

ERADICATING VIRULENT FOOTROT USING SPECIFIC VACCINES

KEY MESSAGES

- Eradication of virulent footrot is possible where producers can reduce disease prevalence to a level where remaining affected sheep can be culled from the mob.
- Outbreak specific vaccines can be used to treat known virulent footrot strains and reduce disease prevalence.
- Producers using outbreak specific vaccines need to know which strains are present in their flock and be vigilant in their approach to disease eradication and ongoing biosecurity management.
- Best results for eradication are obtained when vaccines are limited to two footrot strains (bivalent vaccines); if more strains are present, separate bivalent vaccines should be used with at least two months in between the start of vaccination with different bivalent vaccines.
- Multivalent vaccines, where available, may be used in some circumstances but generally provide less protection and of shorter duration than specific vaccines.
- Regular footbathing can be used instead of vaccination as a means of controlling virulent footrot.
- Ongoing flock monitoring and on-farm biosecurity are critical to keeping footrot at bay after an eradication program.

What is footrot?

Footrot is a serious animal welfare and productivity issue in sheep flocks throughout the world. In 2015, economic modelling estimated that virulent footrot costs the Australian sheep industry around \$32 million annually while causing significant animal welfare problems.

Footrot is a highly contagious bacterial infection caused by the bacterium *Dichelobacter nodosus*. The bacteria possess fine, filamentous appendages called fimbriae or pili, which vary from one strain to another. There are 10 strains or 'serogroups' (A to I, and M) identifiable by variations in the fimbriae. The immune response in sheep is triggered by these fimbriae, and this response provides the basis for developing vaccination programs.

Producers can eradicate footrot from their flocks if they can reduce disease prevalence to a level where all remaining infected sheep can be culled.

The prevalence of footrot can be reduced by foot paring and/or footbathing or antibiotic treatment. If followed by repeated foot inspections and culling of all infected sheep during a non-transmission period, this can result in eradication.



Identification: The top image shows an infected toe at left and healthy toe at right. The bottom image shows a pared back foot ready for footbathing.

Footrot vaccination

Footrot can be treated, controlled and eliminated with the help of vaccines containing *D. nodosus* fimbriae, but vaccination can be challenging. Immunity against *D. nodosus* is serogroup-specific, with little or no cross-protection between serogroups, and virulent strains of *D. nodosus* belonging to several serogroups (up to seven) may be present in a flock. This means a flock must be sampled to determine which strains are present and this information used to develop the vaccination program.

Vaccines that protect against multiple strains (multivalent vaccines) have historically been less effective because the components of the vaccine that provide immunity (antigens) to different strains work against each other. This is called antigenic competition. For this reason, bivalent vaccines (those that provide immunity against two strains) have been found to be much more effective than multivalent vaccines.

Recent footrot vaccine research

AWI has funded an investigation, by the University of Sydney and Treidlia Biovet, to define best practice for vaccination against ovine footrot in different flocks with different types of footrot. The study included two experiments, a small-scale trial at the University of Sydney and a field trial in four commercial Merino flocks in Tasmania conducted during 2019 and 2020.

Small-scale trials

The small-scale trial at the University of Sydney investigated immunity levels for sheep that received a second bivalent vaccine after a two- or three-month interval from the start of the first bivalent vaccine course. Previous studies have reported that leaving three months between the start of one bivalent vaccine course and the first dose of a second bivalent vaccine enabled the second vaccine to produce an adequate response. However, results in this trial found similar antibody levels in sheep that received a second bivalent vaccine two- or three-months after receiving the priming dose of the first bivalent. This suggests that a two-month interval between the next bivalent vaccine and the priming dose of the first bivalent vaccine is sufficient to avoid antigenic competition. This will reduce the time frame producers need to target multiple strains of *D. nodosus* by enabling a vaccination program to be completed more quickly. However, if producers find it beneficial to leave a longer time between vaccinations, this will not change the effectiveness of the vaccines.

The small-scale trial also developed and evaluated four new multivalent vaccine formulations, each containing six (A, B, C, G, H, I) or nine (A to I) *D. nodosus* serogroups. A vaccine for strain M is not currently available. The multivalent vaccines did not stimulate as large or as long-lasting an immune response as the bivalent vaccines. However, some of the new multivalent vaccine formulations were found to be sufficient to provide some control over footrot on-farm. This may provide producers with another option in situations when control against multiple strains is needed in a short time frame.

On-farm trials

On-farm field trials were conducted in four commercial Merino flocks in Tasmania between July 2019 and February 2020. Virulent strains of *D. nodosus* were detected in each flock, with between two and five strains per flock. In each flock, 300 Merino ewes were included in the trial and were allocated to one of three treatment groups:

- Control group – foot-bathed in a 10% zinc sulphate solution monthly.

- Bivalent vaccine group – received the first bivalent vaccine in July and August 2019 and the second bivalent vaccine in October and November 2019.
- Multivalent vaccine group – received the best new experimental multivalent vaccine from the small-scale trial in July and August 2019.
- The 300 sheep in each farm trial were run together as a single mob, and were examined at monthly intervals during the trial. Each month, the feet of each sheep were examined, and blood was collected from 10 sheep in each group to check circulating antibody levels.

