

Footrot in Sheep and Goats

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Animal Biosecurity and Welfare, NSW DPI

What is footrot?

Footrot is a contagious bacterial disease of sheep and goats, caused by the organism *Dichelobacter nodosus* (*D. nodosus*) in association with a number of other bacteria.

There are many strains of *D. nodosus* and they vary in the severity of the disease they cause. In an infected flock, several strains of *D. nodosus* may be present. For regulatory purposes, footrot infection is classified as either benign or virulent at the flock level.

With full expression, virulent footrot is a severe, debilitating disease with significant economic loss from reduced wool growth and quality, poor ewe fertility, poor growth rates, losses from blowfly strike, and reduced value of sale sheep. In infected flocks, there are also significant costs associated with the control of the disease.

Because of these animal welfare and economic impacts virulent footrot is a notifiable disease in NSW with regulatory support for compulsory eradication programs in infected flocks.

The NSW Footrot Strategic Plan

In 1988 the NSW sheep industry implemented the NSW Footrot Strategic Plan. The plan was developed jointly by the sheep industry and government, with the aim of eradicating virulent footrot from NSW.

The Footrot Strategic Plan achieved a major milestone in August 2009 when the entire state was declared a Protected Area for footrot. The prevalence of virulent footrot in NSW had been reduced to less than 1% of flocks.

Ongoing surveillance and response activities have maintained our protected status to date. However footrot remains a significant disease risk to the NSW sheep industry due to the large numbers of sheep movements occurring across the country annually. Eradication programs are continuing in flocks where footrot has been detected, and producers need to remain vigilant to keep the disease out of clean flocks.

Footrot – the disease

Development of footrot in sheep

The development of footrot in sheep depends on both infective and environmental factors.

Infective factors

The bacterium *D. nodosus*:

- must be present for footrot to develop;
- will not survive in the environment for more than 4 days even under the most favourable conditions;
- may persist for many years in the feet of infected sheep, even under dry conditions;
- will not invade dry healthy feet;
- will only establish if conditions are right for the development of dermatitis between the claws.

Footrot is introduced into a clean flock by the introduction of infected sheep or exposure to contaminated land.

Environmental factors

The three main environmental factors necessary for a footrot infection to establish and then transmit from sheep to sheep are:

- an average daily temperature of 10°C or higher for 4–5 days; and
- adequate moisture; and
- adequate pasture length or pasture density to make feet susceptible to infection.

Footrot will not spread during hot and dry weather conditions.

In southern NSW the main footrot seasons are spring, wet autumns and mild winters. In northern NSW, however, summer rainfall is a determining factor and conditions suitable for spread are less predictable.

Table 1: Differentiating between footrot and foot abscess in sheep.

Footrot	Heel abscess	Toe abscess
Usually affects more than one foot	Usually affects one hind foot -which is carried	Usually affects front feet
No swelling	Obvious swelling – which usually spreads the toes	Swelling is not a feature
No pus discharge, but a black-grey slime like substance may be present	Creamy white pus discharge	Pus or fluid may be released from the point of the toe if it is pared or trimmed
Heat may be present in some cases	Hot to touch -especially near the swelling	May be hot to touch
Characteristic putrid smell May be flyblown	May have slight smell Rarely flyblown	Unpleasant smell but different to footrot odour May be flyblown
Spreads rapidly to sheep of all ages including lambs when conditions are favourable	Usually seen in heavy sheep e.g. rams and pregnant ewes	Affects all classes of sheep
No break in the coronet skin but separation of the hoof occurs on the sole	Abscess usually discharges at the coronet or between the toes	Abscess usually forms under the horn at the front of the toe but may discharge at the coronary band. Separation of the front half of the sole is seen in chronic cases.

Strain differentiation

There are many strains of *D. nodosus* and they vary in the severity of the disease they cause.

Benign strains

Usually cause lesions that are mild and resolve as conditions dry off, without treatment. There is usually minimal economic loss. Infection with benign strains is termed 'benign footrot'.

Virulent strains

Usually cause severe lesions associated with lameness, loss of production and, in severe cases, deaths. Lesions can become chronic and cause deformities of the hooves. Infection with virulent strains is termed 'virulent footrot'.

