2014

CATTLE LAMENESS CONFERENCE

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The University of Nottingham
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Topics are:

- Claw horn lesions
- Effective claw lesion treatment
- A practitioner's view
- Digital dermatitis – how is it spread
- Digital dermatitis – practical solutions

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2014

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GENERAL INFORMATION

TIMETABLE of EVENTS

08:45	ARRIVE / REGISTRATION / COFFEE and POSTER DISPLAY	
09:25	CHAIRPERSON'S INTRODUCTION Nick Bell, Royal Veterinary College	
09:35	The role of biomechanical factors in the development of sole ulcer in dairy cattle	Karl Nuss University of Zurich
10.15	Questions and Discussion	
10:30	COFFEE and POSTERS	
	Session 2 Chairperson: Jon Huxley, University of Nottingham	
	INTRODUCTION TO SESSION 2	
11:00	Combining veterinary and social science for the advancement of effective claw lesion treatment	Margit Groenevelt, Sue Horseman University of Bristol Heather Thomas University of Nottingham
11.40	Questions and Discussion	
11:50	The practitioner's approach – estimating performance losses	Jim Willshire Endell Veterinary Group
12:30	Questions and Discussion	
12.40	Industry initiative on dairy cattle lameness	Joanne Speed Dairy Cattle Mobility Steering Group
12:40	LUNCH and POSTERS	
	Session 3 Chairperson: Brian Pocknee, The Dairy Group	
14.00	INTRODUCTION TO SESSION 3 and VOTING ON POSTERS	
14:10	Digital dermatitis – how is it spread and can we stop it?	Stuart Carter University of Liverpool
14.50	Questions and Discussion	
15.00	Practical solutions to digital dermatitis problems	Niamh O'Connell Queen's University Belfast
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CHAIRPERSON'S INTRODUCTION

Welcome to the 5th Cattle Lameness Conference, kindly sponsored by Provita, Vetoquinol, Norbrook and Merial. Without the support of sponsors this conference would not be possible. Due to the International conference on lameness in ruminants held in Bristol last year (to view proceedings of this very successful event go to www.ivis.org), the organising committee felt it was not appropriate to hold the CLC in 2013, but were concerned that this may have lead to lesser interest in attracting speakers for future Cattle Lameness Conferences. This apprehension was misguided as evident by the enthusiasm that the invited speakers accepted our invitations to speak at this year's conference.

A quick search of the peer reviewed literature since 2012 using one database ScienceDirect with the search terms 'lameness' AND 'cattle' yields a staggering 580 publications. However, over 100 of these papers were irrelevant or of minor relevance. Whilst there is a growing evidence-base and it is a major challenge to sort, read and digest them all, it is our hope and intention that this conference will continue to serve busy advisors and influencers of the dairy industry who need to make sense of the available and current evidence aided, of course, by the expertise of our invited speakers.

At this conference we will be exploring several major topics. Professor Karl Nuss has been one of the leaders in improving our understanding of bovine foot anatomy in relation to claw trimming with numerous influential publications, and will be exploring the role of biomechanical factors in claw lesions. Professor Stuart Carter's group at Liverpool University have led the way in the research into the role of Treponemes in digital dermatitis so it is our great pleasure to invite Stuart back to give an update and if we are nearer to preventing this insidious disease. Dr Niamh O'Connell has a broad farm animal welfare interest that includes bovine lameness and she will provide an insight into practical solutions in controlling digital dermatitis. At the International Conference last year Professor Jon Huxley talked about the importance of early detection and early effective treatment of lameness, so we are very pleased to welcome three young researchers (Margit Groenevelt, Sue Horseman and Heather Thomas), who have been exploring these concepts; and finally, the practitioner's approach is delivered this year by Jim Willshire, a veterinary surgeon from Salisbury who studied the performance losses associated with lameness as part of his RCVS diploma thesis. As well as an expert panel of speakers, we are excited to have an increased number of scientific posters, reflecting the active interest in this important topic.

Nick J. Bell
Chairperson of the Cattle Lameness Conference, Royal Veterinary College
On behalf of the CLC Organising Committee

FURTHER INFORMATION

Organised by:

Royal Veterinary College
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University of Nottingham

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PAPERS

Proceedings of the Cattle Lameness Conference (2014) Sixways, Worcester, pp 1 - 11
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THE ROLE OF BIOMECHANICAL FACTORS IN THE DEVELOPMENT OF SOLE ULCER IN DAIRY CATTLE

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INTRODUCTION

Prevalence of sole ulcer

Sole ulcer, also referred to as 'typical sole ulcer' or 'Rusterholz ulcer', is a major cause of lameness in dairy cows (Barker et al., 2010; Capion et al., 2008; Manske et al., 2002; Murray et al., 1996; Sogstad et al., 2005b; Tadich et al., 2010; van Amstel and Shearer, 2006; Weaver, 1975). Sole ulcers are responsible for reduced production and fertility and are expensive to treat (Bach et al., 2007; Green et al., 2002; Hernandez et al., 2005; Hultgren et al., 2004; Warnick et al., 2001). In a study of risk factors for a number of foot lesions, sole ulcer was among the few which were associated with an increased culling risk (Cramer et al., 2009; Machado et al., 2010). The prevalence of sole ulcer ranged from 4.2 % to 27.8 % (Amory et al., 2008; Bicalho et al., 2009; Capion et al., 2008; Martig et al., 1979) and was higher in free stalls (9.2 %) than in tie stalls (4.7 %) (Cramer et al., 2008). In another study on the prevalence of foot lesions in cattle in the UK, the most common lesion was sole ulcer (27%), followed by white line disease (20%) and digital dermatitis (16%) (Amory et al., 2008). In a Swedish study, 60% of 5,000 cows examined had sole haemorrhages (the initial stage of sole ulcer and white line disease), 8.6% had a sole ulcer and 5% were lame (Manske et al., 2002).

Sole ulcer and pain

Although a sole ulcer is very painful when hoof testers are applied to the affected claw, it does not always result in lameness (Shearer et al., 2013). Cows may try to hide their pain and will therefore appear sound, or they may have sole ulcers in both hind feet (Barker et al., 2010; Logue et al., 1998; Manske et al., 2002). A large proportion of lesions including sole haemorrhage, the precursor of sole ulcer, and sole ulcer proper cannot be diagnosed during a clinical lameness examination. In a study of 2,121 stabled dairy cows, the majority (96.0 %) had at least one abnormal claw, and 5.5 % had a sole ulcer, but only 1.2 % of the cows were lame (Smits et al., 1992). Kinematic gait analysis showed no difference between the gait of sound cows and those with sole haemorrhages (Flower et al., 2005, 2006; Flower et al., 2008). However, a recent study showed that sole ulcer had a profound effect on gait resulting in changes in stride length as well as in spine posture (Blackie et al., 2013). These changes are attributable to pain associated with sole ulcers.

THE ROLE OF BIOMECHANICAL FACTORS

Shifting of the cow's centre of gravity

Allowing cows to stand with the front feet in the stall and the hind feet in the manure gutter (perching) is considered detrimental to claw health. Perching time during the two weeks before calving was significantly longer for animals that subsequently developed ulcer lesions (Fregonesi et al., 2009; Potterton et al., 2012). However, the normal proportion of weight bearing by the front and hind feet was not affected by elevation of the front feet (Chapinal et al., 2009). Our preliminary studies in young heifers showed that during perching, the weight was shifted toward the hind limbs, although the observed change was not significant (Weidmann et al., 2013). This suggests that standing on a slanted surface leads only to a small shift in weight bearing from the front to the hind feet. There are no studies on potential long-term adverse effects of this shift. A study of the association between pregnancy and the occurrence of sole ulcer showed no effect of the weight of the fetus on the position of the centre of gravity along the longitudinal axis of the cow. This contradicts the notion that the hind feed are subject to increased load during pregnancy. However, most of the weight of the milk was carried on the back legs. A full udder increased the gait score (score 1, prefect gait; score 5, severely lame) by 0.3 ± 0.1, and the degree of abduction of the hind limbs increased by 83% (Chapinal et al., 2009). Cows had only limited ability to shift weight from the front feet to the hind feet when placed on an uncomfortable surface. Cows put more weight on the hind feet when both front feet were on an uncomfortable surface, but no change was observed when the hind feet were on an uncomfortable surface (Neveux et al., 2006).

The digital cushion

The anatomical structure of the 'shock absorber' mechanisms of the claw, particularly the digital cushion, was only recently investigated in more detail (Bicalho et al., 2009; Räber et al., 2004). Most of the digital cushion is situated posterior to the navicular bone. While walking, it is responsible for cushioning during the impact at the beginning of the stance phase (Meyer et al., 2007; Schmid et al., 2009). Three longitudinal rolls of fat support the third phalanx (P3) when the limb is positioned perpendicular to the ground. The structure of the digital cushion varies with age: in heifers, it consists of loose connective tissue, which in time is replaced by fat. After the third lactation, the fat is gradually supplemented with collagenous connective tissue which possibly reduced the cushioning capacity (Räber et al., 2004). Other authors subsequently observed that cows with a thin digital cushion had a higher prevalence of sole ulcer or white line disease (Bicalho et al., 2009). Thin cows had thinner digital cushions than cows with a higher body condition score (Bicalho et al., 2009), which is in general agreement with the observation that cows with a low BCS at calving and in early lactation were at higher risk of lameness (Hoedemaker et al., 2009). It was speculated whether manipulating the fat content and other components of the digital cushion through feeding management could improve its protective function and thus reduce claw disease (Baird et al., 2010; Raber et al., 2006). However, the causal relationship between the composition of the digital cushion and the occurrence of sole ulcer remains to be confirmed (Telezhenko et al., 2007). Furthermore, it remains unclear why the lateral claw of the hind limb is most susceptible to sole ulcer.

Mechanical injury to the corium and digital cushion may occur in thin-soled dairy cattle, in which the protective function of sole horn has become insufficient, particularly on hard walking surfaces (Van Amstel et al., 2004). Heel horn erosion may cause increased pressure at the heel-sole junction and predispose the claw to sole ulceration (Toussaint Raven, 1985; van Amstel and Shearer, 2006). The latter authors measured the thickness of the subsolar soft tissue layer (dermis and subcutaneous tissue) of the lateral and medial hind limb claws of 23 Holstein dairy cattle using ultrasonography. The subsolar soft tissue layer of the lateral claw was on average significantly thicker (4.29 mm) than that of the medial claw (3.92 mm) (Van Amstel et al., 2004). These results suggested that the soft tissue of the lateral claw underwent hypertrophy, which was responsible for the difference in the thickness of the soft tissue layers of the paired claws. A recent study measured the distance between the external sole surface and P3 in first-lactation cows from day 10 to 220 post calving (Laven et al., 2012a; Laven et al., 2012b). The measurements varied widely (from 5.6 to 14.9 mm for lateral claws) among cows even though the animals had been reared together on pasture. After calving, the measured distance did not decrease with time, and in some heifers, the distance (thickness) even increased (Laven et al., 2012a). These findings indicate that developmental processes of the digital cushion and sole thickness are complex and require more study.

The suspensory apparatus

The suspensory apparatus is an important structure of the claw which transforms the pressure force of the body weight to a tractional force. The suspensory apparatus of the claw consists of a system of dense collagenous fibres extending from P3 to the epidermal lamellae of the hoof wall, thereby suspending P3 within the claw capsule (Westerfeld, 2003). The suspensory apparatus is considerably less extensive at the axial part of the claw capsule, and in this area is absent from the region of the insertion of the deep flexor tendon and from the region of the digital cushion. Consequently, stretching of the fibres of the suspensory apparatus allows slight displacement and rotation of P3 toward the axial groove, which is part of the shock absorbing mechanism. Rusterholz (1920), Smedegaard (1964a and b) and Toussaint Raven (1985) were the first to notice the connection between the asymmetrical suspension of P3, its rotation under load and the development of sole ulcers. When P3 is loaded, the asymmetric suspension causes it to tilt in an axial direction and to compress the soft tissues underneath (Lischer, 2002). If the axial groove is not established (Toussaint Raven, 1985; van Amstel and Shearer, 2006) and the cows are kept on hard ground, the displacement of P3 also predisposes to sole haemorrhage. Continuous displacement leads to compression of the solar corium, which in turn initiates the cascade of vascular compromise, ischemia caused by congestion, oedema and thrombosis, interrupted keratogenesis and finally sole ulcer. The application of wedge-shaped metal shoes to the claws shifted the region of ground contact to the heel area and resulted in sole ulcer (Smedegaard, 1964a, b). Such inclination of the claws occurs naturally when the dorsal wall is too long and the cow remains standing because she will not (uncomfortable stall) or cannot (narrow tie stall) lie down.

The pathogenesis of sole ulcer has been linked to vascular changes related to inflammatory changes at the level of the laminae (Boosman, 1990; Boosman et al., 1989; Greenough and Vermunt, 1991; Greenough et al., 1990; Ossent and Lischer, 1998; Vermunt, 2000). By the end of the last century, it was “widely accepted by workers in the Northern Hemisphere that most bovine claw lesions (and thus lameness) originate from contused tissue within the horn capsule; usually with laminitis as an underlying cause” (Lischer, 2002), and that many claw lesions in laminitic cattle occurred in conjunction with distal displacement of P3 (Ossent and Lischer, 1998). However, while displacement of P3 of the lateral hind claws was commonly observed, the medial P3 of cows with an ulcer was rarely displaced and its position did not differ from that of sound cows (Lischer, 2002). A surprising finding was that there were no pathological changes in the laminae of the lateral claw in spite of marked displacement of P3. Gross as well as histological examination of the lamellae of the wall revealed no difference between cows with a sole ulcer and healthy control cows. Similarly, there were no apparent signs of repair in the form of hyperkeratosis and thickening or lengthening of the epidermal leaflets.

These findings casted doubts on the theory that “laminitis” was a major cause of sole ulcer (van Amstel and Shearer, 2006). Sinking of P3 might therefore be related to changes in other regions of the suspensory apparatus of P3. Tarlton et al. (2002) described weakened connective tissue of the hoof suspensory apparatus and distorted laminae, causing increased susceptibility to sole ulcer. The laxity of the suspensory apparatus of P3 was believed to be associated with hormonal changes that accompany parturition and lactation (Huxley, 2012; Tarlton et al., 2002). The calving process appears to be involved in the occurrence of sole ulcer because of a striking temporal association between the two events; sole ulcers are most common during the first two months after calving (Capion et al., 2009; Enevoldsen et al., 1991; Leach et al., 1997; Leach et al., 1998). In addition, risks associated with increased incidence of sole ulcer included parity 4 or greater. The prevalence of sole ulcer was 4.2 % and 27.8% for parity 1 and parity >1, respectively (Barker et al., 2009; Bicalho et al., 2009).

With respect to the type of flooring, the severity of sole lesions was significantly greater in heifers housed in cubicles (hard flooring) compared with straw yards (soft flooring). Lesions were also more severe in lactating or pregnant heifers than in non-bred heifers (Knott et al., 2007). This suggested a 'parturition effect' involving non-inflammatory changes in connective tissue of the claw that impaired the resilience of the feet to external stresses associated with inadequate housing.

The above-mentioned studies together with the work by Lischer et al. (2002) suggest that sinking of P3 is possible without separation of the corium from the laminae ("laminitis"), most likely because of normal transient softening of the suspensory apparatus associated with hormonal changes related to parturition. This may be exacerbated by increased mechanical stress suffered by the lateral hind claw on hard ground, which appears to cause permanent overstretching of the suspensory apparatus. The high recurrence rate of sole ulcer (Enevoldsen and Gröhn, 1990; Lischer, 2000; Sogstad et al., 2005a) leads to an increased prevalence in older cows and strongly suggests that the suspensory apparatus undergoes chronic overextension.

Differential mechanical loads of the medial and lateral claws

Uneven distribution of ground reaction forces and pressure on the claws are considered important factors in the pathogenesis of sole ulcer. Information regarding the asymmetry of the sole surface of the medial and lateral claws in calves is contradictory (Alsleben et al., 2003; Schwarzmann et al., 2007). In a recent study, pressure and force measurements in non-pregnant heifers (mean age 12 months) indicated that ground reaction forces acting on the lateral claw of the hind limb were significantly greater than those acting on the medial claw, while the opposite was true in the forelimbs (Weidmann et al., 2013). In standing cows, maximum pressures were normally found on the medial claws of the front limbs and on the lateral claw of the hind limbs (Van der Tol et al., 2002). In another study, in heifers at two years of age, the weight load and area of ground surface distribution were relatively balanced between the medial and lateral claws of the hind limb, whereas in the forelimb, the lateral claws were subjected to higher pressure and had larger ground surface areas than the medial claws (Alsleben et al., 2003). In an earlier study, dairy heifers usually had symmetrical claws without significant sole haemorrhages or sole ulcers before calving (Ossent et al., 1987).

Measurement of force and pressure distribution on the sole of dairy cows revealed severe overloading of the lateral claw of the hind limbs during walking (Schmid et al., 2009; van der Tol et al., 2003). Overloading at the walk occurred not only in cows but also in heifers (Meyer et al., 2007). At the forelimbs, the vertical ground reaction force was equally distributed between medial and lateral claw (van der Tol et al., 2003). In contrast, with high speed cinematographic studies, the lateral claw of both the forelimbs and hind limbs were shown to contact the ground before the medial claw in cows as well as in heifers (Meyer et al., 2007; Schmid et al., 2009).

Relatively soon after functional foot trimming, which in dairy cows is done to balance the weight distribution between the lateral and medial claws, the lateral claw began to bear more weight than the medial claw (Kehler and Gerwing, 2004). Furthermore, the development of asymmetrical claws could not be attributed to any particular type of flooring. Varying degrees of slipperiness of different flooring types did not affect the disproportion in weight distribution between lateral and medial claws in cows (Telezhenko et al., 2009; Telezhenko et al., 2008). These facts underline that the asymmetry of the claws of the hind feet is linked to an anatomical difference that causes uneven loading, uneven claw shape and sole ulcers in the lateral hind limbs claws in stabled cattle.

An anatomical difference

A number of researchers before and after Rusterholz suspected that anatomical and biomechanical effects play a role in the occurrence of sole ulcer (Andersson and Lundström, 1981; Fessl, 1968; Hess, 1909; Smedegaard, 1964a) because of the striking difference between the lateral and medial claws of the hind limbs (van Amstel and Shearer, 2006). However, until recently this anatomical and/or biomechanical difference could not be clearly defined. More than 40 years ago, Zantinga (1968, 1973) examined cattle with healthy claws and those with sole ulcer radiographically and reported that "…. the relative position of the medial pedal bone and the horizontal plane was found to differ from that of the lateral pedal bone and the horizontal plane" and "the difference in position …. may be an important factor in the aetiology of the typical lesion of the sole". However, Zantinga's observations have been largely ignored for many years. Asymmetry of the paired digits of pigs was noticed decades ago by Nordby (1939), who reported that the length and size of the paired digits varied in the majority of hogs of different breeds; the medial digits were smaller and shorter than the lateral digits. The incidence of this asymmetry in digital size (smaller medial digit) was assessed as 90.9% in boars, 96.7% in sows and 87.6% in barrows (Grandhi et al., 1986). Nutritional factors were also examined in that study but had very little effect on the digital asymmetry. Furthermore, the inequality in digital length and position was not a primary cause for structural unsoundness. However, a recent study found that the larger lateral claw of the hind limbs of pigs was more susceptible to disease than the medial claw (Lippuner, 2012).

Without knowledge of these earlier studies, we noticed that also the lateral claws in cows reached further distally than the medial claws after both soles had been trimmed to the same thickness, suggesting that the paired toes of the bovine foot differ in length (Nuss and Paulus, 2006). To corroborate these preliminary findings, we measured the lengths of the digital bones of the fore- and hind limbs procured from 40 slaughtered cattle of different ages using digital radiographs (Muggli et al., 2011). The majority of cattle had longer lateral digits in the forelimbs as well as hind limbs. Our hypothesis was that this asymmetry was the reason for the predisposition of the lateral claws of the hind limb to sole ulcer in cattle kept on hard surfaces (Muggli et al., 2011; Nacambo et al., 2007). In a more recent study, the disparity in length between the lateral and medial claws in hind feet with sole ulcer was compared to that in healthy feet (Rüegsegger, 2011). Seventy-five feet with lesions at the typical ulcer site were collected from slaughtered cows and 25 normal feet were used as controls. The results corroborated the length asymmetry of the bovine digits but did not clarify the role of asymmetry in the pathogenesis of sole ulcer: with one exception, the within-feet difference was not significantly different between the ulcer group and the controls. Measurements using radiographs from live standing cows indicated that there is indeed an effective difference in length between the paired digits of the hind feet (Muggli and Nuss, 2014). Clearly, the search for risk factors for sole ulcer must continue. In the hind limbs, the mechanical impact that is transferred from the pelvis directly to the longer lateral digit may play a role in the pathogenesis of sole ulcer (Toussaint Raven, 1985). In contrast, the forelimb is attached to the trunk via tenomuscular structures, which affords a more balanced weight distribution between the paired claws, shifting some of the weight to the medial claw.

Claw dimensions in pastured and housed cattle

Repeated claw measurements (4 times, 2 months apart) in Scottish Highland cattle were carried out to analyse changes related to housing conditions (Kolp et al., 2013). The cows were kept on various alpine pastures before the first measurement, on a two-hectare low-land pasture before the second measurement, in a welfare-compliant straw-bedded free stall before the third measurement and again on an alpine pasture before the fourth measurement. General claw health was assessed, and the dorsal wall length, dorsal wall angle, heel length, height and width, sole length and width, and claw length were measured.

Housing conditions significantly affected claw dimensions. After pasture periods, the cows had relatively large but symmetrical claws, which were composed of dry, hard horn, and had prominent weight-bearing hoof walls and soles with a natural axial slope. The fact that 'normal' biomechanics of weight bearing commonly lead to an overgrowth of the outer claw of the hind leg (van Amstel and Shearer, 2006) did not apply to these pastured cows. Claw lesions were absent in pastured cattle, and it was therefore felt that the long but symmetrical claws seen after pasturing in these cows did not need trimming. Free-stall housing was associated with shorter dorsal walls and larger dorsal wall angles but wider soles in the lateral hind claws and narrower soles in the medial hind claws (increase in asymmetry of the hind claws). In addition, wearing of the hoof wall edges, white line deterioration, sole haemorrhages and heel horn erosion were common (Kolp et al., 2013). These findings emphasise the benefits of pasturing in relation to claw health and underline how quickly the contour and shape of the claws can change with a change in husbandry conditions.

