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Impact of rapid treatment of sheep lame with footrot on welfare and economics and farmer attitudes to lameness in sheep

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Abstract

This review article summarises the evidence for an effective management protocol for footrot to sheep, the welfare and economic benefits of such a protocol and its likely uptake by farmers. Over 90% of lameness in sheep in England is caused by Dichelobacter nodosus*, the aetiological agent of footrot. Farmers can recognise lame sheep both from video clips and when examining their own sheep but make a separate decision about whether to catch lame sheep. Only farmers who catch and treat mildly lame sheep immediately report a low prevalence of lameness (< 5%). From a within-farm clinical trial, treatment of sheep lame with footrot with parenteral antibiotic and topical spray led to over 90% recovery from lameness within 10 days whilst only 25% of sheep treated with foot trimming and topical spray recovered in 10 days. In parallel, a within-farm clinical trial with approximately 800 ewes was run for 18 months to test the hypothesis that rapid appropriate treatment led to reduced prevalence of lameness. Ewes were stratified and randomly allocated to one of two groups. The prevalence and incidence of lameness decreased in the treatment group, where lame sheep were treated with parenteral and topical antibacterials within three days of being observed lame, but remained at approximately 8% in the control group where lame sheep were treated with trimming hoof horn and topical antibacterial spray when the farm shepherd considered them sufficiently lame. Sheep in the treatment group had a higher body condition and produced more lambs that grew faster. The net economic benefit to all sheep (whether lame or not) in 2006 was £6 per ewe put to the ram. A group of 265 farmers were asked about their satisfaction with methods to manage footrot. Satisfied farmers reported a prevalence of lameness of ≤ 5% and used rapid individual treatment. Dissatisfied farmers reported a prevalence of lameness of > 5% and used whole-flock footbathing and vaccination. Overall, farmers stated that their ideal managements would be footbathing and vaccination. One explanation for this apparent inconsistency is that farmers want effective vaccines and footbaths; an alternative explanation is that this is an example of cognitive dissonance, where subjects adopt a belief because it is their current practice despite evidence that it is not effective. We conclude that farmers can identify lame sheep and that rapid treatment of individual sheep lame with footrot with intramuscular and topical antibacterials is currently the most effective control of interdigital dermatitis and footrot in sheep but that in future effective measures that prevent footrot would be ideal.*

Keywords: *animal welfare,* Dichelobacter nodosus, *footrot, lameness, sheep, treatment control*

Introduction

Lameness is considered by farmers (Morgan Davies *et al* 2006) and veterinarians alike to be the greatest welfare concern in sheep. The only two estimates of the prevalence of lameness in sheep from random samples are 8.7% in England, Wales and Scotland in 1994 (Grogono-Thomas & Johnson 1997) and 10% in England in 2004 (Kaler & Green 2008a). Footrot is present in over 97% of flocks. It is the major cause of lameness in 80% of flocks and is responsible for approximately 90% of all lameness (Kaler & Green 2008a). Footrot is caused by the anaerobic bacterium, *Dichelobacter nodosus* (Beveridge 1941), and presents as an interdigital inflammation (known in the UK as interdigital dermatitis) or as a separation of hoof horn from the underlying sensitive tissue. Other causes of lameness include foot abscesses, white line disease (shelly hoof), toe granuloma and contagious ovine digital dermatitis (CODD) (Kaler & Green 2008a).

In 1999, the recommended control measures for footrot were to quarantine brought-in sheep, practise routine foot trimming and footbathing and to cull repeatedly lame sheep. The recommended managements for diseased sheep were to isolate, foot trim, and if severe, give parenteral antibiotics (Morgan 1987).

