

TB TESTING FOR ON-FARM CATTLE

OVERVIEW OF THE CATTLE TESTING PROGRAMME

In New Zealand, a small range of diagnostic tests are used to detect and eradicate tuberculosis infection from our cattle herds. All tests are based on measuring an animal's immune response to the presence of bovine TB. In general, this response is measurably different between infected and non-infected animals.

Tests can be applied directly to an animal with an injected skin test, or can be carried out in a laboratory using a blood sample taken from the animal.

The testing programme operates broadly as follows:

SURVEILLANCE TESTING

In any one year, a large proportion of the national cattle population (3.26 million animals in 2016/17) is skin tested for TB (primary screening test). Tests are allocated to herds in an area-based disease surveillance programme which largely reflects the risk of infection from contact with infected possums. In higher-risk areas, testing is more frequent and is applied across a wider age-range of livestock.

Where the risk of TB infection is considered to be very high, skin-test



positive cattle are usually sent directly to slaughter. However, most skin-test positive animals are given a secondary screening test (as explained below).

N.B: Surveillance testing is also undertaken by routine post mortem inspection of all cattle killed through slaughter premises. This forms an important part of TB disease detection, especially for those herds where many of the animals are killed annually and therefore not skin tested.

SERIAL TESTING

Unless there is a significant risk of TB being present, most cattle that test positive to a skin test are tested again using an *ancillary serial blood test*. Animals which are positive to the ancillary test are sent to slaughter as reactors. After slaughter they are carefully inspected and tissue samples taken for further laboratory analysis. This may or may not lead to diagnosis of TB infection. If TB is diagnosed, the herd is classified 'Infected'.

TESTING IN INFECTED HERDS

Once a herd is classified as infected, skin and blood tests can be used in various combinations in order to detect (and then slaughter) all likely TB cases. Even those animals which have tested negative to a skin test can be tested again, using an *ancillary parallel blood test*. The specific testing regime applied will be documented in the infected herd's Management Plan.

PRE-MOVEMENT TESTING

Areas of highest TB risk are classified as *Movement Control Areas*. In these areas, all cattle must be negative to a skin TB-test before they are allowed to be moved from one herd to another.

MEASURING TEST ACCURACY

Measures of the accuracy of TB tests must take into account the likelihood of a test producing both false positive and false negative result. This requires a measure of two numbers, to describe *test sensitivity* and *test specificity*, as follows:

TEST SENSITIVITY

This is the ability of a TB test to give a correct positive result for animals that truly have TB. Thus if 100 known TB-infected animals were TB tested, and the test correctly identified 85 of them as infected, then its sensitivity would be 85%.

TEST SPECIFICITY

This is the ability of a test to give a correct negative result for animals that are truly not infected with TB. Thus if 100 truly non-TB animals were tested and one of them produced a false-positive result, then the specificity of the test is 99%.

FALSE TEST RESULTS

To understand the accuracy of TB tests, it is first important to understand the underlying problem of false test results.



Most infected cattle respond positively to tuberculin tests. However some truly infected cattle don't respond to the test and produce a *false-negative* test result. This tends to occur when the animal's immune system isn't functioning properly due to some form of health stress (including seriously advanced TB).

False-negative animals pose an obvious disease control problem in that, left undetected, they can go on to infect their herd mates, or another herd if moved. A proportion of such animals may respond to a different diagnostic test if applied around the same time, or to the same test if applied at a later date, especially if any health stress factors have been alleviated.

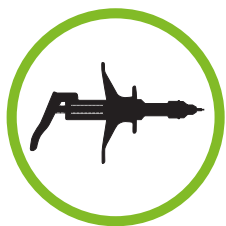
The reverse situation is that some non-infected animals may respond with a *false-positive* test result. This mostly occurs if they have been exposed to bacteria that "look" immunologically very similar to *M. bovis*. The extent of this problem varies over time and between regions, with higher false-positive test rates in various valleys on the West Coast

and in Golden Bay, and in a few herds near thermal areas in Waikato and Bay of Plenty.

