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Proceedings of the 18th International Symposium & 10th Conference on Lameness in Ruminants

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Next conference:

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ORGANISING COMMITTEE



Universidad Austral de Chile

Facultad de Ciencias Veterinarias



INTERNATIONAL CONFERENCE ON

LAMENESS IN RUMINANTS

VALDIVIA - CHILE 2015

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CHARACTERIZATION OF CLAW LESIONS IN HOLSTEIN CATTLE FROM THE NORTHERN SAVANNAH OF BOGOTA, COLOMBIA.	J Córdoba
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THE LAME GAME – CHILE VS NEW ZEALAND - CAN WE BOTH BE WINNERS?

Neil Chesterton

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Introduction:

Chile and New Zealand are both countries with a well-established dairy industry. In both countries lameness is a serious animal welfare issue on many dairy farms. Who is winning in the game to control this problem? In this paper I want to show how it is not always the similarities that allow us to learn from each other but it is often the differences.

Chile (749,000 km²) is 4506 km long and the widest part is only 258 km. 85% of the dairy cows are in the southern regions (XIV, IX, X) between latitudes 35° and 43°. Here there is more consistent rainfall and the dairying is predominantly pasture-based (1).

In New Zealand (268,000 km²) dairying is found from top to bottom - latitudes 35° to 47°. It is predominantly pasture-based where there is dependable rainfall, plus irrigation in dryer parts (2).

Table 1: Comparison Chile and New Zealand Populations (1,2,3,4).

	Human Population	Number of dairy cows	Number of dairy cows
New Zealand	4.6 million	11,864	4,900,000
Chile	18 million	16,000	500,000

Table 2: Farm types and yield in Chile and New Zealand (1,2,3,4).

	Chile	Chile	New Zealand	New Zealand
	Región XIV Mostly family farms	Región X Many corporate farms	Canterbury (larger farms)	Average overall
Average herd size	100	964	996	413
Yield (litres)	4623	7532	5364	4169

My experience over the last four years in Chile has been with pasture based systems in the Southern regions, so I will use that system to illustrate the "lame game". At an international conference like this, the exchange and sharing of knowledge results in benefits to every country, so that we all are winners.

Aim

In this paper I want to look at the similarities and differences between dairy cattle systems in Chile and New Zealand in order to understand the differences in feet problems between the two countries. I will not refer to lameness in the Northern and Central region of Chile where dairying is based on confinement systems. In parts of New Zealand there is some interest in confinement systems (only about 80 barns to date), but in most cases confinement is only for a few months of the year to minimise nitrogen leaching into waterways and reduce pasture damage.

Even more important than just describing the differences, I want to use the two countries as an example of how identifying the differences can help both countries understand and deal better with their own problem.

The Game

In 2011 I was invited to come to Chile and investigate the lameness problems in a number of farms because the perception was that dairying in Southern Chile was the same as New Zealand. The first thing we did was to look at the cows to identify the lesions causing lameness.

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Table 3: Predominant lameness conditions seen on farms in the south of Chile (personal data).

Lesion / Category	Percent of 389 treatments by vets 2012	Percent of 9403 treatments by farm staff 2014-5
White-line injury	38%	62.4%
Sole injury	5.5%	21.8%
Toe abscess	10%	
Inter-digital cracks	8.7%	
Skin DD (infection)	10.5%	8.5%
Foot-rot (infection)		
Solar ulcer	6.9%	12.7%
Miscellaneous	11.3%	
Farm lameness incidence		8.2% - 45.1% (average 25.9%)

The majority of the lameness conditions were the same as those seen in New Zealand and the causes in New Zealand were predominantly from trauma to the claw on walkways and concrete yards. Data when recording all the lesions in all 4 feet in lame cows in Southern Chile identified the most frequent lesions as White-line (68.2%), Solar Ulcer (41.3%) and Double Sole (27.5%) (5).

Table 4: Predominant lameness conditions in New Zealand.

Lesion / Category	Percent of 4,488 treatments North Island (6)	Percent of 8089 farmer reported treatments in South Island (7)
White-line injury	42%	57.7%
Sole injury	29%	16.6%
Toe abscess		
Inter-digital cracks	13%	9.2%
Skin DD (infection)		
Foot-rot (infection)	8%	
Solar ulcer	1%	3.1%
Miscellaneous	7%	13.5%
Farm lameness incidence		4.3% - 64.4% (average 26.2%)

In both countries the predominant lameness of cows on pasture is traumatic lameness. There were noticeably more solar ulcers in Chile. These should not be included as simple traumatic lameness,

being more likely a result of higher input of concentrate (7).

There were two questions that were being asked by most farm managers:

1. Why are there so many lame cows in Chile?
2. Why are so many of the lame cows slow to heal or not responding to treatment of simple injuries of the claw?

1. Why so many lame cows?

i. Long walking distances. This is a key to understanding traumatic lameness in New Zealand. Long distances walked multiply every problem causing foot wear on walkway surfaces (8). This was a major problem in Chile causing sole wear and damage. It is common for the walking distances to the further paddocks to be greater than 1.5 km in one direction (on occasions up to 3 km). Long distances walked on flat surfaces is serious enough. In dairy areas in Chile the terrain is undulating which adds to the problem.

ii. Abrasive walkway material. Volcanic gravels in many parts of New Zealand are very abrasive to cows' feet. The damage was exaggerated where maintenance of the walkway was inadequate (9). Ideally the base material is covered with a less abrasive top walking surface to reduce foot wear. In Chile with its volcanic soils it is difficult to find suitable less abrasive materials for the walking surfaces of the walkways.

iii. Gravel on the concrete surfaces of the milking parlour. In New Zealand lime and other soft rocks are used as a "transition" material to absorb gravel and stones before the cows walk onto the concrete. No suitable materials had been found in Chile, so in wet weather gravel is carried onto the concrete causing bruising and puncturing of soles.

iv. Narrow tracks. Recommendations on track design with the increasing size of herds in New Zealand had resulted in greater choice of foot placement and improved cow-flow (10). On many

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farms in Chile the narrow width of the tracks and either lack of camber or too steep camber were resulting in foot damage.

v. High rainfall. Pasture based farming requires consistent rainfall. However, all the factors causing wear of the foot are exaggerated with periods of persistent rain-fall.

vi. Herding pressure on the track. Impatient herding had been found to be an important cause of lameness in New Zealand herds (9). On many farms in Chile the herdsman was too close to the rear cows. On some farms horses are used to herd cows. Horses walk faster than a herd of cows, so horsemen had to be very careful to keep well back behind the rear cows if they wanted to reduce the compaction of the herd.

vii. Herding pressure in the milking parlour. This is a common cause of stress on herds in New Zealand and it was the same in Chile. In New Zealand low stress handling techniques with dairy cattle are being taught. This is a huge need in Chile.

viii. American Holsteins, European dual breeds and all-year calving. In New Zealand with its pasture based, seasonal calving system, there has been huge selection pressures against lameness, because so many of the lame cows that fail, or are late to get into calf are culled. In Chile the American Holstein genetics has not had the years of selection pressure on pasture as is the case in New Zealand. In Chile where cows are calved all year round, lame cows with delayed oestrus will continue to be milked until they conceive, instead of being culled for lameness.

2. Why are so many of the lame cows slow to heal or not responding to treatment of simple injuries of the claw?

Our game of lameness in NZ was actually quite easy. With early adequate treatment our cows could be returned to the main herd within days. We seldom needed antibiotics for the common lameness le-

sions apart from the foot-rot cases.

So why were there so many non-responsive lameness lesions in Chile? Generally the people doing the treatment were thorough and had well designed treatment crushes. The problem was that Chile had BDD.

Chile has had BDD for at least 30 years (11). Many Chilean veterinarians remember being taught of this disease before it was written about in other countries – some report even seeing it as early as 1975. New Zealand has had no experience of this disease apart from a few individual cases reported on six farms between 2004 and 2011. I had worked in NZ for 35 years without the problem of BDD. I immediately saw something was different in Chile.

The Outcome – diagnosis

Fortunately the “Lame Game” is an international game. Six years previously (2006) at the Lameness in Ruminants Conference in Finland, we had heard about a possibly new disease - “Non healing White lines and Toe necrosis”. Roger Blowey et al had connected this to BDD (12). The slow healing cases had nothing to do with poor treatment. It was due to secondary infection of a claw injury with BDD (12). The wound had a smell that I had never smelled in New Zealand as a clinician. Histology confirmed spiral shaped bacterial clusters consistent with *Treponema* sp.

So the Chile game was different. Even simple injuries such as separation of the WL were often super-infected within a month of calving. I saw ‘toe necrosis’ lesions that I’d never seen in New Zealand.

Table 5: Rates of infection of lesions with BDD (personal data).

Lesion	Percent infected with BDD of 389 treatments
White line	34%
Sole	4.3%
Axial crack	36%
Toe abscess	49%
Solar ulcer	3.7%

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Controlling the BDD and limiting exposure to infection.

International experience again helped, recommending foot bathing as an essential part of control. Many farms in Chile had foot baths but their design was poor. The contaminated baths were probably spreading the disease rather than controlling it. Some of the footbaths were possibly causing foot damage as large herds pushed to get through the narrow baths.

Chile had many large herds so we had to rethink the design of foot-baths. Within two months the skin BDD was dramatically decreasing.

So, so far Chile was winning – because they were benefitting from New Zealand observations/experience and international knowledge.

What about New Zealand's situation? Because of the experience of finding BDD in Chile in almost identical grazing conditions to New Zealand we started looking for it and to our surprise – we have the disease in New Zealand in over 60 % of the herds that were screened in a recent study (data yet to be published).

Everything we had learned in Chile and around the world was available to New Zealand. Now New Zealand was winning also. If we hadn't seen the seriousness of the disease in large pasture based herds in Chile I don't think we would have taken the time to look for it in New Zealand. Dr Dorte Dopfer visited New Zealand in 2015, saw our mild non-lame form of BDD and added to our concern when she said our small lesions are just like those seen in The Netherlands over 35 years ago.

Conclusion

For us all to be winners in the 'Lame Game', we need to continue International collaboration, travelling and conferences like this. We need to remember that although there will be differences, or maybe because of our differences, there will be ideas we can learn from each other and so all of us benefit. So that is the point of my story. The differences and similarities between our two countries gave us the opportunity to benefit from each other's expe-

rience. The game should never be Chile versus New Zealand, but Chile vs Lameness and New Zealand vs Lameness. We can all be winners!

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IS BRAZIL GETTING LAME ? CAUSES OF LAMENESS IN CATTLE IN BRAZIL AND PERSPECTIVES

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1. Introduction

Major advances in agricultural techniques and an estimated agricultural area of over 275 million ha (FAO, 2014) had contribute to Brazil being considered one of the major players in agribusiness in the world. With an approximately cattle population of 200 million and producing over 36 billion liters milk, over 9 million tons of cattle meat and still with 70 million ha sub utilized (SAE 2014), there is an enormous potential beyond productivity gain for growth in the sector. But even when the overall numbers are impressive, brazilian productivity does not reflect the genetic potential of our animals nor the accumulated knowledge in cattle husbandry, nutrition, reproduction and health. In regard to health, claw diseases have a well-known economic impact mainly in dairy cattle production. Our aim in this essay is to contribute in the discussion of what are the main causes of lameness in Brazil and what might be different to the rest of the world under a perspective of how podology in Brazil may evolve.

2. Causes of cattle lameness in Brazil: an overview

To find out what has been done over the last four decades in cattle claw disease science in Brazil, we accessed an internet platform created by CNPq, an federal brazilian organism for the organization, control, promotion and increase of research, called "Plataforma Lattes" (<http://lattes.cnpq.br/>), where we had access to the active research groups, projects and Curriculum vitae of all in Brazil working researchers. The search used keywords and mainly the researcher names known to work in the general

area of ruminant diseases. Afterwards the obtained and identified Curriculum vitae of 27 brazilian researchers, who have been working with cattle claws were analyzed taking into consideration their publications in indexed and peer reviewed scientific journals or texts in books. Other publications as for example annals in congresses or symposia were not analyzed. Papers who where coauthored were counted only once. Seven of these researchers have published papers, but are retired or not anymore working in the area. Eight researchers, although working within the thematic area in clinical or hospital praxis, have no journal publications regarding claw diseases. Since 1974 a total of 87 scientific papers in journals were published and another 17 books or chapters. The overall distribution can be seen in Figure 1.

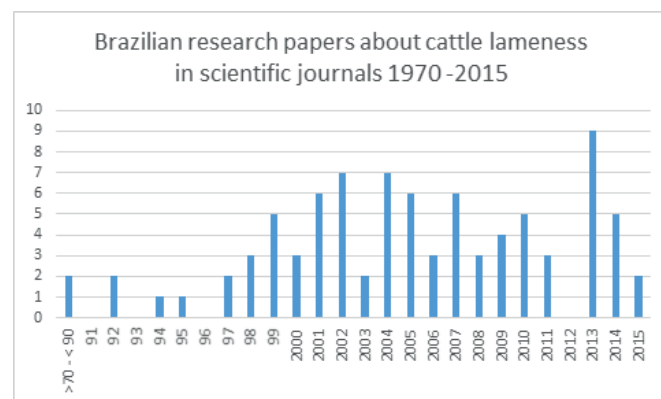


Figure 1 – Distribution of the amount of published articles of Brazilian authors about bovine lameness causes in the period of 1970 – 2015.

Until the end of the nineties, there were very few publications in cattle podology produced in Brazil, becoming more frequent in the last 15 years. The first written text in the analyzed period authored by Prof. emeritus Eduardo Harry Birgel informed about claw amputation in 1974. The first paper classifying claw disease in a modern way and drawing the attention to the fact of occurrence of a lameness problem was Prof. José Renato Borges and his group in 1992 (Borges et al. 1992). The first publication focusing on claw morphophysiology was only published nearly ten years later (Ollhoff and Ortolani, 2001). From the total of journal publications, only

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13,8 % were published in English and surprisingly only one (1,1 %) in Spanish. The first English written paper was published at the Israel Journal of Veterinary Medicine in 2002 (Silva et al. 2002). The total amount in international comparison is not very impressive even though consistent and does not reflect the importance lameness and cattle claw diseases have assumed worldwide in dairy cattle health. On the other hand we have to consider, that several endemic infectious, parasitic and toxic threats are still main causes for cattle losses and low productivity in Brazil, as for example rabies, enzootic leucosis, anaplasmosis, babesiosis, screwworm myiasis and toxic plants only to mention some of them. And what about the lameness causes in Brazil, are they the same as in the rest of the world ?

2.1. Actual knowledge of lameness causes in Brazil

Beginning with the description of lesions in herds and found in the slaughterhouse in the early nineties (Borges et al. 1992; Ribeiro et al. 1992) it was soon clear, that in Brazil we have also a major problem in distal locomotor systems (claws). Nearly the same claw diseases as in the rest of the world had been identified, which could be classified into large etiological different groups: infectious diseases as dermatitis digitalis, interdigital dermatitis, interdigital necrobacillosis, heel horn erosion; primary biomechanical lesions as hematomas, classical sole ulcer, toe ulcer, white line disease; metabolic related as laminitis, fissures and miscellaneous as interdigital hyperplasia, arthritis and arthroses. The description of Tunga penetrans causing lameness in cows is, in our knowledge, exclusive to Brazil (Ribeiro et al. 2007). Traumas, especially fractures, are responsible for most of proximal cases of lameness reported in Brazil (Camara et al. 2014), but also more rare cases of muscle trauma or degenerative lesions (Barbosa et al. 2014, Macedo et al. 2014) have been implicated. All lesions that are not as soon as possible lege artis treated worsen, specially under Brazilian conditions where sometimes the cow is seen only once a year (beef cattle) or created under semi-intensive conditions, which also does not allow a rigorous monitoring of the claw health. Although there are studies considering several herds and ma-

nagement systems under southeastern and middle western Brazilian climatic conditions, there are no papers trying to encompass all regions in Brazil, or at least also considering the southern, northern and northeastern husbandry conditions. This fact, in conjunction with the geographical huge distances and the few resources available for research are one of the main obstacles for more diagnostic and epidemiological evaluations.

Prevalences are substantially influenced by the managing system (for example free stall confinement in southern Brazil or extensive pasture in the Amazon region). With high yielding dairy cattle in a free stall system, the biomechanical problems are still the most important, where as in recently opened pasture areas in northern Brazil hyperplasia interdigitalis probably induced by trauma is much more relevant (Silveira et al. 2009). Other very special situation of Brazil, as for example snakebite accidents in the locomotor system (specially caused by different Bothrops spp.) have never been quantified. Even with fatal accidents the causative relationship is already difficult to establish (Tokarnia et al. 2014). The diversity of zebu and taurine breeds and new breeds originated from mixture of zebuine and taurine breeds as the Girolando represent challenges for the Brazilian podology. The diversity of autochthonous breeds as Caracu, Purunã or Curraleiro as research opportunity for the study of resistance factors regarding claw diseases is underutilized. Only recently (Silva et al. 2015) a morphometric study of the Curraleiro breed has been published. Lameness causes of dairy cattle are very similar to others elsewhere described, although there are environmental influences that are specific for Brazilian conditions. Distal lameness causes have the same relative weight as in other parts of the world. Special features, as for example the "non healing wounds" controversy are, until now, of no impact upon lameness problems in Brazilian cattle. Care in form of cleanliness of the walking areas of the cows, proper functional trimming of the claws, attendance of post-surgical nursing care had to be much more considered. As educational level of cattle

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owners and claw trimmers influences directly lameness indices, a special focus will be given to efforts which had been made to bring more information to the farm level, in order to raise awareness about the lameness problem and the importance of good claw health.

3. Organizational aspects in Brazilian podology: the example of SENAR PR¹

Although cattle are raised in Brazil since the introduction of the first animals by the Portuguese and the huge continental area with well dispersed farms, historically Brazil has not a long tradition in associativism or cooperative organizational forms, which could have developed to overcome the geographical obstacles. With some exceptions, as the dairy cooperatives in the southern region of Brazil (for example Tirol, Castrolanda, Witmarsum), which hire veterinarians to provide technical services for their members, usually until now veterinarians work in small clinics or by their own. Also hoof trimmers are not federal or regionally organized. There are no hoof trimmer associations as seen in the USA or in Europe. Hoof trimmers are trained by courses given at universities or by a federal public service called "SENAR" which aims the social and professional development of people living in rural areas. To take the example of SENAR PR (PR for Paraná, one of the three most southern states of Brazil) 1081 training courses were offered from 1996 – 2011 in functional trimming with a total of 12285 participants ($11,4 \pm 2,6$). A total of 43 instructors were utilized, which were trained by the Association of dairy cattle producers and relies on one dutch teacher. The great advantage of the adopted system was to reach all regions and the main municipalities in state of Paraná. The disadvantage is clearly a bias of teaching and the difficulty to connect this functional trimming actions with the on-farm health registers. Also there is no monitoring of the effectiveness of this training courses or the motives why they may sometimes fail. So the present situation does not allow us to draw a picture, if these training courses actually helped to achieve better lameness goals. So it is possible to conclu-

de that training varies between institutions, there are no uniform criteria in content or in duration of the training course and there is no necessity of attendance of a hoof trimmer program for anyone to provide this kind of service, autodidacts also may be hoof trimmers. In Brazilian law they do not represent a separate profession, but are considered as other farm workers. Observing the equipment used by hoof trimmers, hydraulic chutes are the exception on the market, which does not facilitate the broader adoption of regular inspection of the distal digit. There are no equipment which are designed for very large breeds as for example adult Nelore or smaller ones as Jersey. So sometimes animals still have to be manually restrained and pulled down by ropes on the yard. Probably a high percentage of the training course participants do not trim cattle claws anymore because of the inadequate working conditions in the field.

4. Perspectives of solutions of the lameness problem

Dairy farming constitutes one of the last alternatives for income generation in small areas under Brazilian conditions and may guarantee the survival of a family even with very modest productions of a couple of hundred liters/ day total production. On the other hand, professional dairy production with a gain of scale is also growing, facing international competition. The main solution of lameness problems under these conditions is to invest in the "man-factor", that means:

- Continuous education and training of the owners;
- Continuous education and training of the claw-trimmers;
- Continuous education and training of the veterinarians.

Negligence or ignorance should not be used as an excuse for prolonged animal suffering.

The importance of farmer education in lameness as well as prophylactic measures should be further investigated under Brazilian conditions. In spite of the fact that in Brazil still formaline and copper sulfate solutions are regularly used products

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in footbaths for treatment and prevention of claw diseases, alternatives to these already in some European countries banned products should be pursued. Brazil has, considering its botanical diversity, potential for the development of new products for therapy or prophylaxis based upon vegetable extracts. Some initiatives in this regard are already in prospect. Cheap, effective and for mass treatment suitable procedures should also be addressed. The production of a healthy working environment for the claw trimmers and veterinarians that work with podology also in regard to equipment, preferably cheap and easy to use, would promote the interest of more students and professionals in this area.

At least the advantages of associativism or other forms of cooperativism should be reinforced to stimulate hoof trimmers and veterinarians to form larger teams, with winning situations for the enterprise, for the life quality of their members and for the quality service offered. Healthier claws are necessary and possible.

5. Conclusion

The different methodologies applied in the claw disease prevalence studies, not scoring also lameness as well as the huge differences in breeding systems and climatic influences do not allow us to conclude that Brazil is more lame now than two decades ago. Empirically we would like to state, that a considerable amount of our farmers believe that their problems will be solved through genetics and nutrition. Only consequent curative and preventive measures farm designed will reduce effectively the lameness problems mainly our dairy cattle is facing day after day.

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D-LACTIC ACID AN OLD FOE IN LAMENESS IN DAIRY COWS

Lactic acidosis is the main factor involved in the pathogenesis of acute ruminal acidosis in bovines. The ingestion of excessive amounts of highly fermentable carbohydrates is followed by the proliferation of *Streptococcus bovis* in the rumen. This microorganism metabolizes carbohydrates to produce lactic acid, which decreases the pH of the ruminal fluid to 4.5-5.0. This environment promotes rapid growth of lactobacilli, producing two forms of lactate, D and L. Several tissues, such as liver and heart, quickly metabolize the L form; however, D-lactate is metabolized slowly by mammalian tissues. During acute ruminal acidosis, D-lactic acid reaches the blood stream, leading to lactacidemia of approximately 5 mmol/L. Simultaneously, several inflammatory processes are triggered, causing ruminitis, liver abscesses, laminitis and an increase in acute phase proteins. Acute ruminal acidosis also increases neutrophil infiltration in several tissues causing aseptic polysynovitis.

Polymorphonuclear neutrophils (PMNs) are the first line of defense against pathogens and the primary cellular components responsible for acute inflammatory response. Neutrophils exert their antimicrobial effects via reactive oxygen species (ROS)-dependent and ROS-independent mechanisms. A strong respiratory burst is produced by neutrophils during phagocytosis or after stimulation with a wide variety of agents. ROS production is induced following the activation of nicotinamide adenine dinucleotide phosphate (NADPH, reduced form) oxidase, which is assembled at the plasma membrane. This reaction produces superoxide anions (O_2^-) and hydrogen peroxide (H_2O_2), generating several microbiocidal agents. Neutrophils also possess a wide variety of granules that contain enzymes, such as gelatinase-B/metalloproteinase 9 (MMP-9), which are released to destroy the extracellular matrix [2]. The oxidative and non-oxidative functions of PMNs are components of the innate immune response that may be affected during lactic acidosis.

In order to assess the effect of D-lactic on granulocytes we measured several aspects of biology function. We found that d-Lactic acid did not induce

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calcium mobilization by itself. However, when we tested whether it could affect the calcium release induced by PAF, we observed a reduction in calcium flux with 6 mM and 10 mM of d-lactic acid. Additionally, we observed that d-lactic acid strongly reduced ROS production, as measured by chemiluminescence, in a dose-dependent fashion, with an IC_{50} of 0.7 mM, at this concentration we did not observe changes in extracellular and intracellular pH, suggesting that this effect is independent of pH changes.

The d-lactic acid inhibition of calcium flux induced by PAF also could affect other neutrophil responses such as granule release and CD11b expression. We demonstrated that 6 mM and 10 mM d-lactic acid reduced the release of MMP-9 induced by PAF. MMP-9 is an enzyme of the metalloproteinase family with major roles in the remodeling of extracellular matrix components. However, we also observed that 2 mM d-lactic acid induced MMP-9 release by itself and thus may play an important role in the onset of clinical signs observed during metabolic acidosis. D-Lactic acid at a concentration of 2 or 6 mM reduced the expression of CD11b in bovine neutrophils treated with PAF. However, after treatment with 10 mM d-lactic acid, an increase in CD11b expression was observed. D-Lactic acid at concentrations of 2 mM or 6 mM did not interfere with I-selectin shedding induced by PAF, however 6 and 10 mM d-lactic acid decrease I-selectin expression, suggesting that during acidosis a possible activation could be induced with this metabolite.

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Similarly, in a model of acute ruminal acidosis induced with oligofructose in heifer, a decrease in PAF-induced ROS production is observed at 8 h after oligofructose overload, and is sustained until 48 h post oligofructose overload. A reduction in PAF-induced L-selectin shedding is observed at 16 h and 32 h post oligofructose overload. These animals show polysynovitis and a characteristic increase of neutrophils in synovial fluid at 24 h of oligofructose overload with the presence of DNA extracellular traps (ETs). ETs, is released by neutrophils being a new pro-inflammatory mechanism in several human joint diseases. We proposed that D-lactic acid could be involved in the formation of Neutrophil Extracellular Traps (NETs). In fact, we demonstrated that D-lactic acid increased NETs formation and the adhesion of bovine neutrophils to endothelium under flow conditions in vitro. D-lactic acid-trigger NET formation, which co-localized with H4 Citrullinated 3 and CD11b.

Bovine neutrophils possess monocarboxylate transporters (MCT-1, 4) that are key in the uptake of D-lactic acid. We demonstrated that Ar-c155858 (MCT inhibitor) reduced the NET formation and adhesion of neutrophil to endothelial cells, induced by D-lactic acid. Indeed, the neutrophil adhesion to endothelial cells induced by D-lactic acid was reduced when DNase is added. In a similar way, anti-CD11b antibodies decrease the neutrophil adhesion to endothelial cells induced by D-lactic acid. We demonstrated that DNA extracellular traps isolated from neutrophils treated with D-lactic acid, induces neutrophils adhesion on endothelium cells under flow conditions.

Finally, we concluded that D-lactic acid is able to activate neutrophils degranulation, trigger NET formation and neutrophil adhesion and thus might be involved in the activation of the vascular bed which could contribute to neutrophil infiltration into locomotor apparatus during acute ruminal acidosis in cattle, revealing a new unexpected role of D-lactic acid in lameness.

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COW COMFORT, LAMENESS AND THE ROLE OF BENCHMARKING

Introduction

Poorly designed and managed facilities cause injuries and increase the risk of health problems including lameness and transition cow disease, arguably two of the most serious welfare challenges facing the dairy industry (see von Keyserlingk et al. 2009). In this presentation we firstly review research on the standing and lying areas provided to loose-housed cows, and how design and management decisions can reduce the risk of injuries leading to lameness. We then go onto review experimental results from work on the University of British Columbia's research farm, and comparative results from a large study comparing hundreds of farms in Canada and the United States. Lastly, we summarize our most recent work on the role of benchmarking in improving lameness and hock injuries on commercial farms.

The lying area for cows

The issue of cow comfort has received considerable interest within the dairy industry, with the bulk of research having focused on the design of freestalls and the effect of stall design on stall occupancy and the time spent resting. Our work has shown that the commonly used tool to assess comfort such as the Cow Comfort Index is not a reliable method; but instead, monitoring 30 cows/farm for 3 days gives an accurate estimate of the true lying behaviour (Ito et al. 2009). This research-based knowledge on stall design and its effect on cow behavior - are now beginning to be implemented in the design of new barns (LeBlanc et al., 2006).

Our work on lying areas for cattle has focused on two aspects: the surface cows lie down upon, and how the cubicle is configured. In some of our group's first work on cow comfort we found that cows on farms with mattresses (and little bedding) have more severe hock lesions than do cows on farms that using deep-bedded cubicles (Weary and Tazkun, 2000), and our more recent work comparing practices on commercial farms throughout Canada and the United States has shown that the poorly bedded mattresses are a powerful predictor of the prevalence of lesions and lameness (Chapinal et al., 2013; Barrientos et al., 2014). These findings

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are not unique to North America as other work by our group has shown that Chinese farms with poorly bedded mattresses were associated with higher prevalence of lameness and hock injuries (Chapinal et al., 2014). Most dairy professionals are aware of the risks of poorly bedded mattresses, but too often this surface continues to be used.

Cows also clearly prefer lying surfaces with more bedding, and spend more time lying down in well-bedded stalls (Tucker and Weary, 2004a). We examined the effect of the amount of bedding on the time spent lying and standing by cows housed in cubicles and found that cows spend approximately 1.5 h more time lying down in the heavily bedded cubicles. In addition, cows spent less time standing with only the front legs in the cubicle when the mattresses were heavily bedded. These changes in both standing and lying behavior indicate that cows are hesitant to lie down on poorly bedded mattresses. These differences in stall comfort may also account for a second important health problem; cows housed on mattresses also have a higher incidence of severe lameness than those housed in deep-bedded sand stalls (Ito et al., 2010). The lying surface can also affect udder health, and many studies have now shown the advantages to cows of using sand or other inorganic bedding as a way of reducing the growth of bacteria associated with environmental mastitis (e.g. Zdanowicz et al., 2004).

Making the decision to provide a well-bedded surface is just the first step in achieving a reasonable level of cow comfort – this surface must also be

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properly maintained. In a series of experiments we documented how the sand level declines in stalls that are not maintained, and how this decline reduces stall use by cows (Drissler et al., 2005). Sand levels in deep-bedded stalls decrease over a 10-day period, with the deepest part at the center of the stall. Lying time by cows also declines as the stall empties: every cm decline decreased lying time by about 10 min per day (e.g. one inch decline decreased lying time by about half an hour). Contact with concrete while lying down may explain lower lying times in deep-bedded stalls with less sand, and this concrete also affects leg health. Lesions on the point of the hock are common in deep-bedded stalls (Mowbray et al., 2003), likely due to contact with the concrete curb when stalls are not well maintained. Cows also showed a strong preference for lying on dry bedding during the summer months and when forced to lie down on wet bedding showed a 5 h reduction in lying time (Fregonesi et al., 2007).

The standing area for cows

One challenge in creating suitable cubicles for cows is that this one structure is supposed to do it all. According to popular thinking, when cows are not in the milking parlor they should be eating or lying down. Unfortunately, no one seems to have explained this to the cows: in a number of studies we have found that even when cows have access to well-designed cubicles they spend only about half of the day lying down. Our work has shown that on many commercial farms in North America cows frequently spend in excess of 12 h a day on their feet (von Keyserlingk et al., 2012), and we need to take this into account in designing suitable housing.

A high standing time could suggest a deficit in the cow's environment; for instance, cows housed in pens with insufficient number of lying stalls, low bedding, wet bedding, or restrictive neck rails spend more time standing than those with dry stalls and less restrictive neckrails (Tucker and Weary, 2004a; Fregonesi et al., 2007; Fregonesi et al., 2009). Cows that perch with their 2 front feet in the stall during

transition are also at increased risk for lameness (Proudfoot et al., 2010); as stated above this behaviour has been linked with restrictive stall design (Tucker et al., 2005; Fregonesi et al., 2009).

In most barns the surface for standing outside of the cubicles is wet concrete – a known risk factor for hoof health (e.g. Borderas et al., 2004). Cows can use the cubicle as a refuge, providing a dry, softer surface for standing. However this increases the likelihood that cows will urinate and defecate in cubicle. The common response by barn designers has been to make the cubicles more restrictive (Tucker et al., 2005), forcing cows back into the concrete alley, and explaining in part why lameness is now the most prevalent and costly health problem for cows housed in cubicle barns. With our current barn designs we are stuck with two bad choices: use restrictive cubicles that keep the cubicle surface cleaner but force cows back onto the wet concrete, or use more open designs and increase frequency of cubicle maintenance. Of these two options we favor the latter, but there may also be a third approach – improving the standing surface elsewhere in the barn.

Both the height of the neck rail and its distance from the curb affect standing; more restrictive neck-rail placements (lower and closer to the rear of the cubicle) prevents cows from standing in fully in the cubicle, again increasing the time cows spend on concrete flooring elsewhere in the barn. Gait scores improve when neck rails are moved to a less restrictive position so that cows can stand with all four hooves in the cubicle, and worsen when neck rails are more restrictive (Bernardi et al., 2009). The neck-rail is designed to 'index' the cow in the cubicle while she is standing, but the brisket board achieves this function while cows are lying down. Unfortunately, brisket boards also discourage cubicle use – cows spend 1.2 h /d less time lying down when cubicles have a brisket board compared to when using cubicles without this barrier (Tucker et al., 2006).

Keeping cows out of the stall obviously helps keep the stalls clean. We found that both the narrow free

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stalls and the more restrictive neck rail placements reduced the amount of fecal matter than ended up in the stall (Tucker et al., 2005; Bernardi et al., 2009). Although dirty stalls are undesirable, readers should be aware that stall cleanliness alone is a poor measure of stall design. Free stalls that have higher occupancy rates are most likely to contain feces. Thus well-used stalls require more stall maintenance, just like other equipment used on the farm.

A number of studies have shown that access to pasture improves hoof health, likely because under good grazing conditions the pasture is a more comfortable and more healthy surface for standing upon. Our experimental work has shown that a relatively brief period on pasture could help lame cows recover (Hernandez-Mendo et al., 2007), and our work comparing commercial farms in North America has shown that proving cows with access to pasture during the dry period can reduce the risk of lameness on those farms (Chapinal et al., 2013).