The effect of the current environmental conditions on the expression of footrot (development of lesions) in a flock must always be considered when investigating lame sheep. Distinguishing benign and virulent

footrot may require repeated inspections of a mob, if conditions for spread are not favourable. Flocks will be placed under quarantine for suspicion of footrot if a government veterinarian believes that further inspections are required. A program of inspections and possibly laboratory testing will be developed to determine the diagnosis.

In NSW the term 'footrot', when used in the context of notification, control and eradication, means virulent footrot.

Lesion development

The development of footrot lesions depends on:

- the presence of *D. nodosus* and the particular strain involved,
- host susceptibility (younger sheep are generally more susceptible than older sheep, merinos are generally more susceptible than crossbreds)
- environmental factors (see above),
- predisposing infection with other bacteria between the claws.

In warm moist conditions, inflammation between the claws (score 1 and score 2) can develop into typical virulent footrot (score 3 and score 4) within 2 weeks if virulent strains of *D. nodosus* are present.

In the absence of virulent strains, lesions will not normally progress to the more severe form of the disease, even in the warm, moist conditions that are ideal for spread. However a small percentage of sheep affected by benign strains, especially younger naïve sheep, may sometimes develop scores 3 and 4 lesions. Most of these will heal without treatment when pastures dry off.

The clinical expression of the disease is strongly influenced by any treatments given, and by the environmental conditions at the time. In cold conditions or dry situations, virulent footrot may not develop into the typical score 4 lesion, but may remain at score 2 or score 3. However, when these sheep are exposed to warm wet conditions, the disease will develop.

Distinguishing between the forms of footrot

Benign footrot

In benign footrot, the main lesion is an inflammation of the skin between the claws of the hoof, referred to as interdigital dermatitis (score 1 and score 2).

Benign footrot is indistinguishable clinically from interdigital dermatitis and early virulent footrot. The interdigital skin between the claws is moist and inflamed, and the horn at the heel may slightly underrun.

A high percentage of the flock can be affected but only under favourable conditions.

Usually more than one foot is affected.

Significant lameness is possible, especially in heavy sheep (rams and pregnant ewes) where the weight aggravates the lameness, particularly when sheep first stand up after resting.

The disease can disappear spontaneously without treatment, especially in dry weather or when sheep are moved to dry pasture.

In some circumstances lesions may progress to score 4 in a small proportion of the flock. These score 4 lesions are usually limited in severity (less soft tissue necrosis) compared with those of virulent footrot, and heal without treatment.

Virulent footrot

Virulent footrot should be considered in any flock where sheep show score 4 lesions or where a significant proportion show underrunning (score 3). The arbitrary level of more than 1% of sheep showing score 4 lesions may be a useful guide to suspect virulent footrot, but should not be used as an exclusive criterion for diagnosing virulent footrot.

Under warm, moist conditions, sheep show a severe and progressive separation of the soft and hard horn from the soft tissues underneath, often involving the whole of the sole (score 4) and extending up the wall (score 5). The disease develops rapidly in conditions favourable to its spread and expression. Within 7–14 days, inflammation between the claws (score 2) can develop into advanced underrunning (score 4).

Under ideal conditions for the spread and expression of footrot, more than 10% of sheep can show advanced underrunning (score 4 and score 5), with lesions persisting if treatments are not undertaken.

Usually both claws are affected, and often more than one foot. Lameness is a feature of virulent footrot. The disease is capable of causing significant production losses (including loss of bodyweight of over 10% and half a kilogram in wool production).

In dry conditions or following footrot treatments all the above typical signs can be effectively suppressed. Detection of virulent footrot in these circumstances may be very difficult.

Chronic virulent footrot

Chronic virulent infections have an overgrown horn which is misshapen – the soft tissue underneath is destroyed. The lesion has a black, tarry appearance and is subject to flystrike. There are serious animal welfare considerations if the disease progresses to this stage.

Figure 1 – Chronic footrot

Severely overgrown and deformed hooves prior to trimming.



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Figure 2 – Chronic footrot

Hooves from Figure 1 after corrective trimming. Note black tarry appearance of infected hoof tissue.



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Figure 3 – Chronic footrot

Overgrown, deformed hooves before trimming



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Figure 4 – Chronic footrot

Hooves from Figure 3 – after trimming



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Footrot scoring guide

Figure 5 - Normal foot.

There is normal skin between the claws, with no reddening or inflammation and no loss of hair. There is no exudate present.



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Figure 6 – Score 1.