To develop hypotheses on managements that minimised the prevalence of lameness in sheep, a retrospective cohort study was conducted using 360 farmers who had previously agreed to participate in research into lameness in sheep. Farmers were sent an 11-page questionnaire that requested information on the prevalence of footrot (separation of hoof horn) and interdigital dermatitis (inflammation of hoof horn) in each month of 1999 and whether or not they thought there was CODD in the flock. Farmers were also asked about management practices for each condition in 1999. There were 210 useful responses. The managements associated with a low prevalence of footrot (3%) were isolating affected ewes (7% respondents) and treating ewes with footrot or interdigital dermatitis with a long-acting antibiotic injection (12%), foot trim (74%) and foot spray (62%) (Wassink *et al* 2003a, 2004). Approximately 14% farmers thought that they had CODD, although 31% of farmers did not know whether they had CODD (Wassink *et al* 2003b); the remaining 55% stated that they did not have CODD.

A within-flock clinical trial to investigate the efficacy of rapid treatment of sheep lame with footrot or interdigital dermatitis

The results from the study above led to the hypothesis that treatment of all sheep lame with footrot (both hoof horn separation and interdigital dermatitis) with intramuscular and topical antibacterials reduced the prevalence of footrot. We further hypothesised that given that footrot is an infectious disease, rapid treatment might reduce the incidence rate (new cases) of footrot.

To test this hypothesis, approximately 800 ewes from one flock were stratified by age, body condition and foot lesions and randomly allocated to a treatment or control regime for management of footrot. The treatment was long-acting intramuscular antibacterial (oxytetracycline) at a dose of 1 ml 10 kg^{-1} and topical antibacterial foot spray given within three days of a sheep becoming lame with either presentation of footrot. The control management was a conventional treatment of trimming hoof horn and topical antibacterial spray given when the farm shepherd considered appropriate. These protocols were followed for 17 months from May 2005 to November 2006. The sheep were kept in four groups, two treatment and two control, matched on stocking density and pasture. After five months, the prevalence (mean number of lame sheep/number in group at each observation) of lameness fell from approximately 8 to 2% in the treatment groups and remained at 8% in the control groups. One treatment and one control group were swapped in September 2005. The prevalence of lameness fell in the new treatment group to 1% and rose in the new control group to 6% (Wassink *et al* 2010a).

The difference in welfare between the two groups was assessed by comparing the duration of lameness, the severity of locomotion score (Kaler *et al* 2009; Table 1) and the body condition of the ewes. The productivity of the groups (irrespective of individual treatments) was assessed by recording the number of barren ewes, ewe deaths, lambs born, lamb deaths and growth rate of lambs. Sheep in the groups given prompt treatment with injectable antibacterials were lame for fewer days and also less severely lame; the prevalence and incidence of lameness decreased. These sheep also had a higher body condition, produced more lambs of which fewer died, and those that survived grew faster. The net economic benefit in 2006 was estimated to be £6 per ewe put to the ram (Wassink *et al* 2010a) despite a treatment cost of £1.35 per ewe put to the ram (Tables 2 and 3).

A factorial designed clinical trial to test treatments for footrot

One issue with the trial above was that ewes that were treated with foot-trimming and topical antibacterial spray were often lame for longer before they were treated than those given an antibacterial injection and spray, so the difference observed between the two groups could in part be due to timing rather than type of treatment. To compare treatments under similar conditions, 53 yearling mule ewes (on one farm) lame with footrot for less than two weeks were enrolled into a factorial design treatment trial (Kaler *et al* 2010a). Ewes were given one of the following treatments: parenteral antibacterial and no foot trimming; no parenteral antibacterial injection and no foot trimming; parenteral antibacterial injection and foot trimming; or no parenteral antibacterial injection and foot trimming. After 10 days, 95, 50, 40 and 25% ewes had recovered, respectively (Figure 1); the differences between treatment groups were analysed using discrete time survival modelling and after adjusting for covariates they were significant ($P < 0.05$). This study highlighted that foot trimming delayed healing, even in sheep that were also given an antibiotic injection. A further benefit was that intramuscular antibacterials prevented development of poor foot conformation and increased the probability that poor foot conformation was corrected (Kaler *et al* 2010b).