Treatment of sole ulcer

It is surprising that there has been very little research into the treatment and healing properties of sole ulcer considering that this lesion is seen so frequently in veterinary practice (Potterton et al., 2012). Thus, the relative importance of aspects of current clinical practice (therapeutic foot trimming, bandaging, orthopaedic block, topical antibacterial agents, granulation tissue removal, intravenous regional anaesthesia/antibiotics (IVRA), NSAIDs, cautery, systemic antibiotics, aftercare/management during the recovery period) have not been investigated in well-designed clinical trials (Horseman et al., 2013; Huxley, 2012).

The healing of sole ulcers in 301 cows with 433 uncomplicated claw lesions, most of which were sole ulcers and white line lesions, was the topic of a monograph (Lischer, 2000; Lischer et al., 2001). Treatment in tie stalls consisted of functional foot trimming, removal of loose horn while preserving the corium, aseptic treatment of the corium with chlorhexidine and protection of the wound with a bandage in one group. A block was placed on the partner claw in another group of cows that were pastured in alpine regions and treated experimentally. The first bandage change was on day 3 or 4 and the second from day 10 to day 14; subsequent bandage changes were done every 10 days until the ulcer was covered with a solid layer of horn. The time required for epithelialisation was the criterion for healing (Lischer, 2000). The average healing time of uncomplicated sole ulcers was 14 days when a block was used. When only a bandage was used without a block on the partner claw, the mean healing time was 25 days. Using a block promoted faster epithelialisation and resulted in better horn quality. A prognosis could be made based on evaluation of healing 30 days after the start of treatment: Lesions that were well epithelialized had a good prognosis and those that did not had a poor prognosis. Forty per cent of cows that were treated with a bandage alone had one or more recurrences within several months, and more than half required treatment for sole ulcer in the following lactation. Only one third of the cows were still alive two years later, and the most common reason for culling was lameness because of recurrence of sole ulcer (Lischer, 2000). The author felt that the high rate of recurrence was attributable to lesions of the corium that failed to heal. The importance of early intervention in cattle with sole ulcer was emphasised in that study as well as in a more recent study (Potterton et al., 2012); early treatment leads to faster healing compared with cases in which therapy is delayed.

CONCLUSIONS

The prevalence of lameness due to painful sole ulcers is too high in stabled cattle. In beef cows kept on natural pastures year-round, hypertrophy of the lateral hind claw did not develop, most likely because the relatively soft clean pastures provided even distribution of load to both claws. On hard ground, there is an overwhelming predisposition of the lateral claw of the pelvic limb to overload and develop a sole ulcer, which supports the argument that a mechanical factor, rather than systemic inflammatory factors, is probably the main cause of sole ulcer. It appears that the length difference of the digital bones is the anatomical and biomechanical component for the predisposition of the lateral hind claws to disease. Other factors such as weakening of the suspensory apparatus of P3 appear to be involved in the pathogenesis of sole ulcers. The use of soft barn floors should therefore be explored more extensively in an effort to prevent sole ulcers and other claw horn disruptions. However, to date, we have not succeeded in imitating the natural texture of a pasture for barn floors.

REFERENCES

1. Alsleben, B., Russke, A., Werde, J., Hamann, H., Distl, O., 2003. Messung der Druckverteilung unter den Klauen bei Rindern der Rasse Deutsche Holsteins in den ersten zwei Lebensjahren. Der Praktische Tierarzt 84, 232-240.
2. Amory, J.R., Barker, Z.E., Wright, J.L., Mason, S.A., Blowey, R.W., Green, L.E., 2008. Associations between sole ulcer, white line disease and digital dermatitis and the milk yield of 1824 dairy cows on 30 dairy cow farms in England and Wales from February 2003-November 2004. Prev Vet Med 83, 381-391.
3. Andersson, L., Lundström, K., 1981. The influence of breed, age, body weight and season on digital diseases and hoof size in dairy cows. Zentralblatt Veterinärmedizin 28, 141-151.
4. Bach, A., Dinares, M., Devant, M., Carre, X., 2007. Associations between lameness and production, feeding and milking attendance of Holstein cows milked with an automatic milking system. J Dairy Res 74, 40-46.
5. Baird, L.G., Dawson, L.E., Young, I.S., O'Connell, N.E., 2010. Lipid content and fatty acid composition of the digital cushion of bulls offered different levels of linseed. J Anim Sci.
6. Barker, Z.E., Amory, J.R., Wright, J.L., Mason, S.A., Blowey, R.W., Green, L.E., 2009. Risk factors for increased rates of sole ulcers, white line disease, and digital dermatitis in dairy cattle from twenty-seven farms in England and Wales. J Dairy Sci 92, 1971-1978.
7. Barker, Z.E., Leach, K.A., Whay, H.R., Bell, N.J., Main, D.C., 2010. Assessment of lameness prevalence and associated risk factors in dairy herds in England and Wales. J Dairy Sci 93, 932-941.
8. Bicalho, R.C., Machado, V.S., Caixeta, L.S., 2009. Lameness in dairy cattle: A debilitating disease or a disease of debilitated cattle? A cross-sectional study of lameness prevalence and thickness of the digital cushion. J Dairy Sci 92, 3175-3184.
9. Blackie, N., Bleach, E.C., Amory, J.R., Scaife, J.R., 2013. Associations between locomotion score and kinematic measures in dairy cows with varying hoof lesion types. J Dairy Sci 96, 3564-3572.
10. Boosman, R., 1990. Bovine laminitis. Histopathologic and arteriographic aspects, and its relation to endotoxaemia. In, Veterinary Faculty. Rijksuniversiteit Utrecht, City.
11. Boosman, R., Nemeth, F., Gruys, E., Klarenbeek, A., 1989. Arteriographical and pathological changes in chronic laminitis in dairy cattle. Vet Q 11, 144-155.
12. Capion, N., Thamsborg, S.M., Enevoldsen, C., 2008. Prevalence of foot lesions in Danish Holstein cows. Vet Rec 163, 80-85.
13. Capion, N., Thamsborg, S.M., Enevoldsen, C., 2009. Prevalence and severity of foot lesions in Danish Holstein heifers through first lactation. Vet J 182, 50-58.

14. Chapinal, N., de Passille, A.M., Rushen, J., 2009. Weight distribution and gait in dairy cattle are affected by milking and late pregnancy. J Dairy Sci 92, 581-588.
15. Cramer, G., Lissemore, K.D., Guard, C.L., Leslie, K.E., Kelton, D.F., 2008. Herd- and cow-level prevalence of foot lesions in Ontario dairy cattle. J Dairy Sci 91, 3888-3895.
16. Cramer, G., Lissemore, K.D., Guard, C.L., Leslie, K.E., Kelton, D.F., 2009. Herd-level risk factors for seven different foot lesions in Ontario Holstein cattle housed in tie stalls or free stalls. J Dairy Sci 92, 1404-1411.
17. Enevoldsen, C., Gröhn, Y., 1990. Sole ulcers in dairy cattle: Associations with season, cow characteristics, disease and production. The Journal of Dairy Science 74, 1284-1298.
18. Enevoldsen, C., Grohn, Y.T., Thysen, I., 1991. Sole ulcers in dairy cattle: associations with season, cow characteristics, disease, and production. J Dairy Sci 74, 1284-1298.
19. Fessl, L., 1968. Biometrische Untersuchungen der Bodenfläche der Rinderklauen und die Belastungsverteilung auf die Extremitätenpaare. Zentralblatt Veterinärmedizin - Reihe A 15, 844-860.
20. Flower, F.C., Sanderson, D.J., Weary, D.M., 2005. Hoof pathologies influence kinematic measures of dairy cow gait. J Dairy Sci 88, 3166-3173.
21. Flower, F.C., Sanderson, D.J., Weary, D.M., 2006. Effects of milking on dairy cow gait. J Dairy Sci 89, 2084-2089.
22. Flower, F.C., Sedlbauer, M., Carter, E., von Keyserlingk, M.A.G., Sanderson, D.J., Weary, D.M., 2008. Analgesics improve the gait of lame dairy cattle. Journal of Dairy Science 91, 3010-3014.
23. Fregonesi, J.A., von Keyserlingk, M.A., Weary, D.M., 2009. Cow preference and usage of free stalls compared with an open pack area. J Dairy Sci 92, 5497-5502.
24. Grandhi, R.R., Kornegay, E.T., Veit, H.P., Lindemann, M.D., 1986. A radiographic characterization of toe length disparity and its relation to nutrition and structural unsoundness in boars, barrows and sows. J Anim Sci 62, 1172-1180.
25. Green, L.E., Hedges, V.J., Schukken, Y.H., Blowey, R.W., Packington, A.J., 2002. The impact of clinical lameness on the milk yield of dairy cows. J Dairy Sci 85, 2250-2256.
26. Greenough, P.R., Vermunt, J.J., 1991. Evaluation of subclinical laminitis in a dairy herd and observations on associated nutritional and management factors. The Veterinary Record 128, 11-17.
27. Greenough, P.R., Vermunt, J.J., McKinnon, J.J., Fathy, F.A., Berg, P.A., Cohen, R.D., 1990. Laminitis-like changes in the claws of feedlot cattle. Can Vet J 31, 202-208.
28. Hernandez, J.A., Garbarino, E.J., Shearer, J.K., Risco, C.A., Thatcher, W.W., 2005. Comparison of milk yield in dairy cows with different degrees of lameness. J Am Vet Med Assoc 227, 1292-1296.
29. Hess, E., 1909. Klauenkrankheiten. In: Bayer, J., Fröhner, E. (Eds.), Handbuch der Tierärztlichen Chirurgie und Geburtshilfe, Vol. 4. Braumüller, Leipzig, pp. 115-352.
30. Hoedemaker, M., Prange, D., Gundelach, Y., 2009. Body condition change ante- and postpartum, health and reproductive performance in German Holstein cows. Reprod Domest Anim 44, 167-173.
31. Horseman, S.V., Whay, H.R., Huxley, J.N., Bell, N.J., Mason, C.S., 2013. A survey of the on-farm treatment of sole ulcer and white line disease in dairy cattle. Vet J.
32. Hultgren, J., Manske, T., Bergsten, C., 2004. Associations of sole ulcer at claw trimming with reproductive performance, udder health, milk yield, and culling in Swedish dairy cattle. Prev Vet Med 62, 233-251.
33. Huxley, J.N., 2012. Lameness in cattle: an ongoing concern. Vet J 193, 610-611.
34. Kehler, W., Gerwing, T., 2004. Effects of functional claw trimming on pressure distribution under hind claws of German holstein cows. In: Proceedings of the 13th International Symposium and 5th Conference on Lameness in Ruminants, Maribor, Slovenija, pp. 103-104.

35. Knott, L., Tarlton, J.F., Craft, H., Webster, A.J., 2007. Effects of housing, parturition and diet change on the biochemistry and biomechanics of the support structures of the hoof of dairy heifers. Vet J 174, 277-287.
36. Kolp, E., Braun, U., Weidmann, E., Nuss, K., 2013. Klauenabmessungen von Schottischen Hochlandrindern unter verschiedenen Haltungsbedingungen.
37. Laven, L.J., Laven, R.A., Parkinson, T.J., Lopez-Villalobos, N., Margerison, J.K., 2012a. An evaluation of the changes in distance from the external sole surface to the distal phalanx in heifers in their first lactation. Vet J 193, 639-643.
38. Laven, L.J., Margerison, J.K., Laven, R.A., 2012b. Validation of a portable ultrasound machine for estimating sole thickness in dairy cattle in New Zealand. N Z Vet J 60, 123-128.
39. Leach, K.A., Logue, D.N., Kempson, S.A., Offer, J.E., Ternent, H.E., Randall, J.M., 1997. Claw lesions in dairy cattle: development of sole and white line haemorrhages during the first lactation. Vet J 154, 215-225.
40. Leach, K.A., Logue, D.N., Randall, J.M., Kempson, S.A., 1998. Claw lesions in dairy cattle: methods for assessment of sole and white line lesions. Vet J 155, 91-102.
41. Lippuner, A., 2012. Klauengesundheit bei Mastschweinen, KB-Ebern und Muttersauen in der Schweiz und genetische Analyse von Klauenparametern. In, Farm Animals, Vol. Inaugural-Dissertation. University of Zurich, City, p. 52.
42. Lischer, C., 2000. Sohlengeschwüre beim Rind. Pathogenese und Heilungsverlauf. In, Veterinärchirurgische Tierklinik. Universität, City, pp. 1-178.
43. Lischer, C., J.,Ossent, P., Raber, M., Geyer, H., 2002. Suspensory structures and supporting tissues of the third phalanx of cows and their relevance to the development of typical sole ulcers (Rusterholz ulcers). Vet Rec 151, 694-698.
44. Lischer, C.J., Dietrich-Hunkeler, A., Geyer, H., Schulze, J., Ossent, P., 2001. [Healing process of uncomplicated sole ulcers in dairy cows kept in tie stalls: clinical description and blood chemical investigations.]. Schweiz Arch Tierheilkd 143, 125-133.
45. Logue, D.N., McNulty, D., Nolan, A.M., 1998. Lameness in the dairy cow: pain and welfare. Vet J 156, 5-6.
46. Machado, V.S., Caixeta, L.S., McArt, J.A., Bicalho, R.C., 2010. The effect of claw horn disruption lesions and body condition score at dry-off on survivability, reproductive performance, and milk production in the subsequent lactation. J Dairy Sci 93, 4071-4078.
47. Manske, T., Hultgren, J., Bergsten, C., 2002. Prevalence and interrelationships of hoof lesions and lameness in Swedish dairy cows. Prev Vet Med 54, 247-263.
48. Martig, J., Leuenberger, W., Dozzi, M., 1979. Häufigkeit und Art von Klauenläsionen in Abhängigkeit von verschiedenen Faktoren. Schweizer Archiv für Tierheilkunde 121, 577-591.
49. Meyer, S.W., Weishaupt, M.A., Nuss, K.A., 2007. Gait pattern of heifers before and after claw trimming: a high-speed cinematographic study on a treadmill. J Dairy Sci 90, 670-676.
50. Muggli, E., Nuss, K., 2014. Length difference of the bovine digits in standing heifers. in preparation.
51. Muggli, E., Sauter-Louis, C., Braun, U., Nuss, K., 2011. Length asymmetry of the bovine digits. Vet J 188, 295-300.
52. Murray, R.D., Downham, D.Y., Clarkson, M.J., Faull, W.B., Hughes, J.W., Manson, F.J., Merritt, J.B., Russell, W.B., Sutherst, J.E., Ward, W.R., 1996. Epidemiology of lameness in dairy cattle: description and analysis of foot lesions. Vet Rec 138, 586-591.
53. Nacambo, S., Hassig, M., Lischer, C., Nuss, K., 2007. Difference in the length of the medial and lateral metacarpal and metatarsal condyles in calves and cows - a post-mortem study. Anat Histol Embryol 36, 408-412.
54. Neveux, S., Weary, D.M., Rushen, J., von Keyserlingk, M.A.G., de Passille, A.M., 2006. Hoof discomfort changes how dairy cattle distribute their body weight. Journal of Dairy Science 89, 2503-2509.

55. Nuss, K., Paulus, N., 2006. Measurements of claw dimensions in cows before and after functional trimming: A post-mortem study. Vet J 172, 284-292.
56. Ossent, P., Lischer, C., 1998. Bovine laminitis: the lesions and their pathogenesis. In Practice, 415-427.
57. Ossent, P., Peterse, D.J., Schamhardt, H.C., 1987. Distribution of load between the lateral and medial hoof of the bovine hind limb. Zentralbl Veterinarmed A 34, 296-300.
58. Potterton, S.L., Bell, N.J., Whay, H.R., Berry, E.A., Atkinson, O.C., Dean, R.S., Main, D.C., Huxley, J.N., 2012. A descriptive review of the peer and non-peer reviewed literature on the treatment and prevention of foot lameness in cattle published between 2000 and 2011. Vet J 193, 612-616.
59. Räber, M., Lischer, C., Geyer, H., Ossent, P., 2004. The bovine digital cushion - a descriptive anatomical study. Veterinary Journal 167, 258-264.
60. Raber, M., Scheeder, M.R.L., Ossent, P., Lischer, C.J., Geyer, H., 2006. The content and composition of lipids in the digital cushion of the bovine claw with respect to age and location - A preliminary report. Veterinary Journal 172, 173-177.
61. Rüegsegger, F., 2011. Längenunterschied zwischen lateralem und medialem Zehenskelett bei Kühen mit Rusterholzschen Sohlengeschwüren im Vergleich zu Kühen mit gesunden Klauen. In, Farm Animals, Vetsuisse-Faculty, University of Zurich, City.
62. Schmid, T., Weishaupt, M.A., Meyer, S.W., Waldern, N., Peinen, K., Nuss, K., 2009. High-speed cinematographic evaluation of claw-ground contact pattern of lactating cows. Vet J 181, 151-157.
63. Schwarzmann, B., Köstlin, R., Nuss, K., 2007. Größenunterschiede zwischen den lateralen und medialen Zehenknochen und Klauen von Kälbern. Tierärztliche Praxis 35 (G), 341-349.
64. Shearer, J.K., Stock, M.L., Van Amstel, S.R., Coetzee, J.F., 2013. Assessment and management of pain associated with lameness in cattle. Vet Clin North Am Food Anim Pract 29, 135-156.
65. Smedegaard, H.H., 1964a. Contusion of the sole in cattle. The Veterinarian 2, 119-132.
66. Smedegaard, H.H., 1964b. Eksperimentek fremkaldelse af saleknusning hos kvaeg. Nordisk Veterinaermedicin 1964, 652-656.
67. Smits, M.C.J., Frankena, K., Metz, J.H.M., Noordhuizen, J.P.T.M., 1992. Prevalence of Digital Disorders in Zero-Grazing Dairy-Cows. Livestock Production Science 32, 231-244.
68. Sogstad, A.M., Fjeldaas, T., Osteras, O., 2005a. Lameness and claw lesions of the Norwegian red dairy cattle housed in free stalls in relation to environment, parity and stage of lactation. Acta Vet Scand 46, 203-217.
69. Sogstad, A.M., Fjeldaas, T., Osteras, O., Forshell, K.P., 2005b. Prevalence of claw lesions in Norwegian dairy cattle housed in tie stalls and free stalls. Prev Vet Med 70, 191-209.
70. Tadich, N., Flor, E., Green, L., 2010. Associations between hoof lesions and locomotion score in 1098 unsound dairy cows. Vet J 184, 60-65.
71. Tarlton, J.F., Holah, D.E., Evans, K.M., Jones, S., Pearson, G.R., Webster, A.J., 2002. Biomechanical and histopathological changes in the support structures of bovine hooves around the time of first calving. Vet J 163, 196-204.
72. Telezhenko, E., Bergsten, C., Magnusson, M., Nilsson, C., 2009. Effect of different flooring systems on claw conformation of dairy cows. J Dairy Sci 92, 2625-2633.
73. Telezhenko, E., Bergsten, C., Magnusson, M., Ventorp, M., Nilsson, C., 2008. Effect of different flooring systems on weight and pressure distribution on claws of dairy cows. J Dairy Sci 91, 1874-1884.
74. Telezhenko, E., Lidfors, L., Bergsten, C., 2007. Dairy cow preferences for soft or hard flooring when standing or walking. J Dairy Sci 90, 3716-3724.
75. Toussaint Raven, E., 1985. The principles of claw trimming. Veterinary Clinics of North America: Food Animal Practice 1, 93-107.

76. Van Amstel, S.R., Palin, F., Shearer, J., 2004. Measurement of the thickness of the corium and subcutaneous tissue of the hind claws of dairy cattle by ultrasound. The Veterinary Record 155, 630-633.
77. van Amstel, S.R., Shearer, J.K., 2006. Review of Pododermatitis circumscripta (ulceration of the sole) in dairy cows. J Vet Intern Med 20, 805-811.
78. Van der Tol, P.P., J. H. Metz, E. N. Noordhuizen-Stassen, W. Back, C. R. Braam, Weijs, W.A., 2002. The pressure distribution under the bovine claw during square standing on a flat substrate. Journal of Dairy Science 85, 1476-1481.
79. van der Tol, P.P., Metz, J.H., Noordhuizen-Stassen, E.N., Back, W., Braam, C.R., Weijs, W.A., 2003. The vertical ground reaction force and the pressure distribution on the claws of dairy cows while walking on a flat substrate. J Dairy Sci 86, 2875-2883.
80. Vermunt, J.J., 2000. Risk factors of laminitis - an overview. In: 11th International Symposium on Disorders of the Ruminant Digit and 3rd International Conference on Bovine Lameness, Parma, Italy, pp. 34-45.
81. Warnick, L.D., Janssen, D., Guard, C.L., Grohn, Y.T., 2001. The effect of lameness on milk production in dairy cows. J Dairy Sci 84, 1988-1997.
82. Weaver, A.D., 1975. Ulceration of the sole in cattle. Vet Rec 96, 381-382.
83. Weidmann, E., Wiestner, T., Nuss, K., 2013. Auswirkungen einer geneigten Standfläche und von vorne erhöhtem Stehen auf den Körperschwerpunkt und die Gewichtskräfte der Klauen von Schulter- und Beckengliedmassen. In: Buiatrik-Tagung, München.
84. Westerfeld, I., 2003. Struktur und Funktion des bovinen Klauenbeinträgers. In, Institut für Veterinäranatomie, Fachbereich Veterinärmedizin, Freie Universität Berlin, Vol. Inaugural-Dissertation, City, p. 248.