A lack of rainfall and unusually dry conditions during the field trials meant that the protective effects of the three treatments could not be fully evaluated because the disease may have self-cured or not been expressed. However, the researchers were still able to draw some useful conclusions from the field trial:

- In all four flocks, the antibody levels for sheep that received a bivalent vaccine were generally higher than for sheep that received the experimental multivalent vaccine.
- Control of footrot was achieved in each group of sheep on each farm; that is, the two different vaccine approaches and foot-bathing were equally effective in suppressing footrot.

The researchers concluded that the greater immune response of the bivalent vaccine suggests that it would be likely to have a more long-lasting benefit than the experimental multivalent vaccine when producers are aiming to eradicate footrot from their farm.

WHICH VACCINE SHALL I USE? THINGS TO CONSIDER

There are several factors that should be considered before deciding whether to use a multivalent vaccine, or strain-specific vaccination:



The duration of protection required. This depends on the likely transmission period in the area. Bivalent vaccine protects sheep for longer periods.



Whether or not elimination of footrot from the flock is the target. Elimination is possible with bivalent vaccines due to their greater efficacy.



The number of strains present in the flock, and if more than two, the possibility and the cost of administering several bivalent vaccines.



The willingness to invest in further diagnostic testing in the event that several strains are present in the flock.



The cost of giving frequent booster doses of multivalent vaccine compared to successive bivalent vaccines.

Developing an outbreak specific footrot vaccine program

Specific footrot vaccination using vaccines tailored to the footrot strains present on a property can be a useful tool in eradicating footrot on a property. It takes considerable time and financial commitment but has long-term animal welfare and productivity benefits. The property manager must be confident that once eradicated, footrot can be kept out through rigorous biosecurity measures. The basic procedure involves:

- A vet collects foot lesion swabs from up to 20 sheep, representing different age groups and mobs.
- The samples are sent to the laboratory and it can be determined which footrot strains are present. Vaccines are then developed specifically for the property and advice given as the best way for the vaccines to be administered. This advice will include information on how to proceed if multiple strains are present and when to administer booster vaccines.
- The producer vaccinates all sheep on property — apart from prime lambs and culls that can be identified and kept separate. This vaccination course is best completed before the spring disease spread (transmission period) or held over until weaning.
- Vaccinated ewes will give some 'passive' immunity to their lambs, but this will only last eight weeks. Lambs can be vaccinated at marking, or footbathed to keep the prevalence low until weaning.
- Four weeks or more after the last vaccination, the producer starts inspecting feet. These inspections need only involve enough paring to diagnose whether sheep are still infected with footrot or not.
- If more than 5% (or whatever percentage the producer can afford to cull) of sheep are still infected then lesion swabs may need to be taken again to see whether another strain of footrot has become apparent after the first few strains were removed.
- If less than 5% (or whatever percentage the producer can afford to cull) of sheep are infected these sheep need to be identified (for example, with red branding fluid on the head) and isolated until they can be removed from the property.
- Inspections are repeated every 4–6 weeks until all infected sheep have been culled and removed (at least one 'clean' inspection).
- The specific footrot vaccines give 4–6 months protection and create their own non-transmission period. This means that eradication inspections can continue even if there is an early autumn break.
- Regular (at least monthly) footbathing in 10% zinc sulphate solution can be an effective approach to controlling footrot, but does not give sheep any immunity to the disease.

Commercial footrot vaccine

Coopers Ovilis Footvax Sheep and Lamb Footrot Vaccine is a killed multi-strain *D. nodosus* vaccine to aid in the control of footrot in sheep and lambs caused by *D. nodosus*. The vaccine aids in the both the prevention and treatment of the disease.

Footvax contains *D. nodosus* strains A-I, but not strain M. In regions where strain M is present, advice should be sought on whether strain testing is warranted prior to using the vaccine.

Use of Footvax may be restricted in your State or Territory. Contact your local Department of Agriculture (or similar) for advice.

Monitoring

When footrot appears to have been eradicated, monitor for a breakdown. Check any lame sheep as soon as they are detected. If footrot is found, isolate the affected mob and decide whether to inspect and cull again, or whether to take another set of swabs.

Continue to monitor for as long as footrot is assumed to have been eradicated.



Under surveillance: Regular monitoring and prompt action will ensure footrot is not reintroduced following eradication.

Introducing new sheep

Ask the vendor to provide a Sheep Health Statement with the footrot section completed.

Footbathe, inspect and isolate for as long as possible (a minimum of 6–8 weeks) all introduced sheep, including rams, even if from properties with a good reputation. Ideally, isolate these new sheep in a wet paddock where footrot is likely to show up before being mixed with other sheep.

Ongoing biosecurity

Maintain sheep-proof boundary fences as much as possible.

Ask neighbours to keep any of your strays and contact you to pick them up rather than drop them back over the fence. Treat these as new introductions (see above).

If you find neighbours' strays in with your sheep, immediately isolate the mob, remove the strays, inspect their feet and take appropriate action based on the status of their feet and current conditions underfoot.

More information on footrot, including the full report *Development of footrot vaccine best practice*, can be found at www.wool.com/footrot