Individual farms - tailored solutions and the role of benchmarking

The last factor to consider is that how barns are designed and managed varies among regions due to differences in tradition, barn builders, and availability of materials and bedding; this means that the factors affecting lameness and leg injuries on farms will also vary geographically.

In our work comparing commercial farms in North America, we have found that the risk factors for lameness vary among regions. For example, in British Columbia we found that the mean prevalence of severe lameness (gait score 4 or 5; Flower and Weary 2006) was higher on farms where cows were on mattresses (9% of cows severely lame) versus farms that using deep-bedded cubicles (4% of cows severely lame) (Ito et al., 2010). In the north eastern United States, where many farms used mats or mattresses with little bedding, the occurrence of lameness was reduced by half on farms using deep bedding or providing dry cows access to pasture (Chapinal et al., 2013). In California, all farms used deep-bedded cubicles and almost all farms provided outdoor access (typically to a well-bedded

dry lot). Likely because of these conditions, rates of severe lameness were much lower in this region (Chapinal et al., 2013). Within the California farms, lameness was lowest on farms where cubicles were kept clean (i.e. not contaminated with feces) and on farms that used rubber in the alley leading to the milking parlor. These results illustrate that when one limiting factor is addressed (e.g. by changing from mattresses to deep bedding) new factors can be identified (such as the benefits of rubber flooring) (Chapinal et al., 2013).

The term benchmarking can be traced back to the shoemaking industry in the 19th century when cobblers would measure the feet of their clients for handmade shoes. The cobbler would place each foot on a "bench" and "mark" out the pattern for the new shoes. This pattern became a reference point for the cobbler and helped ensure a better fit. This concept has been now adopted by today's business environment, referring to the evaluation of best practices and the desire for excellence; in essence it describes a process of learning, exchanging ideas and adapting best practice. From benchmarking shoes to benchmarking modern businesses, this process has helped improve countless organizations. The question we were interested in was whether this process could help include improve welfare on dairy farms.

Farmers with an interest in lameness cite 'pride in a healthy herd' and 'feeling sorry and guilty for lame cows' as the primary arguments why they are seeking solutions that will improve hoof and leg health (Leach et al., 2010). However, many farmers remain unaware as to how many cows on their farm are lame (Espejo et al., 2006). Farmers may therefore be motivated to implement changes in practice if they were provided with their own evidence reflecting lameness on their farm.

As highlighted in the first part of the conference proceedings work by our research group has developed practical methods of assessing cow comfort and lameness that are scientifically valid and practi-

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cal to measure on commercial farms. More recently our goal has been to provide individual producers with information on the incidence of lameness on their farms and how they compare (i.e. benchmarking) with their colleagues farming in the same region. We believe that by providing farms with their own data, producers will have the information and motivation to develop solutions that can reduce injuries and improve lameness on their farms.

Our goal is to provide participating dairy producers with data from their own farm, along with averages from other farms in their region, so they could identify areas of success and where work was still needed. Each producer was provided a confidential report he or she could use to develop tailored solutions for their own farm after consulting with their farm staff, veterinarian, hoof trimmer and nutritionist (see also von Keyserlingk et al., 2012).

Cows were scored as not lame (a gait score of less than 3 on a 1 to 5 scale), clinically lame (a gait score 3 or greater), or severely lame (a gait score of 4 or 5) (Flower and Weary 2006). A total of 17,887 cows were gait scored in this study. The three regions varied in clinical lameness rates: 28 % in B.C., 31 % in California; and 55 % in the Northeastern U.S. Severe lameness prevalence averaged 7 % in B.C., 4 % in California, and 8 % in the Northeastern U.S. Within each region, lameness varied greatly, with some farms having very low rates while on other farms more than half the cows assessed were clinically lame. The three regions also varied in hock injury rates: Overall prevalence of hock injuries was $42.3 \pm 26.2\%$ in British Columbia, $56.2 \pm 21.6\%$ in California, and $81.2 \pm 22.5\%$ in Northeastern U.S.; prevalence of severe injuries was $3.7 \pm 5.2\%$ in British Columbia, $1.8 \pm 3.1\%$ in California, $5.4 \pm 5.9\%$ in Northeastern U.S. (von Keyserlingk et al., 2012). In the Northeastern U.S., we undertook a follow up study where we revisited 15 farms that had been benchmarked 12 to 18 months before (Chapinal et al., 2014b). The results from the reassessments are very promising. On average, the prevalence of lameness decreased after the first assessment. The

average change between the two assessments was a reduction of 17% for clinical lameness (range was -43 to 6%) and a reduction of 3% in severe lameness (range = -12 to 4%). Considering the complex multifactorial origin of lameness, it is not surprising the impact of the on-farm assessment varied across herds. Producers' strategies to address lameness were diverse and likely varied in effectiveness.

An even larger improvement was seen in the prevalence of hock injuries with all farms showing a decrease ($-38 \pm 6\%$ [-1 to -87]). The degree of improvement observed at the second assessment was greatest for those farms that had higher lameness prevalence when first assessed, but this was not the case for hock injuries. The changes in prevalence of clinical lameness and overall hock lesions were, however, correlated ($r = 0.62$). The results show the potential for sharing best practices when it comes to lameness and hock injury prevention, particularly within a region where producers share similar opportunities and constraints.

Although the confidential report was often used as a basis for discussion at the time of delivery, producers in the study were not given specific guidelines as to what to change, and were not specifically told during the first assessment or when receiving the first report that they would be reassessed a second time. The resulting lameness and hock injury improvements suggest simply making producers aware of the problems on their farms is enough to motivate change.

Producers taking part in benchmarking programs are encouraged to work with their veterinarians and other farm advisers to use the data, along with the recommendations described in this article and elsewhere, to develop tailor-made solutions for lameness. Farms differ in challenges and opportunities and will require customized solutions.

Conclusion

Over 20 years of research has emphasized the importance of a soft, copiously bedded, dry surface for cow comfort. Deep bedding is also highly protective of hock injuries and lameness in loose-housed

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dairy cows. Access to a comfortable standing area is also beneficial, with a series of studies showing protective effects of pasture access. The most important risks for cow comfort, injuries and lameness vary across regions and farms. Providing farmers their own data for injuries and lameness motivates farmers and helps them troubleshoot cow comfort issues on their farms.

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ADVANCES IN OUR UNDERSTANDING OF THE AETIOPATHOGENESIS OF CLAW HORN LESIONS

Introduction

The aetiopathogenesis of the lesions caused by claw horn disruption (principally sole haemorrhage, sole ulcer and white line disease) remains relatively poorly understood. Early descriptions of claw horn lesions in cattle suggested an aetiopathogenesis similar to that described for 'laminitis' in horses. In cattle, rumen acidosis (associated with the overfeeding of concentrates) was suggested to lead to inflammation and degradation of the laminae and eventually increased movement and sinkage of the distal phalanx within the hoof capsule. Movement of the distal phalanx led to compression of the dermis and the formation of claw horn lesions. Whilst in cross sectional studies the claw horn lesions have been associated with high concentrated diets, causality cannot be attributed using this study design. At the same time, this theory has proved difficult to induce experimentally. The evidence and limitations in this area have been succinctly reviewed (Bicalho and Oikonomou 2013).

Whilst overall the 'laminitis' theory has yet to be completely disproven, other experimental evidence has highlighted alternative aetiopathogenic risk factors. Firstly, Tarlton et al (2002) demonstrated a loss of supporting strength within the laminae around the time of parturition i.e. the distal phalanx was more mobile within the hoof capsule during this period. Secondly, the importance of the digital cushion, a support structure of connective tissue and fat under the distal phalanx, is increasingly being recognised. The digital cushion consists of three parallel masses which run longitudinally beneath the distal phalanx and is thought to protect the more sensitive foot structures during foot strike and limb loading, dissipating force and transferring it to the wall (the structure with the highest tensile strength). The content of the cushion appears to change with age, starting as loose connective tissue in heifers before filling with fat in parities two and three (Räber and others 2004, Räber and others 2006). Finally, a range of anatomical and biomechanical factors, particularly related to the relative shape and size of the bony architecture in the distal limb, have been identified which contribute to/exacerbate other aspects of the aetiopathoge-

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nesis (Nuss, 2014, Bicalho and Oikonomou 2013). Whatever the initial cause of overload in the hoof capsule, the claw horn lesions result from damage to the tissues responsible for sole horn production, eloquently described by Nuss (2014) for sole ulcers: 'Continuous displacement leads to compression of the sole corium, which in turn initiates the cascade of vascular compromise, ischemia caused by congestion, oedema and thrombosis, interrupted keratogenesis and finally sole ulcer'.

Interest in the digital cushion as a potentially important aspect of the aetiopathogenesis of claw horn lesions has increased since it was demonstrated that the thickness of the digital cushion was positively associated with body condition score (BCS) at the time of examination, i.e. thinner animals had thinner cushion and vice versa (Bicalho and others 2009). In the same study the prevalence of claw horn lesions was associated with the thickness of the cushion i.e. animals with thin cushions had a greater number of lesions. The work implied that thin cows had mobilised fat from the digital cushion during weight loss, resulting in compromised claw function and the development of claw horn lesions. However, as this study was cross sectional in nature, no direction to the relationship could be attributed i.e. alternatively lame cows with claw horn lesions could have lost body condition, resulting in thin digital cushions. In a follow on longitudinal cohort study, Machado and other (2011), demonstrated that cows which had a thin cushion at drying off were more likely to develop claw horn lesions in the next lactation.

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This work and work that has followed has attempted to address the question, 'Do lame cows become thin, or thin cows become lame' and the detail of the temporal relationship between these two events e.g. what is the effect of BCS change and how does this link temporally to lameness. Undoubtedly, lame cows lose body condition; a number of previous studies have demonstrated that lameness has a range of negative effects on feeding leading to loss of body condition (reviewed by Huxley 2013). However if cows which lose body condition become lame, BCS management could be an important lameness prevention strategy.

Methods and Results

Over the last few years, part of the work of our group and collaborators has focused on furthering our understanding of the relationships between body condition, the structure and function of the digital cushion and associated structures and lameness caused by claw horn lesions. Three separate UK field studies conducted by the author and colleagues have recently investigated the temporal relationship between BCS change and lameness.

The first longitudinal study was conducted on data collected from a single, 600 cow UK herd over a 44 month period (Green and other 2014). Lesions diagnosed when animals were identified and treated for lameness was recorded. All animals were assessed for BCS at approximately 60 day intervals throughout the study period. Mixed effect binomial logistic regression models were used to investigate the association between BCS and treatment for lameness. A BCS <2.5 was associated with an increased risk of being treated for lameness caused by sole haemorrhage, sole ulcer and white line disease in the following 0-2 and for sole ulcer and white line disease in the following 2-4 months i.e. a low BCS preceded lameness treatment by a number of months. This paper also identified that a key risk factor for lameness was a previous history of lameness (i.e. once animals have become lame they are more likely to go lame again in the future), an as-

sociation which has been identified previously by a range of other authors.

The second paper describes a longitudinal study conducted across four UK herds over an 18 month period (Lim and other 2015). Animals were condition and mobility scored every 13-15 days by a single observer. In total, 6889 observations from 731 cows were analysed in a multilevel multistate discrete time event history model to investigate the transition of lameness (assessed by mobility score) over time. Animals with a low BCS at calving (≤ 2.25) had a higher probability of becoming lame, and if they were already lame, they were less likely to recover. Similarly, when the BCS at the current visit was compared to the BCS at calving, cows which had lost condition had a higher probability of becoming lame, and if they were already lame, they were less likely to recover. Interestingly the converse effect was also identified, an increase in BCS from calving was associated with a lower probability of becoming lame, and if animals were already lame, they were more likely to recover. The study also identified that the longer an animal stayed lame the less likely she was to recover i.e. once lameness become chronic it is less likely to resolve.

The third study was conducted on a very rich dataset available from an intensively monitored research herd (Randall and others 2015). Animals were condition and mobility scored every week. Nearly 80,000 observations from 724 cows over an eight year period were available for analysis in mixed effect multinomial and binomial logistic regression models. Low BCS three weeks prior to a repeat lameness event (i.e. not the animal's first ever lameness event) was associated with a significantly increased risk of lameness. A BCS <2 was the greatest risk, BCS >2 led to a reduced risk. Importantly we were also able to explore the association between BCS and first ever lifetime lameness event (i.e. the first time an animal was ever identified as lame). Animals with a low BCS 16 or 8 weeks prior to a first lifetime lameness event were at greater risk of lameness but only if their first lifetime lameness event occurred when they were in 2nd lactation or

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greater. Low BCS did not increase risk for first lifetime lameness event in heifers. Finally animals which lost body condition in the four weeks after calving were at greater risk of a future lameness event.

More recently a longitudinal cohort study was conducted to fill a small but important link in the body condition – lameness relationship. One hundred and eighty animals were examined at 5 different time points (drying off, calving and throughout lactation) to definitively resolve the within animal link between changes in body condition and digital cushion thickness. Results from this study will be presented at the conference. In a final stream of work, the internal architecture of the feet of culled dairy cows have been imaged using X-ray micro computed tomography to a spatial resolution of 110µm in an industrial scanner. Provisional results suggest that previous lameness events caused by the lesions of claw horn disruption lead to damage in the support structures of the limb skeleton which could well be irreversible (See Newsome and others at this conference).

Discussion

Much remains to be understood about the pathogenesis of the lesions of claw horn disruption. Without a greater understanding, achieving good quality control on farm will remain challenging. The studies described above have highlighted the potential importance of BCS management as a tool for lameness control. Importantly, all three studies identified that change of BCS preceded animals either being identified lame by mobility scoring or being treated for lameness, using robust multivariate statistical techniques. They suggest that managing BCS at a herd level may lead to a reduction in the overall risk of lameness caused by the lesions of claw horn disruption. Initial estimates based on the results of our three recent studies suggest that appropriate BCS management may approximately halve the risk of lameness. That said, seeing the full benefits on-farm may be delayed by animals suffering repeat cases i.e. the effect will only fully manifest in heifers as the benefits will not impact on animals already consigned to a lifetime at greater

lameness risk because of previous lameness events. Further prospective studies are needed to test the impact of herd level BCS management on lameness to demonstrate that this is an effective and practical control strategy for use on farm.

Importantly, all studies published on the relationship between lameness and the digital cushion, to date, have been observational in design (predominantly prospective or retrospective cohort studies). Whilst observational studies can be used to identify associations, they do not demonstrate causality. It remains possible that loss of condition and lesions of claw horn disruption are independently caused by or associated with another earlier factor or event, before they both take a lagged time to appear clinically. Given the biologically plausible association between them, this seems unlikely, however high quality intervention studies are required before the association can be definitively proved.

Our recent work on the internal anatomy of the foot using X-ray micro computed tomography (See Newsome and others at this conference) has provided insights into the long term damage caused by lameness events. These findings may well explain why a first claw horn lesion event consigns an animal to a lifetime at greater lameness risk and why once the disease becomes chronic it is more difficult to treat and less likely to recover. This work also highlights the possible importance of inflammation in the pathogenesis of claw horn lesions and could explain the higher rates of recovery in animals treated with NSAIDs (in addition to foot block and trim) in a recent randomised clinical trial on the treatment of claw horn disease (Thomas et al 2015).

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DERMATITIS DIGITALIS IN CATTLE: INSIGHTS AND POSSIBLE OUTCOMES

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1. Introduction

Since its first description in the early seventies, bovine digital dermatitis (BDD) has turned into a major concern of ruminant podologist in the last 15 years. How did this happen? The quite precise clinical description and the unification of the international nomenclature of the different ruminant claw affections (Weaver et al. 1981, Mills et al. 1986, Greenough & Weaver 1997) helped to spread awareness around the world of the occurrence of BDD which was in sequence described by several authors of different countries and regions (Rebhun et al. 1980, Weaver et al. 1981, Ribeiro et al. 1992, Bergsten 1997). As the knowledge grows about the disease, it was soon clear, that we had not only an infectious character but also a contagious one, as the introduction of BDD into former free herds was observed (Rodriguez-Lainz et al. 1998). Once the infectious-contagious character established, it should be possible to identify the agent or agents and establish step-by-step the postulates of Koch (1890) (apud Fredericks and Relman 1996), that means:

1. The organism must be regularly associated with the disease and its characteristic lesions.
2. The organism must be isolated from the diseased host and grown in culture.
3. The disease must be reproduced when a pure culture of the organism is introduced into a healthy, susceptible host.
4. The same organism must be reisolated from the experimentally infected host.

Koch's postulates should not be understood as

dogmas, but pinpoint the causative relationship between some microorganisms and disease. With the advance of biomolecular techniques, Koch's postulates were reformulated as suggested by Fredericks and Relman (1996):

1. A nucleic acid sequence belonging to a putative pathogen should be present in most cases of an infectious disease. Microbial nucleic acids should be found preferentially in those organs or gross anatomic sites known to be diseased, and not in those organs that lack pathology.
2. Fewer, or no, copy numbers of pathogen-associated nucleic acid sequences should occur in hosts or tissues without disease.
3. With resolution of disease, the copy number of pathogen-associated nucleic acid sequences should decrease or become undetectable. With clinical relapse, the opposite should occur.
4. When sequence detection predates disease, or sequence copy number correlates with severity of disease or pathology, the sequence-disease association is more likely to be a causal relationship.
5. The nature of the microorganism inferred from the available sequence should be consistent with the known biological characteristics of that group of organisms.
6. Tissue-sequence correlates should be sought at the cellular level: efforts should be made to demonstrate specific *in situ* hybridization of microbial sequence to areas of tissue pathology and to visible microorganisms or to areas where microorganisms are presumed to be located.
7. These sequence-based forms of evidence for microbial causation should be reproducible.

2. Etiology of dermatitis digitalis

Applying these recommendations to BDD in recent years some interesting findings were made. First diseased and non diseased skin could be repeatedly differentiated microbiologically with histopathology as well as with biomolecular techniques (Demirkan et al. 1998, Cruz et al. 2005). Although there is a huge variety of microorganisms present in the lesion, probably reflecting since differentiated skin flora, opportunistic agents up to major pathogens,

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there are always a group of Spirochaetes involved (Krull et al. 2014). These Spirochaetes belong predominantly to the Genus *Treponema*. Consistently the following treponemes had been identified: *Treponema phagedenis*; *Treponema denticola*, *Treponema medium*, *Treponema pedis*, with probably *Treponema phagedenis* the main responsible for the classical infection (Krull et al. 2014, Nascimento et al. 2015, Zinicola et al. 2015).

These same species are also the main agents present in the clinical lesional climax, typical strawberry like appearance and in the chronic, proliferative forms of the lesion.

They do appear in different depths in the tissue, which is explainable by the characteristics of treponemes with active movement (Wolgemuth et al. 2006).

Based upon these findings, we could indeed classify BDD as presenting a polymicrobial nature with some predominant species, as it has been done by several authors (Krull et al. 2014, Zinicola et al. 2014). Together with the differences in depth of colonization of the skin it does explain why we have on one side good responses to antibiotic treatments but also a considerable amount of relapses (Laven e Logue 2006, Berry et al. 2012). Also responsible for the relapses and the several species present in the lesion is the capacity of treponemes to depress the host immune system (Zuerner et al. 2007). Different BDD treponemes have different virulence traits in vivo (Elliot et al. 2007).

Other factors are well known in human medicine to enhance virulence, as for example biofilm production together with other bacteria. The role of this biofilms is still unknown in BDD disease development (Dashper et al. 2011) and should be further investigated, as there could be hints for the establishment of the initial disease and disease development.

Recently, a possible reason for the fast spread of the disease throughout the world was identified as

the rumen has been implicated in harboring the pathogenic treponemes (Nascimento et al. 2015, Zinicola et al. 2015, Sullivan et al. 2015). As rumen fluid and feces are being implicated in hosting silently the pathogenic treponemes (Nascimento et al. 2015, Zinicola et al. 2015), this could be considered one more obstacle to identify latent infected or carrier animals and to implement sanitary measures. It was suggested, that only a small group of animals may carry BDD treponemes throughout their gastrointestinal tract (Sullivan et al. 2015).

3. Challenges to overcome

Altogether, despite the amount of knowledge of the disease generated in the last decades, there are still several challenges:

1. The reproducibility of the disease experimentally by several research centers and places;
2. The inexistence of a good model for the disease other than the bovine;
3. The polymicrobial nature of the disease;
4. The lack of reliable prevention methods;
5. The risk of antimicrobial resistance development;

We have also to face, that there is still in the scientific community no consensus about what does the lesion look like in its earliest beginnings (Döpfer et al. 1997, Krull et al. 2014). There might be a gray zone where it is difficult to identify, by means of clinical inspection solely, what is a very early lesion of DD, as there are only slight erosions visible, which might be mistaken for other lesions or abrasions of other nature. So the judgement of the observer of this very early lesions is impaired by his knowledge of presence or absence of the disease in the herd. Another controversial aspect is the velocity of lesion progress, varying from fast (weeks) (Holzhauer et al. 2008) to very slow (months) lesion evolution (Krull et al. 2014).

If there would be clear protocols about effective measures to prevent the (re-)introduction of BDD into a herd, probably the early identification would be of no practical use at all, since at this stage cows

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will not go lame and chronic lesions could be more effectively targeted without the menace of continuous new infections. Once more the effective tools are missing.

To develop such protocols, we must have first some questions answered, that will lead us further into the full understanding of the ethiopathogeny and epidemiology of this disease.

Why do we have most of the cases located only at specific skin areas, between the heel and the dew claws? What does this anatomical area distinguish to be so predisposed to the disease? Why some cows do not develop any symptoms? For how long do carrier cows harbor the pathogenic treponemes?

4. Possible future steps

Once established better the routes and means of transmission, we should control BDD carefully not to allow the spread to other species as other ruminants presented similar lesions (Sullivan et al. 2015a; Clegg et al. 2015), with special focus on sheep (Dhawi et al. 2005, Moore et al. 2005, Sullivan et al. 2015b).

Antibiotic resistance of treponemes is already reality in human medicine (Chadhra and Trindade, 2013) and should be on the radar in veterinary medicine concerning treatment protocols of BDD, as there is a wide use of antibiotic treatments (Manske et al. 2002, Laven and Logue, 2006).

Alternative treatments with the exclusion of antibiotic use had shown interesting results (Kofler et al. 2004) but also face recurrence. There is still a huge field of opportunity for the development of new treatment strategies with the association of functional claw trimming, cleaner claw environment, early detection and fast treatment of every lesion, using antibiotics alone or non-antibiotic substance with or without other therapeutic measures (for example mechanical or chemical debridement) or other treatment devices (for example special wraps).

5. Conclusions

Based upon the actual knowledge we are able to do a foresight building possible scenarios for the future of dermatitis digitalis. Understanding better the transmission routes and the role of reservoir animals, we will be able to execute the necessary prevention method, especially with the focus on maintaining BDD free herds.

Information about the etiology, pathogeny and clinical evolution will enhance our chance to develop more effective therapies, mainly in perspective of the challenge of antibiotic resistance and the necessity to avoid residues in meat or milk. New, possibly less aggressive substances for the environment are in development to substitute classical copper sulfate and formaldehyde as topical (footbath) disinfectants.

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A MULTIDISCIPLINARY APPROACH CHANGING THE PARADIGM OF FOOTROT IN SHEEP

Summary

In this talk I present the change in prevalence and managements of lameness in sheep in the UK since we started our research in 2000 and reflect on the past paradigms of management of footrot, the most common cause of lameness in sheep in the UK. I also present work on detection of *Dichelobacter nodosus*, the causal agent of footrot in sheep and their environment.

Background to lameness in sheep in the UK

The prevalence of lameness in sheep in the UK in 1994 was 10.4% (Grogono-Thomas and Johnston, 1997), that is, about 10% of sheep were lame at any one time. Most of the lameness was caused by footrot presenting as either an interdigital dermatitis (ID) or with under running of the wall horn (severe footrot) (Grogono-Thomas and Johnston, 1997).

From the 1960s until 2000 the management of lameness in sheep did not change. Farmers were recommended to manage footrot with flock level activities. Good practice included quarantine of new stock, routine foot trimming of the flock twice each year (typically at lambing in the spring and before the mating season in the autumn), regular foot bathing and vaccination. The recommended treatment for sheep with interdigital dermatitis was foot bathing, especially when epidemics occurred and a high percentage of ewes and lambs were affected. The recommended treatment for severe footrot was to pare back the hoof horn to expose the foot lesion and to spray with a topical antibiotic. If a sheep had very 'severe' footrot the recommended treatment was an antibiotic injection in addition to trimming the foot and then spraying the lesion (MAFF, 1992; Morgan, 1987; Winter, 1998).

In 1997 a severe cause of lameness was reported (Harwood et al., 1997). This was eventually identified as another infectious cause of lameness and named contagious ovine digital dermatitis (CODD), it is still only present in the UK (Duncan et al., 2014). Contagious ovine digital dermatitis stimulated new concerns about the overall prevalence of lameness in sheep and triggered the research programme at Warwick from 2000 to the present.

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Our research started with the hypothesis that farmers were either not following the managements recommended to control lameness or that they did not work. We tested this hypothesis using standard epidemiological methodologies and used the variability in farmers' management of footrot to provide useful information on current best practice and to generate more specific hypotheses that we could test. In 2000 we sent a questionnaire to about 250 sheep farmers who had previously participated in research into lameness and who had agreed to participate in further work. This non-random sample of compliant farmers was a good sample to use because the questionnaire was long and detailed and we hoped that interested (convenience selected) farmers would be more likely to complete the form. We were not disappointed; 67% farmers returned the questionnaire.

The questionnaire captured data on the prevalence of lameness, severe footrot and ID and CODD during each month in 1999 and the managements that farmers were doing to treat and control each condition. We also asked whether farmers had stopped or started various management practices and why. We did not ask whether they had stopped routine foot trimming (see later).

From this questionnaire we identified the following associations with the peak monthly prevalence of lameness

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1. Farmers treating all sheep with ID or SFR with systemic and topical antibiotics and foot trimming and then isolating these sheep had the lowest monthly peak prevalence of lameness (Wassink et al., 2003)
2. The greater the number of routine foot trimmings of the flock per year, the higher the monthly peak prevalence of lameness (Wassink et al., 2003)

From these associations we generated two hypotheses

1. Rapid treatment using parenteral and topical antibiotics of individual lame sheep with ID or SFR led to rapid recovery and reduced spread of disease and so was beneficial to the sheep and the flock
2. Routine foot trimming feet led to damage that made sheep more lame directly e.g. through causing toe granulomas or more susceptible to footrot

Rapid treatment of lame sheep

From 2004 - 2010 we tested the first hypothesis in two clinical trials. In the first, 800 ewes were in a cross over trial for 20 months. The results indicated that flocks managed by rapid treatment of SFR and ID with parenteral and topical antibiotics had a peak prevalence of lameness of <2%, whilst those managed with foot trimming and topical treatment and foot bathing had a peak prevalence of lameness of 6 - 8%. There was no routine foot trimming in this trial (Wassink et al., 2010).

In a second trial we scrutinized the practice of foot trimming diseased feet. Professional articles had suggested that foot trimming should be delayed for 6 days once footrot had been treated with antibiotics, but there was no evidence that this was correct. The results from the trial indicated that foot trimming either at the time of treatment or 6 days later delayed the rate of recovery by half. This was true whether sheep were given systemic and topical antibiotic, or just topical antibiotic treatment. The best treatment was systemic and topical antibiotic with no foot trimming; 95% sheep recovered within 10 days and the worst treatment was foot trimming and topical spray; 30% recovery in 10 days (Kaler et

al., 2010a). Treatment with systemic and topical antibiotics also led to improved foot shape and reduced repeat cases of lameness within a sheep (Kaler et al., 2010b).

The prevalence of lameness is a combination of how many sheep get lame and how long each sheep is lame and so a treatment that delays recovery increases the prevalence of lameness. Because footrot is caused by a bacterium and is infectious, delaying treatment also allows spread of disease and so the number of new cases of footrot (incidence) increases (Green et al., 2007) when environmental conditions are conducive to spread (Smith et al., 2014).

Sheep lame for a week or more lose body condition and have fewer lambs born and reared. In our study 17% fewer lambs were reared and those reared took longer to reach slaughter condition. This is a considerable welfare and production cost (Wassink et al., 2010).

Further studies from 2008 - 2015 added to the evidence that treatment within 3 days (Kaler and Green, 2008) of an individual sheep becoming lame and use of appropriate treatment (systemic and topical antibiotics for individuals with ID or SFR) is the best treatment for footrot. This is now presented as Six Steps to sound sheep. The steps are

- Step 1. Catch sheep within three days of becoming lame
- Step 2. Inspect, do not trim
- Step 3. Diagnose the cause of lameness
- Step 4. Treat all sheep with footrot or scald with antibiotic injection antibiotic spray Do not trim the foot Spray alone is sufficient for lambs with scald
- Step 5. Mark and record ear tag or mark treated sheep on the affected limb Record all treatments for footrot and CODD
- Step 6. Cull sheep that are lame twice with footrot or CODD

In 2010 we investigated the role of trimming feet further because some vets and farmers stated that sheep with 'long' toes were more likely to become

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lame. A flock of 100 ewes were randomly assigned to one of two groups such that when they became lame they were either treated with systemic and topical antibiotics without foot trimming or foot trimming and topical spray. A subset of ewes was examined regularly throughout the 10 month study. The key results were that the length of foot horn is highly linked to temperature and rainfall with longer toes in wet weather and shorter toes in cold dry weather. Toes became longer after a foot developed footrot, not before. Trimming / not trimming the hoof horn of lame sheep at the time of treatment had no effect on the length of the hoof horn over time i.e. once sheep with footrot were treated and started bearing weight the hoof horn returned to normal shape through wear. Interestingly, the feet of sheep were less variable at the end of the study compared with the start of the study; we conclude that this was one year of prompt treatment (Smith et al., 2014).

In 2013 we sent out another long detailed questionnaire, this time to 4000 randomly selected English sheep farmers. We asked about prevalence of lameness, managements to treat and control lameness and we had 5 sections on farmers' attitudes and personality. From this 2013 study (32% response rate) the results indicated that the period prevalence of lameness had reduced to 5.7%, nearly a 50% reduction from 2004. The percentage of farmers practising routine foot trimming had fallen from 75% to 57% and the percentage using systemic antibiotics on all sheep lame with ID or SFR had increased from 14 - 24%. More farmers (16%) were vaccinating ewes against footrot once per year (Winter et al., 2015).

We used the 2013 questionnaire to explore the association between routine foot trimming and all lameness and CODD. We asked farmers the number of routine foot trimmings per year, the percentage of ewes trimmed at each trimming event and proportion of ewes where the feet bled. The key results from our analysis were that all lameness (dominated again by footrot) and farmer reported prevalence of lameness caused by CODD were higher in flocks where sheep feet bled at routine foot

trimming (Winter et al., 2015; Dickins et al., unpublished). When no feet bled there was no impact on lameness prevalence; foot trimming was no different from no routine foot trimming i.e. it was not associated with lameness (Winter et al., 2015). This indicates that on average farmers practising routine foot trimming without causing feet to bleed are doing no harm, but there is no benefit from this time consuming activity to lameness levels. We have estimated that it takes approximately 8 hours to trim 100 sheep feet. This is a considerable time not leading to any benefit. As a consequence we recommend that farmers stop routine foot trimming. If farmers or vets are concerned about this advice we have suggested either to do a little trial on-farm and leave 50% of the flock untrimmed, or to delay trimming until they think it is affecting the flock (our results would indicate that this would not occur in flocks kept on pasture for much of the year). NB Whilst ewes housed over the winter grow long hoof horn this wears away naturally when ewes are turned out to pasture. However, ewes / rams kept for long periods on concrete floors and fed concentrates have similar foot horn issues as cattle and goats kept in these conditions and hoof horn overgrowth and poor foot conformation do occur and feet need to be managed differently from ewes at pasture for much of the year.

Other key results from the 2013 questionnaire were that a lower prevalence of lameness was associated with reducing contact between infected and uninfected stock through good biosecurity including quarantine for > 3 weeks and checking the feet of sheep on arrival. A lower prevalence of lameness was also associated with increasing resistance of ewes through vaccination of all adults against footrot once per year and selecting replacements from ewes never lame. Once again, rapid treatment, within 3 days of first becoming lame was also associated with a lower prevalence of lameness (Winter et al., 2015).

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In on-going work we are investigating whether farmers attitudes are associated with their management of footrot. We know that some farmers are using the recent recommendations whilst others are not. We can categorise farmers into groups by managements using latent class analysis and we can categorise their attitudes towards footrot (e.g. knowledge of the disease, knowledge of the managements, belief that they can control the disease, emotions they feel towards the disease) using principal component analysis. By comparing the two we can see which attitudes are linked to farmers less likely to be using the optimal management strategies. From this we can hypothesise how we might influence these farmers to change practice.

Dichelobacter nodosus

The paradigm in 1999, in the UK, was that interdigital dermatitis was a different disease from footrot and caused by *Fusobacterium necrophorum*. ID then made sheep susceptible to footrot but could occur in flocks when footrot was not present. ID was commonly seen in lambs as an epidemic of lameness in Spring; treatments of epidemics of ID were typically done by foot bathing using formalin or zinc or copper products.

We now know that interdigital dermatitis is also caused by *D. nodosus* and that ID and footrot with under running (severe footrot, SFR) are presentations of one disease process. Virulent strains of *D. nodosus* (defined by APRV2) dominate in the UK and it is rare to culture benign isolates. There is, consequently, no pattern of association between disease severity and virulent *D. nodosus* with virulent *D. nodosus* detected in feet from healthy to SFR. If we swab healthy feet, feet with ID and feet with footrot we find that *D. nodosus* is present in healthy and diseased feet but that the numbers of *D. nodosus* are significantly more abundant in sheep that go on to develop ID one week later and then remain high for SFR (Witcomb et al., 2014). *F. necrophorum* load is only higher once sheep have SFR (Witcomb et al., 2014). We conclude that sheep with ID, when the load is highest, are probably the most infectious sheep in a flock.