NOTES

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COMBINING VETERINARY AND SOCIAL SCIENCE FOR THE ADVANCEMENT OF EFFECTIVE CLAW LESION TREATMENT

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SUMMARY

Providing evidence based, practical, on-farm solutions for the treatment of lameness requires a multi-factorial approach.

Timing of treatment is a primary consideration in developing protocols. Early treatment of lame cows may result in higher cure rates and a decrease of lameness prevalence on farm according to some authors. A study investigating the benefits and drawbacks of detecting new cases of lameness using a 2-weekly scoring regime and treating animals within 48 hours resulted in high recovery rates, development of less severe lesions, increasing chance of full recovery and decreased the amount of time an animal was lame.

Improving the treatment of lame dairy cows on farms may be more successful if we understand how farmers detect lame cows, decide whether to treat them and get them to the point of treatment. Using social science techniques we can gain important insights into how lameness treatment occurs on farms from the farmers' point of view. Understanding the barriers to treatment experienced by farmers allows us to develop protocols which are practical and relevant on a commercial dairy farm.

Finally we need to identify effective treatments. A variety of options are available for the treatment of claw horn lesions in dairy cattle but to date, little information exists in the literature to support treatment choices. A randomised clinical trial was carried out to test the effectiveness of four treatment options. By providing high quality data on the effectiveness of these it is possible for veterinary surgeons, farmers and hoof trimmers to make informed decisions on appropriate treatment of lame cows.

By bringing together veterinary and social science we can develop practical, evidence based solutions to advance the treatment of claw horn lesions in dairy cattle.

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EARLY DETECTION AND TREATMENT, BENEFITS AND DRAWBACKS

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Introduction

Early treatment of lame cows could result in higher cure rates and a decrease of lameness prevalence on farm according to some authors (2, 7).

A definition for either early detection or early treatment has not been established yet. ‘Early’ could relate to the time an animal has been lame for or the severity of lameness. Those two might relate to each other as studies have shown that delays in detection and treatment of lame cows is a risk factor for the development of severe lameness (3).

The study that will be described here has attempted to quantify the benefits of early detection (within 2 weeks) and early treatment (within 48 h after detection) on recovery from that lameness. Benefits of this strategy with regards to productivity, fertility or longevity will be published at a later date.

Materials and Methods

Four dairy farms in the South West of England were recruited into this study. The participating farmers were asked to continue their normal foot trimming and lameness treatment regime throughout the study. Two weekly lameness scoring (LS) using a 0-3 scoring system (4) was carried out at milking during the housing period for three consecutive years. To ensure all study animals had the same level of soundness at the start of the study, all cows with LS of 2 or 3 in the initial two scoring sessions were excluded. All eligible cows on each farm were then matched by parity and stage of lactation and subsequently randomly allocated to treatment (TX) and control (CX) groups.

Cows that had been included in the TX group study would become eligible for treatment of they had had at least two sound scores (0 or 1) followed by a score 2 on one or both of the hind limbs. Cows that had the same scoring pattern but that had been allocated in the CX group were available for the farmer to treat at his discretion although the farmers were not informed of specific CX cows.

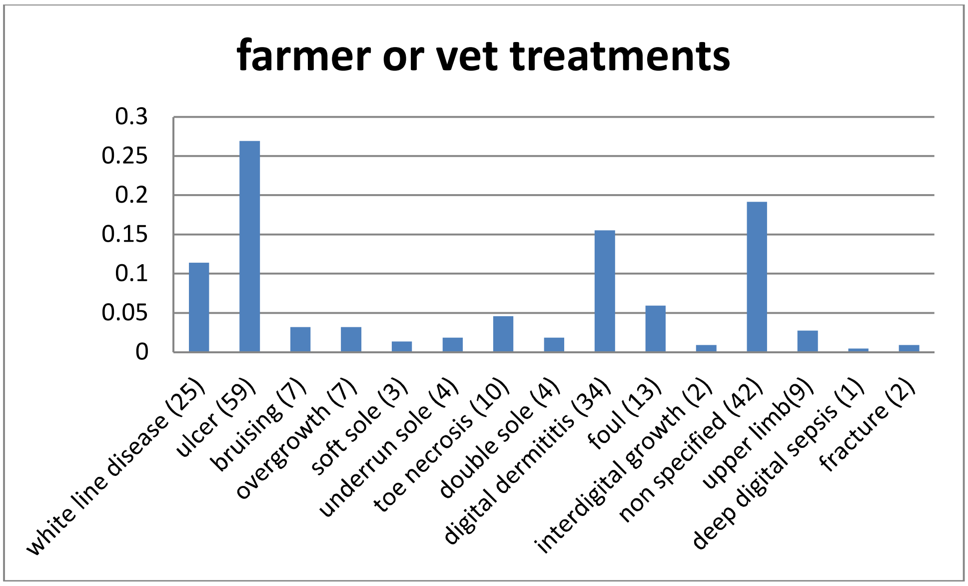
Animals that became eligible in the TX group received treatment according to the Dutch 5 Step Method (8) within 3-48 h. The severity and type of lesions found were recorded.

Results

The proportion of animals that stay sound within both the TX (n=171) and CX (n=256) groups was consistently higher within the TX group. The proportion of animals staying lame was consistently lower in the CX group. Even though the proportion of the animals staying sound decreased over time in both groups, the difference between the two groups was significant for every visit recorded, and appears to widen from 10-12 weeks after the original lameness episode.

The primary lesions found at first treatment in the TX group were mainly sole haemorrhage (41%) and digital dermatitis (33%). Only 6.5% severe lesions (sole ulcers or toe necrosis) were found. Of all animals treated, 88 (51.5%) animals only had claw horn lesions, 22 (12.9%) animals only had soft tissue lesions and 56 (32.7%) had both soft tissue and claw horn lesions. The remaining animals (5) had a combination of upper leg lameness with or without foot lesions (4) and or no lesions found (1).

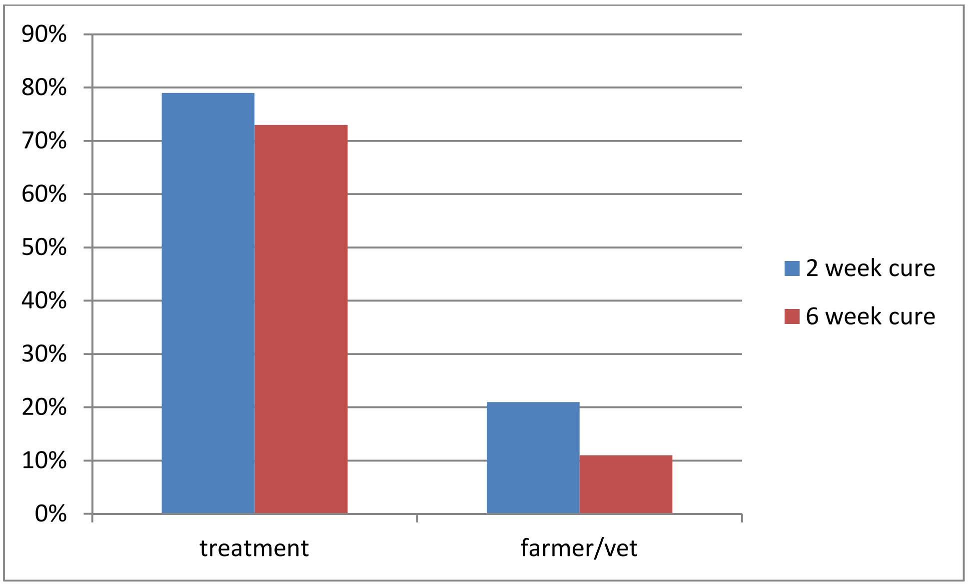
Figure 1: Lesions found on conventional treatment



In the CX group, a total of 19 animals out of 256 had a recorded treatment during the study periods. Of those 19 animals 28.4% had severe lesions (sole ulcers and white line disease). The lesions in the control cows that were not treated remains unknown in this study.

The lesions found on conventional treatment on these farms are displayed in Figure 1. The proportion of severe lesions (ulcers, toe necrosis) found on those treatments is high compared to severe lesions found in the TX group (6.5% to 31%). Also, there is marked difference between cure rates for the TX group at week 2 and 6 post treatment and conventionally treated animals on those farms (Figure 2).

Figure 2: Recovery rates at 2 and 6 weeks post treatment for the TX group and conventionally treated cows



Discussion

In this study the main lesions found on treatment were sole haemorrhage and digital dermatitis. Only a small percentage of the cows treated had a white line lesion (4.4%) or a sole ulcer (6.2%) as primary lesion. This is in contrast to previous studies that show up to 40% lesions found to be white line disease or sole ulcers (1, 6). It might be argued that sole haemorrhage is not a lesion causing lameness as it relates to trauma on the corium that happened previously and probably is not the reason the animal is lame at the moment the animal is scored a score 2. It does however often indicates that that claw has been subjected to an imbalance of weight distribution in the recent past, or the trauma that produced the sole haemorrhage has resulted in imbalance; the sequence of changes leading to these lesions is still not established. Unless a lesion is found that opens directly onto the corium, it is difficult to know exactly what is happening at the level of the corium when trimming a cows' foot. This study suggests however that sole haemorrhage (or its development) in itself can be a painful process for the cow.

A delay in treatment of lame cows is often reported in other studies (5). When looking at the lesions found on treatment of the CX group that was left to the farmers' discretion, the percentages of sole ulcers found is substantially higher than that of the TX group. This percentage is even higher (27%) for animals on those farms that did not enter the study but that did received treatment for lameness. As we do not know the complete history of these cows (some would have been lame for a considerable amount of time, others may have had previous treatments outside the study periods) we cannot fully compare this group of 'conventionally' treated cows with either the TX or CX group. However, as figure 5 clearly shows, the recovery rate of those cows was very poor. This is likely to be a reason farmers often do not like trimming lame cows or get demoralised by the treatments they do as they do not see the effect of treatment and are therefore little motivated to continue to treat lame cows.

Although the difference between TX and CX in recovery is significant, this difference is not as large as the authors' thought it might have been. This is due to both the TX cows relapsing and the CX cows recovering without (recorded) treatment. At least a proportion of the CX cows will have suffered from a soft tissue lesion as digital dermatitis. On three of the four farms foot bathing was carried out on a regular basis and some of the CX cows will have recovered as a result of a herd treatment like foot bathing rather than a recorded individual treatment. Apart from this, some CX cows that suffered minor claw horn lesions might have 'self cured' due to adjusting their lying and standing times. The data in this study however suggested that even if they do self cure initially, the CX cows have a higher risk of relapsing and they do this sooner than the TX cows.

Apart from the above mentioned explanations, there is always a risk that cows are incorrectly scored lame. An underestimation of the score could happen due to lameness on both hind legs or cows running past the scorer instead of walking. An overestimation of the score could be explained due to human error, misidentification of cows or irregular surface. Most of the risk factors for miss-scoring were kept to a minimum during this study but cannot be completely ruled out.

Conclusion

The detection of new lameness cases in a dairy cows using a 2-weekly scoring regime resulted in high recovery rates, development of less severe lesions, increasing chance of full recovery and decreased the amount of time an animal was lame. These findings suggest that regular scoring in combination with early treatment will decrease lameness levels on farm compared to more conventional methods.

References

1. Barker ZE, 2007. Epidemiology of Lameness in Dairy Cows. PhD Thesis, Warwick.
2. Bell NJ, 2006. The alleviation and prevention of lameness in dairy heifers. PhD, University of Bristol.
3. Bell NJ, Bell MJ, Knowles TG, Whay HR, Main, DJ and Webster AJF (2009) The development implementation and testing of a lameness control programme based on HACCP principles and designed for heifers on dairy farms. Veterinary Journal, 180, 178-188.
4. DairyCo 2014 http://www.dairyco.org.uk/technical-information/animal-health-welfare/lameness/husbandry-prevention/mobility-scoring/
5. Leach KA, Tisdall DA, Bell NJ, Main DCJ and Green LE (2012) The effects of early treatment for hindlimb lameness in dairy cows on four commercial UK farms. (Special Issue: Bovine lameness.). Veterinary Journal 193, 626-632.
6. Murray RD, Downham DY, Clarkson MJ, Faull WB, Hughes JW, Manson FJ, Merrit JB, Russell WB, Sutherst JE and Ward WR (1996) Epidemiology of lameness in dairy cattle: Description and analysis of foot lesions. Veterinary Record, 138, 586-591.
7. Reader JD, Green MJ, Kaler J, Mason SA and GREEN LE (2011) Effect of mobility score on milk yield and activity in dairy cattle. Journal of Dairy Science, 94, 5045-5052.
8. Toussaint Raven E (1985) Cattle footcare and claw trimming, Suffolk, UK, Farming press Ltd.

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LAMENESS TREATMENT FROM THE FARMERS' PERSPECTIVE

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Introduction

Interventions aimed at improving treatment of lame dairy cows on farms may be more successful if we gain insight into how farmers detect lame cows, decide whether to treat them and get them to the point of treatment. My research has therefore focused on understanding lameness treatment from the dairy farmers' point of view.

Materials and Methods

A telephone survey was used to gather information on current practice in relation to the treatment of sole ulcer (SU) and white line disease (WLD) on farms. Questions related to time between detection and treatment, the perceived barriers to prompt treatment, treatment methods being employed and attitudes to common treatment methods. A sub-sample of the survey respondents were then interviewed in-depth gain further insight into how lameness detection and treatment occurs on farms and the farmers' experiences of this process (2, 3).

Results and Discussion

Eighty four dairy farmers participated in the telephone survey of which 12 were subsequently interviewed in-depth.

Detection of Lame Cows

The DairyCo Mobility Scoring System (1) was developed to help farmers detect lameness in their cows. During the in-depth interviews farmers discussed some of the perceived benefits to carrying out formal mobility scoring. As one farmer said 'So your score threes [severely lame cows] you'd be picking those up anyway because they're lame and you notice them. But the ones that are starting to go a bit lame, you notice actually she's not walking quite right and you pick those up sooner'. However, the majority of farmers interviewed felt that they were able to detect lame cows as part of their normal working day and doubted the benefits of formal mobility scoring: 'You just wonder how much I actually learn because by bringing the cows in for milking, scraping up, feeding, you see how the cows are indirectly… not by specifically scoring every cow. Because its stockman's eye, the experience, the flavour that you build by doing the job seven days a week'. Further to this there were concerns about the practicality of mobility scoring: 'It's finding a place to do it and finding a person to do it. I don't see much point in chopping and changing, it needs to be the same person all the time'.

Farmer underestimation of lameness prevalence in their herds has been attributed to poor detection skills amongst farmers, and yet the farmers interviewed felt confident in their abilities to detect lameness. Another explanation for this apparent underestimation is that farmers may use different language when talking about lameness as demonstrated by the different phrases they used to discuss cows which were potentially lame:

> 'you notice she's not walking quite right'
> '[cows which are] just a little bit impaired in how mobile they are' and 'it's just her mobility is not very good'
> '[they] aren't walking correctly' and '[they are] walking a little light'

> 'Maybe I'm not good enough at noticing the poor mobility or the impaired mobility'.
> 'so I think generally her mobility is suffering a bit'

It is noticeable that the term 'lameness' is often avoided by farmers when discussing anything other than severe lameness in their cows. Consequently, underestimation of lameness prevalence may have less to do with under detection and more to do with the alternative language which farmers use to discuss 'lame' cows.

Prompt Treatment

Seventy five percent of the farmers who completed the telephone survey reported treating lame cows within 48 hours of detection. Five percent of these stated that this period could be longer if the cow was detected as lame at a busy time or over the weekend. On 8% of farms speed of treatment was reported to depend on the severity of the lameness. Time between detection and treatment was further explored during the in-depth interviews. Treatment delay was often linked to farmers' perceptions of the severity of the lameness and the value of treatment. As one farmer said of the cow he was treating at the time of the interview: 'It's one of those that's just rumbled. It's never been that bad that you want to say "right we've got to get her in" because she's always got about'.

Whilst failure to recognise the value of prompt treatment may be one reason why treatment may be delayed, other factors may also play a part. Lameness treatment occurs within the framework of a complex farming business where many different priorities compete and where there are pressures on both time and staff resources. Other jobs may take priority: 'I know a cow needs her foot done straight away if she's lame but it's stupidity to ruin your silage for the sake of doing some feet', or skilled staff may not be available: ' [the herdsmen] ain't here on a Sunday and I suppose if it was this time of year I might be in a position to have more time to do it, but in winter time I wouldn't have a chance'. During the telephone surveys time, staff availability and 'other activities' were all highlighted as barriers to prompt treatment.

Factors which facilitated prompt treatment also emerged from the survey and interviews. The telephone survey revealed that farmers perceive a good drafting system, good equipment and seeing the cow walk better after treatment as motivators for treatment. The importance of 'cow flow' in the treatment process was emphasised during the in-depth interviews: 'I wanted to have a crush that was within a race so I could put them in easy'.

Farmers also discussed the sense of satisfaction that they got when they could find the cause of the lameness, treat it and in particular when they saw a cow walk better after treatment: 'There's a sense of satisfaction to it. It's nice to put the foot down and see her walk off better than she came in'

Our current scientific understanding suggests that there are benefits to prompt treatment in terms of recovery and reoccurrence but also that some cows do appear to'self cure', even if only for limited periods of time (4 and Margit Groenevelt, see previous section). If we consider 'treatment' to involve some form of trimming, this may have a detrimental effect in some cows, for example those with very thin soles. When we consider this alongside the complexities of the context in which lameness treatment occurs farmers may benefit from guidance about when, from the dairy farmer and cows point of view, is best time to treat and which cows will benefit from treatment. There may also be benefits in broadening what we mean by the term 'treatment', for example placing a lame cow onto straw and/or reducing the amount of walking a mildly lame cow has to do could be considered to be 'treatment' under a wider definition and may be beneficial for some cows.

Treatment Methods

Farmer attitudes towards treatment strategies and their ability to carry out treatments must be considered. These were important considerations in the research (carried out by Heather Thomas and colleagues, as discussed in the following section). The findings from the telephone survey suggested that many farmers had negative attitudes to the placing lame cows onto straw beds. Farmers expressed concern about: not having enough space to house cows on straw, having another group of cows to manage in addition to the main milking herd, increased risk of mastitis, separating cows from the main herd. Some saw the cost of straw as prohibitive. For these reasons, placing cows on to straw was not incorporated into the RCT described below. Whilst neither the survey or the interviews asked specifically about non steroidal anti-inflammatory drug (NSAID) use in lame cows, a minority of farmers reported using them (17% of survey respondents). NSAIDs reduce the hyperalgesia experienced by lame cows (5), the primary justification for including their use in the RCT. Understanding some of the perceived barriers associated with NSAIDs will be important for encouraging greater use on farms. For example, some of the farmers interviewed in-depth knew that NSAIDs were available and could be used as part of a lameness treatment strategy but felt their cows were generally not lame enough to warrant using them: ‘I haven’t had anything that severe that I’ve had to use [a NSAID] because I don’t let them get to that stage’.

Finally, when advocating treatment strategies we need to consider farmers’ abilities to carry these treatments out successfully. Many of the farmers surveyed and subsequently interviewed had not received any formal foot trimming training. Only 31% of the farmers surveyed had received any intensive foot trimming training and many learnt from either watching other people (70%) and/or through experience (65%). Despite this several of the farmers interviewed reported feeling confident in their trimming skills: ‘Because you are doing it on a regular basis it’s reasonably obvious’. It is difficult to quantify the quality of the treatment which an individual cow may receive and furthering our understanding of how farmer treatment techniques and skills impact on lameness is likely to be important as this may confound with treatment delay in studies which compare farmer and vet treatment.

This research gives important insight into how lameness treatment occurs on farms from the farmers’ point of view. This understanding is vital if we are facilitate to improvements in the process.

References

1. DairyCo 2014 http://www.dairyco.org.uk/technical-information/animal-health-welfare/lameness/husbandry-prevention/mobility-scoring/
2. Horseman SV, Roe, EJ, Huxley, JN, Bell, NJ, Mason, CS and Whay, HR IN PRESS The use of in-depth interviews to understand the process of treating lame dairy cows from the farmers’ perspective. Animal Welfare
3. Horseman SV, Whay, HR, Huxley JN, Bell NJ and Mason CD 2013 Current on-farm practice in the treatment of sole ulcer and white line disease associated with lameness in dairy cattle. The Veterinary Journal 197: 461-467.
4. Leach KA, Tisdall DA, Bell NJ, Main DCJ and Green LE 2012 The effects of early treatment for hindlimb lameness in dairy cows on four commercial UK farms. The Veterinary Journal 193: 626-632.
5. Whay HR, Webster AJF and Waterman-Pearson AE 2005 Role of ketoprofen in the modulation of hyperalgesia associated with lameness in dairy cattle. The Veterinary record, 157: 729-733.

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EARLY AND EFFECTIVE TREATMENT OF CLAW HORN LESIONS

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Introduction

A variety of options are available to veterinary surgeons and farmers for the treatment of claw horn lesions in dairy cattle but to date, little information exists in the literature to support treatment choices. A review of the peer-reviewed literature published between 2000 and 2011 on the treatment and prevention of foot lameness in cattle (2) identified 27 studies relating to the treatment of digital dermatitis but only three papers on the treatment of sole ulcers and none on the treatment of white line disease. An extended search prior to 2000 also revealed very few papers on claw horn lesions. From this it is clear that there is little up-to-date information in the literature to inform on the most appropriate treatment interventions at either individual cow or herd level. My research aims to begin to address this issue by investigating the outcome of different treatment options for claw horn lesions.

Study design

It is widely recognised in medicine that the most rigorous way to determine a cause-effect relationship between a treatment and outcome is by conducting a double-blind, randomised controlled clinical trial (RCT). However, conducting such a study for lameness treatments in dairy cattle throws up many complexities. Initial considerations included selection of appropriate cases for inclusion and deciding which treatments to test.

Lame animals were identified using the DairyCo mobility scoring system which is widely recognised in the UK dairy industry (1). The scoring system was modified to a six point scale to allow further differentiation within the lame scores. As well as severity of lameness it was necessary to take duration of lameness into account as severity may alter over time. It was decided that the initial study would concentrate on individuals who were newly lame (2 or more 'non-lame' mobility scores followed by a 'lame' score) with a separate study planned to investigate treatment of the chronically lame individuals. Five dairy farms in central England were involved in the trial. All the cows on each farm were mobility scored fortnightly over a 12 month period. Following enrolment on the study, cows were scored at eight days post treatment, at 14 and 28 days with the herd and independently at 35 days for a final outcome score.