Slight to moderate inflammation with some erosion between the claws. There is no under-running or erosion of the skin or horn



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Figure 7 - Score 2

The skin between the claws is inflamed and raw. This condition may involve part, or all, of the soft horn on the inside of the claws. There is no under-running of the horn.



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Figure 8 - Score 3a

Separation of the skin horn junction, with under-running extending no more than 5 mm.



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Figure 9 – Score 3b

Under-running no more than halfway across the heel or sole.



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Figure 10 – Score 3c

More extensive under-running of the heel or sole but not extending to the outside edge of the sole of the claw.



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Figure 11 – Score 4

The under-running extends to the outside edge of the sole of the claw and involves hard horn.



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Figure 12 – Score 5

This is a severe form of the disease involving the sole, with extensive inflammation and under-running of the hard horn of the hoof.



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Dealing with footrot

Regulatory requirements for virulent footrot

In NSW, virulent footrot is a notifiable disease under Schedule 1 of the *Biosecurity Regulation 2017* (the Regulation). Clause 7 of the Regulation requires a person to notify an authorised officer under the *Biosecurity Act 2015* (the Act) within 1 working day after they suspect or become aware of the presence of footrot in sheep or goats.

This means there is a legal obligation on occupiers of land, owners of stock, persons in charge of travelling stock, and veterinarians or other persons consulted about stock, to notify an authorised officer under the Act (employed by [Local Lands Services \(LLS\)](#)) if footrot is suspected. Regulatory action may result if virulent footrot is not notified promptly.

Notification when lameness is first observed will allow an early diagnosis of the cause of the lameness. It is important to make an accurate diagnosis of virulent footrot before embarking on a costly eradication program.

Once virulent footrot is diagnosed or suspected, the owner/occupier will be advised by an authorised officer that they have to discharge their general biosecurity duty and include identifying the actions required to discharge the duty. The authorised officer would also request from the owner/occupier a biosecurity undertaking which specifies the actions required to eradicate the disease infection. As part of the undertaking, the owner/occupier is obliged to develop an approved footrot eradication program that is to be carried out within an agreed time. This program must be approved by the local LLS District Veterinarian (DV) and requires full documentation of the procedures to be followed.

The eradication program will be reviewed at regular intervals, and if progress is considered unsatisfactory, regulatory action may then be taken. The use of accredited footrot contractors to assist with eradication programs is strongly encouraged.

Destock or on-farm eradication?

Before embarking on an on-farm eradication program, eradication by destocking of the whole flock should be seriously considered. Destocking is a viable option as there is a ready source of clean restocker sheep in NSW.

On-farm eradication programs

If eradication via an inspection and treat/salvage/cull program is the preferred option, there are three phases.

1. **Control phase:** before and during the spread period, to reduce the level of infection in the flock to the stage where eradication becomes feasible.
2. **Eradication phase:** involves the detection and removal of all infected sheep in the flock during the non-spread period.
3. **Surveillance phase:** involves monitoring the whole flock to ensure the disease has been eradicated, and preventing re-infection.

Considerations when undertaking an on-farm eradication program

The following points are important:

1. Rely on the experts.

An on-farm eradication program that is undertaken under the close supervision of an experienced veterinarian (District Veterinarian or private practitioner), with assistance from an accredited footrot contractor or a LLS Biosecurity officer, has the best chance of succeeding.

For more information on accredited footrot contractors see the [Primefact](#)

2. There are no shortcuts to eradication.

Relying on cheap treatments, or skipping treatments or inspections, *will* result in failure. Clean musters every time, and accurate record keeping are essential. All sheep should be marked with scorable paint at each inspection to make it easy to identify any that have been missed. Keeping infected animals that do not respond to early treatment will also result in the breakdown of the program.

3. The eradication program must be planned.

Plan your eradication program in consultation with your veterinarian as early as possible in the year. Allocate suitable periods of time to carry out control and eradication programs in the flock. Prepare contingency plans following the eradication phase in case the disease reappears in one or two mobs. Allocate separate areas of the property for clean mobs and infected mobs, with separate handling facilities wherever possible.

4. Maintain facilities.

Eradication is assisted by having sound fencing and good facilities for the handling, inspection and treatment of sheep.

5. Do not attempt an eradication program while the disease is still spreading.

The disease will spread at a faster rate than it can be cured, so little will be achieved. Seek advice from your veterinarian on the time that spread is likely to occur in your district, and plan to start the eradication phase of your program after that.