Given we detect *D. nodosus* in healthy feet a next question was when do sheep first get exposed to *D. nodosus*, are they born infected? A study of 10 lambs with feet swabbed at birth, before they touched the ground of a communal lambing pen indicated that they were all negative for *D. nodosus*. When the lambs were swabbed again 5 - 13 hours later they were all positive for *D. nodosus*. We used multilocus variable tandem repeat (MLVA) strain typing of the bacteria and found that whilst some strains detected on lambs were the same as their mother's, others were not (Muzafar et al., 2015). We concluded that lambs were exposed to *D. nodosus* at a very young age and that the source of *D. nodosus* were most likely contaminated bedding. We do not know if these same *D. nodosus* strains colonise the feet and go on to cause disease or whether lambs are constantly re-challenged and get diseased when they are susceptible (wet / damaged feet).

Another area of interest is the duration of survival of *D. nodosus* in fields. Empirically we propose 2 weeks maximum in the UK because of early work in Australia (Beveridge, 1941; Whittington, 1995). An initial investigation of soil in laboratory microcosms was done using four soil types with *D. nodosus* seeded into soil. They were sampled at intervals for 40 days. *D. nodosus* was detected at 104 after 40 days and was most persistent in clay soil. It also survived longer at 5°C than 25°C (Muzafar et al., accepted). This is an early study and whilst it cannot be concluded that the dose of organisms detected at 40 days is infectious, or that survival would be this long in pasture, it is an interesting avenue to explore further. In a recent study we have sampled soil, grass, feet, mouths and faeces of sheep and detected *D. nodosus* and *F. necrophorum* at several sites (unpublished data).

Conclusions

The prevalence of lameness in sheep in England has halved since 1999 from an average 10% to 5%. In the UK, farmers who have low prevalence of lameness in their flocks are practicing good biosecurity (quarantine and separation of diseased sheep), rapid appropriate treatment of lame sheep and

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avoiding foot trimming sheep with footrot, CODD or as a routine, a proportion are also using vaccine to reduce the prevalence of lameness. Selection of replacements from never-lame parents also contributes to control and minimising the prevalence of lameness, especially footrot. These factors are also important for control of CODD. The bacteria causing ID and severe footrot is *D. nodosus*, it is detected on newborn lambs only after birth and once they have stood and had contact with bedding. In a laboratory setting, *D. nodosus* persists for more than 6 weeks particularly in clay soils and at low temperature.

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CHALLENGES FACING AUTOMATIC LAMENESS DETECTION: COMBINING BIOTELEMETRY SENSORS TO IMPROVE ALGORITHM PERFORMANCE FOR DETERMINING COW BEHAVIOUR USED FOR EARLY DETECTION OF LAMENESS

Introduction

In this paper we will examine some of the fundamental questions facing applied researchers working in the field of automatic lameness detection and how this has been applied to a biotelemetry solution.

Lameness scoring (or locomotion, mobility scoring) was first described by Manson and Leaver (1986) and has provided researchers with a valid tool for detecting painful foot lesions (Rushen et al., 2006; Whay et al., 1997) and quantifying prevalence, severity and duration of lameness. Lameness scores have been successfully related to productivity (Amory et al., 2008; Hernandez et al., 2002; Hernandez et al., 2005; Sprecher et al., 1997) and welfare impairment (Phillips and Schofield, 1994; Whay et al., 1997), as cow behaviour is likely to mirror the cow's ability to cope within the commercial herd environment. However, there are some limitations to visual scoring methods. Firstly, the repeatability of lameness scoring is acceptable but prone to inter- and intra-observer error (Engel et al., 2003; Winckler and Willen, 2001) affecting precision and accuracy. Two studies looking at the separate behavioural components of a lameness score has suggested many behaviours have reasonable accuracy at predicting painful lesions particularly when combined in a composite scores (Flower and Weary, 2006; O'Callaghan et al., 2003). It is uncertain whether the fluctuating lameness scores reported in some studies (Groenevelt et al., 2014; Reader et al., 2011) is a real phenomenon or poor observer precision. Secondly, foot lesions can have different presenting signs with some early lesions difficult to detect with conventional visual scoring systems (Bell, 2006). For example, cows with mild sole ulcers may be missed by lameness scoring or farmer observation, appearing as incidental findings at foot trimming (Hultgren et al., 2004). This may be due to gradual onset or because they affect limbs bilaterally. Acute unilateral lesions such as white line abscesses may be inherently more obvious to observer and perhaps consequently the automated system too. Similarly 80% of cows with visible digital dermatitis lesions are missed by lameness scores with behaviour being greatly influence by

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type (grade) of lesion (Stokes, 2011). This creates a dilemma for researchers seeking a gold standard. While a lesion-orientated approach is arguably more objective, the consensus appears to be to find a system analogous to visual scoring as this is how farmers manage foot health and it relates well to welfare compromise (Whay et al., 1997). However, the ideal system will surpass human performance by detecting lesions such as sole ulcers before they manifest as lame cows by which time they should be considered severe (Groenevelt et al., 2014). On-farm diagnostics is likely to improve our confidence in detecting lesions at an earlier stage, and automated methods may be part of the solution, but in the meantime this may be a limiting factor. The ideal system should combine lesion and lameness detection in a single algorithm.

Real time monitoring of individual animals is an important area of research within precision animal farming. Oestrus detection in cattle is a good example of the successful implementation of technology to improve on heat detection rates by farmer observation. Oestrus is a relatively simple behaviour to automatically detect and yet on-farm implementation has taken many years. The challenge for lameness detection relative to oestrus detection is vast. Recently combinations of different sensor technologies have been used to enhance utility by creating additional functionality such as rumination monitoring. A variation on this theme that we are exploring is combining several novel technologies with standard tri-axis accelerometers to detect behaviours for the purpose of predicting

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disease. The technology has potential for evaluating management or behavioural risk factors for lameness (for lameness prevention) and for detecting the early behavioural changes associated with disease such as lameness. For example, lame cows show different temporal behaviour compared with non-lame peers, standing up later when food was offered (Blackie et al., 2011).

Materials and Methods

Wireless network sensors which combine several technologies (Omnisense 500 Cluster Geolocation System, UK) were used in a series of studies on a commercial dairy herd in the UK (300 cows producing 11,000 litres milk in 305 day lactation). Sensors were mounted on a neck collars worn by the cows. Embedded in each sensors was a tri-axial accelerometer (Xtrinsic MMA8451Q 3-Axis, 14-bit/8-bit Digital Accelerometer - a proxy for activity), a magnetometer (providing heading, pitch and roll), a local positioning sensor and barometer (providing temperature and pressure). Activity could be recorded between 12.5 and 50Hz and stored in the raw for or a peak and mean measurement reported at the system refresh rate. A 2.4 GHz transmitter module communicated with a CLS-504 location server to create a mesh sensor-node network to determine cow position within the shed. Position was recorded at the system refresh rate typically every 8 or 10 seconds in these trails. The final orientation and temperature measures were taken for each refresh rate. Combinations of data from one or more sensor type were evaluated for their potential to correctly classify behaviours of individual cows. In addition a range of classification methods with differing computational power requirement were tested and their accuracies compared. Cows were scored for lameness using a four-point visual score (Reader et al., 2011) and assessed for lesions at foot trimming.

Experiment 1: Classification of lying, standing and feeding using high resolution activity data.

The acceleration of the sensor in all three axes was logged to an SD card within the sensor at a frequency of 50HZ. Four classification algorithms

were created: decision tree, machine learning, Hidden Markov Models (HMM) and Support Vector Machine (SVM). These were validated and tested using direct observations of six cows.

Experiment 2: Classification of feeding behaviour using activity and position.

Cows were classified as Feeding, Not Feeding or Milking using a decision tree based on the mean activity and position recorded every 8 seconds. The behaviours of 10 non-lame cows (score 2) and 9 lame cows (score 0) were classified for a five day period.

Experiment 3: Classification of behaviour of lying, standing and feeding using activity and orientation data.

Cows were allocated to one or three lameness categories based on the duration of lameness, never lame, acutely lame and chronically lame. The behaviour the cows was classified using a support vector machine, built using mean activity and orientation in the y axes (pitch).

Results

It has been possible to detect behaviour with reasonable sensitivity and precision (e.g. feeding 99% sensitivity, 93% precision) (Vázquez Diosdado et al., 2015) using high frequency data (50hz) recorded on SD loggers (experiment 1). However, this comes at a considerable data processing cost on the collar device (and hence shortened battery life). When sampling rates were reduced to 0.125Hz, a sample rate more realistic for on-farm applications, only feeding was accurately determined with the decision tree (experiment 2). Lying and standing are low activity behaviours with similar activity and postural outputs from the accelerometer. However, the noise associated with positional data (cows switching between lying and standing area due to poor precision of positional data) causes most misclassification. None-the-less, we were able to determine feeding times for lame vs non-lame, with lame cows feeding for significantly less time. Further results from experiment 3 will be presented on

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the classifying lying and standing behaviour using orientation (pitch) and activity.

Conclusions and discussion

Continuous monitoring of a range of behaviours provides an exciting opportunity to improve detection of a range of diseases, particularly lameness. While management strategies to prevent lameness must remain the priority for cow welfare and herd performance, early and effective treatment can potentially shorten duration, reduce severity and prevalence. Lameness presents as a spectrum of severity, with most severely lame cows progressing from mildly lame over several weeks (Stoye et al., 2014). Farmers target the severe forms of lameness leading to reported intervals of 65 days (median) following first detection of lameness being recorded for some farms (Leach et al., 2012). Therefore there is great scope to reduce lameness duration, severity and prevalence.

Regular visual scoring represents one method to improve detection, but strategies for automating this process is likely to enhance consistency of implementation, allowing more objective optimisation of treatment intervention, particularly with respect to timing of first examination and re-examinations. Automatic lameness detection has been the subject of research in cattle for (Scott, 1988) for over 25 years yet there is still no widely adopted system available to dairy farmers. There remains great potential for further application and commercialisation of the existing technologies, but there are some considerable barriers to overcome, particularly in relation to optimising performance in balance with battery life. Sensors that combine technologies are becoming more widely available and present new opportunities for continuous behavioural monitoring. The major challenges include balancing the need for acceptable accuracy and precision with the data processing demands, and this requires further work to evaluate the performance of algorithms at lower sampling rates. Automated systems that provide lameness detection and some insight into risk factors will offer a more powerful tool to farmers than visual scoring alone and could provide the opportunity for commercialisation.

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LAMENESS IN PASTURE V/S CONFINED SISTEM: WHAT THE CHILEAN EXPERIENCE SAYS?

Introduction

Chile has a modern dairy industry. The country has more than 6,000 commercial farmers, concentrated in the region of Los Rios and Los Lagos (south of the country), The country has one million hectares of grassland and 500,000 dairy cows, milk production reached 2,650 million liters and generates 130 and 100,000 tones of cheese and milk powders and other derivatives (ODEPA,2015).

In Chile milk production systems differ widely depending on the geographic and climatic zone in which it operates. **Given our geography is difficult that may exist a single milk production system.** In the central area confined milk production systems are characterized by cows offered a full ration (TMR). In this area cows are kept in barns and have high levels of milk production. In the south central mixed systems are found. Animals can graze and be confined at certain times (at night or during winter). Also cows can be found in complete confinement systems or they can be fully grazing during the entire year. In the south of the country the main system of production is on pasture with this system cows could be supplemented with forage crops or concentrates.

There are few studies about the prevalence of lameness in dairy cows in the south of Chile (Borkert, 2010a). Some authors have reported prevalences between 9.1 and 46.6% (Delpin, 1985; Vidal, 1986; Borkert, 2010b; Galleguillos and Borkert, 2013b, Green et al., 2010). Flor and Tadich (2008) reported a mean prevalence of clinical lameness (locomotion score ≥ 3 , Sprecher et al, 1997) of 16.7% in 91 dairy herds. Levet et al. (2013) reports that in 50 dairy farms kept on pasture, 25 of the farms had a mean prevalence of clinical lameness $\leq 11\%$ and 25 had a mean prevalence $\geq 16\%$. In the same study they found that roads built with different materials was a risk factor for higher prevalence of lameness in the south of Chile. The prevalence of lameness found in other countries ranges from 3.8% to 30% (Israel, New Zealand and USA to name a few) (Wells et al., 1993; Whay et al., 2003). A few studies report the prevalence of lameness in dairy cows in the central area of the country.

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Prevalence of lameness in central area of Chile.

Worldwide, the nature of digital dermatitis infection is a major problem in all countries with dairy cows. The effective prevention or treatment that completely eliminates the digital dermatitis has not yet been identified. A study of prevalence of lameness in 2370 cows in 4 dairy farms done in central area shows that the prevalence was 21.6%. The five most common lesions were overgrowth (47%), digital dermatitis (31%), ulcer (20%), interdigital dermatitis (12%) and white line disease (12%). The hind limbs were the most affected with 73%. A 20% of the lame cows needed a block (rubber) and 56% of the lame cows needed a cohesive bandage. Also, 27% of cows only needed a corrective trim and culling was recommended in 2% of the cows due to the severity of the lesions (Galleguillos and Borkert, 2013a).

Environmental health is the main factor that predisposes to the presentation of digital dermatitis. The most severe outbreaks occur in housed cows in the winter. The disease is associated with wet conditions, poor hygiene and excessive exposure to slurry. This may be the result of infrequent scraping of the yard, milking parlor or feeding area. Also, high densities in yards, overcrowding, prolonged standing time and very large herds predispose this disease (Blowey, 2008).

Prevalence of lameness in south area of Chile.

The white line disease is characterized by the disintegration of the union between the sole and the wall of the hoof. Once the white line has been

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weakened, small fragments of dirt, or even quite large stones, especially if they have sharp edges, can penetrate and make damages on the hoof. The most common points of entry are abaxially and towards the heel (Hettich, 2007; Van Aert and Valckenier, 2013). Factors that predispose the presentation of the white line disease are mechanical stress, laminitis or insufficient intake of vitamins, minerals and trace elements (reducing the quality of corneal tissue) In addition, prolonged standing on hard surfaces (the combination of overload on hard surfaces and the weakness of the suspensory apparatus produces stretch, stretching, bleeding and swelling in that area). The conditions of the surface of the floor where cows walk daily, may increase the likelihood that stones or other material impact inside the sole.

In a study, a total of 11829 lactating cows from 23 herds in the X region of Chile were measured for locomotion scores (LS). These cows were classified according to their locomotion score as 1, 2 or 3 (1 = normal, 2 = abnormal movement with arched back, 3 = abnormal movement with evident limb pain and lameness). A 81.5% of the cows, presented a LS grade 1, 4.7% had a LS grade 2 and 13.7% presented evidence of LS Grade 3 (Galleguillos and Borkert, 2013b).

Borkert (2011) determined in 47 dairy farms of the south area that the lameness prevalence was 9.2%. The 4 most common injuries: white line disease (68.2%), ulcers (41.3%), double sole (27.5%) and overgrowth (24.6%). The hind limbs were the most affected by 72%. According to the results it can be noted that the prevalence of lameness found in Borkert 2011, are similar to those reported in recent studies in Chile.

Chesterton et al. (2013) reported that in Chilean grazing dairy herds, overall 33.1% of lameness cases were in the category of bovine digital dermatitis secondary infection. The prevalence of lameness from skin digital dermatitis ranged from 0.01% to 17.2% in the farms visited. In Chile, a study in 3884

dairy cows of 23 herds in Los Lagos Region, show a prevalence of 8.5% of digital Dermatitis (Arzt et al., 1999).

Conclusion

In the central area of the country, the overgrowth and digital dermatitis was the most common lesion; this is different from the results found in southern Chile where the most common lesion was white line disease. This may be explained in part because in the central area of Chile, cows are maintained in barns and not in pastures. In addition, most of the farms of the central area do not have an established trimming routine. Thus, the prevalence of digital dermatitis agrees to the presentation of this disease in confined systems where stocking density and poor hygiene predispose animals to present this disease.

The white line disease is by far the most important for pasture systems, and this is associated with improper handling, poorly designed infrastructure and poor walking surfaces. It is important to train people who work in dairy farms to improve the identification of lame cows as well as, correct diagnosis of lesions.

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CHRONIC PAIN ASSOCIATED TO LAMENESS IN DAIRY CATTLE

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The International Association for the Study of Pain (IASP) **defines Chronic Pain (CP) as “pain that last for more than 6 months** (Merskey, 2014). Chronic pain continues beyond the normal healing period after injury and its relentless persistence may result in major disability in those with non cancer pain and in major suffering in patients with progressive malignancy (Cavenagh et al., 2006). Occurrence of chronic pain sensations may be spontaneous (stimulus-independent) or touch-evoked (stimulus-dependent), and these episodes may be superimposed on a background of constant pain (Benoliel and Eliav, 2008). Chronic pain occurs as a consequence of a complex sensory system dysfunction and may differ depending on the type of precipitating insult and the individual patient. It is a paroxysmic phenomenon without any adaptive function that induces biochemical and phenotypical changes in the nociceptive system, resulting in and intensifying sensory information. Furthermore, due to the dynamic nature of the pain system, signs and symptoms change over time (Ueda, 2008). Unlike acute pain, which serves as a protective mechanism against injuries and illnesses, chronic pain has no known benefit, and is now regarded by many experts as a disease state (Baliki et al., 2008). Acute pain is an adaptive response that enhances tissue protection and healing. Nonetheless, in a significantly higher number of cases pain persists for months or years after the initial injury has subsided (Kavelaars et al. 2011). Chronic pain, by contrast, is related to a neuronal reorganization called “neuroplasticity”. This plasticity reflects both transcriptional and translational modifications that alter

normal resting states of primary afferent neurons (Latremoliere and Woolf, 2009).

The pathophysiology of chronic pain depends of complex interactions between the neuronal and non-neuronal components along the entire the nervous system (Austin and Moalem-Taylor, 2010). These complex mechanisms involve an increasing number of inflammatory and neurotropic mediators (Scholz and Woolf, 2007; Kawasaki et al., 2008). Chronic pain also violates the boundaries of the thresholds for what normally causes pain, resulting in “*allodynia*”(pain in response to a stimuli that does not normally provoke pain), “*hyperalgesia*”(increases sensitivity to stimulation), and “*sensitization*” (an increased responsiveness of nociceptive neurons to their normal input and/or recruitment of a response to normally subthreshold inputs) (Whay et al., 2005, Manteca, 2009, Bustamante, 2005, Miffilin and Kerr, 2014).

Lameness is a response to pain and foot lesions that cause lameness in cattle are multifactorial and include trauma, metabolic disorders and infections (Leach et al., 2010). According to O’Callaghan (2002), lameness in cattle is a debilitating condition, which is often associated with tissue damage, pain and discomfort. It produces a major impact on the productivity of dairy cattle, reducing milk production, decreasing fertility, increasing the likelihood of other diseases such as mastitis (Laven et al., 2008). Lame cows spend most of their time lying down, lose weight and reduce their milk production between 20 and 50% (Tadich et al., 2005). There is a need for more research into chronic pain in livestock (Stafford and Mellor, 2005). It is well known that lame dairy cattle are in a hyperalgesic state that persists for at least 28 days (Ley et al., 1996, What et al., 1998). Tejada et al., (2005), in a study performed in southern Chile concluded that different degrees of lameness induce a hyperalgesic state, which can affect animal welfare and eventually their productive processes.

Research to evaluate pain is primarily predicated on assessment of the sympathoadrenal and HPA hormones, such as cortisol. Relatively few studies

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have measured catecholamines in farm animals, mainly due to practical difficulties in sample collection and processing. In contrast, several authors have evaluated the acute cortisol response associated with painful procedures, such as castration (Chase et al., 1995). Also, markers of acute inflammation have been extensively used, including haptoglobin and serum amyloid A (Kujala et al., 2010). Nevertheless, these biomarkers have not been evaluated for long-term definition of the transition between acute and chronic pain in lameness. Additionally, more specific markers of nociception have been recently used, including substance P and beta endorphins, both of which have been evaluated after surgical intervention in calves (Coetzee et al., 2008). I strongly believe that the use of more specific biomarkers could help us elucidate the important transition between acute and chronic pain. Preliminary data in lame cows suggest that lameness is a chronic painful condition. Results of our study describe a gradual increase in the plasma concentration of norepinephrine and substance P and a decrease in beta-endorphin. All of these changes were associated to an increase in MS being significant for cows with MS 3. Also, we described a negative correlation between beta-endorphin and substance P, which was previously described in humans with chronic pelvic pain. This correlation was also found in cows with MS 0, which would indicate the correct function of the endogenous opioid anti-nociceptive system. In contrast, the absence of significant correlation between beta-endorphin and substance P plasma concentrations in cows with MS > 1 may indicate that a dysfunction of this system may play a role in the development and maintenance of neuropathic chronic pain in lame dairy cows. Moreover, the negative correlations found between substance P and norepinephrine in MS 3 would further confirm this findings.

Furthermore, many pathophysiological mechanisms underlie the development of chronic pain states. The site of these mechanisms include not only peripheral components, but also changes in the central processing of sensory information, most notably at the level of the spinal cord (Abbadie et al., 2009). Glia, including astrocytes and microglia,

rather than neurons, are now the focus in studies of the regulation of synaptic strength and plasticity and the actual generation of central sensitization (De Leo et al., 2006), because they occur in the vicinity of the terminals in the dorsal horn of the spinal cord (Hansson, 2006). The link between glial activation and pain enhancement was first recognized in the early to mid 1990, by the recognition of the expression of glial fibrillary acidic protein (GAFP) in the spinal cord after various types of peripheral nerve injury (Garrison et al., 1994). Beggs and Salter (2007), found a massive recruitment and activation of microglia in the dorsal horn in vicinity of the central terminals of injured sensory nerve fibers. Recent studies have also demonstrated that trigeminal central sensitization involves glial activation. The presence of GAFP/substance P (SP) or GAFP/calcitonin gene related peptide (CGRP) positive reactions by double labeling immunofluorescence was detected in the gray substance of the spinal cord.

Further, a better understanding of the cellular and clinical mechanisms underlying the transition between acute and chronic pain will be a critical step in the early recognizing of lameness associated pain which will help in the development of new therapies to specifically target the distinct mechanisms of chronic pain.

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ABSTRACTS

POTENTIAL RELEVANCE FOR SOLE ULCER AND DIGITAL DERMATITIS BY DETECTING TRIPONEMAE FROM SOLE ULCER LESIONS BY PCR

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Lameness is one of the most important causes of economic losses in the livestock industry. Lameness is a multifactorial injury and affected by factors such as storage conditions, livestock management, nutrition, personal factors, climatic conditions, production levels and the presence of pathogens. Among lameness, Digital Dermatitis and Sole Ulcer are very important. Digital Dermatitis is caused by Spirochete called Treponeme. On the other hand, Sole Ulcers usually occur after a subclinical laminitis or poor cow comfort due to heat stress or overstocking within the herd but despite this complication is not an infectious disease. It is the study objectives of influential effect of Treponeme Spirochete on development of non-healing Sole Ulcers.

In the present study had been done in two intensive dairy farms with 1800 head industrial lactating Holstein cattle in Shahrekord (farm 1) and another with 300 head of lactating Holstein cattle in Esfahan (farm 2). The herds have had regular hoof care program and all hoof injuries in the herds were carefully recorded. Thirty three tissue samples from hoof and corium (zone 4: the typical zone of sole ulcer between heel and toe) of lactating cows of different ages, parities and milk yield that showed symptoms of Sole Ulcer were carefully taken and kept in ice and were referred to the laboratory in less than 4 hours. Biopsy forceps sterilized and samples were taken of lower layers of horny tissue and the center of the lesions. After DNA extracting, DNA replication through the polymerase chain reaction (Nested PCR) was performed.

The tested samples indicated the presence of bacteria in 42.2% of samples (40% for first farm's samples and 50% for second farm's samples). These results can confirm the hypothesis that Treponeme may penetrate through Digital Dermatitis lesions to corium and effect on Sole Ulcer lesion or it can be as an external contamination. In both cases, presence of Treponeme in Sole Ulcer lesions is a risk factor that contributes to ulcers development or stability. The cases in point are the non-healing lesions of horny tissue in herds which suffer from Digital Dermatitis. The other case in point is that when infectious diseases such as Digital Dermatitis in a herd are controlled, non-infectious diseases (horny tissue lesions) will reduce.

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PREVALENCE OF BOVINE DIGITAL DERMATITIS OF DAIRY CATTLE IN NEW ZEALAND: A SURVEY OF FARMS IN THE NORTH TARANAKI REGION

Introduction:

Bovine digital dermatitis (BDD) is the most important infectious cause of lameness in dairy cattle, but, until recently, has been rarely recorded in New Zealand (NZ). In 2011, five cases were reported to the Ministry of Primary Industries [2], highlighting the potential for BDD to become a significant issue on NZ dairy farms and prompting a survey of BDD prevalence.

Material and Methods:

A survey of 224 dairy farms in the North Taranaki region of the North Island of NZ was undertaken from 09/14 to 02/15. Nine farms were screened to develop robust criteria to confirm BDD visually. A trained technician then inspected the rear feet of every milking cow on 215 farms at milking. The ID of affected cows, the feet involved, and the type of lesion(s) (dried, active or suspicious) were recorded. Foot level (proportion of feet affected), cow level (proportion of cows affected), within-farm (proportion of a herd affected), and between-farm (proportion of farms with \geq one case) prevalences were calculated. For cow level, 95% confidence intervals were obtained using GEE with a robust standard error [1].

Results:

BDD was observed on 143/224 farms; between-farm prevalence was not affected by month ($p=0.703$). Within-farm prevalence ranged from 0 to 12.6%; it was $>>3\%$ on only 23/143 farms. Overall, cow level prevalence was 707/60455 (1.17%, 95%CI: 0.93 - 2.97%); this changed significantly with time ($p<0.0001$). In affected cows 268/707 (37.9%) had a lesion on left foot only, 263 (37.1%) on the right foot only and 177 (25%) on both feet.

Discussion and Conclusion:

In this region of New Zealand, the proportion of affected farms was higher than expected but cow level prevalence was low. It is likely that the latter is an underestimate as the lesions recorded as digital dermatitis tended to be very small, so could easily be missed, particularly if they were inter-digital or on the front of the hind feet. The cow level prevalence showed a seasonal pattern which is likely to

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be related to stage of calving and climate (wet in spring, dry in summer). These data show that digital dermatitis is present on most farms in New Zealand and could potentially become a significant problem on dairy farms in New Zealand, particularly if there are significant changes in the management of cows in New Zealand, such as increased use of housing.

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AN EVALUATION OF THE EFFECTIVENESS OF VISUAL SCREENING FOR DIGITAL DERMATITIS ON DAIRY FARMS IN NEW ZEALAND USING A BAYESIAN LATENT CLASS MODEL

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Introduction:

There is currently no gold standard for the diagnosis of bovine digital dermatitis (BDD). In a recent New Zealand study, BDD was diagnosed based on clinical appearance. The aim of this analysis was to use latent class modelling to assess the reliability of detecting BDD using visual appearance alone.

Material and Methods:

The outcome of the screening was recorded as positive (BDD observed) or negative (no BDD or non-definitive lesions). Apparent prevalence within a random farm k ($p[k] = \varpi[k] \times Se + (1 - \varpi[k]) \times (1 - Sp)$); where $\varpi[k]$ the true prevalence; and Se and Sp the sensitivity and specificity of visual screening, respectively.

$\varpi[k] = z[k] \times \varpi^*[k]$, where $\varpi^*[k]$ is the true within-farm prevalence for a farm with lesions of BDD, and $z[k]$ is farm level digital dermatitis status. ϖ^* can be fitted in a random effect logistic regression model: $\text{Logit}(\varpi^*[k]) = \mu[k]$. The random effect ($\mu[k]$) follows a normal distribution: $\mu[k] \sim \text{Normal}(0, \tau)$, where τ is the precision ($1/\text{variance}$) [1, 2].

Priors were based on expert opinion. Sensitivity and specificity were most likely to be 81.8% (95% sure >75%) and 98% (95% sure >95%), respectively. Expected proportion of infected farms was 10% (95% sure > 8.3%). The prior for within-farm prevalence was based on the previous year's data (median 7.7%; 95% sure that it was >3%). A non-informative prior was used for the random effect. Sensitivity analyses used a non-informative prior for proportion of affected farms and a pessimistic prior (initial prior - 10%) for screening specificity.

Model was built in OpenBUGS (version 3.2.3). The chains were thinned to reduce autocorrelation and run for 25,000 iterations. Model convergence was confirmed using BRG-diagnostics plot and the lack of auto-correlation by using auto-correlation plots.

Results:

Estimated sensitivity and specificity were 80.9% (95%CI: 72.9%-87.3%) and 99.5% (95%CI: 99.4%-99.6%), respectively. The non-informative prior for the proportion of affected farms, changed these to 80.7% and 99.8%, respectively. The pessimistic prior for specificity did not alter either estimate.

Discussion and Conclusion:

The sensitivity analysis suggested that the posteriors were driven by the data rather than the priors. The high specificity suggested that infected farms were truly infected. The relatively low sensitivity may mean that the proportion of affected herds (particularly those with only one or two cows affected) is an underestimate, and it is likely within-herd and cow level prevalence are also underestimated.

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OCCURRENCE OF FUSOBACTERIUM NECROPHORUM IN INTERDIGITAL PHLEGMON, OTHER CLAW INFECTIONS AND HEALTHY CLAWS OF DAIRY CATTLE

Introduction:

Interdigital phlegmon (IP) is an acute infection of interdigital space of bovine claw. *Fusobacterium necrophorum* is considered to be the major causative organism. Rumen is the reservoir of *F. necrophorum* and therefore the organism is supposed to be ubiquitous in the environment. However, there are studies which indicate that healthy cows don't excrete fusobacteria in feces frequently (1). We studied the occurrence of two subtypes of *F. necrophorum* in IP, digital dermatitis (DD), other claw infections and healthy interdigital skin.

Materials and methods:

Samples were taken from 18 farms with an outbreak of IP and four farms without IP outbreak and no signs of DD. Outbreak was defined by minimum of three cases of IP in a week. IP diagnosis was made if a symmetric swelling, possible ulceration and odor appeared in claw region. Suspected early-stage IP without ulceration is referred here to seIP. Cows which had not symptoms of IP, DD or interdigital dermatitis (ID) were considered as healthy controls.

Sampling took place in a trimming chute. Interdigital space was spouted and rinsed with physiological saline. Samples were taken from the inflamed region using sterile swabs and cultured anaerobically on-site. They were plated on Fastidious Anaerobe Agar (FAA) and *Fusobacterium* Neomycin Vancomycin (NV) agar. PCR-samples were taken with a cytobrush.

Primary cultures were further analyzed at the Finnish Food Safety Authority (Evira), Helsinki, Finland. Colony morphology, microscopy and standard biochemical tests for identification of anaerobic bacteria were used for preliminary identification of the isolates. The swab samples were analyzed for leucotoxin coding *lktA* gene (2).

Results:

Fusobacterium necrophorum was isolated most frequently from IP samples (96/122), and cows with DD (17/23), less frequently from samples of other claw infections (18/43) and seIP samples (7/17). Subtype *necrophorum* predominated, either alone or together with subtype *funduliforme*.

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Fifty-eight animals with IP lesions had been treated with antimicrobials before sampling. No animals suffering from DD or seIP were treated before sampling. No *F. necrophorum* bacteria were detected in the samples of IP free herds, and only one sample of healthy control animals of herds suffering from IP was *F. necrophorum* subsp. *funduliforme* positive.

The results of culturing and PCR were consistent. PCR test seemed to be slightly more sensitive than culturing to detect *F. necrophorum* in seIP cows.

Conclusions and discussion:

F. necrophorum was frequently isolated from IP, but also other types of claw infections. The role of fusobacteria in manifestation of different types of claw infections is still not clear. It may be due to the consortium of other bacteria involved in the infection, variation in expression of virulence factors or environmental factors.

The absence of *F. necrophorum* in healthy claws indicates that these bacteria don't colonize the intact skin of interdigital space in large numbers, even when the infection pressure is elevated.

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A RANDOMISED CLINICAL TRIAL ON THE EFFECT OF ANTIBIOTIC OR NON-ANTIBIOTIC TOPICAL TREATMENT OF DIGITAL DERMATITIS IN DAIRY CATTLE

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Introduction:

Digital dermatitis is a superficial, painful, contagious epidermitis of the feet of dairy cattle which frequently results in lameness. A common individual treatment for Digital Dermatitis in Europe is a topical administration of antibiotic chlortetracycline (CTC) spray. Given potential induction of antibiotic resistance there is a need for effective treatments without antibiotics. Intra Repiderma is a non-antibiotic spray containing chelated copper and zinc. We performed a randomised controlled trial to compare clinical improvement of ulcerative Digital Dermatitis lesions following treatment with Intra Repiderma spray versus CTC spray.

Material and Methods:

We included 9 dairy herds of around 100 cows housed in a freestall system with an estimated Digital Dermatitis prevalence of 20-25%. In total, hind legs of 944 cows from 9 dairy herds were trimmed by professional hoof trimmers and scored using the M0-M4 scoring system. All legs with M2 lesions (red, ulcerative) were included and randomly treated with Intra Repiderma spray or CTC spray according to the instructions of the manufacturers. Clinical improvement was defined as the transition of an M2 lesion to any other lesion at treatment evaluation on day 10. At the end of the study 231 cows, of which we included one M2 affected leg each, were eligible for analysis.

Results and Discussion:

The overall clinical improvement rate of Intra Repiderma was higher compared to CTC spray, 86.8%

(between herd range 61.5% - 100.0%) and 47.9% (between herd range 17.7 - 85.2%), respectively. In all 7 herds clinical improvement was numerically higher for Intra Repiderma and in 3 out of 7 herds this was significantly higher. The difference in cure rate between Intra Repiderma and CTC treatment (Relative Risk) was estimated to be 1.9.