Identification of appropriate treatments for use in the study was necessary in order to ensure the protocols developed were both accessible to farmers and relevant to the clinical situation. An expert review was conducted to ascertain key treatment options. From this process it was clear that the main treatments to investigate were use of a five stage, therapeutic foot trim, use of foot blocks and use of analgesia. While use of straw yards was identified during the expert review, this option was discounted due to concerns over management logistics when combined with results of the study looking at on-farm barriers to treatment carried out by Sue Horseman. As all animals would require a foot trim in order to diagnose a claw lesion, it was decided that the five stage, therapeutic foot trim would be used as a positive control group with additional treatments of a foot block, non-steroidal anti-inflammatory drug (NSAID) or combination of both allocated at random (figure 1). Treatment was randomised ensure that no third factor, known or unknown, could influence the outcome. To allow for farm level factors, treatments were blocked by farm then randomised in blocks of four, with one repetition of each treatment in each block to ensure approximate temporal matching over the 12 month period of the study.

Figure 1: Four treatment groups selected for study

		FOOT BLOCK	
		NO	YES
NSAID	NO	Treatment 1	Treatment 2
	YES	Treatment 3	Treatment 4

A key feature of the RCT design includes blinding to prevent bias from preconceived ideas of treatment effectiveness. Ideally the owner/manager of the animals would be blind to the treatments used however this was not possible with use of visible foot blocks and medications which required repeat administration and recording. For this reason the study was only partially-blinded with an independent assessor, blind to the treatments, carrying out the outcome mobility score at 35 days post treatment. Foot blocks were removed at 28 days post treatment to ensure they neither affected the animals mobility nor the assessors observation at the outcome score.

Results

Approximately 1100 cows were mobility scored fortnightly during the course of the study. Of these 512 were identified as newly lame and examined and 183 met the RCT criteria for enrolment. The majority of the cows excluded from the study were found to have lesions affecting both claws and were therefore unsuitable for treatment with a foot block. Treatments were discontinued on one farm after 9 months due to low lameness levels present.

Analysis of the data is still ongoing however provisional results show that response to treatment is significantly different across the groups.

Conclusion

By providing high quality data on the effectiveness of treatments for claw horn lesions it is possible for veterinary surgeons, farmers and hoof trimmers to make informed decisions on appropriate treatment of lame cows. This study looking at the effectiveness of two additional treatments in newly lame cows, compared to a five stage, therapeutic foot trim alone, gives us some insight into this area, however there is much more work to be done looking at other treatment options and cows in different stages of lameness.

References

1. DairyCo 2014 http://www.dairyco.org.uk/technical-information/animal-health-welfare/lameness/husbandry-prevention/mobility-scoring/
2. Potterton, SL, Bell NJ, Whay HR, Berry EA, Atkinson OCD, Dean RS, Main DCJ and Huxley JN 2012 A descriptive review of the peer and non-peer reviewed literature on the treatment and prevention of foot lameness in cattle published between 2000 and 2011. The Veterinary Journal, 193(3): 612-616

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NOTES

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THE PRACTITIONER'S APPROACH – ESTIMATING PERFORMANCE LOSSES

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SUMMARY

Fertility in the modern dairy herd is a multifactorial event, this paper summarises some of the factors affecting fertility and the role lameness plays within it. The accompanying presentation describes the results of an 18 month project following 836 dairy cows collecting approximately 14,000 mobility and body condition scores together with other clinical events which affect fertility (summarised in this paper) in an attempt to define the role mobility score has on the reproductive efficiency of the UK dairy herd – due to other publication commitments the results cannot be published here.

INTRODUCTION

Lameness has been described as the single most common cause of distress in dairy cows (95) and levels in UK have been termed "unacceptable" (36). A recent report suggested that these levels had not changed significantly in the last decade, a situation which needs to be tackled urgently (37). Lameness also has impacts on health and productivity resulting it being a major reason for early culling (15, 40). Domesticated cattle are descended from herbivores and are essentially a prey species; as a consequence they have maintained a strong evolutionary pressure to mask pain and weakness (74), this then transfers to the expression of lameness.

THE UK SITUATION

The current UK lameness situation is difficult to accurately establish as studies often use multiple observers (with the inherent issues of inter-observer variation (20)) and include observations by farmers, who consistently under-report lameness incidence and prevalence (96, 97, 99). Despite this the prevalence is believed to be around 20% (see APPENDIX 1 and APPENDIX 2).

Lameness is described as a debilitating condition, associated with tissue damage, pain and discomfort manifesting as an inability to walk normally (69). Eighty eight percent of lameness is associated with disorders of the feet (82) of which 92% will be in the hind feet with the lateral hind claw being four times more likely to suffer a lameness causing lesion than the medial (21). Sixty five percent of lameness involves the claw (rather than the skin) with sole ulcers (29.3-36%) and white line lesions (22-22.2%) consistently quoted as being the most common causes (8, 21).

Various visual scoring techniques for gauging the degree of lameness have been developed which include; asymmetry of gait (96), back posture when standing and walking (86) and length of stride (98).

Dairy herd fertility in the UK is thought to be declining with first service pregnancy rates falling at a rate of approximately one percent per annum and the calving index of the national herd continuing to rise (54). Much of this decline is attributed to increasing yields, as frequency of standing to be mounted and first service pregnancy rate are negative correlated to yield (27), however other production diseases which can negatively impact fertility cannot be ignored.

LAMENESS AND FERTILITY

Lameness and fertility, as with most production diseases of dairy cows, are multi-factorial and highly interlinked. There is an increasing body of work regarding the negative effects lameness can have on fertility (2, 39, 66), however studies using mobility score as a measure of lameness to investigate the associations with fertility are limited (14, 50, 72, 86). Most studies investigating associations between lameness and fertility find a negative association (23, 58, 89) however others have found no association (22, 29, 72).

Table 1 summarises the recent literature surrounding the effects of lameness on the calving to conception interval, further effects of lameness on various fertility factors can be seen in APPENDIX 3.

Table 1 - Summary of literature regarding effects of lameness on calving to conception interval

Effect on calving to conception	Description	Study location	Study
No effect	Lameness (determined by mobility score) had no effect on calving to conception on UK cows using DairyCo scoring system	UK	(72)
"Extended intervals"	Cows scoring >2 (on a 5-point mobility score)	US	(86)
3.4 day extension	Lameness diagnosed by both farmer and vet	Netherlands	(7)
8.9 day extension	Clinical digital disease in cows culled for this reason	Netherlands	(33)
11 day extension	Sole ulcer or white line disease 36-70 days in milk	UK	(58)
14 day extension		UK	(23)
20 day extension	Cows affected with digital dermatitis	Mexico	(2)
28 day extension		US	(56)
36 day extension	Cows with low cumulative mobility scores	US	(50)
40 day extension	Lame cows with claw lesions relative to healthy	US	(49)
50 day extension	Cows with high cumulative mobility scores	US	(50)

Previous work has associated lameness in the post-partum period with a higher incidence of ovarian cysts (66), delayed onset of ovarian cyclicity (39), reduced pregnancy rates (49, 52, 87), a requirement for more serves per conception (23, 86) and a lower frequency of standing to be mounted (85).

It has been suggested that lameness is more likely to occur in the first 60 days of lactation (41, 79) as a result of claw horn disruption at parturition and the critical changes occurring during the transition period, to include changes to the under-foot and housing environment, feeding management and nutrition (12, 38, 90).

Lameness is a painful and stressful condition resulting in hyperalgesia and catabolism (98) which can result in increases in the circulating levels of catecholamines, glucocorticoids and stress-induced prostaglandins from the adrenal glands (67, 94).

Increases in adrenocorticotrophic hormone, cortisol and progesterone have been related to a delay or inhibition of the gonadotrophic releasing hormone (GnRH) and/or luteinising hormone (LH) surge and the alteration of normal follicular activity with the formation of persistent ovarian follicles (25, 26, 67).

It is likely that this pain results in lame cows spending longer lying down leading to a reduced dry matter intake (DMI) with less time spent ruminating (47, 83). As a result these animals may lose more condition and experience a greater energy deficit when compared with non-lame post-partum animals. Excessive body condition loss during early lactation may effect cyclicity via; an inhibitory effect on ovarian follicular growth and development (24, 59), less frequent pulses of LH and lower serum concentrations of insulin-like growth factor 1 (IGF-1), these act synergistically to promote follicular development (60, 61). Dominant follicles in cows experiencing negative energy balance need more time and must reach a larger size to produce oestradiol levels capable of inducing ovulation (10).

Lameness can also influence oestrus expression, as although lame cows have a similar duration and incidence (once ovarian cyclicity has restarted (93)) as non-lame cows, lame cows have a lower frequency of standing to be mounted, with a recent study reporting 2.4 compared to 8.0 mounts/hour (85) together with a lower “intensity” (91) suggesting that the odds of being served are reduced, probably as a result of the pain related stress.

In summary, as lame cows may lose more weight and may have a more pronounced negative energy balance it seems less likely they will display oestrus and be served, more likely to suffer concurrent disease which might influence conception, but also if served they are less likely to ovulate and conceive.

YIELD AND FERTILITY

High yielding cows experience an increase in energy requirements to facilitate the dramatic increases in daily milk yield which peaks at approximately four to eight weeks post-partum, this increased requirement is met through a combination of increased feed consumption and mobilisation of body reserves resulting in a loss of condition, while it is normal for the high yielding animal to lose body condition and enter a period negative energy balance (42), it is the amount of body condition loss and the depth of the negative energy balance which is important. Body condition score has been genetically and phenotypically correlated to fertility performance (13, 18). Cows who are in low BCS at calving or suffer excessive loss during early lactation are less likely to ovulate, have decreased submission rate, pregnancy rates to first service, six week pregnancy rate and an increased calving to conception interval (77) partly as a result of impaired oocyte competence associated with low BCS (84). Excessive BCS at calving can also have a detrimental effect on fertility performance due to impaired DMI resulting in greater fat mobilisation and a more severe BCS loss (77).

Increasingly, evidence is coming to light of negative energy balance resulting in compromised immune systems (43, 68, 92) leaving the cow concerned more likely to suffer concurrent disease and/or clear pre-existing uterine contaminations – again reducing the risk of conception.

Yield has a negative association to fertility (19, 81) previously defined as a decrease in the percentage of cows standing-to-be-mounted (78, 91, 93), an increase in the number of silent heats (45) and a decrease in the risk of pregnancy and first insemination (87). Yield has also been suggested to increase the risk of lameness, with each additional 100kg of milk produced by 100 days in milk in the preceding lactation the risk of being lame increased by 1.06 (7).

A recent review by Madouasse, Huxley et al. (62) found that the probability of conception before 145 days in milk increased with lower milk production on the second test-day, higher percentage of protein on the second test-day, and higher percentage of lactose on the first test-day.

LAMENESS AND OTHER DISEASE

Milk fever, uterine infection, dystocia, clinical mastitis and retained foetal membranes have all been suggested to negatively influence subsequent fertility (16, 70, 87).

Management of the herd may also have effects on fertility performance. Housing systems can directly influence fertility as cows kept on hard concrete surfaces show less mounting activity than cows kept on dirt yards (17). Housing may indirectly affect fertility performance by increasing the incidence of other diseases including lameness, with cows housed in cubicles having a higher incidence of lameness than those housed on straw yards in one study (5). It has also been suggested that lameness incidence may be higher in larger herds (101).

Lameness can increase the incidence of other disease, lame cows find it harder to lie down and rise which increases the risk of teat tramps (76) which in turn predicts clinical mastitis (11, 32, 71). Herd level associations between poor foot health and high incidence of clinical mastitis have been made (4) with feet being more frequently trimmed in herds with low bulk milk somatic cell count than in herds with high (31). However Hultgren, Manske et al. (52) failed to find any association between sole ulcer and clinical mastitis or elevated bulk milk somatic cell count. Cows who suffer digital diseases are more likely to suffer metabolic disease, with an odds ratio of 1.60, and an attributable risk of 0.12 reported in one study (33). The same study also found that three percent of gynaecological disorders and four percent of retained foetal membranes could be attributed to digital disease.

A seasonal aspect has also been suggested to lameness, with a higher incidence and prevalence in the winter than the summer (21, 101).

REFERENCES

1. Alban, L., Lameness in Danish dairy cows: frequency and possible risk factors. Preventive Veterinary Medicine, 1995. 22(3): p. 213-225.
2. ArgaezRodriguez, F.D.J., et al., Papillomatous digital dermatitis on a commercial dairy farm in Mexicali, Mexico: Incidence and effect on reproduction and milk production. Preventive Veterinary Medicine, 1997. 32(3-4): p. 275-286.
3. Arkins, S., Lameness in dairy cows. Irish Veterinary Journal, 1981. 35(135): p. 163-170.
4. Arvidson, A.-K., Environmental and management factors associated with the incidence of clinical mastitis in high yielding dairy herds with a low incidence of subclinical mastitis. 2000, Department of Animal Nutrition and Management, Swedish University of Agricultural Science: Uppsala, Sweden.
5. Baggott, D. and A. Russell, Lameness in cattle. British Veterinary Journal, 1981. 137(1): p. 113-132.
6. Baggott, D.G., Losses due to lameness caused by physical contact with buildings, in Technical Journal. 1982, Farm Buildings Association: Oxford. p. 12-15.
7. Barkema, H., et al., The effects of lameness on reproductive performance, milk production and culling in Dutch Dairy Farms. Preventive Veterinary Medicine, 1994. 20: p. 249-259.

8. Barker, Z.E., et al., Management Factors Associated with Impaired Locomotion in Dairy Cows in England and Wales. Journal of Dairy Science, 2007. 90(7): p. 3270-3277.
9. Barker, Z.E., et al., Assessment of lameness prevalence and associated risk factors in dairy herds in England and Wales. Journal of Dairy Science, 2010. 93(3): p. 932-41.
10. Beam, S. and W. Butler, Effects of energy balance on follicular development and first ovulation in postpartum dairy cows. Journal of Reproduction and Fertility (Supplement), 1999. 54: p. 411-24.
11. Bendixen, P.H., et al., Disease frequencies in dairy cows in Sweden. V. Mastitis. Preventive Veterinary Medicine, 1988. 5: p. 263-274.
12. Bergsten, C., Effect of conformation and management system on hoof and leg diseases and lameness in dairy cows. Veterinary Clinics of North America: Food Animal Practice, 2001. 17: p. 1-23.
13. Berry, D.P., et al., Genetic relationships among body condition score, body weight, milk yield, and fertility in dairy cows. Journal of Dairy Science, 2003. 86: p. 2193-2204.
14. Bicalho, R.C., et al., Visual locomotion scoring in the first seventy days in milk: impact on pregnancy and survival. Journal of Dairy Science, 2007. 90(10): p. 4586-91.
15. Boettcher, P.J., et al., Genetic Analysis of Clinical Lameness in Dairy Cattle. Journal of Dairy Science, 1998. 81(4): p. 1148-1156.
16. Borsberry, S. and H. Dobson, Periparturient diseases & their effects on reproductive performance in five dairy herds. Veterinary Record, 1989. 124: p. 217-219.
17. Britt, J.H., et al., Determinants of Estrous Behavior in Lactating Holstein Cows. Journal of Dairy Science, 1986. 69(8): p. 2195-2202.
18. Buckley, F., et al., Relationships among milk yield, body condition,cow weight, and reproduction in spring-calved Holstein-Friesians. Journal of Dairy Science, 2003. 86: p. 2308-2319.
19. Butler, W., Energy balance relationships with follicular development, ovulation and fertility in post partum dairy cows. Livestock Production Science, 2003. 83: p. 211-218.
20. Channon, A., et al., Variability of Manson and Leaver locomotion scores assigned to dairy cows by different observers. Veterinary Record, 2009. 164: p. 388-392.
21. Clarkson, M., et al., Incidence and prevalence of lameness in dairy cattle. Veterinary Record, 1996. 138: p. 563-567.
22. Cobo-Abreu, R., et al., The association between disease, production and culling in a university dairy herd. Canadian Veterinary Journal, 1979. 20(7): p. 191-5.
23. Collick, D.W., W.R. Ward, and H. Dobson, Associations between types of lameness and fertility. Veterinary Record, 1989. 125(5): p. 103-6.
24. de Vries, M.J. and R.F. Veerkamp, Energy Balance of Dairy Cattle in Relation to Milk Production Variables and Fertility. Journal of Dairy Science, 2000. 83(1): p. 62-69.
25. Dobson, H., et al., Ultrasound and hormone profiles of ACTH-induced persistent ovarian follicles (cysts) in cattle. Journal of Reproduction and Fertility, 2000. 120: p. 405-410.
26. Dobson, H. and R. Smith, What is stress, and how does it affect reproduction? Animal Reproduction Science, 2000. 60-61: p. 743-752.
27. Dobson, H., et al., Why is it getting more difficult to successfully artificially inseminate dairy cows? Animal, 2008. 2(8): p. 1104-1111.
28. Dohoo, I.R., et al., Disease, production and culling in Holstein-Friesian cows II. Age, season and sire effects. Preventive Veterinary Medicine, 1984. 2(5): p. 655-670.
29. Dohoo, I.R. and S. Wayne Martin, Disease, production and culling in Holstein-Friesian cows: IV. Effects of disease on production. Preventive Veterinary Medicine, 1984. 2(6): p. 755-770.

30. Eddy, R. and C. Scott, Some observations on the incidence of lameness in dairy cattle in Somerset. Veterinary Record, 1980. 106(7): p. 140-144.
31. Ekman, T., A study of dairy herds with constantly low or constantly high bulk milk somatic cell count-with special emphasis on management, in Acta Univ. Agric. Sueciae, Veterinaria 32. 1998, Swedish University of Agricultural Sciences: Uppsala, Sweden.
32. Elbers, A.R.W., et al., Risk Factors for Clinical Mastitis in a Random Sample of Dairy Herds from the Southern Part of The Netherlands. Journal of Dairy Science, 1998. 81(2): p. 420-426.
33. Enting, H., et al., Economic losses due to clinical lameness in dairy cattle. Livestock Production Science, 1997. 49(3): p. 259-267.
34. Esslemont, R. and M. Kossaibati, Incidence of production diseases and other health problems in a group of dairy herds in England. Veterinary Record, 1996. 139: p. 486-490.
35. Esslemont, R.J. and I. Spincer, The incidence and costs of diseases in dairy herds, in Daisy Report. 1993, University of Reading.
36. FAWC, Report on the welfare of dairy cattle. 1997, Farm Animal Welfare Council.
37. FAWC, Opinion on the welfare of the dairy cow. 2009, Farm Animal Welfare Council: London.
38. Fourichon, C., et al., Effects of disease on milk production in the dairy cow: a review. Preventive Veterinary Medicine, 1999. 41(1): p. 1-35.
39. Garbarino, E.J., et al., Effect of lameness on ovarian activity in postpartum Holstein cows. Journal of Dairy Science, 2004. 87(12): p. 4123-4131.
40. Greenough, P. and A. Weaver, Lameness in Cattle. 3rd ed. ed. 1997, Philadelphia: W. B. Saunders Company.
41. Gröhn, Y., et al., Epidemiology of reproductive disorders in dairy cattle: associations among host characteristics, disease and production. Preventive Veterinary Medicine, 1990. 8(1): p. 25-39.
42. Grummer, R., Strategies to improve fertility of high yielding dairy farms: management of the dry period. Theriogenology, 2007. 68 (Suppl. 1): p. S281-S288.
43. Hammon, D., et al., Neutrofill function and energy status in Holstein cows with uterine health disorders. Veterinary Immunology and Immunopathology, 2006. 113: p. 21-29.
44. Harris, D.J., et al., The incidence, cost and factors associated with foot lameness in dairy cattle in south-western Victoria. Australian Veterinary Journal 1988. 65(6): p. 171-176.
45. Harrison, R., et al., Increased milk production versus reproductive and energy status in high-producing dairy cows. Journal of Dairy Science, 1990. 73: p. 2749-2758.
46. Haskell, M.J., et al., Housing system, milk production, and zero-grazing effects on lameness and leg injury in dairy cows. Journal of Dairy Science, 2006. 89: p. 4259-4266.
47. Hassall, S., W. Ward, and R. Murray, Effects of lameness on the behaviour of cows during the summer. Veterinary Record, 1993. 132(23): p. 578-580.
48. Hedges, V., et al., A longitudinal field trial of the effect of biotin on lameness in dairy cows. Journal of Dairy Science, 2001. 84: p. 1969-1975.
49. Hernandez, J., Effect of lameness on the calving-to-conception interval in dairy cows. Journal of the American Veterinary Medical Association, 2001. 218(10): p. 1611-1614.
50. Hernandez, J., et al., Comparison of the calving to conception interval in dairy cows with different degrees of lameness during the prebreeding postpartum period. Journal of the American Veterinary Medicine Association, 2005. 227(8): p. 1284-1291.
51. Hernandez, J., J. Shearer, and D. Webb, Effect of lameness on the calving to conception interval in dairy cows. Journal of American Veterinary Medical Association, 2001. 218(10): p. 1611-1614.