6. The major effort should be spent on the mobs inspected and classed as clean.

Many graziers consider sheep to be clean on the basis of one examination, but in most flocks some infected sheep will be missed. Reinspections of the clean mob to look for infected sheep are essential. Unless they are found and culled these sheep will spread infection in the next footrot season.

7. Footrot is eradicated by culling, not curing, infected sheep.

The sooner treatment of infected sheep can be stopped in non-spread conditions and replaced by culling, the chances of achieving eradication are much better.

8. Cull (remove from the property) all infected sheep as soon as possible.

While infected sheep remain on the property, they are a threat to clean sheep. Many eradication programs fail because infected sheep stray into a clean mob or because graziers spend too much time trying to cure infected sheep and not enough time ensuring that clean sheep are, in fact, clean.

9. Watch for carrier animals.

Under dry conditions, some apparently normal sheep can carry virulent strains of the organism as a small pocket of infection in the claws. These sheep may not be lame, but they can still cause a breakdown in the flock when conditions are suitable for spread.

10. Treatment makes infected sheep harder to detect.

Any treatments applied during the eradication phase, e.g. foot bathing, antibiotics, can make detection of sheep that are not totally cured much more difficult.

11. Dry conditions make infected sheep harder to detect.

Footrot usually cannot be considered eradicated until the flock goes through a season conducive to spread without showing evidence of the disease.

12. Prevent re-infection.

Avoid re-infection from introduced sheep or from neighbouring properties. Isolate all introduced sheep for as long as possible to ensure freedom from footrot.

Phases of an eradication program

Footrot eradication programs have three phases:

1. Control, steps are taken to stop spread of footrot and minimise the number of infected animals.
2. Eradication, all remaining infected animals are identified and culled.
3. Surveillance, to check eradication has been successful.

Phase 1: Control phase

The control phase should be used before and during the spread period to reduce the number of infected sheep that will need to be culled during the eradication phase. Minimise the spread of footrot and the number of infected sheep by foot bathing and paring.

Treatments

- Foot bathing

Traditional foot bathing alone will not eradicate footrot but a well-designed foot bathing program can help clean sheep to resist infection during the spread period and will minimise the number of sheep that need to be culled at subsequent eradication inspections. Sheep must be treated regularly (see below).

Do not use foot bathing in non-spread periods as it will delay or mask the expression of footrot in carrier sheep.

The two main preparations available are:

- Zinc sulphate.

Treat sheep every 5–7 days by walking them through a 10% zinc sulphate solution in a footbath at least 6 metres long. Hold sheep in the bath for 15 minutes, followed by drying on concrete or grating, will cure a significant number of sheep.

- Radicate[®]

This is a commercial copper-based footbath solution. Hold sheep in the solution for 15 minutes, and then allow to dry for 1 hour on concrete or grating. Treatment must be repeated in 1–2 weeks. Good cure rates can be expected in a significant number of sheep.

Formalin was once widely used as an external disinfectant but is no longer recommended due to human health and safety concerns, and the potential for masking lesions in carrier sheep.

- Foot Paring

Minimal paring of feet may assist penetration of footbath chemicals, but it is preferable to postpone paring until the first eradication inspection at the end of the spread period. Vaccination

Commercial footrot vaccines were an important tool in the early stages of the NSW Footrot Strategic Plan, but they are no longer available in NSW. Meat and Livestock Australia (MLA) is currently funding a research project to develop a new vaccine that will protect against all Australian strains of virulent footrot.

Phase 2: Eradication phase

During the eradication infected sheep are identified and culled.

Before an eradication phase is considered, the disease should have been controlled during the spread period and the prevalence of infection reduced to minimise the number of sheep that will need to be culled. Remember that footrot is eradicated from a property by culling, not curing. If the disease has not been controlled during the spread period, more animals will need to be culled.

Consider immediately destocking mobs that have significant numbers of infected animals on the first inspection. An alternative, particularly when the proportion of infected animals is low, is to immediately cull those animals on each inspection.

During the eradication phase only attempt to treat when culling is not an option, e.g. lambs/weaners or high value animals.

Procedure

1. Examine every foot of all sheep in the flock. Make a decision on whether to:
 - cull infected mobs, or
 - cull individual infected sheep, or
 - treat infected sheep.