Ten days after treatment with Intra Repiderma, most lesions (71%) transitioned into an M3 (healing, covered by a scab), while the percentage of M1 (smaller) and M2 lesions was almost equal (14% and 13%, respectively). After treatment with CTC spray most lesions remained M2 (52%). The percentage of M3 lesions after treatment with CTC spray was lower than compared to treatment with Intra Repiderma (20%), while 19% transitioned into an M1.

No adverse effects were observed.

Conclusion:

In conclusion, with a clinical improvement of 86.8% versus 47.9%, the non-antibiotic Intra Repiderma spray was 1.9x more effective than CTC treatment in the reduction of ulcerative Digital Dermatitis lesions.

A RANDOMIZED CONTROLLED TRIAL OF 50 M2 DIGITAL DERMATITIS LESIONS WITH A NON-ANTIBIOTIC GEL CONTAINING CHELATED COPPER AND ZINC

Introduction:

Digital Dermatitis (also known as Mortellaro's disease or hairy heel warts) is a chronic infection of the digital skin in cattle, causing lameness, economical loss and decreased welfare. In Canada, no medication is officially registered for the treatment of Digital Dermatitis. The aim of this randomized controlled clinical trial was to investigate the efficacy of a non-antibiotic gel containing chelated copper and zinc (Intra Hoof-fit Gel) in Canadian dairy cows according to a Health Canada protocol.

Material and Methods:

On three farms, a total of 50 active ulcerative Digital Dermatitis M2 lesions were randomly divided in two groups: A) 25 lesions were treated with Intra Hoof-fit Gel; and B) 25 lesions were used as untreated controls. Group A was treated with Intra Hoof-fit Gel according to the following protocol:

Day 0: Approximately 5 grams of Intra Hoof-fit Gel was applied on the lesion with a brush, then covered with cotton wool and maintained in place by an elastic bandage.

Day 3: The bandage was removed, and approximately 5 grams of Intra Hoof-fit Gel was applied again with a brush, no bandage.

Day 7: Approximately 5 grams of Intra Hoof-fit Gel was applied with a brush, no bandage.

The trial lasted for 10 days, and on day 0, 7, and 10, the animals were restrained in a hoof-trimming chute. The affected hoofs were cleaned with a towel, and lesion characteristics were scored. On day 0 and 10, a digital photograph of the lesions was taken.

All scoring and treatment of Digital Dermatitis was performed by the independent investigator (Emil Sabau, DVM). The results were statistically analyzed using a Fisher's exact test, $p < 0.05$ was considered significant.

Results and Discussion:

On day 7, each single lesion of the Intra Hoof-fit Gel treated group had already changed from an active ulcerative M2 to the M3 healing phase covered with a scab (23 out of 25 lesions) and the M4 non-painful chronic phase (2 out of 25 lesions). This, in contrast to the untreated lesions, that all

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remained red and active M2 lesions on day 7. On the final day, day 10, this striking difference remained unchanged. The association between groups and outcomes was extremely statistically significant ($p < 0.000001$).

Conclusion:

This all-or-nothing effect clearly demonstrates the efficacy of Intra Hoof-fit Gel as a powerful non-antibiotic treatment for Digital Dermatitis in cattle.

THE EFFECT OF LAMENESS BEFORE AND DURING THE BREEDING SEASON ON FERTILITY IN 10 PASTURE-BASED IRISH DAIRY HERDS

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Introduction:

The effects of lameness on fertility have been documented frequently but few data are available from seasonally breeding, pasture-based herds (such as those used in Ireland) where cows are housed during the winter months but managed at pasture for the remainder of the year. This study determined the prevalence of lameness in a group of 786 cows in 10 pasture-based Irish dairy herds before, during and after the breeding season and assessed the relationship between lameness and the reproductive performance in these herds through serial locomotion scoring during the grazing period.

Material and Methods:

This prospective observational study was carried out in 2013 on 10 commercial Irish dairy farms, as part of the on-going herd health management programme conducted by University College Dublin (UCD). All the farms used seasonal breeding and were visited by a UCD veterinarian every 21 days during the calving and breeding season. Reproductive performance was monitored at a herd-level based on Submission rate, Conception risk and Pregnancy rate. Lameness data were gathered by means of serial locomotion scoring of all the animals in the spring breeding herd. Four locomotion scoring visits were scheduled in accordance with the breeding season to allow for cows to be locomotion scored before, during and after the breeding season. Kaplan-Meier survival curves were used to compare the PR distribution and to calculate median days to conception. A Cox proportional hazards model with lameness as time varying covariate was used to identify variables influencing the PR.

Results:

Lameness prevalences of 11.6% before, 14.6% during and 11.6% after the breeding season were found. The median days to conception was 26 for cows never observed lame, 33 for cows lame before the start of breeding but no longer lame during the breeding season, 36 for cows that became lame during the breeding season and 43 for cows lame both before and during the breeding season. After controlling for the effect of, farm, month of calving, body condition score at calving, body condition score loss after calving and economic breeding index in the Cox proportional hazards model, cows identified as lame during the study were less likely to become pregnant. Cows lame before the earliest serve date but no longer lame during the breeding season, cows becoming lame after the earliest serve date and cows identified lame both before and after this date were respectively 12%, 35% and 38% less likely to become pregnant compared to cows never observed lame during the study. However, these findings were only significant for cows becoming lame after the earliest serve date and cows lame both before and after the start of breeding.

Conclusions:

The lameness prevalence found in this study compared favourably to results from housed cattle and is similar to other studies carried out in grazing herds (Haskell et al., 2006, Fabian et al., 2014). The reproductive efficiency was significantly ($p < 0.05$) lower in cows becoming lame during the breeding season and cows lame before and during the breeding season compared to non-lame cows. Cows no longer lame during the breeding season had a lower Submission Rate. However, the PR was not significantly ($p > 0.05$) lower in these animals compared to cows never diagnosed as lame. In addition to lameness status, nutritional status and genetics were found to influence the reproductive performance in pasture-based Irish dairy herds.

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EXPERIMENTAL INFECTION OF CATTLE WITH OVINE DICHELOBACTER NODOSUS ISOLATES

Introduction:

Dichelobacter nodosus is the main causative agent of ovine footrot (1). In cattle, *D. nodosus* is associated with interdigital and digital dermatitis, but the bacterium is also detected in cows with healthy feet (2). Previous research has indicated that cross-infections of both virulent and benign strains between sheep and cattle have occurred on pasture (3, 4). The aim of this study was to investigate if benign and virulent *D. nodosus* isolated from sheep can be transferred to cattle feet under experimental conditions. Further, we wanted to observe the impact of such infection on bovine foot health, and test the effect of topical treatment with chlortetracycline on the infection.

Material and methods:

Six Norwegian Red heifers approximately 16 months old were included in the study. After an initial 18-day maceration period, the heifers were inoculated with 20 ml bacterial suspensions containing 10⁶-10⁷ bacteria/ml on one single foot, three with a benign *D. nodosus* strain belonging to serogroup G and three with a virulent strain belonging to serogroup A. When the bandages were removed after 17 days (day 35), swabs for PCR and culturing and biopsies were taken. Afterwards, the heifers were treated topically with chlortetracycline once (Cyklo spray®). Swabs for cultivation and PCR were also taken on day 59, 84 and 105.

Results:

When the bandage was removed, *D. nodosus* was isolated from all six heifers, and all had interdigital dermatitis. None were lame during the trial. In five of the heifers *D. nodosus* organisms were demonstrated within epidermis. The *D. nodosus* organisms were also invading hair follicles. Twenty-four days after treatment with chlortetracycline all heifers was negative by cultivation, but all six tested positive for *D. nodosus* by PCR. Twenty-five days later, two of them still tested positive for *D. nodosus* by PCR. Seventy days after treatment, all six heifers tested negative for *D. nodosus*.

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Discussion and Conclusions:

This study shows that both virulent and benign *D. nodosus* originating from sheep can be transferred to naïve heifers under experimental conditions. Further, the study supports the hypothesis that infections with virulent *D. nodosus* in cattle are also associated with interdigital dermatitis. The absence of lameness in the six heifers included in our study agrees with previous studies and supports the hypothesis that the presence of *D. nodosus* in cattle is not necessarily associated with lameness. Because of the small study population no conclusion regarding the treatment of *D. nodosus* infection with chlortetracycline was possible. The ability of *D. nodosus* to cross between sheep and cattle is epidemiologically important, and cattle should be considered a possible source of virulent *D. nodosus* to sheep when planning and implementing elimination programs for ovine footrot.

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THE EFFECT OF PRE-CALVING AND POST-CALVING TRIMS ON SUBSEQUENT LAMENESS EPISODES IN DAIRY HEIFERS

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Introduction:

High standards of lameness prevention in heifer cohorts has been identified as important due to the potential for large deterioration in claw health during the first lactation (Offer, et al., 2000), a high recurrence of foot lesions (Manske, et al., 2001), the impact of udder development and the weight of the foetus (Chapinal, et al., 2008) and the lack of a fully developed digital cushion (Raeber, et al., 2004).

The primary aim of the study was to assess both the independent and combined effects of routine foot trimming of heifers at three weeks pre-calving and 14 weeks post calving. We hypothesised that post-calving foot trims in heifers were too late in relation to the risk period for lameness development, with the prophylactic foot trims pre-calving theorised to achieve correct foot conformation and minimise the impact of the physiological changes around parturition.

Materials and Methods:

Two similar highly intensive herds in Dorset, England, were recruited to provide 380 Holstein heifers that were reared under the same management conditions. All heifers due to calve between November 2013 - 2014 were eligible for inclusion on the trial, and were randomly allocated into one of the four treatment groups:-

1. Trim pre-calving, trim post-calving
2. Trim pre-calving, mobility score post-calving
3. Mobility score pre-calving, trim post-calving
4. Mobility score pre-calving, mobility score post-calving

All of the heifers on the trial were also scored for lameness every 2 weeks throughout the trial using the Dairy-Co mobility scoring system (0,1,2,3).

The productivity data was also collected for the first lactation of these heifers to evaluate any differences in fat corrected 305 day yield and fertility, and thus any economic impacts of the trimming regimes.

Results:

The overall lameness incidence was significantly different between the 2 farms ($P < 0.001$), with farm 1 having a lameness incidence of 23%, and farm 2 having a lameness incidence of 49%. Kaplan Meier Survival Analysis for each of the 3 different trim interventions compared to the baseline of mobility scoring only, were carried out. These demonstrated that there were no significant differences between any of the trim interventions and just mobility scoring of the heifers.

Analysis of the 305 day yield has not been completed yet.

Conclusions and Discussions:

The lameness incidence identified on farm 2 may have been due to this farm having been a new build development, resulting in the heifers been exposed to large amounts of freshly laid concrete, leading to a very high wear scenario. These heifers were also introduced into larger group sizes (350 heifers Vs 150 heifers), which may have led to increased bullying behavior and reduced lying times on this farm (both of which are associated with increased lameness incidence).

The survival analysis results indicate that there is no difference in the level of heifer lameness with any of the trim interventions compared to just mobility scoring, so demonstrating the lack of tangible reduction of lameness episodes. Despite this, it is notable that on Farm 2 (which was a very high wear environment), there was no adverse effect of trimming on lameness levels, indicating that the regular trimming did not increase the incidence of thin soles.

Trimming of the heifers may also have some long term benefits for foot health such as reduced lameness severity due to less advanced foot lesions, quicker lameness recovery, and production benefits which are still to be explored.

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EFFICACY OF TWO TOURNIQUET TYPES FOR INTRAVENOUS REGIONAL LIMB PERFUSION (IVRLP) WITH MARBOFLOXACIN IN STANDING DAIRY CATTLE

Introduction:

Antimicrobial IVRLP has become a complementary therapy for treatment of distal limb infections in large animals (1, 2). There are no previous published studies investigating the use of marbofloxacin in IVRLP in cattle.

The goals of the present study were to evaluate the safety and the efficacy of a single IVRLP with marbofloxacin in clinically healthy, standing non-sedated dairy cows, using 2 different tourniquet types detecting potential violative residues in milkings.

Material and Methods:

Ten adult animals were included in the study, which was approved by the local ethical committee (Prot. 41/2012/CEISA). One pelvic limb of each cow was randomly selected and assigned to 1 of 2 groups (5 limb/group). Group 1 had a wide rubber elastic tourniquet (10 x 500 cm, 6-8 full circumferential turns; Esmarch Bandage) and group 2 had a manual pneumatic tourniquet (11 x 76 cm cuff at 300 mmHg; VBM® Germany). The dorsal common digital III vein was used to perfuse the pelvic limb. After the tourniquet was applied by the same clinician above the tarsus around the distal portion of the tibia, a 19 g butterfly needle was introduced into the vein and 0,67 mg/Kg of marbofloxacin (Marbocyl 10%®, Vétoquinol) diluted to 60 ml with sterile water for injections was infused manually by a slow bolus injection over 60–90 seconds. Blood samples were collected from the jugular vein on times: 0 (before injection), 0.08, 0.25, 0.5 (immediately after the tourniquet was released), 1, 2, 4, 8, 12, 24 and 48 hours after injection. Synovial samples were aseptically collected from the tibiotarsal joint on times: 0, 0.5, 1, 2, 4, 8, 12, 24 and 48 hours after injection. Composite milk samples were manually collected from each gland of every cow (pool of all quarters) at the following time: 0, 12, 24, 36 and 48 hours after injection. All samples were analyzed for marbofloxacin concentration using liquid chromatography tandem mass spectrometry.

Results:

No acute or chronic adverse effects concerning the procedure or the antimicrobial drug were observed in any animal. Marbofloxacin was detected in all ve-

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nous samples collected before releasing the tourniquet. Mean peak marbofloxacin concentration in plasma occurred at 0.08 hour after drug administration in group 1 (2.18 µg/ml ±1.15) while in the group 2 it occurred at 0.5 hour (2.87 µg/ml ±1.46). Mean peak marbofloxacin synovial fluid concentration in group 2 (77.33 µg/ml ±6.85) observed at the 1 hour time point was significantly higher than that one of the group 1 (6.18 µg/ml ±1.86) obtained at 0.5 hour post-administration. In both groups the mean peak marbofloxacin values for milk occurred at 12 hours following administration.

Discussion and Conclusions:

The pneumatic tourniquet resulted in a meaningfully higher synovial fluid mean peak marbofloxacin concentrations in all cows, in combination with lower mean plasma concentration before tourniquet was removed and higher plasma concentration just after the tourniquet was released. All milk residual values were below the maximum levels permitted by current European Legislation. Based on the results of this study it can be assumed that the high concentrations of marbofloxacin achieved in synovial fluid with the application of the pneumatic tourniquet may have an effective therapeutic effect against the major bacterial pathogens involved in bovine distal limb infections. This study represents an initial step in evaluating the potential application of marbofloxacin for treatment of deep digital septic conditions in dairy cattle when administered by IVRLP.

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A SPLIT-LEG CLINICAL TRIAL WITH CROSSOVER COMPARING EFFICACY OF FOOTBATHING TWICE DAILY USING HOOFSURE ENDURANCE WITH 4% FORMALIN

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Introduction:

Formalin and copper sulphate are the most commonly used non-antibiotic biocides used in footbaths in parts of England¹ and the US². However, concerns due to formaldehyde being a probable carcinogen and copper being a biohazard means their long term use is questionable. A recent study by found that Provita Hoofsure Endurance significantly ($P < 0.01$) reduced the frequency of infected hooves with digital dermatitis from 57 to 37%⁴. Hoofsure Endurance is considered safe for human health and the environment.

Materials and Methods:

A herd of over 90 milking cows recruited for 24 week trial. A split-leg foot bath was used, with a 12 week cross-over giving two phases of 12 weeks. Treatment was randomly allocated at the start of the trial using a coin toss. One side was filled to 12cm with 4% formalin (Kilco, UK) and the other side was filled with 2% Hoofsure Endurance (Provita, Northern Ireland).

Foot bathing occurred twice daily for five consecutive days each week for 2x12 weeks. Digital dermatitis scoring for digital dermatitis was performed by one scorer (SD) in the parlour at milking by hosing and inspection with a torch. Lesions were scored using a modified M-system³ (Figure 1). The scorer remained blind to treatments.

Results:

Prevalence of non-regressing lesions (M1, M2, M4) in hindlimbs fell through the study. There was no significant difference in prevalence of non-re-

gressing 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%, $p=0.642$).

Conclusion:

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.

Acknowledgement:

The authors would like to thank Provita for sponsoring this trial, the farm staff at Kingston Maurward College for helping run the trial and Andrew Davies from Synergy Farm Health for independently overseeing the health and welfare of the herd.

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CLINICAL EFFICACY OF A SINGLE INTRAVENOUS REGIONAL LIMB PERFUSION (IVRLP) WITH MARBOFLOXACIN FOR TREATING ACUTE INTERDIGITAL PHLEGMON IN THIRTY DAIRY COWS

Introduction:

Interdigital Phlegmon (IP) is a quite common infectious disease causing lameness in both lactating dairy cows and in beef feedlot cattle. Antimicrobial IVRLP therapy delivers high drug concentrations to the digital region with minimal systemic diffusion (1). Therefore the presence of potential violative residues in milk is substantially reduced, if not absent (2). To our knowledge large case series of IP treated with IVRLP are lacking in the literature.

The aim of the present study was to evaluate the clinical efficacy of a single IVRLP with marbofloxacin for treating acute IP in dairy cow.

Material and Methods:

Thirty Friesian adult dairy cows clinically diagnosed with acute IP, based on case history and physical exam, presenting a 3-4/5 locomotion score (3) were enrolled in the study. A manual pneumatic tourniquet (7 x 35 cm cuff at 300-400 mmHg; VBM® Germany) was applied over the proximal portion of the principal metacarpus/metatarsus. Then, a 19 gauge butterfly needle was introduced into the dorsal common digital III vein in a proximal-to-distal direction and 0,67 mg/Kg of marbofloxacin (one third of the daily systemic dose; Marbocyl 10%®, Vétoquinol) diluted to 40 ml with sterile water for injections, was manually infused by a slow bolus injection over 60–90 seconds. The tourniquet was released 30 minutes after the injection. Clinical follow-up data was obtained at 5, 10 and 15 days post-IVRLP. A positive outcome after treatment was defined as digital swelling disappearance, locomotion score reduction at least 2 points/5, and daily milk production returning to previous level.

Results:

Subjects included in the study were aged between 3–8 years; 27 pelvic (11 right and 16 left) and 3 thoracic (2 right and 1 left) limbs were affected. Eleven out of 30 had a locomotion score of 4/5 while 19 out of 30 were diagnosed as having a locomotion score of 3/5. Twenty-six out of 30 (86%) lactating dairy cows showed a positive outcome by the fifteenth days after a single IVRLP with marbofloxacin. Only 4/26 animals showed a mild residual lameness despite of an appreciable improvement in the foot

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lesion and in daily milk yields.

Discussion and Conclusions:

There is no established general treatment protocol to obtain a successful outcome facing with deep digital infectious disorders. Scientific evidence supports the use of early and aggressive antimicrobial systemic treatment for acute IP with ampicillin, penicillin G, oxytetracycline, ceftiofur, florfenicol, sulfadimethoxine and tulathromycin. Antimicrobial concentrations achieved by systemic administration are often nontherapeutic in a highly septic environment as is the phlegmon. A high local drug concentration in the target tissue can be achieved with IVRLP. In clinical practice, the number of perfusions is usually determined on the basis of clinical evidence of improvement. In this field study a single IVRL procedure with marbofloxacin has proven to be safe and clinically effective for treating acute IP in dairy cattle.

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LAME COWS IN PASTURE BASED SYSTEMS: ARE FARMERS AND DAIRY CONSULTANTS AWARE OF THE PROBLEM?

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Brazil is now the 4th largest global milk producer, with farms located in the southern region contributing 1/3 of the national milk supply. Within this region small-scale farm holdings are responsible for 87% of the production. These holdings consist primarily of family-run dairy units. The median herd size is on average 27 cows (range 5-105). The majority of farms relies on pasture as the primary source of nutrition for their cows but may also include some maize silage or concentrate supplementation.

Lameness is one of the most important animal welfare and production concerns facing the dairy industry today. Research has shown that facility design and management can affect lameness. However, other work has also shown that many lame cows go unnoticed by those caring for them. Although training has shown to improve identification of lame cows, little is known about cultural circumstances or knowledge barriers that may also contribute to this problem. The objective of this work was to contextualize farmers and dairy consultants' culture and knowledge on the topic of lameness and understand how these may influence lameness management on Brazilian pasture-based family farms.

As part of a larger epidemiological study looking at risk factors of lameness in the South West of Santa Catarina, Brazil, in-depth interviews were done with participating farmers (n=21) and key dairy consultants (n=13). A "semi-structured" approach was used during the audio recorded face-to-face interview covering: a) the perceived magnitude of

lameness on their farm (or region), b) their opinion on the causes and risk factors for lameness; c) how they would describe a lame cow, and d) of the cows identified as lame, which ones were treated. Participants were also requested to draw any or all types of hoof lesions present on their farms or clients' farms.

Farmers and dairy consultants both agreed that lameness was a problem. However, only 5 of the dairy consultants provided an estimate of lameness prevalence for the region (ranging from 15 to 35%). Over half of the farmers (57%) considered hoof lesions and poor locomotion among the primary challenges on their farm; self-reported prevalence of lame cows by the farmers was low (median 5%, range: 0 - 27%). There was a generalized consensus among all participants that "acidosis" was the primary cause of lameness and that it could be controlled by feeding a "buffer salt" to neutralize the pH of the diet. Many farmers acknowledged having included "buffer salt" as a preventive strategy. Participants were also confident that acidosis and in turn lameness was not a big concern given that in pasture based systems they provided less concentrate compared to zero grazing systems. Interestingly, the drawings provided by them indicated that infectious, traumatic and degenerative processes of the hoof were also a problem. Conversations revealed that the quality of the walkways, high humidity and walking distances were likely responsible for the hoof lesions. Participants perceived these causal factors to be a consequence of their production system and thus beyond their control. Participants all agreed that there are different severities of lameness, but farmers agreed that only "very, very, very lame cows" had to be treated. However, consultants frequently stated that many severely lame cows were not identified in a timely manner to allow recovery. All farmers and most consultants (77%) failed to mention any tool or strategy to detect lame cows. This study provides insights that lameness is a blurry concept among farmers and dairy consultants. Improved understanding of the etiology and the prevalence of lameness within this community may lead to appropriate diagnosis and treatment of lame cows.

TRAINING FOOT TRIMMING: 90 MM IS AN APPROPRIATE CLAW LENGTH FOR THE MODERN HOLSTEIN

Introduction: One component of lameness management is prophylactic foot trimming, intended to equalise weight bearing throughout the claws and reduce risk of lameness (Bicalho and Oikonomou, 2013). The first step of the widely used 'Dutch Method' is to cut the dorsal wall of the claw to 75 mm, derived from the recommendations of Toussaint-Raven (1985) deemed safe for Friesian cows 30 years ago. Cutting the wall too short can lead to over-trimming, which can have severe consequences for the cow and cause lameness (Tsuka et al., 2012). Our aim was to describe the variation in length of the dorsal hoof wall in contact with the dermis, and hence, derive minimum appropriate claw lengths for routine foot trimming.

Materials and Methods: In a post mortem anatomical study, described by Archer et al. (2015), the hind feet of 68 Holstein-Friesian dairy cows from a single farm were collected and the internal structures were visualised using x-ray micro-computed tomography (μ CT). The internal distance from the proximal limit of the wall horn to the distal tip of the dermis was measured from cross-sectional sagittal images. The proximal landmark identified on μ CT was a palpable structure beneath the coronary band, which varied by no more than ± 2 mm with respect to the proximal limit of the perioplic horn on validation, and is a reported landmark for claw length measurement by foot trimmers.

A toe angle of 50° was assumed for all claws and a constant of 14 mm was added to allow for both a minimum recommended sole thickness of 5 mm (Laven et al., 2012) and the mean wall thickness of studied cows: 8 mm. Consequently, the minimum recommended safe cut length for trimming for each claw was derived, when trimming the toe to a point.

Data were evaluated using descriptive statistics and two-level linear regression models with claw nested within cow.

Results: The minimum external dorsal wall length required for trimming for 219 hind claws ranged from 66 to 93 mm (median (interquartile range) = 83 mm (80 to 85 mm)) and exceeded 90 mm for 9 claws (Archer et al., 2015). Dorsal wall length increased by 1 mm per year of age, yet 85 per cent of the null model variance remained unexplained.

Discussion and Conclusions: If trimming the toe to a point, a claw length of 75 mm would have been too short for 85% of claws (Archer et al., 2015). If leaving a 5 mm step at the toe, this measurement would have been too short for 55% of claws. Age was the only predictor of claw length,

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increasing by 1 mm per year. Foot trimmers report varying claw length with cow size; stature data were unavailable in this study, but could explain much variation in the minimum safe trimming length.

Over-trimming can have severe consequences; the authors propose that the minimum recommended claw length stated in training materials for all Holstein-Friesian cows should be increased to 90 mm, measured from the proximal limit of wall horn, when trimming the toe to a point. Small reductions can be made for younger animals: 85 mm would be appropriate for the majority of first and second lactation cows. If a step is left at the toe, the minimum recommended length should be 85 mm or 80 mm for first and second lactation animals. Whilst competent foot trimmers may vary dorsal wall length within safe limits, the large unexplained variation within this small population suggests that 'standard' measures of dorsal wall length used by less experienced operators be increased in future texts and training material.

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DAIRY CATTLE LAMENESS: LINKING BONE-LIKE DEVELOPMENTS ON THE FLEXOR TUBEROSITY OF THE PEDAL BONE WITH LAMENESS FROM CLAW HORN LESIONS

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Introduction: Claw horn lesions (CHLs: sole haemorrhage, sole ulcer and white line disease) cause a large proportion of lameness in dairy cattle, yet their aetio-pathogenesis is poorly understood. Delayed treatment worsens recovery time and chronicity can ensue, whilst early detection and effective treatment reduces recurrence (Groenevelt et al., 2014). Untreated CHLs could incur damage to the internal anatomy of the foot, including the flexor tuberosity of the pedal bone, upon which bone-like development (BD) appears with age and seem to be linked with sole ulcers (Tsuka et al., 2012). Similar BD occurs in humans where high load passes around ligament insertions, often as incidental findings with no clinical significance (Benjamin et al., 2000). Our aim was to assess whether BD at slaughter was associated with poor locomotion and CHL incidence during a cow's life.

Materials and Methods: A retrospective cohort study, described by Newsome et al. (2015, submitted), imaged 142 hind feet from 72 Holstein-Friesian dairy cows culled from a research herd (SRUC Dairy Research Centre, Dumfries, UK) using a cone-beam industrial micro-computed tomography (μ CT) scanner: Phoenix v|tome|x m (GE Sensing and Inspection Technologies GmbH, Wunstorf, Germany), set at 125 kilovolts and 320 microamps to achieve a resolution of 0.11 mm.

Four measures of BD were taken from the flexor tuberosity of each pedal bone in caudal, ventral and dorsal directions and combined to create cow-level variables detailing the average BD on all hind feet (BD-Ave) and BD on the most severely affected foot (BD-Max); these became outcomes in a linear regression model. Explanatory variables described locomotion score (Manson and Leaver (1988) 1-5 scale), which had been assessed weekly throughout life from first calving, age, genetic line and management system. Binary explanatory variables were also constructed to describe lifetime incidence of both claw horn lesions and infectious causes of lameness.

Results: The explanatory variables 'age' and 'CHL incidence' were significantly associated with BD-Ave and BD-Max (Newsome et al., 2015, submitted). Significant locomotion score variables detailed the proportion of scores lame (score 4 or 5) between 3 and 12 mo pre-slaughter; means, medians of locomotion score and data from early life were not significant. Age and the locomotion variable "proportion of scores lame during the 5 months pre-slaughter" predicted BD-Ave and BD-Max.

Discussion and Conclusions: Age explained much variation in BD (Newsome et al., 2015, submitted). The association between BD and a previous history of lameness was a novel finding, and BD appeared specific to CHLs. BD-Max was the best predicted outcome and detailed BD on the most severely affected foot; this is the foot that would seem most likely to influence locomotion. Several mechanisms for the formation of BD are plausible. Inflammation occurring around the flexor tuberosity of the pedal bone during active claw horn lesions could elicit bone-like developments on the flexor tuberosity, which would exert greater forces on and cause further contusions in the germinal epithelium of the sole during foot-strike. Inflammation could also utilise fat depots within the digital cushion for the production of inflammatory mediators and decrease its future cushioning capacity. Both of these mechanisms are likely to become self-perpetuating. In order to stop irreparable anatomical damage within the foot, early identification of CHLs and effective treatment could be critical, particularly for first lifetime cases of lameness.

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ASSESSMENT OF THE IMPACT OF LAMENESS ON AFFECTIVE STATE IN DAIRY COWS

Lameness causes poor animal welfare as the condition is often associated with painful foot lesions. Recent studies have shown that, as in humans, cognitive function and decision-making in animals can be biased by underlying negative affective states such as pain¹. Furthermore, cerebral processing of emotions has been found to be asymmetric with a right hemispheric dominance during negative emotional processing while positive emotions induce high activity in the left hemisphere³. In mammals sensory fibres from the eyes project to the contralateral side of the brain and various studies² have illustrated lateralised sensory exploration of unfamiliar objects. For example, in cattle a general left eye (right hemisphere) preference for visual processing of novel stimuli has been found⁴. If negative affective states such as pain increase this right hemisphere dominance in visual inspection of novel / threatening objects, an enhanced left visual bias would be expected. This study aimed to investigate whether lame animals show more left-lateralised approach and inspection behaviours to novel objects compared to sound animals. One hundred and eighty six lactating Holstein-Friesian cows (3-6 years old) were individually presented with three unfamiliar objects, each of which was presented on three consecutive days. Each animal's response regarding approach behaviour and choice of approach direction (left or right side) was recorded. The relationship between the observations and the animal's mobility (scored ± 1 day of lateralisation testing) was analysed using Pearson's Chi-square analysis. Other factors influencing animal behaviour (e.g. milk yield) and individual habituation (Cochran's Q analysis) were also evaluated. The results demonstrated lateralised approach behaviour in cows. Animals that walked towards the objects without hesitation were more likely to view them in the right visual field while cows that stopped at a distance (possible sign of fear) viewed the objects in the left visual field more often. Most animals showed an investigative response (stopping and sniffing the objects) on day 1 and fewer such responses were recorded on the following two days. Although a greater proportion of left-sided approaches associated with higher milk yield was

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observed, there was no significant association between mobility score and lateralised behaviour. However, a connection between affective state and the animal's response based on observed behaviour (stop in distance and left approach = fear/negative response; stop at object and right approach = curiosity/ positive response) might be possible. In conclusion, lateralisation of sensory processing when cows are confronted with novel objects could give an indication of the animal's emotional state. Therefore lateralisation testing could present a practical method in the assessment of affective state and help to improve our understanding of the impact of lameness on dairy cow welfare.

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DOES A PRE-WASH REDUCE CONTAMINATION IN THE TREATMENT FOOTBATH?

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Despite the widespread use of footbaths in the dairy industry, there is little evidence on optimal footbathing protocols. In particular, the use of a pre-wash bath has been contentious, and expert opinions are conflicting over their usefulness. Some suggest that they reduce contamination in the treatment bath and, in doing so, increase the lifespan and efficacy of the treatment bath^{1,2}. While others argue that they are not effective at reducing contamination in the treatment bath, or that they may even increase the level of contamination, and also that they may dilute the treatment bath³. This study looked to provide clarity on the matter by measuring organic matter contamination in the treatment bath, and recording the percentage of cows that defecated into it, with and without a pre-wash. Fourteen footbath treatments were set up at Boltons Park Farm, Hertfordshire, over a 4 week period.

Half of these treatments were randomly allocated to have a pre-wash (as per the usual farm protocol), and the other half did not. For each footbath treatment, the number of cows that passed through the treatment bath were recorded, as were the number of cows that defecated into it. Samples were taken from the treatment bath for every 10 cows that passed through. These were filtered to extract the organic matter contamination, which was dried and weighed.

Overall there was significantly less organic matter contamination in the treatment footbaths when a pre-wash was present ($p < 0.001$). However, when the data was broken down to each number of cow

passes, there were only significant differences at 20, 40, 60 and 70 cow passes ($p = 0.003, 0.002, 0.002$ and 0.003 , respectively). Whilst at 10, 30, 50 and 80 cow passes there were no significant differences in the level of contamination with and without a pre-wash ($p = 0.340, 0.107, 0.960$ and 0.443 , respectively). There was no significant difference in the percentage of cows that defecated into the treatment bath with and without a pre-wash ($p = 0.975$).

This provides evidence that, in the setup used at Boltons Park Farm, a pre-wash can reduce the organic matter contamination in the treatment footbath. Furthermore, this effect appears to be due to the pre-wash cleaning cows' feet, rather than stimulating extra defecation behaviour. There are two reasons why there may have been no significant differences at 10, 30, 50 and 80 cow passes. Firstly, contamination levels may have been too low to detect any measurable difference (e.g. at 10 and 30 cow passes). Secondly, there were outlier results in the "no pre-wash" group that skewed the data at 50 and 80 cow passes. Future studies should focus on establishing optimal pre-wash setup, and seek to investigate how a pre-wash may influence the lifespan and efficacy of the footbath treatment.

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COMPARISON OF FORMALIN AND AN ORGANIC ACID GERMICIDE HOOF BATH SOLUTION IN THE MANAGEMENT OF DIGITAL DERMATITIS

Introduction:

Hoofbathing is commonly used for the prevention and management of infectious hoof diseases such as digital dermatitis (DD). Currently used hoofbath actives like formalin and copper sulfate raise many human health and environmental concerns. Alternatives for these hazardous chemicals should meet the expectations of the producer, consisting of efficacious and sustainable solutions. In this study, the efficacy of an organic acid hoofbath solution was compared to formalin with regards to prevention of DD.