52. Hultgren, J., T. Manske, and C. Bergsten, Associations of sole ulcer at claw trimming with reproductive performance, udder health, milk yield, and culling in Swedish dairy cattle. Preventive Veterinary Medicine, 2004. 62(4): p. 233-251.
53. Huxley, J., An investigation into the effects of herd health planning and welfare benchmarking on cattle health and welfare on organic dairy farms in South West England. 2005, Royal College of Veterinary Surgeons.
54. Huxley, J.N., Are Lameness and Infertility in Dairy Cows Linked? Cattle Practice, 2009. 17: p. 13-15.
55. Huxley, J.N., et al., Animal welfare assessment benchmarking as a tool for health and welfare planning in organic dairy herds. Veterinary Record, 2004. 155(8): p. 237-239.
56. Lee, L., D. Ferguson, and D. Galligan, Effect of disease on days open assessed by survival analysis. Journal of Dairy Science, 1989. 72: p. 1020-1026.
57. Leech, F., et al., Disease, Wastage and Husbandry in the British Dairy Herd. HMSO. 1960: London.
58. Lucey, S., G. Rowlands, and A. Russell, The association between lameness and fertility in dairy cows. Veterinary Record, 1986. 118(23): p. 628-631.
59. Lucy, M., et al., Influence of diet composition, dry matter intake, milk production, and energy balance on time of postpartum ovulation and fertility in dairy cows. Animal Production, 1992. 54: p. 323–331.
60. Lucy, M.C., Regulation of Ovarian Follicular Growth by Somatotropin and Insulin-Like Growth Factors in Cattle. Journal of Dairy Science, 2000. 83(7): p. 1635-1647.
61. Lucy, M.C., Reproductive Loss in High-Producing Dairy Cattle: Where Will It End? Journal of Dairy Science, 2001. 84(6): p. 1277-1293.
62. Madouasse, A., et al., Use of individual cow milk recording data at the start of lactation to predict the calving to conception interval. Journal of Dairy Science, 2010. 93(10): p. 4677-4690.
63. Main, D.C.J., et al., Effect of the RSPCA Freedom Food scheme on the welfare of dairy cattle. Veterinary Record, 2003. 153(8): p. 227-231.
64. Manske, T., J. Hultgren, and C. Bergsten, The effect of claw trimming on the hoof health of Swedish dairy cattle. Preventive Veterinary Medicine, 2002. 54(2): p. 113-129.
65. McCluggage, L., Foot care and management in the dairy herd. Agriculture in Northern Ireland, 1985. 60: p. 224-226.
66. Melendez, P., et al., The association between lameness, ovarian cysts and fertility in lactating dairy cows. Theriogenology, 2003. 59(3-4): p. 927-937.
67. Nanda, A.S., H. Dobson, and W.R. Ward, Relationship between an increase in plasma cortisol during transport-induced stress and failure of oestradiol to induce a luteinising hormone surge in dairy cows. Research in Veterinary Science, 1990. 49(1): p. 25-8.
68. Nonnecke, B.J., et al., Effects of the Mammary Gland on Functional Capacities of Blood Mononuclear Leukocyte Populations from Periparturient Cows. Journal of Dairy Science, 2003. 86(7): p. 2359-2368.
69. O'Callaghan, K., Lameness and associated pain in cattle - challenging traditional perceptions. In Practice, 2002. 24: p. 212-221.
70. Oltenacu, P.A., et al., Environmental risk factors and interrelationships with other diseases. Acta Vet Scand, 1990. 31: p. 471-478.
71. Oltenacu, P.A., et al., Tramped teats-clinical mastitis disease complex in tied cows. Environmental risk factors and interrelationships with other diseases. Acta Vet. Scand., 1990. 31: p. 471-478.
72. Peake, K., et al., Effects of lameness, subclinical mastitis and loss of body condition on the reproductive performance of dairy cows. Veterinary Record, 2011. 168: p. 301.
73. Peeler, E., M. Otte, and R. Esslemont, Inter-relationships of periparturient diseases in dairy cows. Veterinary Record, 1994. 134(6): p. 129-132.

74. Phillips, C., Cattle Behaviour & Welfare. 2nd Edition ed. 2002, Oxford, UK: Blackwell Science Ltd.
75. Prentice, D. and P. Neal, Some observations on the incidence of lameness in dairy cattle in West Cheshire. Veterinary Record, 1972. 91(1): p. 1-7.
76. Rajala-Schultz, P.J. and Y.T. Gröhn, Culling of dairy cows. Part I. Effects of diseases on culling in Finnish Ayrshire cows. Preventive Veterinary Medicine, 1999. 41(2-3): p. 195-208.
77. Roche, J.R., et al., Invited review: Body condition score and its association with dairy cow productivity, health, and welfare. Journal of Dairy Science, 2009. 92(12): p. 5769-5801.
78. Roelofs, J., et al., Pedometer readings for estrus detection and as predictor for time of ovulation in dairy cattle. Theriogenology 2005. 64: p. 1690-1703.
79. Rowlands, G., A. Russell, and L. Williams, Effects of stage of lactation, month, age, origin and heart girth on lameness in dairy cattle. Veterinary Record, 1985. 117(22): p. 576-580.
80. Rowlands, G.J. and S. Lucey, Changes in milk yield in dairy cows associated with metabolic and reproductive disease and lameness. Preventive Veterinary Medicine, 1986. 4(3): p. 205-221.
81. Royal, M., et al., Declining fertility in dairy cattle: changes in traditional and endocrine parameters of fertility. Animal Science, 2000. 70: p. 487–501.
82. Russell, A., et al., Survey of lameness in British dairy cattle. Veterinary Record, 1982. 111(8): p. 155-160.
83. Singh, S., et al., Behaviour of lame and normal dairy cows in cubicles and in a straw yard. Veterinary Record, 1993. 133(9): p. 204-208.
84. Snijders, S.E.M., et al., Effect of genetic merit, milk yield, body condition and lactation number on in vitro oocyte development in dairy cows. Theriogenology, 2000. 53: p. 981–989.
85. Sood, P. and A. Nanda, Effect of lameness on estrous behavior in crossbred cows. Theriogenology, 2006. 66(5): p. 1375-1380.
86. Sprecher, D., D. Hosteler, and J. Kaneene, A lameness scoring system that uses posture and gait to predict dairy cattle reproductive performance. Theriogenology, 1997. 47: p. 1179-1187.
87. Suriyasathaporn, W., et al., A Cox proportional-hazards model with time-dependent covariates to evaluate the relationship between body-condition score and the risks of first insemination and pregnancy in a high-producing dairy herd. Preventative Veterinary Medicine, 1998. 37(1-4): p. 159-72.
88. Swedish Dairy Association, Cattle statistics 2002. 2002: Eskilstuna, Sweden.
89. Tranter, W.P. and R.S. Morris, A case study of lameness in three dairy herds. New Zealand Veterinary Journal, 1991. 39(3): p. 88-96.
90. van Amstel, S.R. and J. Shearer, Abnormalities of hoof growth and development. Veterinary Clinics of North America: Food Animal Practice, 2001. 17: p. 73-91.
91. Van Eerdenburg, F., et al., The relationship between estrous behavioral score and time of ovulation in dairy cattle. Journal of Dairy Science, 2002. 85: p. 1150-1156.
92. Wagner, S., D. Schimek, and F. Cheng, Body Temperature and White Blood Cell Count in Postpartum Dairy Cows. The Bovine Practitioner, 2008. 42(1): p. 18-26.
93. Walker, S., et al., Chronic stress, hormone profiles and estrus intensity in dairy cattle. Hormones and Behavior, 2008. 53: p. 493-501.
94. Watson, E.D. and C.D. Munro, Adrenal progesterone production in the cow. British Veterinary Journal, 1984. 140(3): p. 300-306.
95. Webster, J., Health and welfare of animals in modern husbandry systems-Dairy cattle. In Practice, 1986. 8(3): p. 85-89.
96. Wells, S., et al., Prevalence and severity of lameness in lactating dairy cows in a sample of Minnesota and Wisconsin herds. Journal of American Veterinary Medical Association, 1993. 202: p. 78-82.
97. Whay, H., et al. Farmer perception of lameness prevalence. in 12th International Symposium on Lameness in Ruminants. 2002. Orlando, Florida.

98. Whay, H., A. Waterman, and A. Webster, Associations between locomotion, claw lesions and nocicepive threshold in dairy heifers during the pre-partum period. The Veterinary Journal, 1997. 154: p. 155-161.
99. Whay, H.R., et al., Assessment of the welfare of dairy cattle using animal-based measurements: direct observations and investigation of farm records. Veterinary Record, 2003. 153(7): p. 197-202.
100. Whitaker, D., J. Kelly, and E. Smith, Incidence of lameness in dairy cows. Veterinary Record, 1983. 113(3): p. 60-62.
101. Whitaker, D., J. Kelly, and S. Smith, Disposal and disease rates in 340 British dairy herds. Veterinary Record, 2000. 146: p. 363-367.

APPENDIX 1

Table 2 - Lameness Incidence Values

Definition	Study	Incidence
Clinical lameness	(87)	31.4cases/100 lactations
Overall incidence of lameness	(48)	68.9cases/100cows/yr
Sole ulcer	(48)	13.8cases/100cows/yr
White line separation	(48)	12.7cases/100cows/yr
Digital dermatitis	(48)	12.0cases/100cows/yr
Digital dermatitis (incidence)	(2)	35cases/100cows/yr
Interdigital necrobacillosis	(48)	7.1cases/100cows/yr
Lameness (incidence, farmer estimate)	(99)	22cases/100cows/yr
Lameness (incidence) Taken when cows was examined for lameness or routinely trimmed	(21)	54.6cases/100cows.yr
Lameness (annual incidence) Based on the number of UK dairy cattle treated by both farmers and vet	(100)	25% (25.2% treated by vets and 74.8% by farmers)
Lameness (annual incidence)	(101)	23.7%
Lameness (annual incidence) best 10% of herds	(101)	2.4%
Lameness (annual incidence) best quartile of herds	(101)	5.8%
Lameness (annual incidence) worst quartile of herds	(101)	50.3%
Lameness (annual incidence) Based on the number of UK dairy cattle treated by vets	(30)	4.7%
Lameness (annual incidence) Based on the number of UK dairy cattle treated by vets	(82)	5.5%
Lameness (annual incidence)	(23)	17%
Lactational incidence risk (acute lameness)	(88)	~2%
Lactational incidence risk	(1, 21, 96)	7-55%
Lameness lesions Interdigital cleft Sole and WLD Wall and coronary band Heel	(80)	Expressed as % of lactations with the disease[1] 11.6% 10.2% 2.1% 3.2%
Lameness incidence	(28)	6%
Lameness incidence	(33)	21%
Lameness incidence	(6)	25%
Lameness incidence	(65)	28%
Lameness incidence	(44)	7%
Lameness incidence (Based on observations made from behaviour of animals)	(63)	20% (Non-freedom food farms)

[1] This expression does not account for cows which might potentially be lame multiple times in the same lactation.

Definition	Study	Incidence
Lameness incidence (Based on observations made from behaviour of animals)	(63)	23.1% (Freedom food farms)
Lameness incidence (Based on farmer's own observations)	(63)	18.6% (Non-freedom food farms)
Lameness incidence (Based on farmer's own observations)	(63)	18.4% (Freedom food farms)
Lameness incidence (Based on record analysis)	(63)	0% (Non-freedom food farms)
Lameness incidence (Based on record analysis)	(63)	5.13% (Freedom food farms)
Lameness incidence proposed intervention level (by panel of 50 experts, agreed by 75% of them) Proportion of farms which achieved proposed intervention level above	(63)	13.8% 20%
Lameness incidence Taken from records of both farmers and vets	(57)	3.88%
Lameness incidence Taken from cases treated by vets	(30)	4.72%
Lameness incidence Cases of lameness seen for free by vet students	(75)	30%
Lameness incidence Based on farmer and vet treatment records taken from the DAISY project	(35)	35.6%
Lameness incidence Data taken from the DAISY project with data entered by both farmers and vets	(34)	24cases/100cows/yr (Best quartile of herds suffered only 4.7cases/100cows/yr, the worst 47.4cases/100cows/yr)
Number of cases of lameness per affected cow	(34)	1.4
Lameness incidence	(73)	8.9%
Lameness incidence in first 30d of lactation	(66)	2.2%
Lactational incidence	(3)	5%
Lactational incidence	(7)	9.3-49.2%
Lameness incidence	(7)	26%

APPENDIX 2

Table 3 - Lameness Prevalence Values

Definition	Study	Prevalence
Lameness (prevalence) Taken at 'routine visits' when cows were scored 1-5 and scores 3+ taken as lame.	(21)	20.6% (2.0-53.9)
Lameness (prevalence, farmer estimate)	(97)	5.7%
Lameness (prevalence, 4-point score)	(99)	22.1% (0.0-50.0)
Lameness (mean lameness score >2/5)	(86)	65.2%
Prevalence of lameness at routine claw trimming	(64)	~5%
Prevalence (Denmark, US and UK)	(1, 21, 96)	14-25%
Lameness prevalence Data taken from the DAISY project with data entered by both farmers and vets	(34)	17.4%
Lameness prevalence	(12)	Estimated to be between 2-20% in modern dairy operations
Lameness Prevalence	(55)	24·2% (6·8 to 55·6)
Lameness Prevalence	(53)	30% (6·8 to 74·2)
Lameness Prevalence	(46)	15% (grazing) 39% (zero-grazed)
Lameness Prevalence	(9)	36·8% (0 to 79·2)
Lameness Prevalence	(54)	34%
Lameness Prevalence Cows scoring 2 or 3 (/5)	(72)	52%
Digital dermatitis (prevalence) Milking cows affected	(2)	33% affected (Of which 68% had lesions in the previous lactation)
Digital dermatitis (prevalence) Dry cows affected	(2)	1% affected

APPENDIX 3

Table 4 - Associations between lameness and various reproductive parameters

Extension	Lesion	Study	Amount
Calving-first service	Sole ulcer or WLD 36-70DIM Note no correction for milk production was made in this study.	(58)	7d
Calving-first service	Note no correction for milk production was made in this study.	(23)	4d
Calving-first service	Lameness 36-71d p-p Note no correction for milk production was made in this study.	(23)	8d
Calving-first service	Lameness foreleg Lameness diagnosed by both the vet and farmer	(7)	4.6d
Calving-first service	Lameness hind leg Lameness diagnosed by both the vet and farmer	(7)	2.9d
Calving-first service	Cows score >2(/5)	(86)	“extended intervals”
Calving to conception	Sole ulcer or WLD 36-70DIM	(58)	11d
Calving to conception		(23)	14d
Calving to conception	Clinical digital disease in cows culled for this reason	(33)	8.9d
Calving to conception	Lameness diagnosed by both the vet and farmer	(7)	3.4d
Calving to conception	Cows score >2(/5)	(86)	“extended intervals”
Calving to conception	Lame cows with claw lesions relative to healthy	(51)	40d
Calving to conception (median)		(56)	28d
Pregnancy rate to first service		(23)	10% lower
Services per conception		(23)	0.42 extra services
Services per conception	Cows score >2(/5)	(86)	“more services require”

Extension	Lesion	Study	Amount
Services per conception	Lame cows with claw lesions relative to healthy	(51)	2 extra services
Odds of conceiving to first service	Foot lame cows	(66)	4.2 times less likely
Odds of conceiving overall	Foot lame cows	(66)	2.3 times less likely
Odds of developing ovarian cyst	Cows diagnosed lame within 30d p-p	(66)	2.6 times more likely
Calving to conception		(50)	36d
Calving to conception (cows with high cumulative locomotion scores)		(50)	50d
Calving to conception (cows with low cumulative locomotion scores)		(50)	36d
Lameness during the first 35d of lactation (relative to non-lame)		(39)	3.5 times more likely to suffer delayed ovarian cyclicity
Risk of conception failure in lame cows relative to non-lame		(50)	Higher risk of conception failure in lame (but not significant)
Calving to conception in cows affected with digital dermatitis		(2)	20d extension
First service conception rate		(66)	Lame cows had a lower first service conception rate than non-lame (17.5% cf 42.6%)
Calving-first service interval		(66)	No statistical difference between lame and non-lame cows
Ovarian cysts		(66)	Cows which were lame in the first 30d of lactation were associated with a higher incidence of cysts (2.63 times more likely to develop a cyst).

Extension	Lesion	Study	Amount
Ovarian cysts		(66)	Lame cows were 3.12 times more likely to develop ovarian cysts than non-lame
Conception rates		(58)	Decreased if lameness was diagnosed 0-60d before a service
First service to conception	Corrected for herd and year of examination	(7)	3.4d longer in lame cows relative to control

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INDUSTRY INITIATIVE ON DAIRY CATTLE LAMENESS

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SUMMARY

The Dairy Cow Welfare Strategy for GB, launched in 2010, highlights lameness as a priority with regards to improving recognition, treatment, prevention and control of the disease. The University of Bristol's Healthy Feet Project identified the challenge of helping farmers utilise their existing knowledge, and recommended they apply their own action plans to tackle lameness. A further recommendation was that an industry lameness group should be convened to continue the legacy and promote the outputs from this project. The Dairy Cattle Mobility Steering group was formed in 2013. This group endeavours to engage with all parts of the dairy industry to promote achievable, affordable and effective measures to minimise lameness and maximise mobility in the GB dairy herd, towards the ultimate aim of eradicating severe lameness.

BACKGROUND

Lameness can have a serious impact on cow welfare and productivity, causing pain and discomfort, and loss of production, including increased culling rates (1). While there is a debate about what are acceptable levels of lameness, there is no dispute that foot and leg health is a priority area for improvement for the dairy industry. The Dairy Cow Welfare Strategy, developed by the Cattle Health and Welfare Group, identifies lameness as a key priority and has broad-based support from DairyCo, BCVA, DairyUK, RSPCA, Holstein UK, NFU, NFU Scotland, RABDF and Red Tractor Assurance for Farms (2). The strategy aims to improve recognition, treatment, prevention and control of lameness. A key commitment to the strategy by DairyCo is to take forward original work completed by the University of Bristol.

In 2006, the University of Bristol commenced the Healthy Feet Project, funded by the Tubney Charitable Trust, to investigate ways to help farmers make changes on their farms to reduce lameness (3, 4). The project was steered by a committee comprised of sponsors and industry collaborators, who were committed to the goals of the project. One of the challenges identified by the project was to help farmer's utilise their existing knowledge to develop and apply their own action plan. On completion of the Healthy Feet Project, its legacy was handed over to industry, to be further developed, ultimately into the DairyCo Healthy Feet Programme (DHFP) (5). Additionally, the project steering committee recommended that a lameness review group should be convened. DairyCo now provide the secretariat to the Dairy Cattle Mobility Steering Group, which is independently chaired and comprises of veterinarians, hoof trimmers, lameness researchers and industry representatives.

REMIT OF THE DAIRY CATTLE MOBILITY STEERING GROUP

The group aims to engage with all parts of the dairy industry, promoting achievable, affordable and effective measures to minimise lameness and maximise mobility in the GB dairy herd, with the ultimate aim of eradicating severe lameness. The group encourages organisations and individuals to develop a structured approach, to allow dairy farmers and their staff to prevent, measure, manage and monitor lameness, in order to minimise the prevalence and severity of lameness in their dairy cows. The group facilitates collaboration and co-ordination between all parts of the industry to promote lameness management, through the DHFP and any other structured cattle mobility schemes. Furthermore, to help develop these programmes to meet the needs of dairy farmers as new knowledge and science emerges, and to transfer that knowledge to participants through every means of communication possible. The group will continue to encourage new scientific research, and help guide researchers towards the needs of the industry. The main objectives set by the group are, to:

1) Keep foot health on the dairy industry's agenda;
2) Provide an industry-wide forum/ stakeholder group, promoting and providing a platform for collaboration on dairy foot health;
3) Identify opportunities to promote better foot health;
4) Collate knowledge/ on-going research on cattle lameness and identify possible gaps;
5) Promote and encourage development of the dhfp: to keep this under continued review as the main vehicle for engaging with dairy farmers on foot health;
6) Discuss and explore best methods to motivate and assist farmers to reduce lameness;
7) Encourage consistency of message and quality of technical information on foot health to dairy farmers, from whatever source;
8) Keep a watching brief on lameness prevalence and major developments/ changes/ technical advances in the industry with relation to lameness.

DAIRYCO MOBILITY SCORE AND HEALTHY FEET PROGRAMME

Lameness is impossible to manage unless it is measured, and this can be achieved by routine mobility scoring. Over the years, several scoring systems have been developed to assess the degree of lameness in dairy cattle, based on observations of the cow's walking gait, behaviour and weight distribution. In 2007, the DairyCo mobility scoring system was developed in partnership with industry (6). The DHFP was launched in September 2011 to provide a structured approach for lameness reduction on individual farms, drawing from the outputs of the University of Bristol's Healthy Feet Project. Since the launch of the DHFP, over 300 farms have been registered on the programme. Over 100 trained providers or "mobility mentors" (vets and licensed foot trimmers) work with these farms over a period of time to improve lameness management. The programme promotes frequent mobility scoring as a means to measure and monitor lameness incidence. As part of the DHFP, an action plan is agreed by the farm team and their DHFP mobility mentor which identifies the most beneficial and economically advantageous solutions to reducing lameness on that specific farm.

In 2012, Defra-funded research led by RADA at Reaseheath College investigated the delivery and impact of the DHFP on farms in North West England (7). On 44 dairy farms, the entire herd was mobility scored quarterly throughout the 12-month period. Half of the farms were enrolled on the DHFP, while the other half were recruited onto the study but did not carry out the DHFP. At the start, lameness levels were nearly identical on both the DHFP farms and non-programme farms. After a year, the DHFP farms had reduced lameness by a fifth -some farms showing a greater improvement than others. The study showed that DHFP farms carried out twice as many improvements to tackle lameness during the year compared to the non-programme farms. This study reinforced the conclusion that a robust lameness plan, such as the DHFP, will help to prevent lameness, reduce production costs, and use fewer resources than the alternative of treating lameness when it occurs. This leads to better productivity, from healthier cows (8).

The Dairy Cattle Mobility Steering Group will endeavour to use any suitable resource, such as the results of the North West Study, to promote greater engagement in mobility and improve the foot health of the nation's dairy cows.