An 'infected foot' is any foot that the operator is not sure is free of footrot. Consider 'doubtful' feet as infected.

2. Reinspect all feet of all sheep in 3–6 weeks and cull all infected sheep. Do not keep any sheep treated on the first round that still have lesions.
3. Repeat the previous step every 3–6 weeks until there have been two successive clean inspections, with no infected sheep found.

Marking all sheep with scorable paint as they are inspected is an important part of the eradication program. It provides a means to separate clean and suspect sheep. It also allows sheep that have missed inspection to be identified back in the paddock. Clean musters are essential. Missing sheep must be found before returning inspected sheep to their paddocks.

At inspection use minimal paring to return feet to normal shape and to expose deep-seated infection. **Avoid radical, or severe foot paring** that will cause lameness and animal welfare issues; it will not improve cure rates. Taking the time to pare feet correctly at first inspection will pay off at subsequent inspections in an eradication program, as assessment will be quicker and more accurate.

Treatments

Where a decision is made to salvage animals by treatment and inspection, the following treatments are available.

- Foot bathing

see previous section.

- Antibiotics

Antibiotics are only available through your veterinarian. Your veterinarian will decide which product is most suited to your eradication program. Accurate dosing and sound hygiene procedures are important.

Generally the sheep's feet must be kept dry (e.g. on grating) for up to 12 hours after treatment. Appropriate withholding periods must be observed before sending sheep to slaughter.

- Foot paring

Light paring to expose infection and facilitate foot bathing or antibiotic treatment is recommended.

Do not spend time trying to cure sheep that have not responded to an initial treatment. Sheep that fail to respond to treatment, either antibiotics or foot bathing, are often very difficult to cure and should be culled.

Phase 3: Surveillance phase

The surveillance phase must:

- allow early detection of any breakdown in the eradication program,
- include a contingency plan to deal with any breakdown, and
- prevent re-infection from strays or introductions.

Inspect your flock regularly for any signs of lameness during autumn, winter and early spring. Seek prompt advice from your veterinarian on the cause of any lameness detected.

If a breakdown is detected, implement your contingency plan to confine the infection to a part of the property, and take immediate steps to eliminate the problem.

Preventing re-infection

Once the disease has been eradicated from the flock, prevent re-infection by minimising the risk from strays and introductions. Keep boundary fences well maintained.

Introduced sheep should only come from a flock known to be clean, and where the owner of that flock is prepared to complete and sign section B of the [National Sheep Health Statement](#). You should always request a signed National Sheep Health Statement from the vendor before taking delivery of any sheep.

In addition, check the sheep carefully on arrival. Keep the introduced sheep in isolation and monitor them closely until they have passed through a spread period without showing any signs of footrot.

Developing a comprehensive on-farm biosecurity program that addresses straying onto and off your property and the risk of disease from introduced stock, is strongly recommended. This will guard against several important diseases of sheep. More information can be found at the [Farm Biosecurity](#) website, or by talking to your veterinarian.

Footrot in goats

Footrot is a notifiable disease in goats, even if they are run on a property with no sheep.

Footrot infection in goats does not behave in the same way as in sheep. It is impossible to distinguish between the benign and virulent strains of footrot by clinically examining a number of goats.

The benign forms of footrot may cause severe underrunning in goats, and the virulent forms may cause only inflammation between the claws, with little or no underrunning. In goat herds, a laboratory test may be used to assist in differentiating between benign and virulent footrot.

However, in footrot eradication programs, goats have to be treated in the same way as sheep, and any lesions in goats must be viewed with suspicion.

Goats can carry the virulent form of footrot between properties and can infect sheep under suitable environmental conditions.

Footrot in cattle

D. nodosus infection does occur in cattle, but nearly all the cases that have been investigated are due to benign strains.

Where cattle and sheep are both grazed on a property, it will not be possible to eradicate benign footrot from the sheep flock as cattle can act as carriers of the bacteria.

Virulent footrot organisms have occasionally been isolated from cattle in other states, but there are no reports in NSW despite the presence of cattle on many properties from which footrot has been eradicated. Owners should discuss with their veterinarian the role of cattle when planning an eradication program.

During spread periods, cattle movements should be considered as a possible method of mechanical transfer of the footrot organism between paddocks.

More information

For more information on footrot contact your [Local Land Services](#) veterinarian.

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For updates go to www.dpi.nsw.gov.au/factsheets

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