were subsequently found to be the principal wildlife reservoir for *M. bovis* in New Zealand. Control of possums was undertaken in the 1970s but funding was interrupted in the 1980s, resulting in a dramatic geographical spread of wild animal infection. Annual infected domestic herd numbers peaked at 1684 infected herds at 30 June 1995 (data held by OSPRI New Zealand) and by 2004, bTB had become endemic in wild animal populations over an estimated 39% of New Zealand's land area (Livingstone et al., 2015).

Recognition by the farming industries and Government of financial and trade impacts of bTB led to the establishment of the Animal

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Health Board (AHB) and the deployment of a National Pest Management Strategy (later called Plan, NPMP) under the Biosecurity Act 1993. The AHB employed a three-pronged approach to control bovine TB. This consisted of (i) a national surveillance system of TB test and slaughter in domestic cattle and deer herds and inspection of all carcases at slaughter premises, (ii) movement restrictions out of areas with high infected wildlife risk and from infected herds, and (iii) possum control to manage TB in infected wildlife populations nationally. As a result of these control strategies, the period prevalence of TB herds has decreased from a peak of 3.87% as at 30th June 1995 to 0.16% at 30th June 2015 (Anon., 2015a). The NPMP was reviewed in 2011, and officially stated for the first time that eradication of bTB from New Zealand was an objective.

Translocation of cattle now accounts for a higher proportion of bTB herd infection in New Zealand than it has in the past, due to both a reduction in the extent of infected wildlife populations over 20 years of possum control, and an increasing volume and geographical extent of stock movements (Mark Stevenson, unpublished data).

The national surveillance of cattle herds in New Zealand has been based on the use of the intradermal caudal fold tuberculin test (CFT). When bTB herd prevalence was high, skin test positive animals were routinely slaughtered as reactors. The γ-IFN test became commercially available as Bovigam™ in 2001 (Wood and Jones, 2001) and has been used in New Zealand since the early 2000s. As the disease prevalence dropped, serial γ-IFN testing began to be routinely applied in skin test positive animals in low-risk herds. This decreased the wastage from false positive skin tests and maintained farmer acceptance of the scheme, although by using two tests in series, some loss of sensitivity was to be expected, to achieve an increase in test specificity. The imperfect accuracy of the currently available tests for bTB is universally acknowledged (de la Rua-Domenech et al., 2006).

As the number of infected herds decreased in New Zealand, the parallel γ-IFN test has been increasingly used in high disease prevalence situations, such as in infected herds, to improve the overall testing sensitivity. The parallel γ-IFN test is applied only to animals that are negative to the CFT (Anon., 2011). Anecdotal evidence from New Zealand in the field since 2008 has shown that parallel γ-IFN testing has found residual infection in herds that had no infection detected by CFT. Based on the CFT alone, these herds would have been given a clear status and had their movement restrictions revoked, allowing freedom to trade. The increase in sensitivity offered by the parallel CFT and γ-IFN test combination allows the removal of some infected animals that are not responsive to skin testing. The γ-IFN test is capable of detecting bTB infection earlier than the CFT test (Wood and Jones, 2001).

There are major industry-wide benefits to achieving the highest possible sensitivity of detection before a herd is free to trade. In the later stages of an eradication programme, maximum sensitivity of detection is required in infected herds, even though it comes at the cost of reduction in specificity (Buddle et al., 2001). In order to have movement restrictions revoked, a herd must complete two clear whole herd tests (WHT) using the CFT on all animals over six weeks of age, with at least six months between the two tests. A clear test is defined as one where no confirmed TB infected animals are identified. The aim is not to clear herd status as fast as possible, but to ensure that residual infection poses less risk to the herd in the future, and to other herds through animal trading.

Following the 2011 NPMP review, dairy and breeding beef herds in New Zealand are now additionally required to complete a parallel γ-IFN test of all animals in the infected cohort at the final whole herd test before having their infected herd status revoked and movement restrictions lifted. This policy change would have resulted in a dramatic rise in cost if applied to all of the infected herds at that time, so was rolled out in herds based on risk of recrudescence; therefore not all eligible herds actually completed the parallel testing. Herds were considered to be at highest risk of recrudescence if they had multiple prior episodes of bTB or had more than one confirmed infected animal found at the latest episode (Dawson et al., 2014), and herds meeting these criteria were given preference for parallel testing at the final whole herd test.

Use of parallel γ-IFN testing occurs in three main ways in New Zealand. Firstly, the parallel γ-IFN assay has been used in skin test negative animals in infected herds at the first WHT after the detection of an infected episode, WHT(1). The objective is to increase the probability of early detection of diseased animals within the herd and thus shorten the time the herd is deemed to be infected. Herds are eligible to receive parallel γ-IFN testing when more than one confirmed infected animal has been found at breakdown, whether by routine slaughter inspection or by tuberculin skin testing. Secondly, parallel γ-IFN is also used to improve confidence that the herd is truly clear of bTB at the final WHT, WHT(F), before movement restrictions are lifted. Finally, parallel γ-IFN is used to confirm the absence of infection in skin test negative animals from low-risk cohorts (e.g. dairy heifers) before movement out of an infected herd to another property, a permitted activity under stringent conditions.

As the new policy has been in place for four years, the aim of this retrospective observational study was to evaluate the effectiveness of the use of parallel γ-IFN in New Zealand's bTB eradication scheme.

2. Materials and methods

A list of all herds that had an infected status between 1 July 2011 and 1 September 2015 was obtained from the OSPRI[1] disease management databases (DMIS—Disease Management Information System and DMS—Disease Management System), maintained by TBfree New Zealand (previously the Animal Health Board). There were 289 herd numbers eligible for consideration. Fifty herds were excluded from the study. These included deer and beef meat production herds where parallel γ-IFN testing was not used. The parallel γ-IFN testing is only used on beef breeding and dairy herds. In addition herds were not included where bTB was not confirmed by culture.

Ninety-nine beef breeding and 140 dairy herds were eligible for the study, making a total of 239 study herds. Data were extracted from DMS to gather the following information:

1. Whether the herd had one or more prior bTB breakdowns in its history;
2. For the first WHT at or after detection of bTB, WHT(1)*:

a Number of skin test positive animals slaughtered
b Number of confirmed bTB cases in the skin test positive animals slaughtered
c Whether a parallel γ-IFN of the infected cohort was undertaken
d Number of parallel γ-IFN reactors slaughtered
e Number of confirmed bTB cases in the parallel γ-IFN positive animals slaughtered;

3. For the final WHT (a minimum of six months after the herd had completed a WHT where there had been no confirmed bTB), WHT(F)**:

[1] OSPRI, Operational Solutions for Primary Industries, the entity that manages the TBfree and NAIT (National Animal Identification and Tracing) schemes in New Zealand.