REFERENCES

1. Dairy Cow Welfare Strategy Report. August 2010. http://www.eblex.org.uk/wp/wp-content/uploads/2013/06/Dairy-cow-welfare-report-2010.pdf Accessed: 9th April 2014.
2. Dairy Cattle Welfare Strategy Year 1 Progress. September 2011. http://www.dairyco.org.uk/resources-library/technical-information/health-welfare/dairy-cow-welfare-strategy/ Accessed: 9th April 2014.
3. Main, D.C .J., Leach, K.E., Barker, Z.E., Sedgewick, A.K., Maggs, C.M., Bell, N.J., Whay, H.R. 2012. Evaluating an intervention to reduce lameness in dairy cattle. Journal of Dairy Science, 95, 2946-2952
4. Whay, H.R., Barker, Z.E., Leach, K.A, Main, D.C.J. 2012. Promoting farmer engagement and activity in the control of dairy cattle lameness. The Veterinary Journal, 193, 617-621
5. DairyCo Healthy Feet Programme. http://www.dairyco.org.uk/technical-services/healthy-feet-programme/ Accessed: 9th April 2014
6. DairyCo Mobility Scoring. http://www.dairyco.org.uk/technical-information/animal-health-welfare/lameness/husbandry-prevention/mobility-scoring. Accessed 9th April 2014.
7. Cattle Mobility: Changing behaviour to improve health and welfare and dairy farm business. Final Report to Defra. http://www.reaseheath.ac.uk/businesses/rada/research-trials-and-demonstrations/ Accessed: 9th April 2014.
8. Huxley, J.N. 2014. Impact of lameness and claw lesions in cows on health and production. Livestock Science, 156, p64-70

NOTES

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DIGITAL DERMATITIS – HOW IS IT SPREAD AND CAN WE STOP IT?

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INTRODUCTION

Bovine digital dermatitis (DD) was first reported in Italy in the early 1970s, in the UK in 1987 and is now endemic in the UK and a worldwide threat to livestock welfare wherever there are cattle. It is the apparent infectious nature of this severe disease and poor response to treatment which makes it a major global problem. Indeed, the problem does not just seem resistant to treatment measures but the infectious nature of DD means it is spreading into other species and into other sites on cattle.

CAUSE OF BDD

To understand the spread of a disease, it is important to have a clear picture of the cause. DD is patently a disease with very significant bacterial involvement, often of many bacterial species and these are the main target for the favoured current treatment approaches (toxic footbaths and topical antibiotics). However, over the years, it has become apparent that most of the bacteria present in lesions are opportunistic secondary invaders of tissues and not the primary infective cause of BDD. That role is now ascribed to novel bacteria, a new group of Treponema spp, which appear to be highly adapted to foot tissues of livestock. Until recently, these bacteria have been very difficult to study because of major problems involved in isolating and culturing them. However, at Liverpool, we have developed some antibody based technology to isolate these treponemes from BDD lesions which has been very successful and we now have a considerable archive of treponemes from many BDD lesions and also some from other animals and body tissues. This has proved a valuable resource and allowed us to make considerable in-roads into understanding how they cause disease and how they are transmitted.

Firstly, we needed to classify the treponemes in the archive to understand how many species and types were present. By a range of biochemical, immunological and genetic assessments, it became quite clear that there were 3 distinct treponeme groups in BDD lesions and that at least one of them was classifiable as a new species, Treponema pedis. This was consistent with observations from the USA and elsewhere. These 3 treponeme phylogroups were shown to be present together in almost all BDD lesions and were not detected on normal cattle foot skin, raising the question of how they combined (if at all) to initiate the BDD lesion, creating damage so that other bacteria in the farm environment (primarily the indoor environment) can invade and take hold as significant infections which exacerbate the damaging and painful inflammatory response seen in full-blown M2/M3 lesions.

TRANSMISSION BETWEEN ANIMALS

It is well recognised that BDD is readily transmitted between cattle, but how is unclear. It is apparent that it is most readily transmitted when animals are housed, making it a particular issue for cattle housed all year round. Furthermore, whilst the disease regularly recurs on infected farms, it may sometimes be kept in check by very rigorous attention to farm hygiene. However, it is rare that a cow with DD is actually completely cleared and this is almost certainly due to the fact that prevention and treatment measures fail to tackle the deep seated treponemal infection in tissues because this puts them out of the reach of what are essentially topical foot treatments.

In terms of disease transmission, the three main questions are 1) what are the reservoirs of treponeme infection in animals or on farms? 2) how are the treponemes transmitted between animals and farms? 3) are other animals at risk?

RESERVOIRS OF TREPONEMES

We have developed BDD-treponeme phylotype specific PCR assays to search for the associated bacteria in animal tissues and on farm environments. Despite major investigations, virtually all of our studies pinpointed that the main, or possibly only, reservoir of infection was the BDD lesion itself. Some positive sites of infection have been seen in cattle rectal anal junctions and gingiva, but all other GI tract tissue have so far been negative for the BDD organisms (they have plenty of other treponemes though). Indeed, all other cattle tissues were negative for BDD treponemes. Further work is continuing on this line.

Analyses of the farm environment have also proved quite negative. Samples ranging from fresh faeces and urine, slurry, puddles and soil have all failed to show any BDD treponeme presence. A range of flying insects captured on dairy farms also failed to show any positive results, ruling them out as disease vectors.

TREPONEME TRANSMISSION ROUTES

As our studies clearly showed that the major infection site is the BDD lesion itself, it was important to understand how the treponemes were localising to that site. Epidemiological studies clearly showed that the disease mainly manifests when cattle are together and housing periods are the main issue. This could be because either the housing environment enables the primary treponeme infection to spread more easily between cattle or because it encourages invasion of a range of secondary bacterial organisms which lead to full blown clinical lesions. Histopathological examination of early lesions in cattle, using antibodies raised against the BDD treponemes, showed that the treponemes were entering through the skin itself and then moving to deeper lying tissues, presumably because of their anaerobic nature. Interestingly, the treponemes were most commonly associated with hair follicles and could be seen migrating away from the follicles to the deeper tissue. This apparent opportunism would be consistent with their highly motile nature, suggesting a route by which they can move directly from infected lesions into healthy foot tissues. This would require either direct foot-to-foot contact or more likely, a period of time of unknown duration of the BDD treponemes in the farm environment, probably in faeces/slurry. However, as previously stated, our current molecular technology has not been able to identify these treponemes in any slurry samples.

Although the foot-to-foot route of transmission is probably very important, that does not preclude transmission by other routes or the role of other infection reservoirs. Among the many risk factors for transmission of digital dermatitis, the human factor features several times with a number of farm management approaches having effects on disease prevalence and severity on individual farms. Over the years, anecdotal reports have suggested that foot trimmers may carry the disease between farms and we set out to investigate this possibility. Using bacterial culture and PCR detection systems, we followed some foot trimmers on dairy and beef cattle farms and also on sheep farms. We took swabs of hoof trimming knives after usage and then after dipping in a disinfectant solution. We managed to culture a BDD treponeme from a blade swab and also found that 95% of blade swabs were PCR positive for a BDD treponeme. After disinfection, we were still able to detect BDD treponemes on 29% of blades tested. Positive results have also been shown with swabs of hoof trimmer's gloves, knife holders, power grinder and the crush. Thus, the evidence is that current foot trimming practises may well be important for transmission of BDD within a farm. The next question is whether the treponemes survive on the trimming equipment long enough to transmit the disease between farms. What we will need to do for considering this hypothesis is to determine how long the BDD treponemes can survive on a trimming knife and on other equipment.

PROMISCUOUS TREPONEMES: NEW FORMS OF DISEASE

In cattle, all reports of digital dermatitis have been describing different aspects of the disease in dairy cattle, despite many regarding the disease as an issue in beef cattle. We made the first documented report in 2013 and showed the same treponemal association as in dairy cattle.

In 1997, the first worldwide report of digital dermatitis in sheep was reported in the UK. We have shown that exactly the same treponemal bacteria are present in the sheep lesions as seen in BDD and the disease is now universally known as contagious ovine digital dermatitis (CODD). This disease has spread very quickly in the UK (and in Ireland), but has not been definitively reported elsewhere, to date. However, CODD must be a threat to other countries, given the speed of its spread in the British Isles and vigilance is essential because it is a much more severe form of disease than the bovine form, with hoof loss a common outcome.

Much more recently (2014), we have recorded what we consider to be the first cases of digital dermatitis in UK goats, again as a very severe form of lameness. As in CODD, the same treponemes as found in BDD lesions were recovered and identified. We propose this disease be named caprine digital dermatitis (CDD).

Aside from associations with lameness in livestock, the BDD treponemes are also reported in skin lesions in pigs in Sweden.

Farmers and vets in the UK are increasingly reporting new forms of classical foot diseases in dairy cattle; these are severe painful lesions which are patently infected with bacteria and for which there seem very few viable treatments. These include 'toe necrosis', 'non-healing white line disease' and 'non-healing sole ulcer'. As these have been reported to be associated with farms with BDD, we analysed lesions of these 3 diseases and detected BDD treponemes in 84%, 81% and 56% of cases, respectively. Samples from typical heel horn lesions were all negative when tested. This data would again point to the opportunistic nature of these organisms so that whilst they are the primary infection causing BDD, they may also be secondary infections in other lesions.

The classical appearance of BDD lesions is between the heel bulbs at the back of the rear feet. However, livestock vets in the UK are increasingly reporting lesions appearing on the coronary band on the front of the hoof. The infection then tracks down inside the hoof shell and can cause under running and hoof detachment. This is the classical appearance of the lesion in CODD, but there is no apparent reason why this new presentation has occurred in cattle.

Thus, the BDD treponemes are associated with much more than BDD in dairy cattle and livestock industries will need to be vigilant for any other new forms of disease which may involve these organisms. We should also consider that other species, particularly cloven hooved ones, could be susceptible to infection; these may be domesticated or wildlife species.

PREVENTION AND TREATMENT

In the UK, most dairy herds have BDD as a common or endemic problem. The best form of prevention of BDD seems to be closed herds, so that there is little chance of bringing in the disease via infected animals. However, even that is not always effective. In practise, most farms have developed strategies based on disease limitation exercises. Most of these relate to hygiene in housed animals and on some farms, where the hygiene is rigorously observed, clinical BDD may well be effectively suppressed. However, the majority of farms have long standing BDD persistence which requires either regular footbaths (to both treat and prevent BDD) or use of topical antibiotic treatments for identified lesions. There are significant problems with these approaches. The footbaths usually contain solutions of toxic products such as copper sulphate or formalin which are not very effective, probably because they only address the secondary infection bacteria and do not reach the deep lying treponemes; hence the disease is not dealt with conclusively. These foot bath products are also a real threat in terms of their deleterious potential effects on the rural environment. As a result, some of these products are now banned in footbaths in some EU countries. Alternatively, animals are treated with antibiotics, either in footbaths or as topical agents directly onto lesions. Again, these reagents tend to only deal with the secondary infections. Indeed, our work has shown that the favoured antibiotics actually have very little activity against the BDD treponemes, at least in vitro. The most effective antibiotics against treponemes, unfortunately, either pass into milk or are being withdrawn from farm use to prevent generation of antimicrobial resistance which would be a potential threat to human and animal welfare. Thus, the two main current ways of treating BDD are not only expensive and relatively ineffective, but are likely to be legislated against in the near future.

Disappointingly, it must be stated that there is a relative dearth of published case-controlled clinical trials of most of the treatments used on farms and this is a real issue in terms of developing and trialling new treatment methods to replace them with improved approaches. It is quite possible that completely new means of treatments with antiseptics, specific nutritional components etc may be developed but it is not clear how these can be compared with the current regimes for efficacy. As a result of these treatment deficiencies, it is probably time to take a different approach, preferably one which prevents disease rather than attempts to treat the symptoms.

Apart from avoidance of infections, the best way to prevent infectious diseases is by vaccination. This is not always easy to achieve, especially when the infection already induces a host immune response, albeit non-protective. In BDD, the cows generate an antibody response soon after treponeme infection and will maintain this immunity during clinical disease and also when the disease is in remission. Thus, any vaccine will need to address this issue and generate a different or more powerful immune response. To date, attempts to vaccinate with a crude treponemal extract (a bacterin) have not been successful and new approaches are required. At Liverpool, we have generated and mapped the BDD treponeme genomes and are currently mining these genomes by bioinformatics techniques to attempt to identify novel surface expressed proteins which may be useful vaccine candidates. Depending upon the success of this work, it may then be possible to apply a protective vaccine to prevent the lengthening list of diseases and hosts associated with the BDD treponemes.

HOST GENETICS AND BDD SUSCEPTIBILITY

It has been shown that there is a substantial host genetic component contributing to BDD susceptibility and we have identified eight SNPs (single nucleotide polymorphisms) on three bovine chromosomes as linked to disease status. Larger studies are needed to further identify important loci and subsequent diagnostics developed in order that screening and targeted breeding be carried out in an attempt to reduce the number of animals with BDD. Such a route to disease prevention would be very beneficial to the dairy industry as it would reduce disease burden without the overuse of antibiotics or environmentally challenging footbathing chemicals. It could also be useful to identify those cattle most likely to generate an affective and protective immune response to any developed vaccine.

CONCLUSIONS

Bovine DD has been with us for at least 30 years and unless drastic changes to treatment and prevention are made it may be here to stay. However, given the significant scientific leaps in progress made over the last decades we should be able to design significant interventions. Hopefully, in the future we may be able to finally prevent this disease by using a mixture of vaccines, good farm practice and effective treatment.

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RECENT LIVERPOOL DIGITAL DERMATITIS PUBLICATIONS.

Evans NJ, Brown JM, Demirkan I, Murray RD, Vink WD, Blowey RW, Hart CA, Carter SD (2008). Three unique groups of spirochetes isolated from digital dermatitis lesions in UK cattle. Vet Microbiol; 130: 141-50

Evans, N. J., J. M. Brown, I. Demirkan, R. Birtles, C. A. Hart, and S. D. Carter (2009). In vitro susceptibility of bovine digital dermatitis associated spirochaetes to antimicrobial agents. Vet. Microbiol. 136: 115-20

Evans, N. J., J. M. Brown, I. Demirkan, R. D. Murray, R. J. Birtles, C. A. Hart, and S. D. Carter. (2009).Treponema pedis sp. nov, a novel spirochete isolated from Bovine Digital Dermatitis lesions. Int. J. Syst. Evol. Microbiol. 59: 987-991

Sayers G, Marques PX, Evans NJ, O'Grady L, Doherty ML, Carter SD, Nally JE. (2009). Identification of Spirochetes associated with Contagious Ovine Digital Dermatitis. J Clin Microbiol. 47:199-201

Evans, N. J., J. M. Brown, I. Demirkan, R. D. Murray, P. Singh, B. Getty, D. Timofte, W. D. Vink, R. W. Blowey, C. A. Hart, and S. D. Carter. (2009). The association of unique, isolated treponemes with bovine digital dermatitis lesions. J. Clin. Micro.47: 689-96

Evans, N.J., Timofte, D., Brown, J.M., Blowey, R.W., Carter, S.D. (2010) The association of treponemes with bovine ulcerative mammary dermatitis. Vet Rec 166: 532-3

Evans NJ, Blowey RW, Timofte D, Isherwood DR, Brown JM, Murray R, Paton RJ & Carter SD (2011) Association of bovine digital dermatitis treponemes with a range of 'non healing' bovine hoof disorders. Vet Record 168: 214

Evans NJ, Brown JM, Murray RD, Getty B, Birtles RJ, Hart CA, Carter SD (2011). Characterisation of novel bovine gastrointestinal tract Treponema and comparisons with bovine digital dermatitis treponemes. Appl Environ Microbiol. 77: 138-147.

Vink WD, Jones G, Johnson WO, Brown J, Demirkan I, Carter SD, French NP (2009) Diagnostic assessment without cut-offs: application of serology for the modelling of bovine digital dermatitis infection. Prev Vet Med. 92: 235-48

Duncan JS, Grove-White D, Oultram JW, Phythian CJ, Dijk JV, Carter SD, Cripps PJ, Williams HJ (2011) Effects of parenteral amoxicillin on recovery rates and new infection rates for contagious ovine digital dermatitis in sheep. Vet Rec. 169: 606

Evans NJ, Timofte D, Isherwood DR, Brown JM, Williams JM, Sherlock K, Lehane MJ, Murray RD, Birtles RJ, Hart CA, and Carter SD (2012) Host and environmental reservoirs of infection for bovine digital dermatitis treponemes. Vet Microbiol 156: 102-109

Evans NJ, Brown JM, Hartley C, Smith RF & Carter SD (2012) Antimicrobial susceptibility testing of bovine digital dermatitis treponemes identifies macrolides for in vivo efficacy testing. Vet Microbiol 160: 496-500

Scholey RA, Blowey RW, Murray RD, Smith RF, Cameron J, Ollier WE & Carter SD (2012) Investigating host genetic factors in bovine digital dermatitis. Vet Record 171: 624

Scholey RA, Evans NJ, Blowey RW, Massey JP, Murray RD, Smith RF, Ollier WE & Carter SD (2013) Identifying host pathogenic pathways in bovine digital dermatitis by RNA-Seq analysis of lesions. Vet J doi.10.1016/j.tvjl.2013.03.008

Sullivan LE, Carter SD, Blowey R, Duncan JS, Grove-White D & Evans NJ (2013). Digital dermatitis in beef cattle. Vet Rec.173: 582. doi: 10.1136/vr.101802.

Angell JW, Duncan JS, Carter SD &Grove-White DH. (2014) Farmer reported prevalence and factors associated with contagious ovine digital dermatitis in Wales: A questionnaire of 511 sheep farmers. Prev Vet Med. 113: 132-8. Epub 2013 Oct 10 doi: 10.1016.

Sullivan LE, Blowey R, Carter SD, Duncan JS, Grove-White DH, Angell JW & Evans NJ (2014). A high association of digital dermatitis treponemes on cattle and sheep hoof trimming equipment. Vet Record (In press)

LE Sullivan, NJ Evans, SR Clegg, SD Carter, JE Horsfield , D Grove- White & JS Duncan (2014) Digital dermatitis treponemes associated with severe foot disease in dairy goats. Veterinary Microbiology (submitted).

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PRACTICAL SOLUTIONS TO DIGITAL DERMATITIS PROBLEMS

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SUMMARY

Digital dermatitis (DD) in dairy cows is still a relatively new problem where many questions remain unanswered. This paper provides a summary of some of the recent research that my colleagues and I have undertaken in this area. Research aimed at understanding the basis of individual variation in susceptibility to DD is discussed. While inherent differences in skin characteristics related to barrier function do not appear to be key, skin permeability is increased by contact with slurry. A follow-up study showed an apparent relationship between time spent standing in slurry and susceptibility to DD. Applied research into different copper sulphate footbathing strategies is also discussed. Reducing solution concentrations or increasing the interval between footbaths do not appear to be appropriate strategies for reducing copper usage. Use of 'additives' may be a better approach, but further research is required. The widening gap between scientific findings and on-farm practice relating to DD control is also considered.

INTRODUCTION

The effects of DD in dairy cows are well publicised. We know that it accounts for a significant proportion of lameness problems (8), and that it is reported in the majority of major dairy producing countries in the world (9). It is estimated to cost £75 to £82 per case in the UK (4), and therefore affects the profitability of dairy enterprises. The links between DD and pain, and thus reduced animal welfare, have also been highlighted (5).

Identifying prevention and treatment strategies for DD constitutes an active area of research among veterinary and animal welfare scientists. However DD still remains the leading infectious cause of lameness in dairy cows, and the problem is now also apparent in the beef sector (15) and in sheep as contagious ovine digital dermatitis (3). A greater fundamental understanding of transmission mechanisms and the underlying basis of individual variation in susceptibility to this problem is critical. However there is also an immediate requirement for applied research on the effectiveness of different treatment strategies. Many farmers are currently relying on anecdotal advice, and would benefit from robust yet practical independent research where findings are clearly communicated. This paper describes some of the recent research that my colleagues and I have undertaken into susceptibility to DD, and into footbathing strategies for control.

FACTORS ASSOCIATED WITH INCREASED SUSCEPTIBILITY

The fact that some cows persistently suffer from DD problems and others do not is intriguing. A comprehensive understanding of the basis of this variation will be key to identifying effective treatment/prevention strategies. Together with colleagues from the School of Pharmacy at Queen's University Belfast, we initially investigated whether this individual variation was related to differences in skin characteristics related to barrier function. There is evidence from the human literature that atopic dermatitis is associated with impaired skin barrier function (2), and that individuals with this condition are more susceptible to certain skin infections, including those with a bacterial basis (7). Skin samples obtained post mortem from culled dairy cows with and without a history of DD, however, did not differ significantly in permeability to methylene blue dye, in the thickness of the stratum corneum, or in hair follicle density (11). Interestingly, though, this study showed that soaking the skin in slurry for 24 hours significantly increased permeability. This may be one route through which contact with slurry could facilitate DD infection.

This finding led nicely to a subsequent study which investigated if the behaviour of dairy cows was associated with their susceptibility to DD. Cows within one particular house were subjected to detailed behavioural observations over a 28 hour period in early lactation (at approximately day 46 post-partum (and prior to any animal showing signs of DD)). The results showed apparent links between the time that individual animals spent with their hind feet in slurry and subsequently development of DD (12). This suggests that differences in behaviour influence susceptibility to DD in dairy cows, and provides further evidence that increased contact with slurry supports development of DD. This may be related to two key factors: 1) damage to the skin, and 2) transfer of infectious material. In terms of practical solutions (and these are not new suggestions), ensuring that housing environments are as clean as possible and that cubicles are comfortable for lying are likely to have significant impacts on DD problems.

FOOTBATHING TREATMENTS – THE PITFALLS

Often the simplest and more labour-efficient method of controlling DD on commercial farms is through the use of footbaths. This is reflected in the fact that 79% of 257 dairy farmers surveyed in Northern Ireland used a footbath to control DD (6). Although this is recognised, there are surprisingly few independent, peer-reviewed studies assessing the effectiveness of different treatments or strategies under commercial conditions.