Materials and methods:

The study was conducted in four zero-grazing commercial dairy farms in The Netherlands from November 2014 until February 2015. For three months, cows went through a split hoofbath 3 times a week (Mon-Wed-Fri). The right side of the hoofbath contained a 5% formalin (FOR) (37%) solution and the left side contained a 2% organic acid germicide EasyStride (OAG) solution. The hind hooves were scored for DD lesions (Britt et al., 1999) every three weeks in the milking parlor after cleaning the hooves with a water hose. Only cows that were scored at least 4 times and did not receive any antibiotic treatment during the trial were included in the final analyses. The Fisher exact test of SAS 9.3 (SAS Institute Inc., Cary, NC, USA) was used to test differences between treatment groups on each farm.

Results:

A total of 344 cows were included in the final data set with a total of 3250 hooves scored throughout the trial. All four farms started with a very high (32-65%) prevalence of DD. After an increase in the number of DD lesions for both FOR and OAG treated hooves in the first 3 to 6 weeks, due to warm temperatures and humid conditions, a decrease in prevalence of DD lesions was seen in the last 6 to 9 weeks in all farms. Similar trends were seen in the amount of the different types of DD lesions during the trial within both treatment groups on all farms. On a farm level, the number of hooves that got infected at least once throughout the trial was almost identical for FOR (farm 1: 14; farm 2: 18; farm 3: 26; farm 4: 55) as for OAG (farm 1: 12; farm 2: 17; farm

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3: 25; farm 4: 53). Overall, no significant differences were found between both groups ($P > 0.05$).

Conclusions:

In general, the OAG solution performed as well as FOR in the four farms. Considering the high prevalence of DD on all farms, a more aggressive approach of the hoof lesions is necessary considering hoofbathing alone is not sufficient to dramatically reduce DD prevalence. For example, the frequency of hoofbathing could be increased according to the challenge on farm, and maintained until an acceptable level of DD is reached.

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INVESTIGATIONS INTO TREPONEME ASSOCIATED HOOF DISEASE IN NORTH AMERICAN WILD ELK (*Cervus elaphus*)

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Introduction: Since 2008 reports of limping with severely deformed hooves have sharply increased in south west Washington State. Investigations into causes of this hoof disease revealed striking similarities in the gross lesions, histopathology and bacterial association to digital dermatitis of livestock, including isolation of genetically related *Treponema* species. Dubbed Treponeme Associated Hoof Disease (TAHD), observed cases now include several herds in Washington and northern and central Oregon, indicating a rapid spread of this hoof disease in the elk populations. Investigations were undertaken to determine the impact of TAHD on overall health of the elk and disease dynamics within elk populations in a severely affected region.

Materials & Methods: In February of 2015, Washington Department of Fish and Wildlife initiated a mortality-sensitive, Global Positioning System-equipped radio-collar study on a sub-population of elk in a highly endemic area to determine the effects of TAHD on reproduction rates and mortality. While capturing animals for placement of radio-collars, hoof disease status was determined, hoof swabs were taken for bacterial culture, measurements were taken to assess pregnancy rates, body condition, and blood was drawn to determine immune reactivity to bacterial antigens associated with infectious hoof diseases.

Results: Of the animals captured in the endemic area, 56 of 75 (75%) had visible hoof disease consistent with TAHD. Affected elk had lower red blood cell counts (RBC), hemoglobin concentration, and hematocrit values than unaffected elk. Furthermore, elk with TAHD had significantly higher neutrophil lymphocyte ratios (NLR) than unaffected elk. Samples from a subset of 30 animals were cultured for *Treponemes*, and 18 of 30 (60%) were culture positive, including one elk that was visually

negative for disease but resulted in positive culture. As is seen with livestock cases of digital dermatitis, multiple treponeme morphologies were observed along with other anaerobic bacteria including *Fusobacterium*-like organisms, black-pigmented anaerobes (most likely *Porphyromonas* species) and small gram positive anaerobic cocci. Elk with TAHD exhibited higher serum antibody titers to *Treponema* sp. antigens. Lymphocytes from TAHD-affected elk in the endemic area exhibited significant proliferation as measured by membrane intercalating dye and flow cytometry in response to pathogenic *Treponema* sp. antigens compared to elk from outside the TAHD-endemic area, but did not differ in response to *Fusobacterium necrophorum* or *Dichelobacter nodosus* antigens.

Discussion/Conclusion: The larger than expected percentage of sampled animals with visible diseased hooves reflect the widespread problem in these affected herds. Presence of treponemes in diseased hooves confirms TAHD. Higher NLR in elk affected with TAHD may indicate a systemic inflammatory response to the causative TAHD bacteria and/or tissue destruction resulting from TAHD infections. In chronic inflammation, RBC, hematocrit, hemoglobin all decrease as non-specific response theorized sequesters iron and vital nutrients from pathogenic organisms. Lower RBC parameters may also reflect poor nutrition as an indirect effect of TAHD infection due to diminished ability to ambulate and forage normally. Increased serum antibody response and lymphocyte proliferation responses of TAHD-affected elk to *Treponema* sp. antigens, but not to *D. nodosus* or *F. necrophorum* antigens, support treponeme involvement in TAHD in elk. Like livestock species, elk exhibit systemic immune reactivity during active TAHD or digital dermatitis infection, but if this immune response is long lived, protective from re-infection or can be maternally transmitted remains under investigation. Understanding the underlying complications of TAHD will help shape policy decisions in managing this wildlife disease.

DEVELOPMENT OF A DIGITAL DERMATITIS MODEL IN SHEEP

Introduction:

Digital dermatitis is an infectious cause of lameness, primarily affecting dairy cattle, but also found in beef cattle, sheep, goats, and recently in a small population of North American wild elk. Digital dermatitis is associated with mixed bacterial infection, including several *Treponema* species, and other aerobic and anaerobic bacterial species. Whilst the exact etiology has not been shown, a number of bacterial, host and environmental factors likely contribute to disease development and progression. In order to study host-bacterial interactions and develop effective therapeutics, a reproducible laboratory model needs to be developed.

Materials & Methods:

Crossbred sheep of mixed ages were obtained from a breeding herd free of hoof diseases (total of 20 sheep used, in two independent trials). Feet were wrapped prior to inoculation using various methods in order to mimic wet, anaerobic environments, similar to those believed to predispose animals to infection. Feet were abraded to create a small wound and inoculated by exposure to macerated lesion material from active cases of bovine digital dermatitis. In a small number of sheep (n=6), intradermal inoculations were made using lesion material using fine gauge needle in the space between hoof and dewclaw.

Animals were monitored for lameness and lesion development for several weeks. Serum was drawn at various time-points and tested by ELISA for antigen specific antibody. Serum titers were analyzed by ANOVA. Lesion development or histologic changes to the dermis as scored by a blinded pathologist were statistically compared using Chi-squared with Fisher's exact test.

Results/Discussion/Conclusion:

Conditions were achieved that allowed for persistence of the *Treponema* and other bacterial species on the hoof for several weeks following inoculation. After intradermal inoculation, several test animals developed antibody titers to treponemal antigens. The pilot tests are promising; but these studies are

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ongoing and model development and refinement continues in order to develop a sheep model of bovine digital dermatitis.

CELLULAR RESPONSE FOLLOWING NATURAL DIGITAL DERMATITIS INFECTION

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Introduction:

Digital dermatitis is an infectious cause of lameness, primarily affecting dairy cattle, but also beef cattle, sheep, goats, and a similar process has recently been described in a small population of North American wild elk (*Cervus elaphus*). Proliferative, ulcerative lesions located near the heel bulb or interdigital cleft are dominated by anaerobic bacteria. Several *Treponema* spp. have been isolated from digital dermatitis lesions, and there is a strong association with other anaerobic bacteria such as *Porphyromonas levii*, *Fusobacterium necrophorum* and *Dichelobacter nodosus*. Data based on serum antibody responses indicated that immunity to digital dermatitis is short lived. To date, few investigations have been made into the cellular response elicited by infection. In order to develop vaccines and other targeted therapeutics, additional investigations into the cellular immune response elicited by digital dermatitis should be performed.

Materials & Methods:

Peripheral blood mononuclear cells (PBMCs) were isolated from cattle or North American wild elk which were known to be free of digital dermatitis, or which had digital dermatitis within the past 6 months. Diagnosis was made by visual inspection during routine hoof trimming or at the time of blood collection. PBMCs were stimulated with bacterial antigens prepared from bacteria isolated from digital dermatitis and PBMCs were analyzed for proliferation, phenotype and surface marker expression by flow cytometry.

Results:

PBMCs from animals with digital dermatitis proliferated to treponemal antigens in a dose dependent manner after 5 days of stimulation. The majority of the PBMCs proliferating were B cells, which supports the strong serum antibody response observed in these animals. In bovines, there was a significant population of proliferating γ -TCR⁺ cells; however there were also a number of proliferating CD4⁺ cells. Additional investigation is underway to further categorize and determine the memory phenotype of these cells. Interestingly, in both bovine and elk PBMCs, there were a significant number of CD8⁺ cells proliferating in response to stimulation with treponemal antigen. However, there was no difference in PBMC proliferation between animals free of digital dermatitis and those with lesions of digital dermatitis when stimulated with antigens from *Fusobacterium necrophorum* or *Dichelobacter nodosus*.

Discussion/Conclusion:

In order to develop effective vaccines or other targeted therapeutic interventions, it is necessary to understand the natural disease process, including the humoral and cellular immune response to bacteria key in development of the disease. Reoccurrence of digital dermatitis in some animals would suggest that the immune response is lacking or quickly wanes after infection. These results suggest that during or shortly after active infection, there is specific acquired immunity as indicated by the antigen specific proliferation of CD4⁺ and CD8⁺ PBMCs. Further investigation is needed to determine the length of immunity, memory phenotype and other characteristics of these antigen specific cellular responses.

PREVENTIVE EFFICACY OF A TOPICAL HOOF SPRAY DISINFECTANT SOLUTION

Introduction:

Infectious diseases of the bovine foot are increasing in most countries. The most common strategy to manage them are disinfecting hoofbaths. Questions about the impact of hoofbath chemicals on human health and the environment, and concern about water usage are common. Topical spray disinfectant solutions are an interesting alternative to hoofbaths because water savings and impact to the environment are decreased significantly. Following a standard hoofbathing practice (200L hoofbath for 200 cow passes), 1L disinfecting solution is required per cow per treatment, while only 50mL would be required if spraying at milking. The efficacy associated with preventing infectious foot problems by spraying hooves at the parlor were explored in this study.

Materials and Methods:

An experimental trial was conducted for three months in a pasture-based commercial dairy farm in the Buenos Aires Province, Argentina. During the trial period a total of 251 cows were scored for hoof lesions every month. Animals diagnosed with an active infectious disease at any visit, were treated with antibiotics by the farm veterinarian advisor until healing, thus lesions scored in the following visits were considered new infections. Treatment consisted of spraying daily a quaternary-ammonium based hoof disinfectant (QUAT) at a 5% dilution every milking (2x/day) on the right-hind leg. Left-hind legs remained untreated as control group (NEG). Trial data was analyzed using PROC GENMOD of SAS 9.4 (SAS Institute Inc., Cary, NC, USA) consisting of a binomial logistic regression model. The outcome variable was a new digital dermatitis (DD) lesion or an interdigital dermatitis (IDD) lesion, with covariates that included treatment and visit number.

Results:

Prior to the trial the farm utilized antibiotics and trimming to manage infectious hoof diseases. During the study period, the farm had a very low level of infectious foot problems, averaging 1.3% for DD and 0.9% for IDD. A total of 1720 observations were analyzed. In total there were more new DD

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cases in the NEG group (n = 13) compared to the QUAT group (n = 8), but differences were not significant (P=0.277). There was a higher prevalence of IDD in the NEG group (n = 11) compared to the QUAT group (n = 1) (P=0.021).

Conclusions:

Throughout the trial period, there were very low incidence and prevalence levels of infectious diseases in the study herd. Nevertheless, a positive effect of spraying hooves with QUAT was observed for both DD and IDD management. When integrated into a well established hoof management routine, spraying hooves with disinfecting solutions during milking provides beneficial effects on cow health, improved water management and reduced environmental impact of hazardous chemicals.

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PRELIMINARY HISTOPATHOLOGY RESULTS OF AN INVESTIGATION INTO LAMINITIS IN DAIRY GOATS ON A LOW FORAGE DIET

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Introduction: There are several reports of dairy goats on high concentrate diets ($\geq 70\%$) reaching higher levels of production, compared to goats on low concentrate rations ($\leq 30\%$), with little negative health effects (1, 4). However, to the best of our knowledge, there are no published data documenting the feeding of high concentrate diets to dairy goats for periods longer than 250 days. In this study, cases of severe lameness are investigated on a dairy goat herd using an ad lib concentrate diet throughout the life of the goats, as is common practice in the United Kingdom. Reported here are the gross post mortem and histopathological results, in order to investigate a link between severe lameness, rumen health and diet.

Material and methods: A dairy goat farm (320 lactating Saanen and Toggenburger goats) was investigated for an ongoing lameness issue. The farm was feeding ad lib concentrates with ad lib access to roughage. As part of a detailed investigation, five severely and chronically lame animals with poor prognoses were humanely euthanased on farm and a post mortem carried out. Rumen and claw samples were taken for microscopic analysis. Five dairy goats originating from a farm with a mixed ration that were euthanased for issues other than hoof health served as controls.

Results – gross pathology: Four of the five case animals presented at post mortem contained large amounts of intra-abdominal fat while one animal contained negligible amounts of abdominal fat. Rumen content pH of these animals measured between 5.26 and 5.46.

Foot pathology was similar in all cases and consisted of marked distortion of the claw shape, with marked irregular fissures over the solar and bulbar horn. On longitudinal sections, multifocal red discoloration was visible along the dermis of the wall, sole, coronary region as well as along the distal phalanx. The distal phalanx was visibly rotated downwards on two claws. None of these changes were seen in the controls.

Results – histopathology: The rumen mucosa of all five case animals showed diffuse mild to moderate hyperkeratosis.

In all cases the histological findings were similar and consisted of irregular hyperplasia of the epidermal laminae with parakeratotic hyperkeratosis, most prominent in the solar region. Moderate to marked, perivascular to band-like lymphocyte and mononuclear inflammatory cell infiltration was noted throughout the hoof connective tissues, mainly concentrated within the superficial and deep solar dermis with up to 100 cells per 400 X field in these areas, compared to 7 cells per 400 X field in the control animals. There was moderate to marked arteriosclerosis visible mainly in the solar connective tissues with multifocal occlusion of these arterial lumens due to intimal collagen proliferation. Vascular thrombi and perivascular macrophages containing hemosiderin were often noted. Extensive, chronic granulation tissue was visible throughout the claw.

Discussion: The histological hoof lesions found in this study are similar to those reported in cattle with chronic laminitis (2). Although in cattle, the causal relationship between nutrition and laminitis is still not clearly understood (3), it was thought that a causal link could be made here, due to the chronic extreme nutritional circumstances, the chronic lameness, and the gross and histological findings. The parakeratotic hyperkeratosis seen in all rumen samples indicates a degree of chronic rumen epithelial irritation, most likely following prolonged periods of acidosis.

Conclusion: In this case, chronic laminitis was confirmed as a cause of lameness in dairy goats on a farm feeding a high concentrate diet throughout the life of the animal. Further research is needed to investigate the full consequences of using a high concentrate ration on a commercial dairy goat farm throughout the life of the goat.

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CURRENT ADVISES FOR CUBICLE DIMENSIONS IN DAIRY HERDS

Introduction:

A clear relationship has been demonstrated between suboptimal cubicle dimensions and the risk of both infectious and non-infectious claw disorders (Gomez and Cook, 2010). The problems are related to longer standing periods and even worse, standing with the front legs inside and the hind legs outside the cubicles on the slatted floors. Lamé cows have more problems lying down, when the cubicles have optimal dimensions (Cook et al., 2008) and suboptimal cubicle sizes may even worsen some disorders. So, good advices for cubicle sizes do not only prevent but contributes to better healing of claw disorders also.

In Europe, both herd sizes and dairy cows have become larger, while a lot of cubicles, dimensions have not been adapted. The Dutch Animal Health Service (GD) has developed a new and simple calculation model to calculate the best sizes for the dairy cows in a specific herd. These are more or less in line with the information you can find on the web site of AHDB Dairy's (UK).

Material and Methods:

- Cubicle dimensions are based on the 20% largest cows and especially the withers height (WH) and the back length (BL)
- It is advised to have the dairy farmer
 - to estimate WH of the 20% largest cows in the herd. The mean WH of European HF dairy cows is around 146 cm, so the 20% largest are > 148 - 151 cm in any case, especially when taking account of next generating cows
 - estimate BL of the 20% largest cows, estimated from the front side of the shoulder joint to the back side of ischia tuberositas. The mean BL of European HF dairy cows is >175 cm, so the 20% largest are >180 cm
- Head space and the space to move forward (space before brisket board or knee tree) must be 2/3 of the WH in case of a closed front side or 1/3 of the WH in case of a open front side,
- The width of the cubicles (center of the pipes) is advised to be 0.8 x WH
- The height of the neck rail is advised to be 0.8 x WH and positioned perpendicularly above the brisket board, with preferably a rounded flexible sur-

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face. Recently, a lot of dairy herds have introduced ruffled neck rails and most dairy farmers are happy with that.

- The height of the brisket board is advised at 10-15 cm above the lying surface with preferably a rounded flexible surface.
- In the heading space no obstacles should be present.
- If a heading rail is placed, it should preferably be placed 85-90 cm above the bedding; a stretch belt at 100 cm between the cubicles is optional to prevent crossing by cows.
- Height of the bedding is advised at 15-20 cm above the walking area, with a fall of 3-4 %.

Conclusions:

Cubicle dimensions based on herd-specific cow sizes may contribute to better use of cubicles, what should result in longer resting periods, less claw problems and cleaner cows.

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MYCOPLASMA ARTHRITIS OUTBREAKS IN DAIRY HERDS

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Introduction:

Mycoplasma outbreaks in The Netherlands occurred over 50 times in the last 3 years, causing mainly serious painful arthritis in the carpal and fetlock joints of the front legs. In most cases it started suddenly and after 2 months, > 90% of the cases could be closed as there were no new patients.

Material and Methods:

Herds were initially suspected of mycoplasma infection because of the severity of clinical signs. The average percentage of affected cows within the investigated herds was 7.7% (SD: 4.5%). In 60% of the herds, both arthritis and mastitis problems associated with Mycoplasma bovis (M. bovis) were observed. Respiratory problems of replacement calves were reported in < 50% of the herds, while none of the herds showed respiratory problems in the dairy cows. For welfare reasons, affected cows were culled or euthanized immediately in most herds. At post mortem examination, affected dairy cows demonstrated acute or chronic serofibrinous to purulent inflammation (septic arthritis) of the front leg fetlock or carpal joint or the hock joint. One cow suffered from polyarthritis. In addition chronic peri-articular inflammation of the soft tissue (peri-arthritis) and chronic (necrotizing) mastitis were observed. Consistent with the clinical results no lung lesions were found in any of the examined cows. During herd visits a survey was conducted to gather information on possible risk factors at both cow and herd level.

Results:

No relationships were found between clinical disease and parity, stage of lactation or breed. The mean herd size in affected herds was larger (183 dairy cows) than the average herd size in the Netherlands (91 dairy cows; CBS (National reference Statistics Office) 2013) and herds were mainly located in the northern region of the country. Based on a matched case-control multivariable analysis, case herds were significantly associated with purchase of cattle (Odds ratio (OR)= 6.1) and a higher (> 3.45%) protein percentage in milk (OR= 2.6). All M. bovis isolates (from joint infections dairy cows/calves, pneumonia cases calves, and (clinical) mastitis cases) were genotyped using Multi Locus VNTR Analysis (MLVA) typing to determine relatedness of the M. bovis isolates both within and between herds. Using MLVA typing several distinct types of M. bovis isolates could be distinguished. M. bovis isolated from affected joints in dairy cows/calves did not form a distinct group as compared to the M. bovis isolates from infected lungs in calves, from mastitis- and historical samples. Most affected herds were infected by a dominant strain of M. bovis, although, in a few herds, different strains of M. bovis were isolated from the same herd. There was very little overlap in strains between herds; most herds were associated with herd-specific strains.

Conclusions:

Typing results indicated that the recent outbreaks of M. bovis in the Netherlands were not due to entrance or spread of one specific strain rather than due to spread of the species. Larger herds which purchased animals were more at risk.

RISK FACTORS ASSOCIATED WITH MAJOR CLAW DISORDERS ON 40 DUTCH DAIRY HERDS: PRELIMINARY RESULTS

Introduction:

Claw disorders are the main cause of lameness in dairy cows and can be associated with various risk factors including housing system, farm management and cow characteristics. The aim of this study was to identify and quantify risk factors associated with digital dermatitis (DD), sole haemorrhages (SH) and white line disease (WLD).

Material and Methods:

Information about 40 Dutch dairy herds was collected during regular claw trimmings. Inclusion criteria were: herd size, regular trimming by a professional hoof trimmer and more than average claw problems. A farm survey was performed in accordance with a protocol to determine potential risk factors associated with claw disorders (housing conditions, occupancy, access to pasture, purchase of animals, management). Two professional hoof trimmers scored the hind claws for presence/ absence and severity of the claw disorders DD, ID/HHE (interdigital dermatitis/ heel horn erosion), WLD, SU (sole ulcer) and SH. Milk production registration (MPR) data prior to the hoof trimming day was requested and included in the model. Categorical risk factor data were recoded into biologically plausible categories. For the risk factor analysis, a logistic regression model was built and biological plausible interaction terms were checked for significance.

Results:

The prevalence of DD, SH and WLD in the 40 herds in this study was estimated at respectively 28.7% 27.2% and 29.2%

The main risk factors for DD in this study were no access to pasture (OR = 2.05), a higher protein percentage in milk (OR=0.71) and the presence of ID/HHE (OR=1.67).

The main risk factors for SH in this study were no access to pasture (OR= 1.88) and housing young stock in the same stable as dairy cows (OR= 0.67). Additional important risk factors were associated with milk production, such as higher protein percentage in milk (OR= 0.33), a somatic cell count between 70,000 and 157,000, a cow that produces more than expected (OR= 1.24) and increasing parity. There is an interaction between parity and days

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in milk.

The main risk factor for WLD in this study was the presence of SH (OR= 1.86). Permanent indoor housing gives higher odds for WLD, and increasing parity gives higher odds for WLD in cows having access to pasture.

Discussion:

Although the herds in this study were not representative for the total Dutch population and therefore the results cannot be extrapolated to the whole population, this study may contribute to better understanding of the risk factors for the above claw disorders at herds with high prevalence. Housing young stock in the same stable as dairy cows gives lower odds for SH; this interaction might be influenced by the fact that in newer, more comfortable stables, young stock is more often housed in the same building as dairy cows.

Low protein percentage in milk preceding the claw trimming increased the OR for DD and SH; this is probably a confounder (ketosis). Cows which produced more than expected were at higher risk of having SH, an observation which cannot be explained based on the current available data. Recurrence of SH and WLD might explain the increased odds for these disorders with increasing parity.

Conclusions: In this study, access to pasture reduced all three main claw disorders (DD, SH, WLD). Presence of ID/HHE increased the odds of having DD, presence of SH increased the odds of having WLD. Higher parity increased the odds of having SH or WLD.

SUMMER DERMATITIS IN DAIRY COWS

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Introduction:

Dermatitis in more cows around dairy cows claws and dewclaws is most times associated with infectious claw disorders like Digital dermatitis, Interdigital dermatitis and Interdigital phlegmon (Greenough et al., 2007). Other options, affecting the skin of the distal parts of the legs are muddy eczema and affection of the skin by incorrect use of footbaths (Boosman and Nemeth, 1987). In The Netherlands GD Animal Health is every year and especially in summer, 3-5 times contacted about crusty dermatitis in the area between the dewclaws and the coronary band, whereby the disorder was different from definition as mentioned above.

Material and methods:

One typical herd (90 dairy cows, exclusive young stock, 305 DIM production 8500 kg) was investigated in June 2015. In all cases only hind legs were affected and biopsies of the border of the lesions were taken and also blood samples were taken to determine serum zinc level.

Results and Discussion:

In the herd dairy cows were pasturing for 3-4 months at the moment the practitioner and GD was consulted and cows could drink water from small canals. Only hind legs were affected and hind legs were not dirty at all (no indication for muddy eczema) and the crusty dermatitis lesions were located on the skin without connection with claw horn of the claws or the dewclaws. The number of affected animals was 9% in this herd and topical treatment (tetracyclin-sprays) did not result in any

improvement. There seemed to be no relationship with parity and DIM. The results were in line with others herds for the no. of affected animals (5-10%), parity and DIM. Production level in other herds was moderate also.

Histological investigation at the GD laboratory demonstrated hyperkeratosis and parakeratosis, with no indications for parasitic infestation. The histological observations could however be consistent with Zn deficiency. Serological examination of some patients (n= 5) revealed low normal blood values in these patients. Investigation on the origin of this type of lesions is ongoing and preliminary results will be presented during the conference. After corrections in the ration spontaneous cure was seen. The importance of recognizing this type of lesions has to do with the differential diagnosis of other infectious claw disorders and the origin of the disorders is important where zinc has different important functions in the normal regulation of different functions within the cow (Nocek et al., 2006).

Conclusions:

In low to moderate production herds hyper and parakeratosis of the skin in the distal parts of the legs may be presented related to Zinc deficiency, whereby the difference with other well-known claw disorders is of importance.

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SEVERE NECROTIZING DERMATITIS PROBLEMS DUE TO INCORRECT USE OF FOOTBATH PRODUCTS

The application of footbaths, in combination with acute treatment of active lesions, increased hygiene etc. are done for prevention of and/or transition to new active (M2) lesions. Dutch herds are not allowed to use antibiotics in footbaths for treatment and they mainly use formalin, copper and/or zinc sulphate. Only a small number of farmers use modern disinfectants because of the (experienced) health risks of formalin and their attitude to environment and society (Holzhauer, 2007, not published).. The main reason not to use modern disinfectants are (i) the high treatment frequency required and (ii) the prices of these products. GD Animal Health was recently involved in 2 herds with serious problems due to incorrect use of different products in their footbath.

A 1st case concerned a herd with 40 pregnant youngstock. 20% of these animals showed very serious lameness (unwilling to walk), affection of the claws (complete with de-shoeing (loss of horn shoes)) and deep erosive-ulcerative affection of the skin. A 2nd case concerned a dairy herd using a commercial product in their footbath. According to the manufacturer, the lesions were caused by the fact that the cows stood in the footbath for too long, The exact mechanism and root cause of the lesions is not yet fully understood.

One serious affected animal was euthanized. Post mortem examination revealed an extensive necrotizing dermatitis of the skin above the coronary band of the interdigital space and undermining of the hoof capsule in all four claws. These findings are a clear indication for contact dermatitis. At histological examination, epidermis was present only locally and abrupt transition to complete full-thickness epidermal necrosis with superficial neutrophil inflammation and a clear demarcation zone was seen. In other biopsies of the same animal only a thick layer of granulation tissue, without the presence of epithelium or hair follicles was found.

Both the macroscopic and microscopic presentation fitted the consequences of contact of the skin with a corrosive substance, possibly a cleaning pro-

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duct of the milk tank (pH 13-14) had erroneously been used as footbath product.

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PRESSURE DISTRIBUTION OF CLAWS OF LACTATING COWS STANDING ON DIFFERENT TYPES OF FLOORING

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Introduction:

The incidence of lameness is so high in many dairy herds that treatment of all lame cows is not feasible (Horseman et al., 2013). Because soft barn flooring may alleviate the problem of claw horn lesions, we conducted a study to measure the ground reaction forces and pressure distribution in claws on 4 different surfaces. Materials and Methods: Using a force plate and a pressure plate system, 12 lactating dairy cows were tested standing on a level hard surface, the same surface with a 3% incline toward the front legs, a level firm rubber mat and a level soft rubber mat. The latter mat was soft because of multiple, evenly-spaced, rubber projections on the underside of the mat. The vertical ground reaction forces were measured, and the mean and maximum pressures on the claw soles calculated separately for the fore and hind limbs. The pressures in the toe and heel regions of the lateral and medial claws were also calculated. Results: The four surfaces did not differ with respect to the pressure distribution recorded in the lateral and medial claws. The medial claws of the forelimbs and the lateral claws of the hind limbs consistently sustained significantly greater pressures than their partner claws. The heel regions of the medial forelimb and lateral hind limb claws were exposed to the greatest pressure on all surfaces, with the exception of the soft rubber mat, where the mean pressure of the toe region of the lateral hind claw was slightly higher than that of the heel region. The mean pressures on the firm rubber mat and the maximum pressures on the soft rubber mat were significantly larger than on the other surfaces. Conclusions and Discussion: The tested

surfaces had no significant effects on the pressure distribution between paired claws, but one rubber mat had a modifying effect on mean and the other on maximum pressures. These findings can explain why sole ulcers still occur in herds kept on rubber flooring (Kremer et al., 2007), although they also can help to explain cow preferences for rubber flooring (Eicher et al., 2013; Vanegas et al., 2006).

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FORCE DISTRIBUTION BETWEEN FRONT AND HIND FEET AND BETWEEN PAIRED CLAWS IN LACTATING DAIRY COWS STANDING ON DIFFERENT SURFACES

Summary Objective: Space is usually limited for dairy cows in free stalls and cows either walk or stand on a hard surface in the alley or lie in a cubicle that inclines slightly toward the front. In addition, cows are often seen perching, which describes a cow standing with the front feet in the stall and the hind feet in the alley. Perching is also seen in lame cows with claw disease. The objectives of this study were to investigate the effects of an inclination, of perching (Chapinal et al., 2009), and of claw trimming on force distribution between fore- and hind feet and between the paired claws of a foot. Our hypotheses were that the surface angle and functional claw trimming have a significant effect on force distribution. We also hypothesised that perching and functional claw trimming equalise the forces acting on paired claws.

Materials and Methods: The vertical ground reaction forces were measured in 32 lactating Brown Swiss and Holstein Friesian cows (mean body weight [BW] 618.6 kg) using a pressure sensitive mat combined with a force plate. Measurements were made before and after functional claw trimming in cows standing on a level surface, on a surface with a 3% incline toward the forelimbs, and in cows perching on a 25-cm platform. The force distributions among the limbs and between the paired claws within each limb were determined. Differences between the various positions and before and after trimming were analysed by a paired t-test for normal data or a non-parametric Wilcoxon signed-rank test.

Results: On a level and an inclined surface, the forelimbs carried 53.6% (median, interquartile range (IQR) 1.4%) and 53.5% (median, IQR 1.5%) of BW, respectively. When cows changed to the perching position, a small but significant weight shift toward the forelimbs (54.3%, IQR 1.2% of BW) occurred. The medial-lateral force distribution among the paired claws of the fore- and hind limbs on a level surface and before trimming differed; higher loads were incurred by the medial claws in the forelimbs (72%:28%, IQR for both 36%) and by the lateral claws in the hind limbs (33%:67%, IQR for both 31%). Changing from a level to an inclined surface altered the force distribution toward the medial claws of the forelimbs; however, the force distribution among the claws of the hind limbs did not differ by changing the position from a level to an inclined surface or to perching. Functional claw trimming affected the medial-lateral load distribution only between paired hind claws. After

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trimming, the load distribution was more balanced on both level and inclined surfaces, but did not change in the perching position.

Discussion and Conclusions: The change from a level surface to an inclined surface was associated with force changes between the lateral and medial claws only in the front limbs. Functional claw trimming improved (Carvalho et al., 2005; Kehler and Gerwing, 2004; van der Tol et al., 2004) but did not equalise the weight distribution between the lateral and medial claws of the hind limbs. It appears that perching behaviour does not alleviate the asymmetry between lateral and medial claws but rather serves to shift weight from the hind limbs to the forelimbs and thus to relieve strain on the hind limbs. Whether perching causes a shift in weight from the heels to the toes in the hind limbs and thus serves to relieve strain in the heel region requires further investigation.

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FIBULARIS TERTIUS MUSCLE RUPTURE IN CATTLE – CLINICAL AND ULTRASO-NOGRAPHIC FEATURES AND NEW ANATOMICAL ASPECTS

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Introduction: Rupture of the fibularis tertius muscle in cattle is described in case reports in the elder literature and in textbooks (Andrews 2004, Greenough 2007). This muscle is involved in the reciprocal mechanism, which ensures that the stifle and hock joints flex in unison. The characteristic signs of this injury are over-extension of the hock with the stifle flexed, during the walk and when the leg is pulled back manually. Despite its common occurrence, in-depth investigations into this condition, especially ultrasonography and long-term results, are scant.

Material and Methods: A review of medical records of cows diagnosed with rupture of the fibularis tertius muscle at our clinic from 2002 to 2013 was conducted. In addition, goniometric joint measurements in pelvic limb specimens from cattle in which various parts of the fibularis tertius muscle and long digital extensor muscle had been transected, and an ultrasonographic study of these two muscles in hind limbs specimens and in live healthy and affected cattle were undertaken.

Results: Patients with rupture of the fibularis tertius muscle included 19 cattle of three breeds. Causes of muscle rupture included acute trauma (n=5), after effect of a splint bandage (n=4) and recumbency (n=3); the cause in the remaining 7 patients was unknown. We observed two different clinical presentations of fibularis tertius muscle rupture in the 19 patients. Sixteen had the classical clinical sign previously described, but 3 animals were also unable to extend the foot and therefore knuckled

over at the fetlock. Based on the results of the goniometric joint measurements and ultrasonography of specimens, a diagnosis of rupture of the fibularis tertius muscle accompanied by rupture of one of the/both parts of the long digital extensor muscle was made in the latter 3 patients. The ruptures occurred preferably in the muscle bellies of these two muscles; tendon ruptures were not observed. Treatment was conservative and consisted of box rest for 6 to 8 weeks. Eleven patients were discharged, six of which were productive for >2 years post treatment and 5 had been culled for various reasons. Of these, 2 were slaughtered because of recurring rupture of the muscle.