Recognition and decisions to treat lameness by farmers

Given an effective treatment for footrot, a next stage was to investigate whether farmers could recognise lame sheep. Approximately 200 farmers at four agricultural meetings were shown video clips of sheep with varying degrees of lameness and asked whether they considered the sheep was lame and whether they would catch the sheep to inspect its feet (Kaler & Green 2008b). Farmers ranged in their responses from those who would catch one mildly lame sheep and who self-reported a median prevalence of lameness of 5% in their own flocks, to those that would catch a few, more severely lame sheep, and who self-reported a median prevalence of lameness of 10% in their own flocks, and those who reported never catching individual lame sheep and who reported a median lameness of 15% in their own flocks. We concluded that farmers could recognise even mildly lame sheep but made a separate decision on whether to catch them for treatment. Those that self-reported that they waited longer and until a group of sheep were lame also self-reported a higher prevalence of lameness in their flocks.

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Table 1 Locomotion scoring scale.

Locomotion score	0	1	2	3	4	5	6
Bears weight evenly on all four feet	■						
Uneven posture		■	■	■	■	■	
Short stride		■	■	■	■	■	
Noticeable flicking of head in time with short stride			■				
Excessive flicking of head in time with short stride				■	■		
Not weight-bearing on affected limb when standing				■	■		
Discomfort when moving				■	■		
Not weight-bearing on affected limb when moving					■		
Extreme difficulty rising						■	
Reluctant to move once standing						■	
More than one limb affected						■	
Will not stand or move							■

Shaded area = description included in score. Source: Kaler *et al* (2009).

Table 2 Financial and time assumptions for the cost-benefit analysis (Table 3).

Slaughter lamb value (per lamb)	£35.00	Cost of parenteral antibacterial (per ewe)	£1.00
Store lamb value (per lamb)	£25.00	Cost of antibacterial spray (per sheep)	£0.30
Flock replacement cost (per replaced ewe)*	£48.50	Foot spraying# (per sheep)	0.3 min
Feed costs (per ewe)*	£13.50	Parenteral antibacterial# (per ewe)	0.5 min
Veterinarians and medicine (per ewe)*	£5.00	Catch individual sheep# (per sheep)	4.6 min
Other costs (per ewe)*	£3.80	Minimum wage cost† (per hour)	£5.05

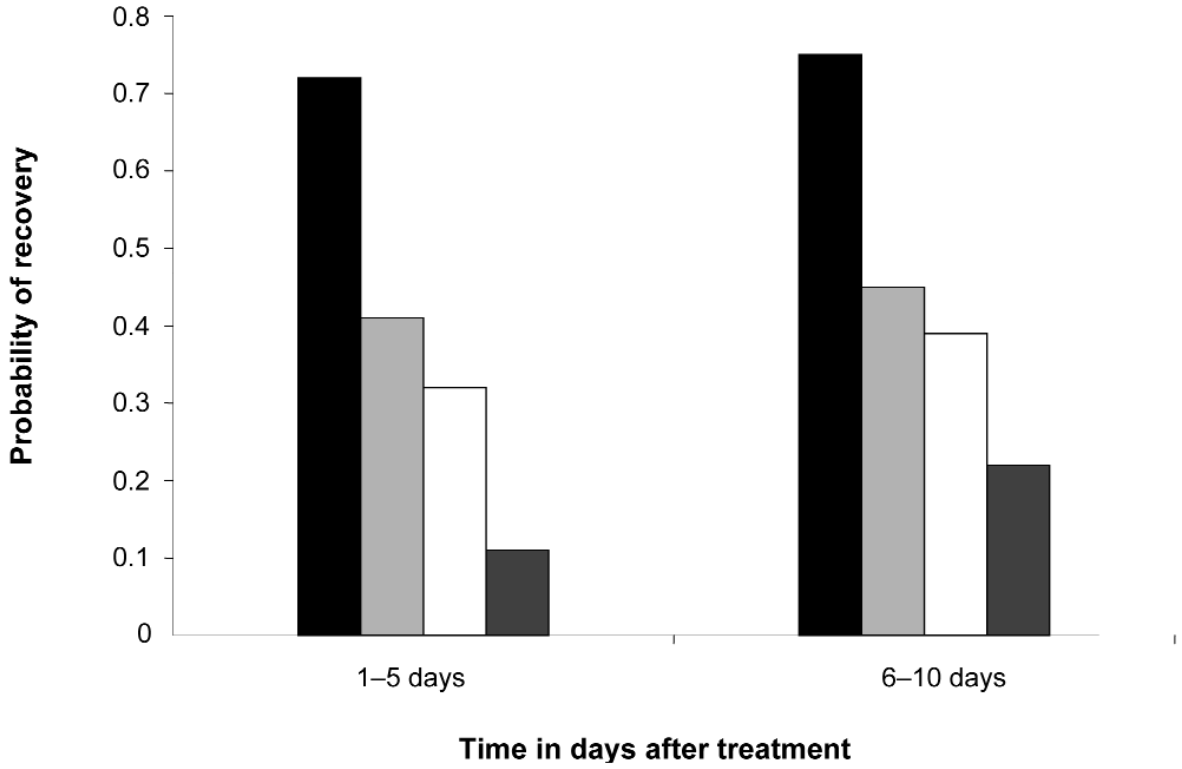
* Based on the average of 49 lowland breeding flocks in England 2005/2006 (MLC 2007).# Based on unpublished data (George 2006), The University of Warwick, UK. † Minimum wage in 2005/2006. Source: Wassink *et al* (2010a).