The need for this research is particularly apparent in light of evidence that farmers are using a wide variety of solutions in their footbaths. The choice of solution is sometimes based on anecdotal evidence, and the actual effectiveness of solutions in treating and preventing DD is not always clear. A case in point is the use of ‘parlour washings’ as a footbath solution. This involves pumping circulation cleaner from the milking parlour wash cycle into the footbath. The active ingredient in this solution is often hypochlorite or ‘bleach’. Controlled research was conducted to determine the effectiveness of a 2% hypochlorite solution when used as part of a regime that involved twice daily footbathing for 2 consecutive days each week for 5 weeks. The results showed that use of this solution was as effective (or rather ineffective) as our control treatment where no footbathing was applied (13). This is in contrast to previous research suggesting that a 1% hypochlorite solution was effective in treating DD lesions (1). However in the latter study the solution was used daily for 30 days following surgical cleansing of lesions. These results strongly suggest that a key practical step in reducing DD problems is to actively monitor the effectiveness of the solution being used. Being cognisant of the conditions under which solutions were scientifically evaluated would also appear to be important.

COPPER SULPHATE – CAN WE REDUCE LEVELS USED?

The study described above (13) also involved a treatment where a 5% copper sulphate footbath solution was used. Unsurprisingly, this solution was highly effective in reducing levels of active DD lesions. This corresponds with findings from other research (10). The use of copper sulphate must be preferable to that of formalin or repeated antibiotic use, and, in fact, it was the most commonly-used footbath solution among the farmers that we surveyed (6). However there are increasing concerns about the environmental and human health implications of copper. This is particularly the case given that many footbath solutions are mixed with slurry and disposed of by land application.

These concerns led us to conduct research aimed at investigating the impact of reducing copper usage in footbaths on effectiveness in controlling and preventing DD. In the first instance, a controlled study was conducted to determine the effect of 2% or 5% copper sulphate footbath solutions when used in conjunction with weekly or fortnightly footbathing regimes (13). Footbathing was applied following milking on four consecutive occasions each week, and the weekly and fortnightly treatments were applied to animals with a high and low prevalence of active DD lesions, respectively. In both cases, the 5% solution was significantly more effective than the 2% solution in reducing levels of DD. This would suggest that reducing the concentrations used in footbaths is not the most appropriate method of reducing copper use.

In a follow-on study, the effect of extending the period between copper sulphate footbaths was assessed as an alternative strategy of reducing copper usage (14). Cows with a high prevalence of active DD lesions were assigned to a weekly or fortnightly footbathing regime with a 5% copper sulphate solution, and those with a low prevalence were assigned to a fortnightly or monthly footbathing regime. As previously, footbathing was applied after milking on four consecutive occasions in each treatment week. The results suggested that in both groups of cows, extending the period between footbaths led to a reduction in the effectiveness with which DD was controlled and therefore was not an appropriate method of reducing copper usage.

GAP BETWEEN RESEARCH AND REALITY

Work described above suggests that copper sulphate is effective in controlling and preventing DD but that the concentration used is vitally important. Despite this fact, a recent survey suggested that 74% of dairy farmers that used copper sulphate footbaths were unaware of the concentration that they used (6). These findings must be viewed in the context that they arose from a small survey involving farmers randomly approached at cattle markets and an agricultural show. The research should be repeated on a larger scale, but the findings are, nonetheless, worrying.

In addition, almost half of the farmers that we surveyed that used copper sulphate solutions used an additive such as salt or washing-up liquid (6). Use of additives could potentially lead to a decrease in levels of copper required in footbaths but there are relatively few controlled studies in this area. Consequently, use by farmers is largely based on anecdotal advice. In our first trial in this area, we assessed the effect of acidifying a 2% copper sulphate footbath solution with vinegar. This was assessed over a 10 week period using a split footbath and the results showed no significant effect on levels of DD lesions (6).

In addition to the effectiveness of footbath additives, there are very many other ‘real world’ questions which should be answered through applied research. For example, what is the impact on effectiveness of leaving footbath solutions to stand for different lengths of time, and/or of different levels of contamination with faecal matter? To what extent should different solutions be alternated between treatment weeks? How effective are summer footbathing regimes in reducing DD problems in subsequent winter periods?

CONCLUDING REMARKS

From a farmers perspective, maintaining a clean, comfortable housing environment for dairy cows and proactively monitoring the effectiveness of treatment strategies are basic, yet vital, first steps in controlling DD problems. It is clear that there is also an onus on the research community to not only continue fundamental work in this area, but also to conduct applied research to answer some of the real world questions raised above. They should also work to ensure that the findings from this research are communicated effectively to the farming community.

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REFERENCES

1. Da Silva, L.A.F., Silva, A.F., Borges, J.R.J., Fioravanti, M.C.S., Borges, G.T. & Atayde, I.B. (2005). A clinical trial to assess the use of sodium hypochlorite and oxytetracycline on the healing of digital dermatitis lesions in cattle. Canadian Veterinary Journal, 46: 345-348.
2. Di Nardo, A., Wertz, P., Giannetti, A. & Seidenari, S. (1998). Ceramide and cholesterol composition of the skin of patients with atopic dermatitis. Acta Dermato-Venereologica, 78: 27-30.
3. Dhawi, A., Hart, C.A., Demirkan, I., Davies, I.H. and Carter, S.D. (205). Bovine digital dermatitis and severe virulent ovine foot rot: a common spirochaetal pathogenesis. The Veterinary Journal, 169: 232-241.
4. Esslemont, R.J. (2005). The costs of lameness in dairy herds. UK Vet, 10: 41-49.
5. Higginson Cutler, J.H., Cramer, G., Walter, J.J., Millman, S.T. & Kelton, D.F. (2013). Randomized clinical trial of tetracycline hydrochloride bandage and paste treatments for resolution of lesions and pain associated with digital dermatitis in dairy cattle. Journal of Dairy Science, 96: 7550-7557.
6. Jennings, C.J., Speijers, M.H.M., Doherty, S. & O'Connell, N.E. (2013). Farmers' favourite footbath additives. International Conference on Lameness in Ruminants, Bristol, 11-14 August, 2013. 224.
7. Jung, T. & Stingl, G. (2008). Atopic dermatitis: therapeutic concepts evolving from new pathophysiologic insights. Journal of Allergy and Clinical Immunology, 122: 1074-1081.
8. Laven, R.A. (2003). Desktop review into the management and treatment of digital dermatitis. Technical Report No. 02/T3/07. Milk Development Council, Cirencester, UK.
9. Logue, D.N. (2011). Understanding bovine digital dermatitis. Veterinary Record, 168: 212-213.
10. Logue, D.N., Gibert, T., Parkin, T., Thompson, S. & Taylor, D.J. (2012). A field evaluation of a footbathing solution for the control of digital dermatitis in cattle. The Veterinary Journal, 193: 664-688.
11. Palmer, M.A., Donnelly, R.F., Garland, M.J., Majithiya, R. & O'Connell, N.E. (2013). The effect of slurry on skin permeability to methylene blue dye in dairy cows with and without a history of digital dermatitis. Animal, 7: 1731-1737.
12. Palmer, M.A. & O'Connell, N.E. (2012). The relationship between dairy cow behaviour in a cubicle house and susceptibility to digital dermatitis. Cattle Lameness Conference, Worcester, 2 May 2012. 41-42.
13. Speijers, M.H.M., Baird, L.G., Finney, G.A., McBride, J., Kilpatrick, D.J., Logue, D.N. & O'Connell, N.E. (2010). Effectiveness of different footbath solutions in the treatment of digital dermatitis in dairy cows. Journal of Dairy Science, 93: 5782-5791.
14. Speijers, M.H.M., Finney, G.A., McBride, J., Watson, S., Logue, D.N. & O'Connell, N.E. (2012). Effectiveness of different footbathing frequencies using copper sulphate in the control of digital dermatitis in dairy cows. Journal of Dairy Science, 95: 2955-2964.

15. Sullivan, L.E., Carter, S.D., Blowey, R., Duncan, J.S., Grove-White, D. & Evans, N.J. (2013). Digital dermatitis in beef cattle (Short Communication). Veterinary Record, 173, 582.

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THE EXPANDING HOST RANGE OF DIGITAL DERMATITIS TREPONEMES

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Digital dermatitis (DD) causes major problems in cattle (both dairy and beef) in the form of bovine DD, which is an international disease and in sheep as contagious ovine DD which has only been reported in the UK and Eire. This causes a large economical loss to farmers through loss of milk, meat and wool production, as well as veterinary treatments.

Although many bacteria can be isolated from a DD lesion, the most highly associated bacteria belong to the genus Treponema. Dairy cattle DD lesions generally contain treponemes from several Treponema phylogroups identified as, “Treponema medium/Treponema vincentii-like (group 1)”, “Treponema phagedenis-like” (Group 2) and “Treponema denticola/Treponema putidum-like (Group 3)” BDD spirochetes with the latter now recognised as a new species, Treponema pedis.

It would appear that over time, the evolution of treponemes allowed a host species transition from cattle to sheep, likely aided by contact of sheep and cattle in the farm environment. This host species transition into sheep was associated with high morbidity, and caused major animal welfare issues for sheep farmers. Therefore, it is important to investigate new diseases with similar signs to BDD for the presence of treponemes for further host range expansion, which could affect disease control measures and biosecurity.

Non healing bovine hoof horn lesions, such as toe necrosis, non- healing sole ulcers and non-healing white line disease cause painful lameness for cattle. When tested, these were also commonly found to contain treponemes, similar to the DD lesions.
In addition, treponemes have also been isolated from shoulder lesions, and ear necrosis and skin ulcers of pigs, with the same three groups as previously isolated from these lesions as from cattle foot lesions. This is based on PCR of infected tissue, rather than bacterial isolation as described here, so the bacteria may not be functional or causing the infection.

Recently, a DD like disease was reported in Roosevelt Elk from North America. In collaboration with the Washington Wildlife and Fish Department, we received samples collected from lesions of infected elk feet. We were able to isolate spirochetes from these foot lesions and identify them as DD associated treponeme phylotypes, suggesting that the bacteria may have made a host species jump to affect elk. This could prove significant as this is the first isolation of the bacteria from wild animals, which are notoriously difficult to control disease in. Although this animal is not directly relevant to potential disease spread in the UK, this research does suggest that potential wild animal reservoirs do exist. Further studies plan to examine deer from the UK.

In addition, a recent outbreak of lameness baring similarities to contagious ovine DD was observed in a large goat flock in North West England. Microbiological investigations of the respective lesions allowed us to isolate treponemes from the goats, the first report of treponemes isolated from goats. This disease has recently been named as contagious caprine digital dermatitis (CCDD).

The bacteria were isolated using selective medium, and blood agar plates and grown until a pure culture of a single treponeme phylogroup was obtained. The treponemes isolated here from elk and goats were compared to others isolated from cattle and sheep in previous studies using 16s rRNA PCR and sequencing. Phylogenetic analysis of the respective 16S rRNA gene sequences revealed that the spirochaete bacteria from elk and goats were very similar, or in some cases identical to those previously isolated from cattle and sheep. Given the spirochetal bacteria isolated from cattle, sheep, goats and elk lesions are identified as belonging to the same treponemal phylotypes, this research does raise suggestions of potential intra species transmission. In addition, elk, and potentially other wildlife could spread the causal treponemes and therefore digital dermatitis from farm to farm. Further characterisation of possible within farm and between farm infection reservoirs are important future studies within our laboratory.

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IDENTIFYING INFECTION RESERVOIRS OF DIGITAL DERMATITIS IN DAIRY CATTLE

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SUMMARY

Relatively little is known about the infection reservoirs of the treponemes associated with bovine digital dermatitis. This study aims to better understand the relationship between the bovine host, BDD treponemes and the dairy farm environment by conducting a sampling survey using in vitro culture and PCR approaches. The growth and survival of the treponemes under different conditions will also be assessed along with their associations with apparently healthy tissue.

INTRODUCTION

Bovine digital dermatitis (BDD) is one of the major contributors to lameness in the dairy industry in the UK and worldwide and has an infectious aetiology (1). The lesions are usually painful and result in lameness in most cases (2). This can cause reduced productivity from the cow (3), and thus not only reduces welfare but also profitability (4). Considered a polymicrobial disease; a polytreponemal primary infection has now been identified. In the UK and USA, three phylotypes of treponemes known as Treponema medium-like, Treponema phagedenis-like and Treponema pedis have been consistently identified in lesions (5,6); however, further infection reservoirs of BDD treponemes and routes of transmission have not been identified.

AIMS AND METHODS

This project aims to understand the relationship between the dairy farm environment, the bovine host and the BDD treponemes by identifying infection reservoirs in the environment and in the host.

Aim 1: Survey of bovine and dairy farm samples for BDD treponemes. The major focus of the study will be collection of specific samples from cattle and the dairy farm environment for the detection of BDD treponemes. Samples will be collected from healthy and BDD cows. Samples chosen are based on a previous study which found BDD treponemes associated with rectal and gingival tissue (7). A larger scale survey of theses tissues will be undertaken along with samples from BDD lesions, healthy foot tissues and the environment including faeces, bedding, water and food. Mucin casts will also be collected from faeces based on known Escherichia coli 0157 carriage and the identification of mglB, a gene implicated in mucin utilisation, found in the BDD treponemes (8). Samples will undergo culture for bacterial isolation, DNA extraction and PCR assays for BBD detection. Treponemes isolated from culture will be 16S rRNA sequence typed.

Aim2: Optimisation of DNA extraction methods from faeces. DNA can be difficult to extract from faeces due to the many inhibitors it can contain. Different extraction kits/ methods will be compared for their ability to extract DNA from faeces spiked with treponemes. PCR assays for faecal samples will also be optimised.

Aim 3: Understanding the survival and growth of BDD treponemes in the dairy farm environment and under different host conditions. Predicting the location and duration of infection reservoirs will aid the development of improved intervention strategies. BDD treponemes will undergo survival experiments in soil, bovine faeces and slurry using microcosms to study the effect of the dairy environment on growth and survival. Treponemes will also be grown on microplates with varying mucin concentrations, pH and oxygen concentrations to understand their survival and growth under different host conditions. Growth will be analysed over time by phase contrast microscopy and BDD treponeme PCR assays.

Aim 4: Assessing the association of healthy foot tissues with BDD treponemes. A previous study found evidence of BDD treponemes on healthy foot tissues (7). Immunohistochemistry of healthy foot tissues from the survey that are positive for BDD treponemes will be used in order to identify whether BDD treponemes can be associated with healthy foot tissue without causing disease and where in the tissue they are found. Rectal and oral tissue will also undergo the same procedure.

POTENTIAL IMPACTS

The results of the project will improve our knowledge of the relationships between the bovine host, BDD treponemes and dairy environment. This information could then be applied to other species affected by the disease. Identification of reservoirs and specific risk factors will help to elucidate transmission routes and aid the development of prevention strategies.

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REFERENCES

1. Blowey RW & Sharp MW (1988). Digital dermatitis in dairy cattle. Vet Rec 122: 505-508.
2. Whay HR, Waterman AE & Webster AJF (1997). Associations between locomotion, claw lesions and nociceptive threshold in dairy heifers during the peri-partum period. Vet J 154: 155-161.
3. Relun A, Lehebel A, Chesnin A et al (2013). Association between digital dermatitis lesions and test-day milk yield of Holstein cows from 41 French dairy farms. J Dairy Sci 96: 2190-2200.
4. Cha E, Hertl JA, Bar D et al (2010). The costs of different types of lameness in dairy cows calculated by dynamic programming. Prev Vet Med 97: 1-8.
5. Evans NJ, Brown JM, Demirkan I et al (2009). Association of unique, isolated treponemes with bovine digital dermatitis lesions. J Clin Microbiol 47: 689-696.
6. Stamm LV, Bergen HL & Walker RL (2002). Molecular typing of papillomatous digital dermatitis-associated Treponema isolated based on analysis of 16S-23S ribosomal DNA intergenic spacer regions. J Clin Microbiol 40: 3463-3469.
7. Evans NJ, Timofte D, Isherwood DR et al (2012). Host and environmental reservoirs of infection for bovine digital dermatitis treponemes. Vet Microbiol 156: 102-109.
8. Naylor SW, Low JC, Besser TE (2003). Lymphoid follicle-dense mucosa at the terminal rectum is the principal site of colonisation of enterohemorrhagic Escherichia coli O157:H7 in the bovine host. Infect Immun 71: 1505-12.

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A HIGH ASSOCIATION OF DIGITAL DERMATITIS TREPONEMES ON CATTLE AND SHEEP HOOF TRIMMING EQUIPMENT

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SUMMARY

This study investigated whether BDD Treponema phylogroups can be present on equipment used to trim ruminant hooves. After trimming, “Treponema medium/T. vincentii-like”, “Treponema phagedenis-like” and Treponema pedis BDD spirochetes, were shown to be present on 16/24 (67%), 15/24 (63%) and 10/24 (42%) of knives, respectively. An isolate belonging to the T. phagedenis-like spirochetes was identified from a knife sample after trimming a DD positive cow.

INTRODUCTION

Bovine digital dermatitis (BDD) is an ulcerative lesion of the digital skin causing severe lameness in dairy cattle which was first reported in the UK (1) and was very recently confirmed in beef cattle in the UK (2). The primary causative agents are considered to be spirochetal bacteria with a polytreponemal aetiology suggested (3,4,5). Three Treponema phylotypes have been isolated from dairy cattle lesions in the UK and USA (6, 7). The phylotypes are described as “Treponema medium/T. vincentii-like”, “Treponema phagedenis-like/T. phagedenis-like” and Treponema pedis/ T. pedis BDD spirochetes (5, 7).

Treponemes associated with BDD are only consistently detected in the lesions themselves, suggesting that direct foot-foot contact may be a significant route of BDD transmission. One item that regularly comes into direct contact with the feet of cattle is hoof trimming equipment. A study published in 1999 (8) raised the possibility of an association between animal hoof trimming and the incidence of BDD. This study investigated whether BDD Treponema phylogroups could be detected on hoof trimming equipment after trimming the feet of cattle suffering from BDD and therefore question whether BDD may be transmitted between animals by this route.

MATERIALS AND METHODS

Samples were taken by the attending vet on the farm during routine foot trimming and/or treatment of cattle (n=24) feet. The foot was trimmed using a typical stainless steel hoof knife or shears. After the trimming of a foot, the trimming instrument used was tested by swabbing, using a fixed protocol of a single swab passage across each side of the blade, on both sides of the instrument. The trimming instrument was then rinsed in a DEFRA approved iodine disinfectant (containing 2.5% (w/v) available iodine) for two to three seconds, wiped to remove excess disinfectant and then re-tested with a fresh swab using the same technique. For PCR analysis, cotton swab samples were thawed and DNA extracted using a DNeasy kit (Qiagen, United Kingdom). All samples were subjected to the Treponema genus PCR assay (9) and to nested PCR analysis specific for the three DD treponeme phylogroups (5, 7). Bacterial isolation was attempted on four swab samples, two swabs after trimming and another two swabs used to sample the same blades after disinfection. The swab samples were transferred into an anaerobic cabinet (85% N_2, 10% H_2 and 5% CO_2, 36 °C) and inoculated into oral treponeme enrichment broth (OTEB; Anaerobe Systems, Morgan Hill, CA, USA) with 10% foetal calf serum (FCS) and the antibiotics rifampicin (5 µg/ml) and enrofloxacin (5 µg/ml), subcultured on fastidious anaerobe agar (FAA) plates (LabM, Bury, UK) and single colonies inoculated into growth media. DNA was extracted from treponeme cultures as described previously (7).

RESULTS AND DISCUSSION

After trimming, blades were found to be positive for general Treponema DNA in 23/24 (96%) of cattle blades. This was reduced to 7/24 (29%) after disinfection of the blade. After trimming, “T. medium/T. vincentii-like”, “T. phagedenis-like” and T. pedis BDD spirochetes, were shown to be present on 16/24 (67%), 15/24 (63%) and 10/24 (42%) of knives, respectively. After disinfection, detection rates for the BDD treponemes were 5/24 (21%), 2/24 (8%) and 1/24 (4%), respectively. Following culture of a swab, an isolate belonging to the Treponema phagedenis-like spirochetes was identified from a knife sample after trimming a BDD positive cow. The high detection rate of BDD Treponema phylotypes on trimming blades soon after trimming cattle hooves from BDD cases suggests this may be a significant and worrying route for transmission between animals and, possibly, between farms. The isolate obtained from a blade after trimming a BDD animal, which shared 100% sequence identity to the T. phagedenis-like BDD spirochete strain T320A (Genbank accession: EF061261), shows that bacteria can survive on the blade and therefore have the potential to infect the next animal to come into contact with the blade. This further highlights how important the disinfection of trimming equipment is in terms of DD transmission.

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REFERENCES

1. Blowey, R.W., Sharp, M.W. (1988) Digital dermatitis in dairy cattle. Veterinary Record 122, 505-508.
2. Sullivan, L.E., Carter, S.D., Blowey, R., Duncan, J.S., Grove-White, D., Evans, N.J. (2013) Digital dermatitis in beef cattle. Veterinary Record, 173, 582.
3. Klitgaard, K., Boye, M., Capion, N., Jenson, T.K. (2008) Evidence of multiple Treponema phylotypes involved in bovine digital dermatitis as shown by 16S rRNA gene analysis and fluorescence in situ hybridization. Journal of Clinical Microbiology 46 (9), 3012-3020.
4. Nordhoff, M., Moter, A., Schrank, K., Wieler, L.H. (2008) High prevalence of treponemes in bovine digital dermatitis-a molecular epidemiology. Veterinary Microbiology 131(3-4). 293-300.
5. Evans, N.J., Brown, J.M., Demirkan, I., Singh, P., Getty, B., Timofte, D., Vink, W.D., Blowey, R.W., Birtles, R.J., Hart, C.A., Carter, S.D. (2009) The association of unique, isolated treponemes with bovine digital dermatitis lesions. Journal of Clinical Microbiology 47, 689–696.
6. Stamm, L.V., Bergen, H.L., Walker, R.L. (2002) Molecular typing of papillomatous digital dermatitis-associated Treponema isolates based on analysis of 16S–23S ribosomal DNA intergenic spacer regions. Journal of Clinical Microbiology 40, 3463–3469.
7. Evans, N.J., Brown, J.M., Demirkan, I., Murray, R.D., Vink, W.D., Blowey, R.W., Hart, C.A., Carter, S.D. (2008) Three unique groups of spirochetes isolated from digital dermatitis lesions in UK cattle. Veterinary Microbiology 130, 141–150.
8. Wells, S.J., Garber, L.P., Wagner, B.A. (1999) Papillomatous digital dermatitis and associated risk factors in US dairy herds. Preventative Veterinary Medicine 38, 11–24.
9. Moore, L.J., Woodward, M.J., Grogono-thomas, R. (2005) The occurrence of treponemes in contagious ovine digital dermatitis and the characterisation of associated Dichelobacter nodosus. Veterinary Microbiology 111, 199–209.