Conclusions and Discussion: Determination of the site of the fibularis tertius muscle rupture and involvement of the long digital extensor muscle could be made via ultrasonography. Because of the intimate anatomical relationship between the fibularis tertius and long digital extensor muscles, the current concept of an isolated fibularis tertius muscle rupture should be revisited, and each case should be considered carefully with respect to involvement of the two parts of the long digital extensor muscle. Cattle with additional involvement of the long digital extensor muscle had a worse prognosis than cattle with mere rupture of the fibularis tertius muscle. Recurrence of muscle rupture in two cases suggests that the duration of conservative treatment in case of fibularis tertius muscle rupture should be extended to several (3-5) months.

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RADIOGRAPHIC MEASUREMENT OF DIGIT LENGTH IN STANDING HEIFERS

Introduction:

Lameness caused by claw horn lesions is one of the most important reasons for premature culling of dairy cows (Cramer et al., 2009). Sole ulcer occurs predominantly in the lateral hind claws (Rusterholz, 1920). A study based on anatomical and radiographic measurements made postmortem showed an anatomical difference in the length between the lateral and medial digital skeleton (Muggli et al., 2011). However, the position of the foot postmortem differs from that in the live animal; particular differences occur in the angle of the digits, the position of P3, and the tension of the tendons. The goal of the present study was therefore to determine whether there is an anatomical difference in length between the lateral and medial digital skeleton using radiography in standing heifers.

Material and Methods:

The digital skeleton of the hind limbs was evaluated radiographically in 27 standing healthy Brown Swiss heifers. The hind feet were positioned on a wooden block and a wooden block covered with a thin rubber mat. One plantaro-dorsal view of each hind limb was obtained from each surface, so that four radiographs were taken in each heifer. Measurements of the bones were made using computer imaging software. After normal distribution of the data was confirmed using the Shapiro-Wilk test, a paired t-test was used to analyse differences between the lengths of the lateral and medial digits.

Results:

The lateral digital skeleton was significantly longer than its medial counterpart on both a hard (wooden block) and a softer (wooden block covered with a thin rubber mat) surface. There were no significant differences between lengths measured on the hard and the softer surface. The difference between the length of the lateral and medial digits originated at the level of the condyles and increased with P1 and P2. The length difference was partially compensated by a higher third phalanx in the medial digit, but this did not offset the overall length difference. Conclusions and Discussion: The findings of this study confirmed that the length asymmetry of the paired digits of cattle documented previously

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in postmortem specimens is also present in sound heifers standing on a hard or softer surface. Further investigation is required to determine the link between the length asymmetry of the digital skeleton in cattle and the predisposition of the lateral claws of the hind limbs of cattle to claw horn lesions.

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LAMENESS PREVALENCE IN GRAZING DAIRY CATTLE IN SOUTHERN BRAZIL

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Lameness is a major welfare and production problem in dairy herds. It is associated with pain and is known to reduce milk production and reproductive performance, and promote early culling. Grazing systems have traditionally been perceived to be associated with lower rates of lameness compared to confinement zero grazing systems. Little is known regarding the prevalence of lameness in grazing systems in southern Brazil. Thus the objectives of this study were to describe the lameness prevalence in grazing dairy herds in southern Brazil and to determine whether farmers are able to identify lame cows on their farms.

Lameness prevalence was estimated by a veterinarian trained in locomotion scoring (expert) and by the owner of the dairy farm (farmer) on 44 dairy grazing based dairy farms located in the south west region of Santa Catarina, Brazil. Herd size was on average 36.8 ± 1.4 lactating cows that were housed on farms that averaged 21.3 ± 11.6 ha. Milk production averaged 18.8 ± 13.6 L/d. In addition to being provided access to pasture for a minimum of 12 h/d of pasture, cows were provided on average 18.0 ± 7.5 kg as fed/d (mean \pm SD) of silage and 5.2 ± 1.6 kg as fed/d of concentrate twice daily immediately after milking. Holstein was the main breed found on 59.1% of the farms visited, with cross-bred cows (Holstein-Jersey), Jersey and other mixed breeds making up in 20.5%, 11.4%, and 9.1% of farms, respectively. The locomotion expert visited each farm once between February 1 and June 30, 2015. Just prior to locomotion scoring farmers were asked to estimate the number of lame cows on their farm.

All lactating cows on each farm were then locomotion scored using a five-point lameness score (≥ 3 clinically lame and ≥ 4 severely lame), as they exited from the milking parlour. Agreement between the lameness prevalence estimates reported by the expert and farmers estimates were tested using a Mann-Whitney test.

On average the prevalence of clinical and severe lameness estimated by the expert was $31.1 \pm 15.3\%$ (median = 30.0%; min = 9.7%; max = 70%) and $14.4 \pm 13.1\%$ (median = 11.8%; min = 0%; max = 56.7%), respectively. In contrast, the farmers' estimated lameness prevalence was on average $6.6 \pm 5.2\%$ (median = 5.7%; min = 0%; max = 25%). Agreement between the trained expert and the farmer on the prevalence of clinical or severe lameness was only observed on 1 and 9 farms, respectively. In all other cases farmers grossly underestimated the prevalence of lameness on their farms. We compared the lameness prevalence between these farms ($n = 10$) and those farms where little agreement was found ($n = 34$) using a Mann-Whitney test to determine if a farmers ability to identify lame cows affected the actual prevalence of lameness on these farms. Our results indicate that in this sample of farms lameness prevalence was lower (mean: $19.1 \pm 7.81\%$ vs $34.5 \pm 15.1\%$; $p = 0.002$) compared to those farms where no agreement between the expert and the farmers was noted.

This study indicates that lameness prevalence on farms that house their cows primarily on pasture is similar to that previously reported for other production systems (i.e. confinement). As previously shown by others working with confinement systems, farmers in this study also underestimated the prevalence of lameness on their own farms. The large variation between lameness prevalence between the farmers' estimate and that of the trained expert suggests that extension efforts focusing on training farmers to identify lame cows, particularly clinically lame cows, may be an important step in reducing lameness in grazing based systems.

IDENTIFYING RISK FACTORS FOR LAMENESS IN PASTURE-BASED DAIRY FARMS ACROSS NSW, AUSTRALIA

Introduction:

Lameness has been recognised as an important welfare concern in dairy cattle. In order to prevent lameness a concise knowledge of the risk factors is needed. The objective of this study was to identify risk factors for lameness in pasture based dairy farms and to determine the relative contribution of these risks to the prevalence of lameness in dairy herds.

Material and Methods:

Lameness prevalence determinations and on farm lameness risk assessments were conducted on farms across NSW. Farms were chosen in a non-randomized opportunistic method. Selection criteria included farming system (pasture-based). A literature review was conducted to establish a comprehensive list of "lameness risk variables" for consideration in the farm assessments. A farm lameness assessment package was developed for data collection. The assessment package is composed of three parts: 1). The "Farmer Sheet" which includes an interview on management practices applied on the farm; 2). The "Investigator Sheet" which includes a data collection template to record data pertaining to milking parlour, track, feedpad design; 3). The "Locomotion Scoring Sheet" which is utilised to determine the prevalence of lameness in the herd. Each farm assessment takes between 4 to 10 hours depending on the milking herd size and the farm layout. The assessment included an interview with the farmer, evaluation of the farm environment (subjective and objective measurements of the holding yard, feed pads, and tracks), and post milking observation to locomotion score all cows in the milking herd. Cows were locomotion scored on a scale of 1 to 4 according to the Nordlund and Cook system (2004)[1].

Results:

Data have been gathered from 63 farms across NSW. The number of milking cows in a herd ranged from 90 to 1025 cows with an average of 300. The walking distance estimated by farmers was an average of 2.6km per day with a range of 1 to 5.5km per day. Across different farms using feedpads (with no headlocks) the space available per cow was 17

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to 100cm (average of 59cm). The space available in the holding yard ranged from 1.1m² to 2.4m² per cow and the gradient in the holding yards ranged from 2 to 14 percent.

Cows with scores of 1 or 2 at time of locomotion scoring were considered to be sound. A total of 18960 cows were locomotion scored. The overall prevalence of lameness (scores 3 and 4) across all farms was 19.1% with a range of 5% to 44.5% across farms. The differences between the values on farms indicate that lameness is a preventable condition. At the completion of the univariate analysis, 21 risk factors with a p-value < 0.2 were entered into the multivariate analysis. Multivariate analysis revealed risk factors in cow handling, breed, holding yard conditions, rainfall and feedpad design to be significant.

Conclusions:

The study provides dairy producers with a methodology (lameness assessment and associated statistical model) to identify variables contributing to lameness and a means to prioritize allocation of resources to reduce the prevalence of lameness in their herds.

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EFFICACY OF AN ORGANIC ACID GERMICIDE COMPARED TO COPPER SULFATE ON PREVENTION OF NEW DIGITAL DERMATITIS INFECTIONS

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Introduction:

Painful lesions developed during the course of bovine digital dermatitis (DD) often result in lameness and its known consequences to the cow and the dairy producer. Clinical observations support the conclusion that hoofbath treatment is efficacious against infectious foot diseases such as DD. In this study, the clinical efficacy of an organic acid product (EasyStride) was evaluated relative to a positive control (copper sulfate) in the prevention of DD.

Materials and methods:

A split herd non-inferiority positive-control field trial was conducted in a 4,600 dairy cow dry manure open lot operation in New Mexico, USA. Before the trial started, cows walked through a 5-10% CuSO₄ solution five times per week, refreshing the 60 gal hoofbath after 500 cow passes (8.3 cows/gal). For the study, four pens of 230 cows were assigned to either a 2% organic acid (OAS) (EasyStride, DeLaval) solution or 5% CuSO₄ (CUS) hoofbaths solution for a period of 12 weeks. Both groups went through the hoofbath solution three times per week, and milkers were instructed to refresh the 60 gal hoofbath after 230 cow passes (3.8 cows/gal). Hind hooves were scored for DD lesions every three weeks in the milking parlor after light cleaning of hooves with a water hose. Generalized linear mixed models (SAS ver 9.4, SAS Institute Inc., Cary, NC, USA) were used to analyze the difference in prevalence and incidence risk of new DD lesions between OAS and CUS. Only cows that stayed on the study for the entire 12 weeks were considered for data analysis.

Results:

A total of 4,132 hooves were enrolled in the study, but records of only 1,622 hooves (CUS = 768, OAS = 854) were analyzed. The overall prevalence of DD was 8.9% for OAS and 9.1% for CUS (P=0.4824), which was lower than pre-trial values. A decrease in prevalence occurred over time for both groups compared to initial values (P<0.0001). On average, initial prevalence was 14.3% and decreased to 8.4% after 12 weeks. Also, OAS showed a lower prevalence than CUS on the final evaluation (CUS = 10.9% vs. OAS = 5.9%) (P=0.0097). Although the mean incidence risk of new DD lesions was lower for OAS (4.08%) compared to CUS (4.95%), no statistical difference was detected (P=0.1113). Similar to prevalence rates, mean incidence risk was almost 50% lower in OAS (3.8%) compared to CUS (7.2%) in the last parlor score (P=0.0032).

Conclusions:

Results of this trial indicate that OAS was non-inferior to CUS. The prevalence and risk of new DD lesions for OAS was lower than CUS at the end of the study. Apart from the similar clinical efficacy between OAS and CUS, the observed reduction in DD problems was also likely due to improved monitoring and management of the hoofbath. Effective hoof management practices require proven hoof sanitizers that are used properly in the farm.

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EARLY DETECTION OF LAMENESS IN COWS THROUGH ANALYSIS OF AUTOMATICALLY RECORDED ACTIVITY AND PERFORMANCE DATA

Introduction:

Lameness impairs welfare and performance in cows [1, 3]. To avoid greater impact on the well-being of the animal it is essential to detect lame animals as early as possible. However carrying out supervision of an individual becomes more and more difficult due to the increasing number of animals in modern dairy herds. In the study automatically recorded activity and performance data were analysed in order to detect lameness in cows.

Material and Methods:

A herd of 60 Simmental cattle housed in a free stall barn was observed from April 2014 to April 2015. Various sensors were installed for the automatic recording of each cow's daily milk yield, live weight, feed intake and feeding behaviour as well as activity parameters (standing and lying time, steps). Additionally a locomotion scoring according to Sprecher et al. 1997 [3] (1-5, 1 = healthy, 5 = severely lame) was made weekly for the entire herd. Every animal with a score higher than 3 was treated. Receiver Operating Characteristic (ROC) analysis was used to find out the parameters with the highest accuracy.

Results:

On average lame cows showed a significantly lower number of visits to the weighing troughs and a higher total daily lying time than sound cows. No significant difference in milk yield, live weight or total daily feed intake was found between lame and sound cows.

The behavioural parameters total daily lying time, number of visits to the weighing troughs, feeding rate and total daily feeding time had best results in the ROC analysis (area under the curve (AUC) >0,7) Definite results will be presented in the conference presentation.

Conclusions and Discussion:

In the study lame cows showed a change in feeding and lying behavior. Hence, behavioural parameters can be suitable indicators of lameness.

Those parameters with a certain level of the AUC are to be used in a "lameness alert". When two or more parameters of one individual cow exceed a

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certain threshold, this alert considers the individual to be lame.

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LAME COWS EAT LESS AND VISIT THE FEEDER LESS FREQUENTLY BEFORE CALVING

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Lameness has long been recognized as a major welfare concern in dairy cattle, as it is clearly associated with pain (Whay et al., 1997). If cows are lame during the transition period, they are also at increased risk of metabolic disease (Calderon and Cook, 2011) and culling (Vergara et al., 2014). One of the driving factors contributing to these outcomes may be a change of feeding behaviours, including dry matter intake (DMI), but little is known about how lameness affects feeding behaviour during transition. Therefore, the objective of our study was to investigate detailed changes in feeding behaviours of lame cows during the two weeks before calving.

During the three weeks before calving, 20 cows of mixed parities were housed as a dynamic group in a free stall pen with 24 lying stalls. Cows had *ad libitum* access to a total mixed ration delivered twice daily. Cows were provided feed from 12 electronic feeding bins that automatically recorded individual, specific bins visited, feed intake and the duration of each feeding event. Locomotion was video recorded weekly and scored by a trained observer using a 5-point numerical rating system (NRS; Flower and Weary, 2006). Multiparous cows were rated as lame when they were scored 3 or higher at least once in the two weeks before calving and in the consecutive weeks (L, n=8). These lame cows were matched with 8 sound cows that scored 2 or lower during both weeks before calving and had similar clinical health status after calving (H). Lame and sound cows were compared for dry matter intake (DMI), time spent at the feed bunk, visits to the feed bunk and meals (as defined by DeVries et al., 2003). For statistical analysis, all behaviours were summarized by week (wk) relative to calving. Analyses were performed using the PROC MIXED procedure in SAS (SAS Institute Inc., 2002 - 2012). Results are reported as least square means and standard errors.

Lame cows had a NRS of 2.9 ± 0.7 in wk -2, and of 3.4 ± 0.5 (means \pm SD) in wk -1. Sound cows were scored with a NRS of 1.5 ± 0.5 in wk -2 and 1.9 ± 0.5 in wk -1. There was no difference in DMI for wk-2 (L: 16.3 ± 0.8 , H: 17.1 ± 0.8 kg/d), but lame cows had a lower DMI during the week before calving (L: 14.6 ± 0.7 , H: 16.7 ± 0.7 kg/d, $P=0.05$). Lame cows tended to spend less time at the feed bunk in wk -1 (L: 168.9 ± 12.9 , H: 204.4 ± 12.9 min/d, $P<0.1$), but not in wk -2 (L: 192.8 ± 14.3 , H: 220.7 ± 14.3 min/d, $P>0.1$). Lame cows visited the feed bunk less often in both weeks (wk -2: L: 41.7 ± 4.7 , H: 60.1 ± 4.7 , $P<0.05$; wk -1: L: 34.2 ± 4.3 , H: 53.4 ± 4.3 no/d, $P<0.05$). There was no difference in the number of meals between both groups (wk -2: L: 6.5 ± 0.4 , H: 6.4 ± 0.4 , $P>0.1$; wk -1: L: 6.8 ± 0.5 , H: 6.8 ± 0.5 meals/d, $P>0.1$), but lame cows tended to use fewer feed bins per meal than healthy cows during the week before calving (L: 3.6 ± 0.4 , H: 4.5 ± 0.4 bins/meal, $P<0.1$).

These results indicate that lame cows have altered feeding behaviour compared to sound cows in the weeks before calving. Specifically, lame cows ate less and visited the feeder less frequently, especially during the week before calving. We conclude that lame cows may benefit from special management during the transition period, including access to a low competitive feeding environment. Future work should focus on identifying management practices that identify lame cows early and result in mitigating the number of cows that enter the transition period with impaired locomotion.

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PREVALENCE AND DESCRIPTION OF CLAW HORN LESIONS AT THE TIME OF TREATMENT IN NEWLY LAME COWS

Introduction:

Claw horn lesions are some of the most common causes of lameness. Previous studies in earlier interventions have described more mild lesions such as bruising in comparison to delayed interventions where more severe lesions e.g. ulcers were observed. The present study aims to describe the type and size of claw horn lesions observed during a study carried out in newly lame cows in the United Kingdom.

Material and Methods:

A randomised clinical trial comparing lameness treatments was carried out between January 2012 and February 2013. The trial enrolled newly lame cows according to the following criteria: newly lame (a lame score following 2 or more consecutive non-lame fortnightly mobility scores), only lame on one hind limbs and one single claw affected with claw horn lesions (sole ulcers, sole haemorrhages, white line disease or a combination of these lesions). Mobility score was carried out every two weeks following the UK industry standard scheme. Five commercial farms were selected to participate in the trial, these farms had between 187 and 353 cows in their herds with 305d adjusted milk yields ranging from 7,394 to 11,579 L. A total of 183 cows were enrolled during the study and 329 cows were observed but not enrolled because they did not fulfil the criteria.

Data from cows selected for the present study were drawn from both the enrolled and excluded groups. Pictures of 119 newly lame cows were analysed and classified using a modified classification system developed at the University of Nottingham. This method included both the presence and size of lesions identified (sole ulcers, sole haemorrhage, white line separation and white line haemorrhage).

Results:

From 119 cows, seven cows had no lesions at all in the lame foot; the remaining 112 cows were diagnosed with a variety of claw horn lesion combinations. Fifty-seven cows were diagnosed with a single type of claw horn lesion. Haemorrhage was the lesion most frequently observed followed by

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white line haemorrhage. A higher percentage of lesions were observed in the sole area and in the lateral claw. Milder lesions were bigger or longer in comparison with severe lesions that were smaller in area or length. Five cows out of 119 were mobility score 3, these animals presented with bigger areas affected either by ulcers or haemorrhages in comparison with cows with mobility score 2.

Discussion and Conclusion:

The present findings confirm that an intervention in newly lame cows is more likely to encounter milder claw horn lesions.

EFFECTS OF LAMENESS TREATMENT ON MILKING AND RUMINATION BEHAVIOUR

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Introduction:

Lame cows alter their behaviour in order to reduce pain on the affected limb. Cows reduce their feed intake as they increased their resting behaviour; this latter may also reduce their voluntary visits to automatic milking system (AMS). Recent technological advances allow researchers to standardised data collection, through the use of rumination collars and the data collected from the AMS. Prompt lameness treatment may not only help to reduce pain and discomfort caused by the lesions, it may also reduce the prevalence of lameness; it could be postulated that improvement in the condition should be reflected in the behaviour of lame cows. The aim of the present study was to observe the effect of lameness treatment on the frequency of milking, the time of milking and on total rumination time.

Materials and methods:

Data for this study was drawn from a randomised controlled trial testing treatments for claw horn lesions in dairy cows. Mobility scoring was carried out every 2 weeks, only newly lame cows and with one hind limb affected were selected for the study. A further selection was carried out before treatment only cows with a single claw affected were finally enrolled into the study. Data from 163 cows was used; 79 animals randomly received one of 4 treatments: therapeutical hoof trimming (a); treatment (a) plus a foot block (b); treatment (a) plus NSAID (c) (Ketoprofen 3mg/body weight for 3 days); and treatment (a) plus (b) and (c). Behavioural data from non-lame cows (n=84) was used for comparison. Non-lame control cows were selected if they had been non-lame for more than a month and were matched to the treated lame cows by parity, DIM and farm/pen. Data for total rumination

time and milking visits were collected continuously as standard procedure on the farms, so each cow was observed on the day prior to treatment (day 0) and on the following 5 days after treatment (treated days). For both periods, observations were made from 00:01 to 24:00 hours per observed day.

Results:

Milking behaviour: Before treatment no significant association was observed between lameness status and milking behaviour. After treatment, no significant association was observed between lameness treatment groups and milking behaviour. Though, lame cows treated with trim and block visited the milking unit less at night and during the evening. Before and after treatment a significant association was observed between milk production and number of visits to the AMS.

Rumination behaviour: Before treatment no significant association was observed between lameness status and rumination behaviour. After treatment, cows in the trim and NSAID treatment group ruminated less than control cows. Cows in parity ≥ 2 ruminated more than cows in 1st parity, and rumination time decreased as DIM increased.

Discussion and Conclusion:

Lameness did not have any significant effect on milking visits and rumination time in cows housed in automatic milking systems diagnosed with acute and mild lameness caused by claw horn lesions. Lameness treatment affected behaviour. Lameness treatment did not affect the number of milking visits but this result may have been affected by farm management factors. Cows treated with trim and block showed less visits to the automatic milking system than non-lame cows between 18:00 and 06:00 when farm management interventions are reduced. Trim and NSAID treatment reduced the rumination time of lame cows in comparison to non-lame cows.

STANDARDISED CLAW TRIMMING PRACTICES IN LARGE SWEDISH DAIRY HERDS

Introduction:

The most important preventive measure to reduce lameness problems is probably regular claw care with functional trimming. Infrequent claw care increases the risk of acute and chronic injuries, so a 6-month interval should not be exceeded in average-yielding dairy herds. In herds with higher milk yield and/or inferior management conditions, additional claw care sessions may be required. The need for claw trimming and the risk of developing claw disorders and lameness vary with season and lactation stage. Because most claw diseases originate from the transition period, they affect both production and fertility during peak lactation and can also compromise sustainability, resulting in premature culling. In order to improve claw health and reduce lameness, this pilot study investigated the preventative effect of claw trimming related to individual calving time.

Materials and Methods:

A standardised operating procedure (SOP) was applied in 19 large dairy herds (150-600 cows) served by eight certified claw trimmers, who also recorded claw disorders. Each individual cow was scheduled for trimming at drying off or, optional for heifers, 1-2 months before expected calving. The next claw care visit was made 2-3 months after calving. Problem cows, i.e. with observed claw irregularities, were scheduled for checking again after 4 months. Thus the claw care schedule was 4 + 7-8 months, with 2 trimmings/year, or 4 + 4 + 4 months, with 3 trimmings/year. The objective was to have a shorter interval around calving time, when the risk of claw disorders developing is greatest. During the study period (2014-2015), barely half the cows met the criteria for SOP and therefore cows that met the criteria were compared with those that did not. The effect of SOP, lactation number, lactation stage and breed on the probability of recorded claw disorder was tested using multilevel logistic regression models.

Results:

The probability of dermatitis (including digital dermatitis) and heel horn erosion, sole haemorrhages, sole ulcer and white line abscess was significantly lower in cows with claws trimmed according to

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SOP. However, the probability of more chronic claw horn lesions (laminitic ring, white line fissure, double sole) was higher. Interdigital hyperplasia (corns) and wart growth did not differ between trimming strategies. All claw disorders except dermatitis were most prevalent from the third lactation onwards. Swedish Holstein cows had a significantly higher prevalence of all claw disorders evaluated than Swedish Red cows.

Discussion and Conclusions:

This study shows that the most common claw disorders causing lameness could be reduced using the SOP for claw care proposed. However, it probably takes longer to prevent more chronic laminitis-related disorders and chronic skin disorders than was possible in this relatively short pilot study. Moreover, when interpreting the results, it was not possible to clearly determine cause-effect, i.e. cows with recorded claw disorders could have been selected for trimming because of poor claws or lameness. Internationally, detecting and treating lameness as quickly as possible is the main priority, but preventing the source of lameness, i.e. claw disorders, would advance the overall goal of prevention. However, our SOP involves more regular visits by the claw trimmer year-round, and is therefore most applicable for large herds.

With this SOP and healthier first calvers, there is a good chance of improving claw health, reducing lameness and increasing sustainability and profits.

Acknowledgements:

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SURVEY OF INFECTIOUS HOOF DISEASES IN FINLAND

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Introduction:

In recent years interdigital phlegmon (IP) has been a major hoof problem in Finnish dairy herds. Outbreaks of IP have occurred especially in newly built loose house stalls. Morbidity has been 10-70% of cows within two months. On single farms, an outbreak has caused great economic losses.

We wanted to study the current situation of infectious hoof diseases in Finland: the outbreaks of IP, existence of interdigital dermatitis (ID) and digital dermatitis (DD).

Material and methods:

In spring 2013 a questionnaire was sent to all farms (n=1134) that had more than 50 dairy cows. The data was collected from the Finnish national dairy herd recording database from Agricultural Data Processing Centre Ltd. The response rate was 34% (n=390). Only loose house stalls were included in the study (n=365). The occurrence of IP, ID, DD, verrucose dermatitis (VD) and interdigital hyperplasia (IH) was detected by descriptive questions of symptoms. Swelling, bad odor and lameness were considered as symptoms of IP. The diagnosis of an outbreak of IP was made by the number of affected cows within two weeks and by the symptoms of affected animals. Cows with strawberry-like lesions or lesions between the hooves or dermis of the heel were considered as ID/DD. Altogether (VD, IH, ID/DD) were presented as a variable other infectious hoof diseases. Use of hoof baths during the outbreak of IP or prevention was determined. Statistical analyses were carried out using Stata IC version 11.2 (Stata Corporation, Texas, USA). Descriptive statistics are presented as percentages. Chi square test was used to examine the association of outbreak of IP and existence of other infectious hoof diseases.

Results:

Outbreak of IP had occurred in 19.2% of the dairy farms (70/365) and additionally a few occurrences of IP were detected in 9.6% (35/365) farms. ID/DD was present in 27.1% (99/365), VD in 13.2% (48/365) and IH in 30.4% (111/365) of the farms. The occurrence of all other infectious hoof diseases was compared with the history of an outbreak of IP at the farms. Farms with the outbreak of IP suffered from other infectious hoof diseases more often than farms without IP, 77.1% (54/70) and 34.2% (89/260), respectively. Farms with a few IP occurrences had also more other infectious hoof diseases 60% (21/35) compared to farms without IP, all $p < 0.001$. From the information received by the survey, it was impossible to say which infectious hoof disease appeared first.

During an outbreak of IP hoof baths were used in 60% (42/70) of the farms. However, only 17.8% (65/365) of all of the farms used hoof baths as prevention, of which 9.2% (24/260) without the IP outbreak and 42.9% (30/70) with the outbreak. In herds with a few IP occurrences hoof baths were used as a preventive treatment in 31.4% (11/35) of the farms.

Conclusions and discussion:

Although IP currently is the major infectious hoof problem in Finland, our study indicates presence of other infectious hoof diseases, such as ID and DD. If the farm had IP outbreak, they usually had other infectious hoof diseases as well, which may refer to their common etiological background.

LOW BODY CONDITION PREDISPOSES CATTLE TO LAMENESS

Introduction: Lameness is one of the most significant current challenges facing the dairy industry with extensive impacts on herd performance (Huxley, 2013). Low body condition score (BCS) has been identified as a risk factor for lameness (Green et al., 2014; Lim et al., 2014). Green et al. (2014) reported that cows with BCS ≤ 2 (0 to 5 scale) are more likely to be treated for lameness in the following 2 or > 2 to 4 months. One hypothesis is that low BCS is associated with an increased risk of lameness, caused by claw horn lesions, due to a decrease in the digital cushion thickness which has been positively correlated with BCS (Bicalho et al., 2009). This study aimed to investigate the hypothesis that low BCS is associated with an increased risk of lameness (first and repeated lameness events). Effects of other cow level risk factors, including body weight (BW), were also investigated. This work has been published open access in the Journal of Dairy Science (Randall et al., 2015); <http://dx.doi.org/10.3168/jds.2014-8863>.

Materials & Methods: Records were obtained from a total of 724 cows, managed at the Scotland's Rural College's (SRUC) Crichton Royal research farm, for the period 1st Sept 2003 to 31st Aug 2011. Locomotion scores (1 to 5 scale) and BCS (0 to 5 scale; 0.25 increments) were recorded weekly. BW was recorded automatically after milking 3 times daily. Cows were categorised as not lame (LS 1 to 2), mildly lame (LS 3) or severely lame (LS 4 to 5). BCS, BW and milk yield data were lagged by 2 through to 16 weeks to explore their longitudinal association with lameness. Mixed effect hierarchical models were used to explore the relationship between explanatory variables and lameness outcomes. Modelling was conducted in 2 stages;

1. Multinomial model for repeated lameness events; to explore the relationship between explanatory variables and long term repeated lameness.
2. Discrete time survival models for first lameness events in a) heifers and b) 2nd lactation and greater cows; to investigate the relationship between BCS and lameness, without the confounding effect of a previous lame event causing BCS loss

Results

Descriptive statistics; The proportion of lame (mild and severe) observations in each lagged BCS category had a trend of decreasing percentage of lame events from BCS < 2 to BCS > 3, with BCS 2.5 having the lowest percentage.

Modelling;

1. Repeated lameness events model; Cows BCS < 2 (3 to 16 weeks prior to the lameness event) were at significantly greater risk of lameness compared with other BCS categories. Risk decreased as BCS increased. Low BW cows (<550kg category) were at significantly increased risk of mild or severe repeated lameness events compared with cows in heavier BW categories (550 – 700 and >700kg).
2. First lifetime lameness event models; a) Heifers; BCS and

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BW were not associated with increased risk of lameness. b) ≥ 2 nd lactation cows; BCS ≥ 2.5 16 weeks prior to a first mild lameness event were at reduced risk of lameness compared with BCS < 2. The same effect was seen at BCS = 2.25 8 weeks prior to a first severe lameness event.

Discussion And Conclusion: Findings from this study indicate that BCS < 2 is associated with the greatest risk of lameness, and risk decreases with increased BCS. Results suggest that maintaining BCS ≥ 2.5 may be optimal for reducing the risk of lameness. Low BW (independent of BCS) was also identified as an important risk factor for repeated lameness events. The results from this study provide evidence to support targeting management towards maintaining BCS to minimise the risk of lameness in dairy cows.

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AUTOMATED DETECTION OF LAME DAIRY COWS

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Introduction:

Orthopedic disorders causing lameness belong to the most common and economically most relevant production diseases of dairy cattle worldwide. Detection of lame cows is important to improve animal welfare. Automated methods for lameness detection have the potential to facilitate recognition and monitoring of lame cows in large dairy herds. It was the aim of this study to evaluate the suitability of various automated methods for the assessment of altered behavior in cows, associated with lameness caused by "deep, non perforating, septic pododermatitis" (DNPS) of one individual hind claw.

Materials and Methods:

Thirty-two lame cows (group L; >2/13) and 10 non lame cows (group C; <2/13), housed in a commercial loose stall for German Holstein dairy cows, were included in this study. Degree of lameness was scored as previously described by Offinger et al., 2013. Locomotor activity by tridimensional accelerometers (RumiWatch®), weight distribution between hind limbs by the 4-scale weighing platform, feeding behavior by the nose band sensor (RumiWatch®) and heart activity by the POLAR® device were assessed. For statistical analyses, ANOVA, Pearson correlation coefficients, logistic regression models and Receiver Operating Characteristics (ROC) were calculated.

Results:

Neither the evaluated variables of the feeding activity nor of the heart activity revealed significant differences between the two groups. The lying time

of cows of group L was significantly longer as compared with cows of group C. Furthermore, cows of group L showed significantly different results concerning the variables derived from the weighing platform. Moderate to high correlations ($r = 0.56$ to 0.68 ; -0.46 to -0.67) were found between the lameness score and the evaluated variables of behaviour of cows of group L.

Discussion and conclusions:

It is concluded from the results of this prospective experimental field study that the 4-scale weighing platform as well as the tridimensional accelerometer (attached to one hind foot) represent the most valuable of the evaluated tools for automated identification of lame cows suffering from a DNPS of one individual hind limb, when compared with non-lame cows. Variables of feeding and of heart activity are of minor value in this context.

Acknowledgements:

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TREATMENT OF CLAW HORN LESIONS: THREE RANDOMISED CLINICAL TRIALS

Lameness is a common condition affecting the welfare and production of cattle globally. Despite this there are few published clinical trials investigating cow level treatments, particularly of the diseases of claw horn disruption (principally sole ulcer, sole haemorrhage and white line disease). The authors have recently conducted three randomised clinical trials, two comparing treatments for lame cows with claw horn lesions and one evaluating the preventive effect of foot trimming in primiparous heifers.

The first trial (Thomas et al, 2015a) was a randomised, positively controlled clinical trial comparing four treatments for newly lame cows with claw horn disease in 183 dairy cows from five farms in the UK. Cows were locomotion scored fortnightly and were eligible for recruitment if they presented with a new case of lameness in a single hind-limb. Enrolled cows were randomly allocated to receive 1. A therapeutic foot trim only, 2. A trim and foot block, 3. A trim and non-steroidal anti-inflammatory drug or 4. A trim, foot block and NSAID. Based on having a sound locomotion score 35 days after treatment the cure rates were 24.4%, 35.9%, 28.6% and 56.1% respectively. Compared with group 1, cows in group 4 were significantly more likely to be sound at outcome.