Table 3 Physical information and cost-benefit analysis of the rapid treatment of sheep with footrot from weaning 2005 to weaning 2006 per 100 ewes put to the ram.

Physical results	Rapid treatment group (n)	Control group (n)	Financial results	Rapid treatment group (£)	Control group (£)
			Income and fixed costs		
Empty ewes	4	7	Slaughter lamb sales	1,098	331
Ewe deaths	3	5	Store lamb sales	3,572	3,701
Productive ewes	93	88	Wool	140	132
Total lambs born	186	176	Gross income	4,810	4,164
Lambs born dead	7	10	Replacement costs	811	1,055
Lambs born alive	179	166	Total output#	3,999	3,109
			Variable costs		
Lambs deaths after birth	5	9	Feed costs	1,201	1,136
Lambs reared	174	157	Veterinarians and medicine	465	440
Lambs finished	31	10	Treatment group costs	150	0
Lambs sold as stores	143	148	Other costs	356	337
			Total variable costs	2,172	1,913
			Gross margin†	1,827	1,196

* Ewes were in their respective intervention and control groups from lambing 2005 and treated accordingly. # Gross income – replacement costs. † Total output – total variable costs. Source: Wassink *et al* (2010a).

Figure 1



The probability of recovery from lameness and footrot lesions 1–5 and 6–10 days after treatments. Adapted from Kaler *et al* (2009). The probability of recovery (y-axis) from lameness and footrot lesions within 5 days when treated with or without a parenteral antibacterial injection with no foot trimming or foot trimming at discrete times T1 and T2. Black bar: parenteral antibacterial and no foot trimming; light grey bar: no parenteral antibacterial injection and no foot trimming; white bar: parenteral antibacterial injection and foot trimming; dark grey bar: no parenteral antibacterial injection and foot trimming.

Whilst farmers identified lame sheep from videos it was not possible to conclude from the above study that they could accurately identify all lame sheep in their own flocks. This led to a study in which 35 sheep farmers, with a median flock size of 330, were visited and asked to show the visiting researcher the group of sheep with the highest prevalence of lameness. Farmers were asked what percentage of sheep was lame in this group. The farmer then left the researcher to score the locomotion of the sheep in the group and estimate the level of lameness. The researcher and farmer then looked at the group together. All 35 farmers considered that sheep with locomotion score ≥ 2 (Table 1) were lame, although three said that they would not include sheep lame at score 2 in an estimate of prevalence. The sheep farmers' estimates of lameness were correlated with the researcher's score (Figure 2), although once the prevalence of lameness was > 9% farmers tended to underestimate the prevalence of lameness by approximately 2%. We conclude that farmers can identify lame sheep and use an internally consistent method to assess lameness. Farmers estimated the percentage lame fairly accurately, with modest under estimation (King & Green 2011). This information is very useful because it indicates that publications on the prevalence of lameness in sheep based on farmers' own reports are likely to be valid (Grogono-Thomas & Johnson 1997; Wassink *et al* 2003a,b, 2004, 2005, 2010b; Green *et al* 2007; Kaler & Green 2008a,b, 2009).