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QUANTIFYING TRANSITIONS BETWEEN DIFFERENT LEVELS OF MOBILITY SCORE IN DAIRY COWS

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INTRODUCTION

Lameness is one of the most important health and welfare challenges facing the dairy industry (1). Recent initiatives have highlighted the role of mobility scoring for detecting lame cows, monitoring herd prevalence and motivating staff to improve lameness levels. However, there is little evidence describing the expected rate of change in mobility score in the short term. In this study individual cow mobility score records were used to explore the progression of lameness cases between consecutive scoring events.

MATERIALS AND METHODS

The data was collected on four English dairy farms during the winter housing periods only for three consecutive years (2010-2012). Fortnightly mobility scoring was carried out on all lactating cows in each herd during the study period. The widely recommended 0-3 scale was used for mobility scoring, where 0 – Good mobility, 1 – Imperfect mobility, 2 – Impaired mobility, 3 – Severely impaired mobility (2), and animals scored <1 are considered lame. Consecutive scores were examined in pairs according to the change in MS over the fortnight. For example, a cow with consecutive scores of 0, 1, 2, 2 would be recorded as 0-1, 1-2, 2-2. MS were considered consecutive if they took place within 30 days of each other, and 95.3% of score pairings used in the analysis occurred within 14 +/- 3 days of each other. After exclusions, 19,587 score pairings were available for analysis.

RESULTS

Table 1 shows the relationship between the start score of each score pairing and the score two weeks later. The data shows that only 7.7% of animals that were scored as MS 0 were recorded as clinically lame at the next recording. Of the 9072 animals with a start score of MS 1, 1855 (20.4%) were clinically lame at the next recording and 7217 (79.6%) remained sound. Of the 6528 animals with a start score of 2, 70.1% remained lame two weeks later. Only 4.9% of MS 3 cows were not lame at the next recording, with 49.9% still MS 3.

Table 1. Distribution of observations of consecutive score pairs. Percentages are expressed out of pairings with the same starting score, so each row totals 100%

		Score two weeks later % (number of observations)				
		0	1	2	3	Total
Start score	0	1324 (43.0%)	1522 (49.4%)	228 (7.4%)	9 (0.3%)	3083 (100%)
	1	1427 (15.7%)	5790 (63.8%)	1806 (19.9%)	49 (0.5%)	9072 (100%)
	2	218 (3.3%)	1783 (26.6%)	4105 (62.9%)	467 (7.2%)	6528 (100%)
	3	6 (0.7%)	38 (4.2%)	409 (45.2%)	451 (49.9%)	904 (100%)

This indicates that progression from being sound to being lame (and vice versa) tends to happen over the course of multiple consecutive recordings (i.e. over several weeks), with only 1.5% (286 of 19,587) of scores increasing by more than one score between fortnightly measurements. To examine this further, scores were grouped according to the change in score between consecutive scorings (Table 2). This shows that nearly 60% of pairings showed no change between the start and end score of consecutive recordings, and only 2.8% of pairings showed a two or three score change, including both increasing and decreasing scores.

Table 2. Summary of the size of score changes between consecutive scorings

	None	1 score	2 score	3 score	Any change
Increase	11670 (59.6%)	3795 (19.4%)	277 (1.4%)	9 (<0.1%)	4081 (20.8%)
Decrease		3619 (18.5%)	256 (1.3%)	6 (<0.1%)	3881 (19.8%)

The most frequently observed score pairings were 1-1 (5790 events, 29.6% of pairings) and 2-2 (4105 events, 21.0% of pairings) (Table 1). The high frequency of animals that remain at MS 2 for at least a fortnight suggests that a substantial proportion of lame animals are either not being treated or are being treated unsuccessfully.

CONCLUSIONS

The results suggest that most cows transition through successive mobility scores. This implies that if mobility scoring takes place fortnightly the majority of lame cows can be identified when they become MS 2, before progressing to MS 3. As MS 3 is defined as an animal that has 'severely impaired mobility', MS 3 cases have the greatest impact on animal welfare. Previous work has demonstrated that early detection and treatment of lameness cases (within two weeks of the first MS 2 recording) can increase the speed of recovery (3). Fortnightly mobility scoring provides useful information about changes in overall herd mobility whilst still being reasonably practical for the farmer.

The results also raise the question of whether there is potential for intervention at the MS 1 level to be used to prevent progression to MS 2, but further work is required in this area. In the authors' experience some MS 1 cows may have disorders that are less amenable to treatment, including thin soles and chronic osseous changes, so if foot trimming were employed preventatively for MS 1 cows it would need to be carried out by a skilled operator to minimise the risk of increasing lameness through over-trimming.

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REFERENCES

1. Farm Animal Welfare Council (2009) Opinion on the welfare of the dairy cow. FAWC, London: UK. http://www.fawc.org.uk/pdf/dcwelfar-091022.pdf.
2. Anon (2013) DairyCo Healthy Feet Programme Mobility Score Instructions. http://www.dairyco.org.uk/resources-library/technical-information/dairyco-healthy-feet-programme/mobility-score/. s
3. Leach, K.A., et al (2012) The effects of early treatment for hindlimb lameness in dairy cows on four commercial UK farms. The Veterinary Journal, 193, 626-632

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CHOOSING TO REDUCE LAMENESS

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INTRODUCTION

In 2012/13, a DEFRA funded North West England Dairy Cattle Mobility Project studied lameness prevalence amongst 11,500 dairy cows on 45 farms over a period of 18 months. A structured interview was carried out for each farm to ascertain farmers' beliefs and understanding about their herds' mobility, and attitudes to lameness reduction in their own herds and nationally.

METHOD

Following an open question to identify potential reasons for not reducing lameness, participant farmers were asked to score their own personal barriers to reducing lameness within their own herds. Scores were 0 (no barrier) to 4 (major barrier). Potential barriers were:

1. I do not have enough time
2. I'm not sure which actions I can take which will make a difference
3. I do not have enough motivation
4. Taking action on mobility is not a high priority for me
5. Cattle mobility does not interest me
6. Taking action on mobility would not provide an economic return

During analysis of data, farms were ranked by lameness prevalence. Responses given by farmers with the lowest lameness prevalence were compared with those given by farms with the greatest prevalence (top and bottom quartiles).

RESULTS

The greatest perceived barriers were lack of time, not being sure which actions to take and lack of motivation (see graph over). There was a clear difference between answers given by farmers with the least lameness in their herds, compared with those with the greatest lameness prevalence. A composite mean score for all perceived barriers was 4.9/24 (20%) for farmers with least lameness and 14.7/24 (61%) for farmers with most lameness.

CONCLUSION

Results from this study provide evidence that farmers who perceived their personal barriers to be lower had better mobility in their herds. Lameness prevalence appeared to be related to the attitude of the farmers. It can be hypothesised that good herd mobility can be a "choice".

DISCUSSION

The same study found farmers were inclined to attribute lameness in their herds to extrinsic factors, such as weather, nutrition, and environment. In fact, the findings were that intrinsic attitudes and beliefs were the most significant factors which were associated with varying lameness prevalences between farms.

Lower personal barriers might indicate higher perceived behavioural control and greater intent. This is an important observation when considered alongside the Theory of

Planned Behaviour (1). Briefly, the theory suggests that intentions are a function of three factors:

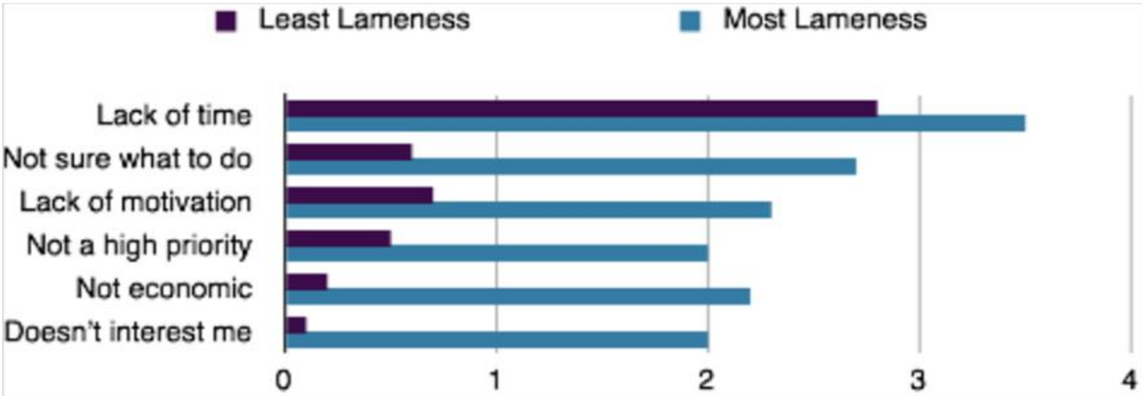
- attitude, which is formed from an overall evaluation of the behaviour;
- subjective norm, which reflects perceived social pressure; and perceived behavioural control, which reflects confidence that the behaviour can be performed.

So, in order to have an intention to reduce lameness, a farmer must believe that lameness is not a good thing (attitude to lameness); believe that he/she has more lameness than they should (compared with their subjective norms); and believe that reducing lameness is within their control (perceived behavioural control). Working to increase farmers' perceived behavioural control is likely to be beneficial.

Altering human behaviour in order to effect a change is a common challenge. Farmers accepting responsibility for lameness within their own herds is probably a pre-requisite before expecting them to implement any technical advice on how to reduce lameness. Developing a farmer's belief in their own ability to control lameness, then providing simple practical tools to do so, might increase the likelihood of them *choosing* to reduce it.

Searching outside the traditional realms of veterinary or dairy science for experience and understanding of successful programmes for changing behaviours will continue to be valuable in our quest for better cattle health and welfare. A useful example is the Department of Transport's ongoing campaign to reduce deaths associated with speeding motorists (2). In this instance, speed awareness workshops have resulted in some measured success by adopting simple principles of behavioural change, including the Theory of Planned Behaviour (37). Delegates are encouraged to accept responsibility for their own speed and are given simple tools to alter their inherent habits, both of which can increase their perceived behavioural control.

Graph showing mean scores for potential barriers for farmers with least and most lameness



REFERENCES

1. Ajzen, I. (1991) The Theory of Planned Behavior. Organizational Behavior and Human Decision Processes, 50, 179–211.
2. Department of Transport, 2006. Road Safety Research Report No. 66. Effective Interventions for Speeding Motorists. DfT Publications, PO Box 236, Wetherby LS23 7NB or online via www.publications.dft.gov.uk
3. McKenna, F.P., 2007. Do attitudes and intentions change across a speed awareness workshop? In proceedings of Behavioural Research in Road Safety 2007, Seventeenth Seminar, Department of Transport. pp 265-276.

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DEVELOPING A VACCINE FOR DIGITAL DERMATITIS OF CATTLE AND SHEEP: A REVERSE VACCINOLOGY APPROACH

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SUMMARY

Digital dermatitis (DD) is a transmissible treponemal disease that affects the feet of cattle and sheep and is a leading cause of lameness in both species. Current control measures are inadequate and an effective vaccine offers the best chance of disease eradication. To this end, a genome-centred approach to vaccine design, termed reverse vaccinology, is now being utilised to identify new bacterial vaccine candidates for inclusion in a recombinant vaccine, tailored to be concurrently effective against all DD treponemes.

BACKGROUND

Bovine Digital Dermatitis (BDD), a transmissible bacterial disease of the feet in cattle, is a common cause of infectious lameness in UK dairy and beef herds, and is characterised by ulcerative lesion development and pronounced localised inflammation (1). Similarly, Contagious Ovine Digital Dermatitis (CODD), affecting sheep flocks, shares the same clinical and pathological features with BDD. Prevalence of both diseases continues to increase globally, impacting on both animal welfare and agricultural performance (2).

DD is a complex multibacterial disease, and numerous bacterial species have been localised to the site of infection. However, studies have consistently demonstrated the presence of Treponema spp, in abundance, deep within the lesions of DD (3). In addition, an experimental infection model has confirmed their role in the aetiology and propagation of this disease (4). Subsequent genetic analysis has revealed that co-infection with Treponemes from three phylogenetic groups is essential for the development of BDD/CODD: Treponema medium/Treponema vincentii-like (group 1), Treponema phagedenis-like (Group 2) and Treponema denticola-like (Group 3) (3).

Whilst useful as control measures, current approaches to disease management (including antibiotic therapy, biosecurity and foot-bathing) do not provide an effective means of disease elimination (5). Conventional approaches to vaccine design have so far failed to yield an effective vaccine for BDD/CODD. However, a novel bioinformatics-centred approach, termed reverse vaccinology, has enabled, via in silico analysis of the Treponemal genomes, the identification and classification of all proteins expressed by these organisms. Subsequently, the proteins deemed most suitable for inclusion in a vaccine have been selected and are being synthesised. In an attempt to identify cross-protective immunogens, particular focus has been given to proteins that are homologous across the three Treponemal groups. In vitro testing of these vaccine candidates will be followed by vaccine trials in sheep and cattle to determine safety and efficacy.

METHODS

The genomes of the Treponema spp. implicated in DD were sequenced. Computer-based analysis of these genomes permitted the identification of multiple genes that encode proteins localised to the outer membrane, and with favourable size and topology. Recombinant DNA technology was used to express these genes as proteins in Escherichia coli. Expression was analysed using SDS-PAGE. These proteins are to be purified using metal affinity chromatography, analysed for immunogenic properties, and trialled clinically as vaccine components.

RESULTS

The in silico phase of this project has yielded 15 vaccine targets with sequence homology across the three groups. All Treponemal Group 1 outer membrane proteins with cross-group homology have been successfully cloned and expressed using Gateway® recombination cloning technology (Invitrogen, Carlsbad, CA).

DISCUSSION

Reverse vaccinology offers a new approach to vaccine design and, through in silico genome sequence analysis, permits access to the entire antigenic repertoire of the DD Treponemes. This has resulted in the identification of multiple and hitherto uncharacterised outer membrane proteins with immunostimulatory potential. Cloning, expression and analysis of these proteins continues, and clinical trials of the first recombinant vaccines against DD are planned.

REFERENCES

1. Scholey R.A., Evans N.J., Blowey R.W. et al. Identifying host pathogenic pathways in bovine digital dermatitis by RNA-Seq analysis. Vet J. 197 (3), 699-706.
2. Brandt S., Apprich C., Hackl V., et al. (2011). Prevalence of bovine papillomavirus and Treponema DNA in bovine digital dermatitis lesions. Vet. Microbiol. 148 (104), 161-167.
3. Evan N.J., Timofte D., Isherwood D., et al. (2012). Host and environmental reservoirs of infection for bovine digital dermatitis treponemes. Vet. Microbiol. 156 (1-2), 102-109.
4. Gomez A., Cook N.B., Bernardoni N.D., et al. (2012). An experimental infection model to induce digital dermatitis infection in cattle. J. Dairy Sci. 95 (4), 1821–1830.
5. Laven R. A. & Logue D. H. (2006). Treatment strategies for digital dermatitis for the UK. Vet. J. 171 (1), 79-88.

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SURVEY OF PERCEIVED VS ACTUAL VOLUME AND CONCENTRATION OF FOOTBATH SOLUTIONS

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INTRODUCTION

Digital Dermatitis is a highly significant cause of infectious lameness (3), causing both acute and chronic lameness, as well as contributing to more serious, non-healing conditions such as toe necrosis (1). Footbathing is a key component in the control of infectious lameness, particularly digital dermatitis and is now common practice on most dairy farms. There is often a lot of discussion around the type and concentration of chemical to be used but in order for these decisions to be meaningful it is vital to know the volume of water being used so that the correct dilution rate can be calculated.

Inaccuracy of dosing in footbaths has been highlighted previously (2) and is something we often come across when implementing lameness control programs. A survey was designed to evaluate this knowledge on a farm level, and to help highlight where footbathing was not being done effectively.

MATERIALS & METHODS

A survey was produced and circulated around the mobility team to complete on farms that they visited. First the farmer was quizzed on the volume of the bath(s) being used, and the amount of chemical(s) used and what concentration was being targeted. The bath was then measured and the volume calculated (or assessed using measured buckets for baths with uneven shape) to obtain the true value. Data was also collected regarding number of cow passes, frequency of bathing and siting of the bath in order that this can be compared with mobility score and lesion data gathered by the paraprofessional team going forwards. The results for footbath frequency are also summarised in a table.

RESULTS

Of the 26 farms surveyed, the majority were underestimating the true volume of their footbath, leading to a high risk of under-dosing of any chemicals used to counteract digital dermatitis (see table 1.)

Table 1. Bath and Chemical Results Summary

	Volume	Average Error	Chemical Concentration	Average Error
% Correct (within 5%)	23%	-	23%	-
% Overestimated	23%	14%	42%	8%
% Underestimated	54%	53%	15%	35%
% Not made an estimate	-	-	19%	-

Only 23% of farms surveyed were correctly estimating the volume of the footbath.
Only 23% of farms were adding the right amount of chemical required to achieve their desired concentration.

Only 3 farms (12%) were correctly estimating both volume and concentration as some had achieved the correct concentration despite being incorrect about bath volume.
Of the farms over-estimating the size of their bath, the average error was 14%, leading to an 8% over-dose of chemical.

Of the farms under-estimating the size of the bath, the average error was 53%, leading to a 35% under-dosing of chemical.

DISCUSSION

This quick and simple survey has highlighted the fact that only a minority of farms are carrying out routine footbathing in an accurate fashion and that nearly half of the farms surveyed are failing to achieve expected concentrations of chemical in their footbath due to these inaccuracies.

Formalin is still by far the most commonly used footbath chemical (18/26 farms surveyed) and its disinfection properties improve with greater concentration so ensuring the correct amount is added to the bath is critical to the success of any footbathing regime.

Work is ongoing to increase the number of farms surveyed and to use other data, such as mobility and lesion records, to improve the quality of our advice with regard to footbathing and digital dermatitis control.

CONCLUSION

In conclusion, a footbathing program is a critical component of lameness control in most dairy herds and this brief review has demonstrated the importance of including a discussion on the volume and dilution rate of footbath solution to be used in order to maximise the efficacy of this measure.

REFERENCES

1. Atkinson O. (2012) Necrotic Toes and Axial Wall Splits. Cattle Practice Vol 20, 63-64
2. Blowey R. (2008) Cattle Lameness and Hoofcare.
3. Laven R.A. (2006) The Relationship Between Hoof Conformation and Digital Dermatitis in Dairy Cattle. Cattle Practice Vol 15, 93-95

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Royal Veterinary College, The Dairy Group and University of Nottingham

A QUASI-RANDOMISED, NON-INFERIORITY CLINICAL TRIAL COMPARING HOOFSURE ENDURANCE WITH 4% FORMALIN

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SUMMARY

A split-leg, cross-over foot bath trial was conducted to compare the efficacy of 2% Hoofsure Endurance with 4% formalin in a 2x12 week trial using 90 dairy cows though a winter housing period. No significant difference was found in efficacy between the two treatments and prevalence of non-regressing digital dermatitis lesions fell from 42.5% to 21.9% over the 24 weeks.

INTRODUCTION

Formalin and copper sulphate are the most commonly used non-antibiotic biocides used in footbaths in parts of England (1) and the US (2). However, concerns due to formaldehyde being a probable carcinogen and copper being a biohazard means their long term use is questionable. Therefore there is an urgent need for alternatives that do not pose risks to human health, animal welfare and/or the environment.

MATERIALS AND METHODS

A herd of over 90 milking cows were recruited for a split-leg with crossover design foot bathing study. One side of the split foot bath was filled to 12cm with 4%formalin and the other side was filled to 12 cm with 2% Hoofsure endurance (Provita, Northern Ireland). Treatments were assigned to each side for the initial of the two cross-over phases using the toss of a coin. Cows were walked through the foot bath twice daily for five consecutive days each week which continued for 12 weeks at which time the sides that the treatments were allocated to were swapped (cross-over). The herd were scored for digital dermatitis by hosing and inspection with a torch at milking in the parlour. Lesions were scored using a modified M-system (3). The trial ran from 18/10/13 through the winter housing period, concluding 10/4/14.

RESULTS AND DISCUSSION

The trial was completed with very few animals requiring treatment. No adverse effects of the twice daily foot bathing were observed for either of the treatments. Prevalence of non-regressing lesions (M1, M2, M4) fell through the study from a hindlimb prevalence of 42.5% at the start to 21.9% at the cross-over point and 19.3% at the end. There was no significant difference in prevalence of non-regressing lesions between treatments at crossover (formalin 21.0% vs Hoofsure endurance 22.9%, $p=0.433$) or at the final scoring (formalin 20.8% vs Hoofsure endurance 18.4%, $p=0.642$). This preliminary report suggests that Provita Hoofsure Endurance is as efficacious as 4% formalin when used twice daily for 5 days a week, with both treatments resulting in a falling prevalence of lesions through the trial period.

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REFERENCES

1. Bell, N. J. Assessment of prevalence, treatment and control of lameness-related disease in dairy heifers on 30 farms in Southwest Britain. In: ZEMLJIC, B., ed. 13th Symp. Lameness in Ruminants, 11-15th February 2004 Maribor, Slovenia. 39-40.
2. Cook, N. B., Rieman, J., Gomez, A. & Burgi, K. 2012. Observations on the design and use of footbaths for the control of infectious hoof disease in dairy cattle. The Veterinary Journal, 193, 669-673.
3. Dopper, D., Koopmans, A., Meuer, F. A., Szakall, I., Schukken, Y. H., Klee, W., Bosma, R. B., Cornelisse, J. L., Vanasten, A. & Terhuurne, A. 1997. Histological and bacteriological evaluation of digital dermatitis in cattle, with special reference to spirochaetes and Campylobacter faecalis. Veterinary Record, 140, 620-623.

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