The second trial (Thomas et al, 2015b) was also a randomised, positively controlled clinical trial comparing three treatments for claw horn disease in 156 cows from seven UK dairy farms. Cows were randomly allocated to receive a trim only, a trim and foot block or a trim block and NSAID. In contrast to the first trial cows were only eligible for enrolment following multiple presentations as lame at fortnightly locomotion scoring, resulting in selection of more chronically lame cows which had been locomotion score lame for at least two weeks. In this trial no differences were detected between treatments and the percentage of cows locomotion scored as non-lame after 6 weeks was around 15% for all groups. This is markedly lower than the newly lame cows in the first trial. Importantly a large number of animals had become lame on the opposite hind leg i.e. the treated leg had improved but they remained lame.

The third trial (Maxwell et al, 2015) was a negatively controlled randomised clinical trial evaluating the impact of an early lactation foot trim on production in 282 primiparous heifers from eight dairy farms in the UK. Heifers between 50 and 80 days in milk were randomly allocated to either untreated control groups or to a treatment group. Heifers in the treatment groups received a functional foot trim and if required a therapeutic foot trim. No significant difference in 305 day milk production or 100 day in calf rates was detected between groups, however, multivariable modelling identified a large increase in milk yield for heifers identified as lame at the time of enrolment in the treatment group

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compared to non-lame heifers in the control group. On examination, 95% of animals in the treatment group had some pathology identified on at least one claw. The authors conclude that screening for, and treatment of, newly lame cows should be carried out fortnightly and cows treated for claw horn disease should receive treatment with a foot block and NSAID wherever possible. The difference in cure rate between the first and second trial is striking, the key difference being that cows in the second trial were not treated immediately they became lame. The third study also highlights the large number of heifers with pathology at an early stage, and clearly shows a production benefit to treating those identified as lame early in lactation.

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CAN DIGITAL DERMATITIS BE CONTROLLED THROUGH BIOSECURITY MEASURES IN DAIRY CATTLE HERDS? – PRELIMINARY RESULTS

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Introduction:

Biosecurity on cattle farms involves practices to protect herds against external sources of infectious diseases as well as practices to restrict the spread of pathogens among animals of a herd (Brennan and Christley, 2012). Digital dermatitis (DD) is a major disease problem in many dairy cattle herds. Despite many preventive and curative measures being tried to control DD in recent years, they are not entirely effective since the disease shows a tendency to spread rapidly between and within herds (Refaai et al., 2013). The knowledge about the association between external and internal biosecurity measures and the prevalence of DD is limited. The aim of this study was to investigate the association between status of biosecurity and DD prevalence in Danish dairy cattle herds.

Materials and methods:

From February to September, 2015, 23 commercial dairy herds located in different parts of Jutland in Denmark were visited to collect data about their implemented biosecurity practices and the prevalence of DD. This was performed using a questionnaire and an observational checklist covering potential sources of infection to susceptible cattle (e.g. via animals, humans, manure, vehicles, equipment and facilities). A total of 52 variables were categorized into good or poor biosecurity practice. Based on the number of good biosecurity practices in the studied herds, which varied from 24 to 39 (out of 52), a threshold was defined based on the median (≥ 33 = high level of biosecurity, < 33 = low level of biosecurity). Digital dermatitis in these herds were

scored in lactating cows during milking, evaluating the hind legs for the presence or absence of DD lesions, as described by Thomsen et al. (2008).

Results and Discussion:

Digital dermatitis lesions were present in 404/4109 (9.83%) of dairy cows in 22/23 (95.65%) of the herds evaluated; the herd level prevalence of DD ranged from 0% to 41.76%. Among the herds with DD prevalence lower than 5%, there were 7/8 (87.5%) with high level of biosecurity, while in the herds with DD prevalence between 5.1 and 10% and greater than 10%, the frequency of high level of biosecurity was 2/5 (40%) and 2/10 (20%), respectively. The study is planned to include a total of approximately 50 herds and further analyses are required to assess the influence of external biosecurity practices such as cattle purchasing, pests control, sharing of equipment and vehicles, contact with visitors; and internal biosecurity practices such as handling animals of different groups, cleaning and disinfection procedures, movement of staff within the facilities, handling of manure and hoof health management on DD prevalence. However, these preliminary results suggest that 'good' biosecurity in dairy herds may be associated with lower risks of DD. This need to be verified by analyzing the contribution of different biosecurity practices to the control of DD.

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CLASSIFICATION OF TIME BUDGET USING SENSOR DATA FOR NEVER, ACUTE AND CHRONICALLY LAME COWS

Introduction:

Prompt treatment of dairy cows reduces severity and duration of lameness cases (Leach et al, 2012); however, this relies successful identification of lameness at an early stage. Changes in behaviour often precede clinical signs of disease and may therefore be useful predictors of disease (e.g. Gonzalez et al., 2008). This study investigates the potential for a sensor combining location, activity and orientation to detect changes in time budget associated with lameness.

Materials and Methods:

All cows from a group of 120 high-yielding dairy cows were fitted with neck collars mounted with Omnisense 500® sensors between July and December 2014. A support vector machine was used to classify the cows as standing, lying or feeding. Cows were mobility scored every 2 weeks using the DairyCo. Mobility Score. Cows were classified as never lame (had no incidence of lameness in the data collection period), acutely lame (up to three consecutive lame scores before 2 non-lame scores) or chronically lame (four or more consecutive lame scores) with 10 animals in each group. Cows were matched for parity, days in milk and mean daily milk yield. Standing, lying and feeding behaviour variables were compared using one way Anova (Genstat v17). A paired t-test compared the time budgets of the acutely lame cows before (-14 to -8 days) and after diagnosis (+1 to +7 days).

Results:

Overall feeding lying and standing times across all groups were 5.4 (± 0.94), 13.0 (± 0.95) and 2.6 (± 1.3) hours (mean \pm SD). There was wide intra- and inter-animal daily variation with no significant differences in overall standing time, mean bout duration or number of bouts per day for feeding, standing or lying. There were no significant differences in these variables comparing pre- and post-diagnosis in the acutely lame cows.

Discussion and conclusions:

This study confirms the large differences in daily behaviour reported by Alsaad et al, 2012 that may confound identification of behavioural changes associated with disease. We have previously reported di-

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fferences in feeding behaviour in a small case-control study (Barker et al 2015) using the same technology and it is likely that more precise classification of behaviours including time, location, synchrony with other cows and other variables will be needed in a successful detection system.

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LAMENESS IN DAIRY CATTLE: FARMERS' AND VETERINARY SURGEONS' ATTITUDES TOWARDS THE USE OF ANALGESIA

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Introduction: Farmers and veterinary practitioners rarely use pain relief as part of their treatment strategy for lameness in cattle (O'Callaghan 2002), despite evidence that lame cows experience pain (Whay et al. 1998; Green et al. 2002). Non-steroidal anti-inflammatory drugs (NSAIDs) can relieve short term discomfort, and reduce foot sensitivity over many weeks, consequently it is unclear why pain relief is not used more to improve the welfare of lame cattle. In the study described here, in-depth, semi-structured interviews were conducted with farmers and their veterinary surgeons to gain insights into their use of, attitudes towards, and beliefs about pain relief for the treatment of lameness in cattle. The interviews focused on lameness incidence, treatment protocols, the farmer-vet relationship and barriers to the use of analgesia. Interviewing the farmer and their own veterinary surgeon allowed an exploration of their relationship, as well as their communication with one another about pain relief.

Materials and Methods: Thirteen interviews were conducted in total, with six vets and seven farmers. Farmers were recruited from across the South West and, with their permission, their veterinary surgeons were then recruited. Farms had between 50 and 230 dairy cattle and veterinary practices were either mixed or farm specialist. Face-to-face interviews were conducted by EC and lasted from 45 minutes to over three hours. The interviews were fully transcribed and analysed to identify recurring themes as well as interesting individual comments.

Results: Five veterinary surgeons and four farmers agreed that lameness caused the cow pain however there was widespread uncertainty and disagree-

ment regarding the pain caused by specific lesions. Several participants felt that lameness had to be severe or prolonged before pain relief was necessary. All six veterinary surgeons reported providing analgesia to lame cattle, but further discussion revealed this was not always the case. Some were concerned that analgesia may mask signs of improvement, whilst half of the veterinary surgeons interviewed felt that NSAIDs were not strong enough to provide relief to the cow. A range of analgesics were mentioned and there was confusion regarding their use. Most farmers used NSAIDs to treat other problems on farm, but had not considered using them for lameness or did not think it was necessary.

Two farmers used pain relief for all lame cattle, and were associated with the only two veterinary surgeons who reported advocating its use routinely. Most of the practitioners interviewed claimed frequently to discuss analgesic use with farmers, and believed they were already using pain relief for lame cows. Most farmers said they did not discuss lameness treatment with their veterinary surgeons and did not use analgesia. However farmers did report a good relationship with their veterinary surgeon and almost all said they would follow their advice on treatment.

Discussion: Use of analgesia in the treatment of lameness was inconsistent both within and between farms. There was evidence that, despite reportedly good relations between farmers and their veterinary surgeons, communication about the use of analgesics as part of lameness treatment was generally poor. This may, in part, be because of the lack of certainty that practitioners feel about pain and pain relief associated with lameness in cattle.

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DIGITAL DERMATITIS TREPONEMES IN DIFFERING SITES AND SPECIES (1) BOVINE ISCHAEMIC TEAT NECROSIS

Introduction:

Although first reported some ten years ago (Blowey 2004; Holzhauser 2004), there has been an anecdotal increase in cases of ischaemic teat necrosis (ITN) in the UK, with some herds losing up to 20% of fresh calved heifers. Typically appearing as an area of encrusted skin on the medial aspect of the teat-udder junction, a moist area of epidermal inflammation develops beneath the scab, often with a pungent foetid odour, similar to that reported in treponeme-infected 'non healing' hoof lesions (Evans et al, 2011). The erosion expands over the medial aspect of the teat and often intense irritation develops, and affected animals may remove the whole teat, or in occasional cases, all four teats, by progressive licking. Due to the similarity in appearance to bovine digital dermatitis (BDD) we hypothesised that the same or similar treponemes may be involved.

Materials and Method:

Photographs of all suspect cases of ITN were submitted by farm veterinarians (usually after discussion with RB), and if the diagnosis was tentatively confirmed a questionnaire and sampling instructions were sent to the farm vet. Deep tissue samples or scabs removed from twelve ITN affected teats were subjected to culture and 22 dry cotton wool swabs from ITN cases were analysed by PCR for the presence of DD-associated treponemes. These results were compared with 20 samples taken from visually normal teats at a local fallen stock centre. Both PCR testing and bacterial isolations were carried out as described previously for cattle samples in oral treponeme enrichment broth (OTEB) by Evans et al, 2009.

Results:

From the questionnaires it would appear that ITN occurs primarily in first lactation heifers, 1 – 12 weeks after calving, with occasional cows up to 4th lactation affected. At less than 20%, complete recovery rates were poor. At least one of the three cultivable DD-associated treponeme phylogroups was detected by PCR in 11 of the 12 ITN deep tissue cases sampled. In five of the samples where contamination levels were sufficiently low to allow culture, *Treponema medium*/*Treponema vincentii*-like, *Treponema phagedenis*-like or *Treponema denticola*/*Treponema putidum*-like treponemes were present in all except one sample, which was probably due to the poor quality of the sample. Three (27%) of the lesions contained all three DD-treponeme phylogroups, seven (64%) contained two, and one (9%) just one. When tested by nested PCR, one or more DD trepone-

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mes were detected in 19 of the 22 (88%) of the swabs. All tissue samples and swabs taken from the same sites on unaffected animals were all negative, and all cases of ITN were negative to Bovine Herpes Virus PCR.

Discussion:

In this study, the high association (88%) of ITN with DD treponemes suggests that they have a role in the disease, but further study is needed to determine if they are primary or secondary pathology organisms. Limited histopathological studies suggest that thrombi and infarcts are involved with the pathology. Despite the level of bacterial involvement, antibacterial and anti-inflammatory agents appear to have little effect on the progression of the condition, and there is an urgent need for further study.

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DIGITAL DERMATITIS TREPONEMES IN DIFFERING SITES AND SPECIES (2) BOVINE HOCK LESIONS

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Introduction: Hock lesions affect a large number of cattle worldwide, causing significant welfare issues, and leading to production losses and decreased longevity (Huxley et al, 2006). Lim et al., (2013) suggested that hock lesions could lead to lameness, or alternatively lameness may lead to hock lesions due to increased recumbency time and lesions may also alter the gait of cattle (Potterton et al, 2011). This study hypothesised that bovine digital dermatitis (BDD) treponemes are contributing to the pathology of hock lesions in dairy cattle, most probably by retarding healing.

Materials and method: Swabs were taken from lateral (n = 13) and medial (n= 8) open (epidermis eroded) and closed (hair loss but epidermis intact) hock lesions from two farms in Gloucestershire during milking, with additional tissue samples from open lesions (3 lateral and 4 medial hock lesions) from the same farms. Swabs were also taken from normal skin, approximately 2 cm from the hock lesion, to ascertain if the bacteria were spreading from the lesion. Deep tissue samples from closed lesions and control samples (7 lateral and 8 medial) were taken from normal hocks at a local fallen stock centre. Bacterial isolations and PCR assays for the three DD-associated treponeme phylogroups, *T. medium*, *T. phagedenis* and *T. pedis* were performed as described previously by Evans et al, 2008.

Results: Of the seven cultures of tissue from open hock lesions, all of the cultures were positive (by phase microscopy) for spirochete growth, and this was confirmed by *Treponema* genus PCR assay and nested PCR assay for the three cultivable DD treponeme phylogroups. All 15 control samples were negative. Of the seven closed hock lesions cultured, one contained low numbers of spirochaete-like organisms but was negative when tested by *Treponema* PCR assays.

Of the 21 swabs analysed by PCR, all 15 from open lesions were positive for BDD treponemes, whereas all tissue samples and swabs taken from closed hock lesions, or from unaffected hocks were negative. From swabs taken from normal skin 2cm from the lesion, those from near to open hock lesions were PCR-positive for DD treponemes, but all swabs from skin near to closed lesions were negative. This suggests that bacteria may be moving out from the wound to potentially infect other sites.

Discussion: The lack of BDD treponeme isolation from closed hock lesions, combined with the 100% prevalence of these spiral bacteria in the open lesions suggests that BDD treponemes are opportunistic invaders of wounds such as hock lesions, and potentially foot lesions, thus identifying a further route for transmission of BDD.

The human pathogen *Treponema denticola*, has a chymotrypsin enzyme encoded within its genome which degrades connective tissues and immunoglobulins, and may explain the slow healing of infected wounds (Uitto et al, 1988). Preliminary genomic analysis of DD treponemes (Clegg et al, unpublished) suggest that they could have the same enzyme encoded within their genomes, thus explaining the slow healing of BDD infected lesions. It would be interesting to study hock lesions in other countries, where typical BDD foot lesions are much less prevalent.

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OCCURRENCE OF HOOF LESIONS IN SOUND DAIRY COWS AT PASTURE

Introduction:

With the aim to identify the frequency of occurrence of hoof lesions in dairy cows at pasture with a mobility score 0; 108 dairy cows from four farms in the South of Chile, were examined.

Material and Methods:

Each farm was visited once. From each farm, between nine and twenty cows were randomly selected, depending on the number of available sound cows present in each visit. Cows were selected using the DairyCo mobility score. The examination was made in a shute and consisted in an exhaustive inspection of the hooves after they were washed and cleaned using tap water and a brush to eliminate the organic material and when required a grinder or a hoof knife was used to find lesions.

The findings were recorded in a spread sheet (Microsoft Excel 2010) containing information of the owner, name and place of the farm, date of the visit, number of cows in milk, tag number, leg and hoof with lesions, diagnosis and location of the lesion. The information was analyzed and presented as descriptive statistics (percentage, mean, and standard deviation).

Results:

The frequency of presentation of hooves lesions in cows with mobility score 0 was 44%. The most frequent findings were overgrowth (29.2%), white line disease degree 1 (27.8%), heel erosion (27.8%), digital dermatitis (9.7%), double sole (2.8%) and sole hemorrhage (2.8%). A 52.9% of the lesions were located in the forelimbs, and a 47.1% in the hind limbs. From the 48 cows with hoof lesions a 39.6% had injuries in one leg, 43% in two legs, 8.3% in three legs and 8.3%. According to parity 49% of primiparous cows examined presented lesions, 43% of cows with two or four calving's, 38% of cows with three calving's and 50% of cows with five or more calving's had lesions.

Conclusions:

It can be concluded that the frequency of presentation of lesions in cows at pasture with mobility score 0 was high. Thus, all cows must always be included in any protocol of functional trimming, since many of

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these lesions in early stages can be easily treated before causing lameness.

SPRAYING HOOVES WITH ORGANIC ACID SOLUTION IN THE PARLOR PREVENTS ACUTE DIGITAL DERMATITIS

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Introduction:

Management of hoofbaths varies greatly between farms, and in many instances hoofbath recommendations are not followed, thus compromising germicidal efficacy and producer expectations. Spraying of hooves with disinfecting solutions during milking is an interesting alternative to hoofbaths because the solution is applied fresh and directly onto lesions, and water savings are evident. This study evaluated the efficacy of an organic acid (OAS) hoof care product (EasyStride™, DeLaval), applied as a topical spray to prevent digital dermatitis (DD) acute lesions (ulcerative lesions) compared to a negative control.

Material and Methods:

The study was conducted from July to August 2015 in a commercial free stall dairy in Wisconsin, USA. A pen of 100 animals was assigned to each of the treatment groups: 8% EasyStride™ DeLaval (OAS group) or Control group (NEG: water plus blue dye). Hind hooves were sprayed once a day, three times a week, for three weeks using a garden sprayer. An average of 40 ml solution was applied to a cow at each spraying session. Weekly parlor evaluations for DD lesions were made during the morning milking. Cows were examined for DD immediately after washing hind hooves with a medium-pressure water hose and illuminating with a flashlight. DD was scored using the M-stage scoring system (Döpfer et al. 1997). The outcome variable was a new DD acute lesion (M1 or M2) occurring during the study period. Prevalence of acute lesions was also evaluated. Trial data were analyzed using PROC GEN-

MOD of SAS 9.4 (SAS Institute Inc., Cary, NC, USA).

Results and discussion:

A total of 1,472 observations were analyzed from 184 cows that had complete records. Overall, the incidence of new acute DD lesions was 2.8 times (95% CI 1.5 – 5.2; $P < 0.01$) higher for hooves sprayed with NEG (5.1%) compared to the disinfectant OAS (1.8%). Therefore OAS demonstrated to be very efficient in preventing new acute DD lesions. The prevalence of acute DD lesions at the beginning of the study averaged 5.6% for both groups ($P = 0.077$), with a higher proportion in the OAS group (7.8%) compared to NEG (3.4%). At the end of the study the prevalence of acute DD lesions was 5.7% for OAS and 13.6% for NEG ($P = 0.012$) group.

Conclusions:

There were 66% fewer new acute DD lesions when hooves were disinfected with OAS compared to the negative control. This resulted in a lower prevalence of acute DD lesions at the end of the study. When incorporated into well established hoof management routine, spraying hooves with an organic acid (OAS) hoof care product (EasyStride®, DeLaval) is an interesting alternative to hoofbaths. Considering the solution is applied directly to lesion sites, the producer can better manage digital dermatitis on farm.

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THE IMPACT OF ENVIRONMENT PRE-CALVING ON DIGITAL DERMATITIS BEFORE AND AFTER CALVING

Introduction:

Control of digital dermatitis (DD) in the pregnant heifer is essential. Heifers can become infected at a young age, and DD before calving affects milk production, fertility and DD risk during the first lactation [1]. In adult cattle, the environment is crucial in the development of DD [2]. This is likely to be true in heifers, but more data are needed to assess the impact of rearing environs on DD in heifers and to assess the effect of changes in DD during that period on DD after calving, particularly for heifers are kept in high risk environs after calving.

Materials and methods:

40, 12-month-old, Holstein heifers were randomly allocated to: 1) straw yard with no access to concrete (S) or 2) cubicles with daily scraped solid concrete passageways (C). One month before calving all heifers were all moved to a straw yard, with concrete passageways. After calving all heifers were housed in the same cubicle house with concrete passageways. Both hind feet were examined for DD at: housing, mid-pregnancy, 6 weeks pre-calving, in the first week post-calving and 12 and 40 weeks later. The effect of time and housing on the DD prevalence of was assessed using two repeated measures generalised linear mixed models (one from mid-pregnancy to calving and one for post-calving examinations) with a binary response (presence/absence of DD) predicted by a logistic regression model.

Results:

At housing only one heifer (group C) had DD. DD prevalence was higher at mid-pregnancy in (35% [group S] and 57% [group C]). The proportion of heifers affected in Group C continued to increase during pregnancy whereas there was no such effect in Group S heifers. After calving, there was no effect of time, but the proportion of affected heifers in group C (85%) remained higher than the proportion of affected group S heifers (45%).

Discussion and Conclusion:

The differences between groups in DD prevalence were large and persisted after calving. Keeping pregnant heifers in straw yards reduced the proportion

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with visible DD not only during pregnancy but also after calving when heifers were in a high risk environment. It is likely that this benefit is actually greater than just decreasing the proportion of animals diagnosed as being infected as preventing DD before calving also affects the length of time that DD is present and the severity of DD ([2]), both of which affect the impact of DD [1]. Better management of the environment of pregnant heifers is likely to be crucial if we are to reduce the impact of DD on dairy farms.

Acknowledgements:

Chris Livesey and Cath Marsh for data collection.

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MEASURING HOOF CONFORMATION – ARE DIFFERENT TECHNIQUES EQUIVALENT AND DOES IT MATTER?

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Introduction:

Measurement of hoof conformation is crucial for evaluating the impact of environment. However, many methods have been used to measure hoof conformation toe angle has been measured using at least 4 different devices, and at 2 different sites [1, 2]. However, there are only limited data on repeatability or on comparisons between methods. Yet, it is often assumed that results from one study can be simply compared to those of another and reports of conformation measurements too often include no methodology [2].

Materials and methods:

The literature was systematically reviewed to identify and assess the data available regarding the repeatability of conformation measurements. The claws of 54 cows were collected post mortem, and comparison made between manual and digital measurements of toe angle and length, claw length and width, and abaxial groove length. Limits-of-agreement (LOA) plots were used to assess the between-method difference and its variance.

Results:

Only 4 studies were found which evaluated the repeatability. There were no method comparison studies; only inter and intra observer variability using the same method were assessed. All reported intra-class correlation coefficients (ICC), with ICC >0.7 indicating sufficient repeatability. In the comparison study, only toe angle was found to have 95% LOA (-1.3 - 5.5°) that were not too wide for the manual and digital methods to be interchangeable.

Discussion and Conclusion:

The review confirmed the lack of data. All studies used ICC, which is dependent on measurement variability and measurement range; if measurement variability is the same a study with toe angles from 35 - 50° will report a higher ICC than one with angles of 45 - 50°. ICC does not provide an estimate of how large variation in measurement is likely to be.

Manual and digital results were not interchangeable for 4/5 measures. The differences were large and biologically important. Even for toe angle they were at the top end of acceptability, but as we only have ICC data for repeatability we do not know if differences found were larger than would be expected for multiple measurements using the same technique.

Studies reporting hoof conformation need to include comprehensive methodology and repeatability data. We also need more method comparison studies. Finally, unless there are data demonstrating equivalence, between study comparisons should not focus on actual measurements but only on the direction of changes.

Acknowledgements:

Wang Libin for the digital measurements and Corey Regnerus for the initial statistics.

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THE IMPACT OF ENVIRONMENT PRE-CALVING ON DIGITAL DERMATITIS BEFORE AND AFTER CALVING

Introduction:

Hoof size (volume) is related to risk of claw damage [1]. Measuring it could thus be useful in investigating lameness. However, as its measurement in the live animal is not currently feasible, research on hoof volume has focussed on predicting it using linear measurements

The first model [1] used measurements which were difficult to determine accurately in vivo, so a subsequent study [2] focussed on measures that could be easily made in the live animal. That study found hoof volume to be related to 3 measures: 1) abaxial groove to flexure of dorsal surface along proximal border of coronary band (PX); 2) abaxial groove to toe along distal weight bearing region (DS); and 3) length of abaxial groove (ABX). This equation was based on beef cattle and thus needs validating for dairy cows.

Materials and methods:

The distal limbs of 17 dairy cows were collected and individually identified. PX, DS, ABX, toe angle and length, and claw length and width were measured on both claws of all feet, using a cloth tape measure (except toe angle - engineer's angle finder). Hoof volume was measured using water displacement.

The agreement between predicted volume using the model from [2] and measured volume was assessed using Liao's modified concordance correlation coefficient (mCCC).. Linear regression (with backwards elimination) was then used to establish an optimal model for predicting hoof volume from the data collected. The predictions of this model were then tested using mCCC and limits-of-agreement (LOA) analysis.

Results:

Predicted volume using the model from [2] and measured were significantly correlated ($r^2=0.877$). However, mean model volume was 510 cm³ cf. to mean measured volume of 286 cm³ and mCCC was poor (0.13). The optimal model identified using linear regression was predicted volume = $(13.55 \cdot PX + 15.5 \cdot DS + 1.69 \cdot \text{toe angle} - 458.78)$. The mCCC was 0.9 and the 95% LOA were 34.97 to 35.34 cm³.

Discussion and Conclusion:

The model used by [2] was unsuitable for use in dairy cattle as it predicted much larger hooves than was the

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case. The optimal model for hoof volume from this dataset used toe angle, PX and DS and had a high mCCC and 95% LOA which were within acceptable limits. Further research is required to test this model in a different group of cows and to assess the effect of factors such as age and stage of lactation on the optimal model.

Acknowledgements:

Thanks to Mike Hogan and Neil Ward for technical support

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CHARACTERIZATION OF CLAW LESIONS IN HOLSTEIN CATTLE FROM THE NORTHERN SAVANNAH OF BOGOTA, COLOMBIA

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Introduction: Lameness is one of the most important health problems in dairy cattle and one of the main reasons for culling cows (Radostits et al., 1994, Bao & Giller 1996, Flor & Tadich 2006). Lesions of the bovine hoof are common in dairy cows managed in a variety of different farming systems. (Nordlund et al., 2004). These injuries are classified into three primary groups – *infectious digital disease, *laminitis and associated claw horn lesions, and *lesions caused by exaggerated hoof wear and/or trauma. This classification provides a simple and useful framework (Guard 2000, Nordlund et al., 2004). The excessive overgrowth of the hoof horn and the presence of trauma, lead to laminitis and is associated to different claw horn lesions (Nordlund et al., 2004).

Materials and methods: Four dairy farms of northern savannah of Bogota, Colombia were visited from August 2014 to April 2015, under consent of the owners. There were assessed 126 Holstein lactating cows. There were recorded all the injuries presented in the hooves. A hoof trimmer performed the clinical approach of the hooves.

Results: 462 hoof lesions records from 126 lame cows and 4 herds were collected by one hoof-trimmer in the northern savannah of Bogota, Colombia. According to the three group classification, the most prevalent lesion of the hooves was laminitis and associated claw horn lesions (389: 84,19%), followed by excessive hoof wear and/or trauma (70: 15,15%), and infectious digital diseases (3: 0,64%).

Referring to the type of lesion presented for a total of 462 pathologies, there were 367 (79,4%) of sole hemorrhages, 70 (15,2%) claws with overgrowth of the horn, 13 (2,8%) claws presented white line disease, 9 (2%) claws with double sole, 2 (0,4%) with interdigital dermatitis and 1 (0,2%) with digital dermatitis.

The frequency of hooves lesions in forelimbs was 144 (31,15%), with the medial claws containing the most lesions (89: 19,25%), and the lateral hooves with 55 le-

sions (11,9%). The hooves lesions in hindlimbs was 318 (68,82%), with the lateral claws affected with 210 lesions (45,45%), and medial claws with 108 lesions (23,37%). According to the number of claws affected for each animal, 35 (27,7%), 28 (22,2%), 23 (18,3%), 21 (16,7%), 9 (7,1%), 5 (4%), 4 (3,2%), 1 (0,8%) cows reported lesions in one, two, three, four, five, six, eight and seven hooves respectively.

Discussion: The most typical lesions found in this study were hemorrhages of the sole and excessive hoof wear (total of 94,6%). These lesions belong to the group of *laminitis and associated claw horn lesions, and *lesions caused by exaggerated hoof wear and/or trauma. (Guard 2000, Nordlund et al., 2004).

Murray (1996), reports that medial hooves of the forelimbs and lateral hooves in the hindlimbs are the most affected. In this report, the findings were similar.

There are no reports about the number of claws affected. Despite this, in this study only 27,7% of the cows presented lesions in one claw, so is recommended to check and verify all the hooves to determine the real health status of this tissue.

Conclusions: Medial hooves of the forelimbs and lateral hooves in the hindlimbs are the most affected. The most frequent lesions are linked to laminitis, associated claw horn lesions, excessive hoof wear and/or trauma. Only a quarter of the patients had lesions in one claw. It is essential to check all the hooves to prevent lameness.

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ASSOCIATION BETWEEN LYING BEHAVIOR AND LAMENESS IN CANADIAN HOLSTEIN-FRIESIAN COWS HOUSED IN FREESTALL BARN

Introduction: Lying behavior is an important measure of comfort and well-being in dairy cattle; furthermore, changes in lying behavior are potential indicators and predictors of lameness.^{1,2} Therefore, the objectives were to determine individual and herd-level risk factors associated with lying behavior parameters, and to evaluate whether automated measures of lying behavior can be used to detect lameness.

Materials and Methods: A purposive sample of 40 Holstein-Friesian cows was selected from each of 141 dairy farms in the Canadian provinces of Alberta, Ontario and Québec. Lying behavior was automatically and continuously recorded (accelerometers) over 4 d on 5,135 cows, from where daily lying time (h/d), bout frequency (bout/d), bout duration (min/bout), and standard deviation of bout duration (SD/bout) were calculated for each cow. Data hypothesized to influence lying behavior were collected, including information on individual cows (lameness, parity, and days in milk), management practices (feeding and milking management) and facility design (stall dimensions, base and bedding type, width and floor of feed alley, and stock density). To assess lameness, cows were gait scored by trained observers on the presence or absence of limping. Associations between predictor variables and lying behaviors were assessed using generalised linear mixed models, including farm as a random effect and province as a fixed effect. Non-linear logistic regression models were used to determine whether lying behavior can detect lameness.

Results: On average, cows had 10.2 ± 4.7 lying bouts daily, averaging 63 ± 28 min each, for a total daily lying time of 10.6 ± 2.3 h/d. Mean herd-level daily lying time ranged from 8.2 to 13.2 h/d and individual daily lying time for cows ranged from 1.3 to 22.1 h/d. At the cow-level, daily lying time increased with increasing stage of lactation, although lying behavior depended on parity. In that regard, primiparous cows had high frequency but short duration of lying bouts in early lactation, changing to mature-cow patterns of lying behavior in late lactation (fewer albeit longer lying bouts). At the herd-level, stalls with high curbs, the use of sand or deeper bedding increased average daily lying time by 1.44 and 0.36 h/d, respectively. Similarly, wide feed alleys and stalls increased daily lying time by 0.39 and 0.33 h/d, whereas rubber in the feed alley decreased lying time by 0.47 h/d.

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Lame cows had more prolonged lying times, albeit fewer and more variable bouts, compared to non-lame cows. Several lying behavioral thresholds were associated with increased risk of being lame. Daily lying time and bout frequency had a non-linear relationship with lameness; cows with lying time ≥ 14 h/d, bout frequency ≤ 5 times/d, bout duration ≥ 110 min/bout and SD of bout duration ≥ 70 min/bout had 3.7, 1.7, 2.5 and 3.0 higher odds of being lame, respectively.

Discussion and Conclusions: This was the largest study conducted to investigate lying behavior and associated risk factors in dairy cows on commercial farms in Canada. We inferred that factors related to comfort of lying and standing surfaces significantly affected lying behavior. In addition, lame cows differed in their lying behavior from non-lame cows, and they exhibited extreme lying behavior more often. Finally, automated measures of lying behavior may improve lameness detection, especially when interpreted in the context of other individual (e.g. parity and stage of lactation) and environmental (e.g. stall surface) factors known to impact lying behavior.

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EVALUATING THE IMPACT OF IMPLEMENTING A STANDARDIZED FOOTBATH PROTOCOL IN THE PREVENTION OF DIGITAL DERMATITIS IN ALBERTA DAIRIES

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Introduction: Digital dermatitis (DD) is the most prevalent foot lesion in Alberta (AB) and Canada.¹ The most common on-farm prevention strategy is the use of footbaths. However, based on a lameness study we conducted on 81 AB dairy farms, there is a wide variability in on-farm practices related to footbath management, including footbath dimensions, frequency of use, products used and concentration. Despite a wealth of information regarding the most effective practices in the scientific literature, there seems to be a knowledge translation gap between research and on-farm application. Therefore, the objective of this study was to evaluate the effectiveness of a literature-based standardized footbath protocol in the field as a preventive measure for DD.