Recognition of lesions by farmers and veterinarians

Whilst farmers are able to recognise lame sheep there is evidence that farmers are not using the correct nomenclature to name the lesions that they see in the feet of sheep. Approximately 800 farmers were shown six photographs and descriptions of six common foot lesions: ID, footrot, CODD, shelly hoof (white line disease), foot abscess and toe granuloma. The percentages of farmers who correctly named these lesions was 83, 85, 36, 28, 65 and 43%, respectively. Only 23% named all six lesions correctly. In addition, many farmers named any foot lesion in which the hoof horn was abnormal, footrot, however, judging by their responses to the prevalence of lameness caused by each lesion, farmers could differentiate lesions but, nevertheless, called them all footrot. Approximately 60 expert veterinarians (attendees at a sheep veterinary society meeting) who were shown the photographs did use correct nomenclature, with 79% naming all six lesions correctly (Kaler & Green

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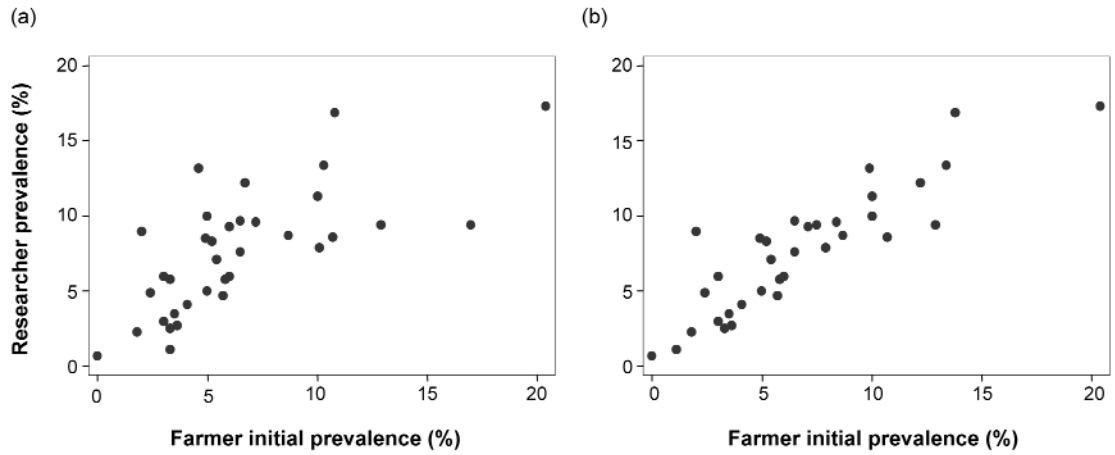
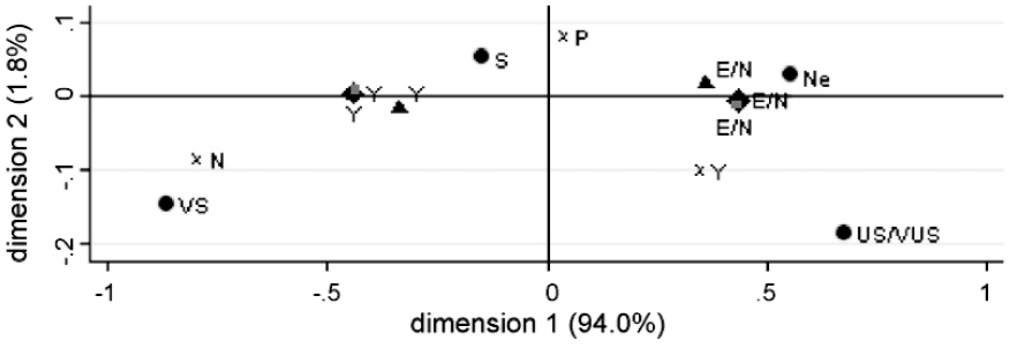
Figure 2



Scatter diagrams of researcher-estimated prevalence of lameness against farmer estimates of the initial estimate of the prevalence of lameness in (a) the group and (b) the re-estimated prevalence of lameness in the group. Adapted from King and Green (2011).