While false-positive cattle in themselves don't compromise the effectiveness of the control programme, they often still need to be slaughtered, which can be regarded as a wasteful cost (including compensation costs payable to farmers).

The hard reality is that there is always a trade-off between false-negative and false-positive test results. Tests can be adjusted for bias either way but not both ways at once. If tests are adjusted to minimise false-negative results (so as to minimise the risk of leaving infection behind on the farm) this would mean more false-positive results and more wasteful slaughter of healthy animals. Conversely, setting the testing programme towards reducing the wasteful slaughter of healthy animals would lead to greater risk of leaving undetected disease behind.

A smart testing programme manages these trade-offs by employing a range of tests in various combinations and sequences, while balancing disease risk against waste and cost.



THE TESTS

INTRADERMAL TUBERCULIN TEST (TB SKIN TEST)

The skin test is used in the TB programme as a primary screening test. To perform the test an approved technician injects 0.1 ml of tuberculin (a standardised protein extract derived from killing bovine TB bacteria (*Mycobacterium bovis*)) into a cleaned fold of skin at the base of the tail of a cattle beast. Three days after the injection, the tester returns and 'reads' the test on each of the animals that were injected. Any animal that has a visible or palpable swelling response at the injection site is classified as being "test-positive." The animal is then tagged with an official orange tag and its identity is recorded.

The sensitivity* of the intradermal tuberculin test in cattle as applied under New Zealand conditions is 75-85% (Pharo and Livingstone 1997). That means that if there are 100 TB cattle in a herd, the intradermal tuberculin test would be expected to identify 75 or 85 of those 100 infected animals.

The specificity* of the skin TB test as applied under New Zealand conditions is 99.6% (Pharo and Livingstone 1997), which means about four cattle in every thousand tested would be expected to be false-positives.

THE GAMMA INTERFERON TEST (BLOOD TEST)

The gamma interferon test is performed on a blood sample taken from cattle. Biologically, the test measures the same response as the skin test, except it is performed on live blood cells. Although care must be taken in extracting and transporting the blood sample, the test is more reliable for being performed in a controlled laboratory situation. The gamma interferon blood test is used in the following two ways in New Zealand:



Ancillary serial blood test

This is where the blood test is performed on cattle that were positive to a previous skin test. All cattle that are positive to both the skin test and the following blood test are sent to slaughter. This combination of the two tests greatly reduces the number of false-positive animals wastefully slaughtered, and reduces compensation costs payable to farmers. However it does somewhat increase the risk of leaving infected animals behind, so it is not used in known high TB risk situations.

The sensitivity of the standard ancillary serial gamma interferon test between 82-94%.

*Reference: Pharo, H., Livingstone, P. Tests to diagnose tuberculosis in cattle and deer in New Zealand. *Surveillance*. 1997; 24(3): p12-14.



Ancillary parallel blood test

An ancillary parallel blood test is performed on skin test-negative cattle, normally in infected herds. Using the blood test after a negative skin test in this way improves the overall sensitivity of detecting TB in a herd. All cattle that are identified as positive to the parallel gamma interferon test are classified as TB reactors and sent for slaughter.

The combined sensitivity of the intradermal skin test and the parallel gamma interferon test is estimated at 95%.

TEST PROGRAMME OUTCOMES

Critics of the TB testing programme often focus on perceived limited accuracy of just one aspect of a single type of test. However as outlined above, the testing programme uses different tests in various sequences and combinations in order to strike a balance between reliably detecting

disease and avoiding wasteful slaughter. The programme must also be affordable, and the relatively low cost of a skin TB test – at about one-tenth the cost of a blood test – is significant.

On balance there do not seem to be any major disease control problems arising from limitations in test accuracy. The focus for the coming years will be on better risk assessment – including using livestock movement data now becoming available from the NAIT tracing programme – to develop a more targeted testing programme with fewer tests overall.

While cattle TB tests are not perfect, it is worth reflecting on the fact that even in human health care – with much greater resources available – TB is still notoriously difficult to diagnose. Definitive diagnosis in humans often relies on costly processes such as X-ray and surgical tissue biopsy. These methods are clearly not available for large scale use in farmed cattle.



FURTHER INFORMATION

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