Figure 3



coordinates in principal normalization

● satisfaction: VS – very satisfied, S – satisfied, Ne – neither satisfied nor unsatisfied, US/VUS – unsatisfied/very unsatisfied
◆ time: Y – yes, E/N – to some extent/no
■ money: Y – yes, E/N – to some extent/no
▲ methods worked: Y – yes, E/N – to some extent/no
x change: Y – yes, P – possibly, N – no

Multiple correspondence analysis of satisfaction with lameness management, willingness to change methods, whether methods worked and whether the method used made best use of money and time. Source Wassink *et al* (2010b).

2008a). We conclude veterinarians are using the correct nomenclature but that it is different from that used by many sheep farmers. It is therefore important that both farmer and veterinarian see lesions on the feet of sheep before advice is given, otherwise there is a risk that the farmer receives the wrong advice and sheep the wrong treatment.

Farmer satisfaction and attitudes towards treatment and control of footrot

Given the success of rapid treatment with injectable antibiotics and its economic benefits, one question remaining was, were farmers satisfied with this treatment protocol? We therefore contacted 265 farmers by post and sent a ques-

tionnaire on their satisfaction with current management of footrot and their ideal management of footrot. Approximately 160 farmers responded and, on the basis of their replies, could be clustered into groups relating to their satisfaction, to the prevalence of lameness and to management protocols (Figure 3). One cluster was satisfied with current management, which was to catch lame sheep within three days of first seeing them lame. These farmers estimated that the prevalence of lameness in their flock was < 5%; similar to the study of Kaler and Green (2008b). Farmers dissatisfied with the results of their current management of lameness practised routine foot-trimming, footbathing and vaccination against footrot and reported a prevalence of lameness ≥ 5%. Farmers' top five ideal managements (see Wassink *et al* 2010b for details of methods) were that they would control footrot by culling/isolating lame sheep, source replacements from non-lame parents, trim feet less, use antibacterial treatments less and use vaccination and footbathing more. This may reflect a wish for better vaccines and footbaths and for flock managements that avoided catching individual lame sheep. It could be an example of cognitive dissonance: cognitive dissonance is a theory that provides an explanation for the apparent inconsistency between farmer ideal and currently effective managements. The theory is that peoples' beliefs reflect their behaviour rather than *vice versa* (Festinger 1957; Festinger & Carlsmith 1959): in this case, farmers using vaccines and footbathing to control lameness, (a sub-optimal behaviour) name it as an ideal management to reinforce their current management despite its association with a high prevalence of lameness and poor use of time/money (Wassink *et al* 2010b).

Animal welfare implications

Currently, approximately 8–10% sheep are lame in an average flock at any one time. The vast majority of lameness in 80% of these flocks is footrot, presenting as hoof horn separation or interdigital dermatitis. A combination of intramuscular and topical antibacterial treatment to sheep lame with footrot without trimming the horn leads to recovery in approximately 1–10 days (Kaler *et al* 2010a; Wassink *et al* 2010a). If all farmers were prepared to adopt rapid treatment of individual lame sheep then the prevalence of lameness would fall to well below 5% and the industry would be on target to reach the Farm Animal Welfare Committee's aspiration of an average prevalence of lameness of < 2% by 2021 (FAWC 2011). The welfare of sheep would increase with fewer sheep lame, reduced severity of lameness and higher body condition. The sustainability of sheep farming would also increase because non-lame ewes are more productive. In the long-term, an effective vaccine would prevent sheep from becoming lame, thus improving welfare further and avoiding some of the costs of treatment.

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