Materials and Methods: A longitudinal field trial was conducted on 9 Alberta (AB) farms over 7 months. Participating farms used copper sulfate (CuSO₄), the most common footbath product in AB. Each farm served as its own historical control, and a total of 1,300 cows were evaluated before and after the introduction of a footbath intervention. The intervention consisted of implementing a new, computerized automated footbath on all farms using a standardized protocol based on literature recommendations of: footbath design (300 cm long x 50 cm wide x 15 cm high),³ product concentration (5%),⁵ frequency (4 consecutive milkings per week),⁵ and refill (≤ 200 cow passes).⁴

DD scoring was done every 2 weeks in the milking parlour and confirmed with the gold standard of hoof trimming observations (at the beginning, half-way and end of the study) using the M-stage scoring system.² M0, M1 - M2 - M4.1, and M3 - M4 scores were considered healthy foot, active lesion and chronic lesion, respectively. In cases with more than one lesion per foot or cow, the most severe lesion was considered for analysis according to the hierarchy of M2 > M4.1 > M4. Results were dichotomized into presence/absence of each lesion category. Pearson chi-square tests were used to analyze the difference in the proportion of lesions before and after

the intervention. Through survival analysis, a better insight in the preventive effect of the standardized footbath protocol will be provided.

Results: Controlling footbath dimensions, along with CuSO₄'s concentration and frequency of use, resulted in a change in DD dynamics. A decrease ($P < 0.001$) in the percentage of active lesions (from 21 before to 8% after intervention) and an increase of chronic lesions (from 41 before to 56% after intervention) was detected when cows were scored in the milking parlour. Results were similar when cows were evaluated in the trim chute. On all farms, the percentage of healthy feet increased (from 31 before to 39% after intervention), the percentage of active lesions decreased (from 41 before to 25% after intervention), and chronic lesions increased (from 28 before to 35% after intervention) ($P < 0.001$ for all).

Discussion and Conclusions: Rather than testing new footbath products, changes were made to the footbath design and protocol, highlighting the importance of management practices with respect to footbathing systems. The use of a standardized footbath protocol significantly decreased the presence of active DD lesions and increased the number of cows without lesions as observed in the trim chute. Potential lesion misclassification in the milking parlour due to lack of a detailed inspection resulted in different lesion percentages between the milking parlour and the trim chute. Following footbath management guidelines as recommended by scientific literature can result in control of DD dynamics to a steady state, with a significant reduction of new cases and well-regulated presence of chronic lesions. In conclusion, controlled and standardized footbath management resulted in significant reduction of the prevalence of DD.

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ASSESSING FOOTBATH PROTOCOLS FOR THE PREVENTION OF DIGITAL DERMATITIS IN DAIRY CATTLE: A SYSTEMATIC REVIEW AND NETWORK META-ANALYSIS

Introduction:

Digital dermatitis (DD) is an infectious disease causing erosive, ulcerative skin lesions typically found above the heel bulbs or along the coronary band of cattle. As a result, cattle may be reluctant to walk on affected limbs, and resulting lameness leads to decreases in cow comfort, longevity, milk production, and fertility.

Footbaths are the most used practice for preventing DD lesions. However, the variability in the field and in the literature makes it difficult to compare protocols and provide recommendations. There is a need to be able to compare protocols available in the literature and rank the efficacy of these protocols to determine the most effective footbath protocol. The objective of this study was to identify footbath protocols available in the literature, and compare and rank these protocols based on their efficacy in prevention of DD using meta-analysis.

Materials and Methods:

A search of the online databases MEDLINE (PubMed), CAB Abstracts, Agricola, and Web of Science will be conducted to identify articles. The search strategy will not be limited by study design nor footbath product, concentration or frequency in order to capture all relevant comparisons available for a comprehensive network meta-analysis. Criteria for inclusion in the systematic review and network meta-analysis will include the use of original data, a footbath intervention focused on lactating dairy cattle with digital dermatitis lesions as the reported outcome. Included articles will have relevant data abstracted for the network meta-analysis and risk of bias of each study will be assessed. A network meta-analysis will be conducted to determine direct and indirect comparisons between all footbath protocols included to compare and rank protocols on efficacy in preventing DD lesions.

Relevance:

This systematic review and network meta-analysis will provide information on the footbath protocols available in the literature and how these protocols compare. Results from this study will be valuable in providing recommendations on the most efficacious footbath protocols and can be used to inform a sub-

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sequent economic decision model to determine the cost-benefit of each footbath protocol.

ECONOMIC EVALUATION OF VARIOUS COPPER SULPHATE FOOTBATH PROTOCOLS IN THE PREVENTION OF DIGITAL DERMATITIS IN ALBERTA DAIRY CATTLE

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Introduction:

Digital dermatitis (DD) is an infectious disease affecting the hooves of dairy cattle. It has implications on production as well as animal welfare as the lesions are painful and may lead to lameness. A common method to prevent DD is the use of footbaths to decrease the occurrence and severity of DD in the dairy herd. However, numerous products are used and result in immense variation of protocols with differing products, concentration, and frequencies. A cost-benefit economic decision model would be indispensable in the comparison of footbath protocols. The objective of this study is to create an economic decision model to compare the net benefit of footbath protocols and to evaluate the cost-benefit to the farmer of three copper sulphate (CuSO₄) footbath protocols in the prevention of DD.

Materials and Methods:

A decision model was created to calculate the net benefit of each protocol for the average Alberta herd over one lactation. The three footbath protocols to be compared were 5% CuSO₄ 4 times weekly, 2% CuSO₄ 4 times weekly, and 5% CuSO₄ 4 times every other week [1]. The net benefit of use of these protocols was calculated on a herd basis using costs and prevalence estimates from Alberta data where available. Net benefit was calculated as the revenues due to milk sales and slaughter value minus replacement costs, subsequent treatment costs, fertility losses, footbath costs and the cost to fill quota. Revenues were affected by the consequences of DD lesions on milk yield, fertility, and risk of culling.

Results:

The net benefit for an average Alberta dairy farm (herd size of 142) using one of the three CuSO₄ footbath strategies are as follows: \$24 231.56 for 2% 4 times weekly; \$22 957.88 for 5% 4 times every 2 weeks; and \$19 255.51 for 5% 4 times weekly. The incremental benefit of using strategy 2% 4 times weekly over 5% 4 times every other week and 5% 4 times weekly are \$1273.67 and \$4976.05 respectively. The main drivers of the model were herd size and milk sale revenue, as variations in these, resulted in large variations in the net benefit. Following these, the important sources on uncertainty were the on-farm prevalence of DD, and the effectiveness and cost of strategy 2% 4 times weekly. Only milk sale revenue, at an extremely low value representing close to \$0 profit, resulted in a negative net benefit. One-way sensitivity analysis of all inputs resulted in strategy 2% 4 times weekly providing the greatest net benefit over all input values.

Conclusion and Discussion:

Footbath strategies for the prevention of DD lesions in dairy cattle in Alberta are cost effective with 2% CuSO₄ 4 times weekly resulting in the greatest net benefit to farmers over one lactation on a farm with 20% DD. Percentage of cows with DD and herd size were the main drivers of this model and results cannot be generalized to all dairy operations without incorporating these and other variables. An economic decision model calculating the net benefit of footbath protocols provides an additional method to compare potential footbath protocols.

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PEN WALKS AS A TOOL TO DETERMINE THE PREVALENCE OF DIGITAL DERMATITIS IN YOUNG STOCK ON ALBERTA DAIRY FARMS

Introduction:

Digital dermatitis (DD) is an infectious, bacterial disease that can impact production and welfare of dairy cattle, and is the most prevalent foot lesion in Alberta (AB) and Canada. DD management practices and peer-reviewed research mainly focus on the lactating herd. However, DD has been identified in young stock and its presence in young stock is associated with an increased risk of DD after calving [1, 2]. It is essential before implementing control practices in young replacement animals to understand the prevalence of DD in heifers and identify potential risk factors for DD lesions specific to AB. The objectives of the study were to 1) determine the sensitivity and specificity of pen walks to identify DD lesions in young stock compared to hoof inspection in a chute, and 2) determine prevalence of DD in young stock (< 24 mo.) on AB dairy farms.

Materials and Methods:

A cross-sectional field trial was conducted on 24 Alberta dairy farms and all young stock on farm (<24 mo. of age) were assessed for DD using pen walks that dichotomously (present/absent) scores DD on the hind feet. To determine the sensitivity and specificity of pen walks, 5 farms (583 heifers) were selected for chute inspection of DD lesions (scored using M-stage system [3]) by the researcher following pen walk DD identification. The sensitivity and specificity of the pen walks was then applied to approximately 30 total farms to determine apparent and true prevalence estimates of DD.

Results:

Pen walks as a means of identifying M2, M3, or M4 DD lesions on the hind feet in young stock had a sensitivity and specificity of 73.6 and 96.7%, respectively, whereas positive and negative predictive values were 84.8 and 93.7%, respectively. DD was identified in young stock on 13/24 (54%) farms using pen walks. Apparent within-herd prevalence estimates ranged from 0 to 15.5%, with a median and mean of 1.7 and 3.5%, respectively. The true within-herd prevalence of DD in young stock, calculated using the sensitivity and specificity of the pen walks, ranged from 0 to 17.4%.

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Discussion and Conclusions:

Pen walks are a simple and non-invasive method of detecting DD lesions in young stock. The use of which can identify groups that may require the implementation of preventative and treatment routines to decrease the DD lesions. DD lesions were identified in 54% of farms surveyed with within-herd true prevalence estimates of up to 17%. This provides evidence that this group may act as a potential reservoir of disease that will be transmitted to the lactating cattle upon calving. In future, determining risk factors for DD lesions in this group and implementing management practices to prevent disease proliferation and transmission is an important step to help manage DD on farms. In conclusion, more than half of all dairy farms assessed had evidence of DD in young stock. Additionally, pen walks can be used to identify young stock affected with DD and inform management decisions to increase control of this foot lesion.

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COMPARISON OF LYING TIMES, MILK YIELD, RUMINATION TIMES, AND EATING TIMES OF LAME VERSUS SOUND CATTLE USING PRECISION TECHNOLOGIES

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Lameness is the one of the most significant challenges facing the dairy industry. Among United States operations, small operations (< 100 cows) had 21.1% lameness, medium operations (100 to 499 cows) had 30.8% lameness, and large operations (> 500 cows) had 28.4% lameness (NAHMS, 2007). The most common way to assess lameness is visual locomotion scoring. However, this is time consuming and subjective. Therefore, an automated lameness detection system would be helpful. Precision dairy farming is the use of technologies to measure physiological, behavioral, and production indicators on individual animals to improve management strategies and farm performance. The objective of this study was to compare lying time, milk yield, rumination time, and feeding time, determined by precision dairy farming technologies, in lame cows versus sound cows. The study was conducted at the University of Kentucky Coldstream Dairy from June 08, 2014 to April 23, 2015. Holstein (n = 103) cows were housed in two freestall barns, balanced for parity and days in milk. One barn was equipped with sawdust covered Dual Chamber Cow Waterbeds™ (Advanced Comfort Technology, Reedsburg, WI) and the other barn with sawdust covered rubber-filled mattresses (Promat Inc., Woodstock, Ontario, Canada). All cows were equipped with an IceQube® (IceRobotics, Edinburg, Scotland) on their left rear leg, which determined daily lying time, an HR tag® (SCR Engineers Ltd., Netanya, Israel) around their neck, which recorded daily rumination time (RUM), and a CowManager SensoOr® tag (Agis Automatisering, Harmelen, Netherlands) in their left ear, which recorded daily

eating times (EAT). The AfiMilk milking system® (AfiMilk, Kibbutz Afikim, Israel) recorded daily milk yield (MY). Cow gait was assessed weekly using a 1 (sound cow) to 5 (severely lame cow) scale for general symmetry, speed, head bobbing, spine curvature, tracking, and abduction and adduction. Cows were classified as lame if the gait aspect was ≥ 3 . The MIXED procedure of SAS® (SAS Institute Inc. Version 9.3, Cary, N.C.) was used to evaluate factors influencing gait scores. Hours lying, rumination times, eating times, and milk yield were used to evaluate their influence on each gait aspect. Significance was set at ($P < 0.05$). Lying time was not a significant ($P \geq 0.05$) predictor of tracking and abduction and adduction. However, LT was a significant ($P < 0.05$) predictor of general symmetry, speed, head bobbing, and spine curvature where lame cows lied down for 10.24, 10.22, 10.40, and 10.42 hours per day and sound cows lied down for 9.89, 9.96, 9.98, and 9.94 hours per day respectively. Milk yield was not a significant ($P \geq 0.05$) predictor of general symmetry, speed, spine curvature, and tracking. However, MY was a significant predictor ($P < 0.05$) of head bobbing and abduction and adduction where lame cows MY was 32.35 and 33.45 kg per day and sound cows MY was 33.22 and 33.01 kg per day, respectively. Rumination time was not a significant ($P \geq 0.05$) predictor of general symmetry, speed, head bobbing, spine curvature, and tracking. However, RUM was a significant predictor ($P < 0.05$) of abduction and adduction where lame cows daily RUM was 460.78 minutes per day and sound cows was 453.86 minutes per day. Eating time was not a significant ($P \geq 0.05$) predictor of abduction and adduction. However, EAT was a significant predictor ($P < 0.05$) of general symmetry, speed, head bobbing, spine curvature, and tracking where lame cows EAT was 175.34, 175.85, 167.03, 164.99, 178.90 minutes per day and sound cows EAT was 184.66, 182.45, 182.04, 184.25, and 184.13 minutes per day, respectively. In conclusion, lame cows lied down longer and had lesser eating times than sound cows.

EVALUATION OF CLAUDICATION IN HIGH-PRODUCTION DAIRY COWS IN THE HIGH TROPICS 2010-2015 IN THE DEPARTMENT OF ANTIOQUIA, COLOMBIA

Summary

Introduction: Lameness in high producing dairy cows is a common problem that limits productive and reproductive performance. The dairy industry currently considers this problem to be one of the most important challenges it faces, due to decreases in milk production, deterioration in body condition, and increased culling. Claudication causes pain and stress, affecting the animal's welfare, and is related to production and feeding systems and to environmental conditions.

Objective: The objective of this research was to prepare a descriptive analysis of the main claw disorders for cattle in the high tropics and relate them to some possible factors causing a predisposition for developing lameness.

Methodology: The research evaluated 4374 incidents in the health records of 3024 cattle seen in specialized examinations from 2010 to 2015 from different dairy herds in several geographic regions. The clinical review and diagnosis of the illnesses was done by a Veterinarian, and the data was recorded in the individual health records. Twenty-three different types of claw disorders were diagnosed. The data was analyzed using the statistical software program STATGRAPHICS Centurion.

Results: Of the health records obtained, 4240 (96.94%) were for Holstein cattle and 134 (3.06%) were for Jersey cattle. The dairies were distributed among four of the nine regions in the Department of Antioquia, in 13 municipalities. Of the incidents, 1736 (71.73%) of the claw disorders recorded were in the hind legs and 684 (28.26%) were in the front legs. For the Holstein cows, 1711 (72.07%) of the claw disorders recorded were in the hind legs and 663 (27.92%) were in the front legs. In the Jersey cows, 25 (54.34%) of the lesions were in the hind legs and 21 (45.65%) were in the front legs. The greatest number of claw disorders occurred in the right hind leg, with 904 (37.35%), while there were 336 claw disorders (13.88%) in the left hind leg. Conditions were similar for the two breeds evaluated. White-line abscess was the most frequent claw lesion (26.24%) with 635 incidents, followed by sole abscesses with 253 (10.45%), and laminitis with 202 incidents recorded

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(8.35%). For the Holstein breed the most common claw disorder was white-line abscess, followed by sole abscess. For the Jersey breed, the most common disorder was corkscrew claw, followed by imbalance between the claws. The claw most affected and with the greatest degree of severity was the lateral claw of the right hind limb. The most severe claw disorders were seen in the hind legs, but the greatest degree of severity was minor in both limbs. In the metropolitan area of Valle de Aburrá and Oriente the most common causes of claw disorders were white-line abscess, sole abscess, and laminitis. In the high plains regions in the north and southwest of the Department, white-line abscess was the most frequent claw disorder, followed by laminitis and sole abscesses. The climate at the end of the year and start of the following year favored the occurrence of claw diseases.

Conclusions: Cattle in specialized dairies experience claw disorders with a high frequency, caused by feeding problems and environmental conditions. White-line abscesses are the most common illness in animals seen in clinical examinations. These are probably caused by factors associated with environmental conditions and with moving the cattle to the milking parlor. The frequency of disorders in the hind legs causes a marked variation in the biomechanics of the cows, associated with bearing the load of the mammary gland and the weight of a possible pregnancy.

Key Words: Cow, lameness, inflammation, pain
Poster or oral presentation.

IMPACT OF HOOF TRIMMING ON ACTIVITY, RESTING TIME, AND MILK YIELD

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Introduction: Lameness is detrimental to the well-being and productivity of the animal. Effects on milk production, reproduction and culling have been shown in various studies (Huxley, 2013). With the significant economic loss associated with lameness it is important to prevent and treat lameness. One of the commonly recommended prevention methods is hoof trimming (Shearer et al., 2001). However, there has been limited research done to support this recommendation or how hoof trimming affects the behaviour of the animal. Studies that have focused on how hoof trimming affects cow behaviour have shown both positive (Tanida et al., 2011) and negative effects (Chapinal et al., 2010a, b). For this reason there is a need to understand the effect of hoof trimming on both dairy cattle behaviour and productivity to allow us make evidence based recommendations and to serve as baseline information for comparing treatments. The objective of this study was to determine the effect of routine hoof trimming on daily activity, resting parameters, and milk yield.

Materials and Methods: Data for this project was collected from 4 farms from March-August 2015. Farms were recruited for participation using a convenience sample. Selection criteria for inclusion in the study required that farms use free-stall housing, electronic pedometers capable of measuring lying time and have a regular hoof trimming schedule. Activity, total yield, resting parameters data was collected from pedometers (Afi PedoPlus or AfiACT2) attached to the rear leg of the animal as they entered the parlor for milking. Data was analyzed using linear regression models. Outcome measures evaluated included daily activity, milk yield, resting time and resting bouts. Outcomes measures from 1-7 days post trimming were compared to values 7 days before trimming. In addition to trimming status (before or after), all models included farm, lactation group and

days in milk (DIM) as fixed effects. For outcomes measures a significance level of 0.05 was used.

Results: A total of 853 cows were trimmed and used in the analysis. At the time of trimming average lactation group was 1.9 (95% Confidence interval (CI):1.9-2.0), average DIM was 209 (95% CI: 201-217) and average daily milk was 37 kg (95% CI: 36-38). Average activity and lying time were 434 steps/hour (95% CI: 424-443) and 631 minutes/day (95% CI: 620-642) respectively. Hoof trimming did not have an association with total activity or total yield during the 7 days post trimming. Daily rest time did have a significant association with being trimmed on days 1 through 7 after hoof trimming. The largest decrease in lying time occurred on day 1 post hoof trimming with a decrease of 21 minutes (95% CI: -36.4- -5.4). The number of resting bouts was also significantly associated with hoof trimming on all of the days following hoof trimming. The largest decrease in lying bouts was seen on day 4 post trimming when resting bouts decreased 0.5 bouts/day (95% CI:-1.0- -0.02).

Conclusion: Results from this study showed that the act of being hoof trimmed has a small influence on cow resting parameters. The findings of a decrease in lying time in this study are contradictory to the findings of an increase in lying time post trimming in other studies (Chapinal et al., 2010a,b). Since the current study only looked at behaviour of cows with no lesions the source of change in behavior is unlikely to be due the effect of lesion treatment. Other possible reasons include: the act of hoof trimming or the disruption of the cow's time budget due to being sorted for hoof trimming.

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COMPARING THE EFFECT OF 3 LAMENESS DETECTION STRATEGIES ON LAMENESS PREVALENCE IN DAIRY COWS

Introduction: Lameness prevalence in in freestall dairy herds has been reported to be as high as 55% (von Keyserlingk et al., 2012). Lameness in a cow impacts the way and amount she eats, lowers her reproductive success, affects her quality of life, and minimizes her overall value to the herd (Huxley, 2013). This makes lameness both an animal welfare and economical concern. Currently, the majority of efforts to prevent lameness have focused on lowering the incidence of lameness. However, the amount of success possible in lowering the prevalence can only be maximized if the strategies to lower incidence are combined with methods of detecting and treating lameness in affected cows (Leach et al., 2012; Groenevelt et al., 2014). The aim of the study was to compare 2 different lameness detection methods to determine if they would result in reduced lameness prevalence. The hypothesis of this study was that the 2 different systems would be comparable and more effective than the farm's standard protocol at lowering lameness prevalence.

Methods: Using 1 site from a multi-site 9000 cow dairy, a convenience sample of 3 pens of 400 cows were subjected to 3 different detection methods. The CONTROL method used the farm's current method of detection and treatment. The LS method identified lame cows weekly by locomotion scoring as the cows left the milking parlor. Locomotion scoring was done using a 3 point scoring system. The HL method involved weekly lameness evaluation in the head locks during the routine procedure of heat detection. The HL method was an adaption of a previously evaluated method (Hoffman et al.), and evaluated back arch, weight bearing and shifting and hock rotation. Cows in all 3 groups were locomotion scored weekly. Lameness prevalence at 6 weeks was only evaluated in the cows that were scored not lame (score 1) at enrolment. For both the HL and LS methods lame cows were evaluated and treated within 24 hours. Cows found to have lesions in the HL and LS groups were rechecked after 4 weeks. The locomotion score of cows after 6 weeks was considered the outcome measure. Lameness prevalence was calculated as the number of 2's and 3's in each group divided by the total number of cows in each group. The prevalence of each group was then compared to each other.

Results: At total 1010 cows were scored on the initial scoring day and 556 of these cows were scored at 6 weeks. Average days in milk was 104 (95% Confidence Interval (CI): 96-112), 131(95% CI: 122-140), and 140 (95% CI: 129-151) for the CONTROL, LS, and HL groups, respectively. Mean lactation did not differ between the 3 groups. Initial prevalence was 33.8% (95% CI: 28.8, 38.9), 31.3% (95% CI: 26.3,

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36.3), and 31.1% (95% CI: 26.3, 36.0) for the CONTROL, LS, and HL groups, respectively. After 6 weeks the prevalence was 32.3% (95% CI: 25.1, 39.5), 19.3% (95% CI: 13.6, 25.1), and 19.6% (95% CI: 14.3, 25.0) in the CONTROL, LS, and HL respectively.

Conclusion: Similar to other studies (Groenevelt et al., 2014; Leach et al., 2012) prevalence was reduced when implementing an active early detection and treatment protocol. Interestingly although the relationship between HL scoring and locomotion scoring is not great (Hoffman et al.), in this study HL scoring was able to reduce lameness prevalence at the pen level. Considering that HL scoring can be done during a routine management procedure and requires a lot less time it should be considered as an alternative to locomotion scoring for lameness screening.

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AN EVALUATION OF THE AGREEMENT BETWEEN DIGITAL DERMATITIS SCORING METHODS IN THE PARLOR, PEN AND HOOF-TRIMMING CHUTE

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Introduction: Digital dermatitis (DD) is one of the most common causes of lameness in dairy cattle with prevalence levels of approximately 20% at the time of hoof trimming (Cramer et al., 2008). The disease has been shown to have a significant impact on milk production, profitability, and the welfare of dairy cattle (Bruijnjs et al., 2012). To minimize the effects of DD on the animal and the farm there is a need for rapid detection methods. Currently, the gold standard in detecting cows with DD lesions is the hoof trimming chute. Scoring in the hoof trimming chute is time consuming and other scoring methods have been developed to identify cows with digital dermatitis in the milking parlour (Relun et al., 2011). The objective of this study was to evaluate the performance of a 5 point DD scoring method in three different parlor types and in 3 alternative locations on dairy farms.

Materials: Herds were recruited to participate using a convenience sample from Wisconsin and Minnesota. To be eligible for inclusion in the study herds had to use; freestall housing, a herringbone, parallel, or rotary parlour, a professional hoof trimmer regularly, and have some DD present. Once herds were identified all herds were visited prior to or on the day of hoof trimming to score cows in the parlour and pen, headlocks, or management/chute lane. All cows were scored in the parlor and in 1 of the other locations prior to being examined in the hoof trimming chute. To assess the feet in all locations, the feet were examined visually using a flashlight. Digital dermatitis status was recorded using the modified 5 point M scoring system (Berry et al., 2012). To evaluate the performance of the

scoring system in each location the Cohen's kappa statistic and sensitivity (SE) and Specificity (SP) were calculated with DD status from the chute evaluation being the gold standard.

Results: A total of 1104 legs were evaluated in 17 herds. Herds ranged in size from 100 to 4200 cows. A total of 9 herringbone, 5 parallel and 3 rotary parlours were scored. No significant differences were found in M scores between right and left hind legs in any of the locations thus, further analysis was completed without considering leg side. In the chute, 56% of cows did not have any signs of DD. Overall, the 5 point M scoring system had slight agreement with chute scoring for all locations. Dichotomization of the scoring system to lesions >2cm in size improved agreement to a moderate or substantial level. When the data was evaluated for diagnostic test performance for lesions >2cm, SE ranged from 65-78% and SP from 93-99% in the different parlour systems. For the other locations SE was highest for headlock and lowest for pen scoring.

Conclusion: This study showed that the headlocks or the parlor were the most accurate places to score cows for the presence of DD lesions. Parlour type was not shown to have an effect on the performance of the scoring system. The ability of the scoring system to differentiate different stages of DD was limited in all locations. In summary, a simplified 2 point scoring system appears to be the most appropriate way to evaluate cows for DD.

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THE DEVELOPMENT OF 'HEALTHY HOOVES', THE AUSTRALIAN NATIONAL LAMENESS PREVENTION PROGRAM

Introduction:

Dairy Australia is the national services body for dairy farmers and the industry in Australia, and is partly funded by a levy paid by the farmers. Part of the mission of the body is to develop national programs which will assist farmers to maximise production and profit, but also which will address key health and welfare issues in the industry. Examples of these programs include 'Countdown 2020'; a national mastitis and cell count control program and 'InCalf'; a national project for improving herd fertility. The Australian dairy industry, unlike many other countries does not yet have a coordinated industry program to address lameness. The issue of lameness in the dairy industry is a worldwide concern, from both an economical and welfare perspective, and as herd sizes in Australia increase and farming practices become more intensive, it has been identified as a growing area of concern for the industry. In 2012, it became targeted as one of the key areas of welfare to be addressed by Dairy Australia.

Dairy Australia has previously invested in the development of lameness fact sheets and on-demand delivery of lameness workshops for advisers and farmers. These activities can be the first step to improving farmers' approaches to lame cows. However, tackling lameness of individual farms requires a tailored risk management approach to detection, recording, prevention and treatment which usually requires input from a skilled lameness adviser.

The concept of a national program was developed in 2012 by bringing together many of the Australian key researchers, veterinarians, hoof trimmers and farmers for a stakeholder workshop. Since then, through the work of several steering groups, the framework of the 'Healthy Hooves' program has been put in place, with the target of a June 2016 launch.

Objectives of the Healthy Hooves Australia program:

The objectives of the Healthy Hooves Australia project are to promote animal welfare, industry sustainability and farm profitability through:

Establishment and adoption of a national lameness recording system, and

Improved management and prevention of lameness through the delivery of resources and training to farmers and their advisers.

Key activities:

Resource development

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A lameness investigation pack: Aimed at advisors. Including the evaluation of existing nomenclature to align with the ICAR standard nomenclature.

Updating of the farmer lameness workshop

Farmer resources: Including lameness prevention guidelines, wall charts and booklets for lesion identification, data collection sheets and Standard Operating Procedures.

Video resources: A suite of videos that can be used for training and displayed on the Dairy Australia website

Data activities

Data capture tool: Performance of a full environmental scan of data capture in Australia and develop a platform that will allow farmers to capture lameness data quickly and easily.

Locomotion scoring: Agreement on an Australian industry approach to locomotion scoring.

Adviser activities

Piloting of the investigation tool: Using 3-4 farms in different systems to pilot the investigation tool before delivering adviser training

Webinars to upskill veterinarians or other industry trainers: For farmer lameness workshops

Anticipated benefits for the industry:

It is anticipated that following the launch of the Healthy Hooves project, there will be an increased awareness of lameness and farmers will have access to high quality resources to help them better manage it, with better methods to capture incidence. Additionally, it is hoped that using best practice guidelines, the development of an advisor base in Australia will enable farmers to access professional advice to manage the problem.

Este paper podría ir ORAL el primer día ya que son planes nacionales.

MONITORING THE EFFECTS OF A TEA TREE OIL/ORGANIC ACID FOOT BATH IN THE CONTROL OF DIGITAL DERMATITIS

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Introduction: It is now widely accepted that, in addition to hoof hygiene, frequent foot bathing is an important preventive option in the control of digital dermatitis (DD). A range of products are in use, each with their own advantages and disadvantages. Formalin is a carcinogen but is rapidly broken down in the environment; copper sulphate is less toxic during use but a build-up in soil has led to crop failure. The current trial monitored the effects of substituting a commercial tea tree oil/organic acid product (HSE, Hoofsure Endurance, Provita Ltd) on a farm where formalin had been in long term use for the previous ten years.

Materials and method: The farm consisted of around 500 milking cows in a total confinement system feeding TMR. Only the fresh calved group were monitored, as these were considered to be the most likely to develop lesions of DD. Using a torch, the washed heels of the hind feet were examined when standing in the parlour at morning milking, the first scoring being prior to the change from formalin to the test product (HSE), the second after two weeks on HSE, and the third and fourth after 4 and 8 weeks respectively. Lesions were scored on the basis of their size (0 to 25mm+ diameter) and appearance, classified as 'O' (normal), 'U' (ulcerative), 'G', granulomatous, or 'H' (hyperkeratotic), corresponding approximately to M0, M2, M3 and M4 of the Dopfer scale (Dopfer et al 1997).

Results: Prior to the introduction of the test product (assessment one) lesions were seen on 34% of cows and 28% of hooves, and these prevalence scores remained approximately constant throughout the period of monitoring, with lesions being seen on 35% of cows and 28% of hooves at assessment four, two months after the introduction of the test product.

For management reasons, namely the introduction of

fresh calved cows and other cows moving out into the lower yielding group, the cows within each group changed at each assessment. There were however 50 cows that were present at each assessment. In this group lesions were seen in 61% of hooves at assessment one, and 33%, 29% and 49% of hooves at assessments 2, 3 and 4 respectively.

Discussion: Levels of DD remained low throughout the period of monitoring, and no animals were visibly lame from DD. On a herdbasis the prevalence of lesions varied from 22% to 28% whereas for the 50 animals monitored at each assessment, the prevalence fell from 61% to 49% of feet examined. The reason for a higher prevalence of lesions in this cohort is not clear, although a higher prevalence of lesions in animals in early lactation has been reported previously (Blowey et al 2004).

The majority of lesions were chronic hyperkeratosis (M4 type) although this did confirm the presence of DD in the herd. There was a small increase in the prevalence of ulcerative M1 and M2 type lesions (one at assessment three and 6 at assessment 4). As the trial ran from December to March 2008, this could reflect the increasing infection pressure over the course of a normal winter housing period. In the absence of any control group it is not possible to reach any firm conclusions. However, there are positive results from other studies using the same footbath formulation where a control group with copper sulphate (Smith et al 2014) or formalin (Bell and Dyson 2015) has been used.

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INSTITUTION OF A FIVE-POINT LAMENESS CONTROL PROGRAMME TO REDUCE THE RATE OF 'NON-HEALING' BOVINE HOOF DISORDERS

Introduction:

In both housed and pasture based dairy herds Bovine Digital Dermatitis (BDD) has two manifestations – the superficial skin infection and the deeper infection of the corium of the claw (non-healing white-line, non-healing sole ulcer and toe necrosis) (1)

The authors postulated that instituting a plan of controlling skin BDD would result in a decline in the rate of secondary infection of claw injuries.

Material and Method:

Data was collected over three years from a group of farms, milking over 20,000 cows through twenty five milking parlours in Southern Chile, after the institution of a five-point programme to control lameness.

The five areas focussed on were: 1) Reducing foot damage. 2) Hygiene. 3) Foot-bathing. 4) Early, effective treatment. 5) Culling or claw amputation of chronic cases.

Data was collected from two sources:

1. Lameness treatments done by farm staff.
2. Lameness treatments, screenings and compliance assessments done by the authors.

The initial diagnosis of 'secondary infection with Treponemes' of claw disorders was confirmed by histology and silver stain of samples of seven typical lesions. A field "positive diagnosis" was applied where the lesion fulfilled three criteria: (1)

1. The wound (White-line, Axial crack, sole defect) had a distinctive putrid smell
2. The surface of the granulation was "stippled"
3. The wound granulation was deeper into the corium/dermis than that experienced with lesions after simple under-running of the wall or sole

Results:

Compliance with the five-point lameness control programme improved over time and the average lameness prevalence of all lameness conditions decreased. The average prevalence of classical BDD lameness dropped dramatically from 31% of the treated cows to 5%. Average herd prevalence year to year of BDD lesions on screening was between 2.9% and 7.1%. The herd by herd average secondary infection rate of claw disorders was reduced after three years, but was still greater than 24%.

Discussion:

The continuation of secondary infection of new hoof disorders despite the dramatic reduction in skin BDD over three years was disappointing. On some farms no

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skin BDD was visible on screening, but still new cases of non-healing wounds were occurring.

This raises the question "What is the source of the bacteria infecting the lesions if the skin BDD is low?" There are at least three possibilities:

1. Continued contamination of the environment. However, if this is the only source, then it suggests that super-infection of claw injuries doesn't need a very high infection pressure.
2. Contamination of the environment with Treponemes from untreated non-healing, suppurating hoof disorders.
3. Contamination of a bovine hoof disorder with Treponemes in the rumen fluid of cows. (2)

Conclusion;

To reduce the lameness prevalence in herds with endemic BDD, there needs to be both the control of BDD and the prevention of new claw lesions. We had hoped that by controlling skin BDD the rate of secondary infection of claw lesions could also be significantly reduced. We have not seen this over the three years. More study is needed on reducing rates of secondary infection of hoof disorders.

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A CASE STUDY: TREATMENT OF NON-HEALING BOVINE HOOF HORN LESIONS

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Introduction:

"Non-healing bovine hoof horn lesions" are an increasing problem in dairy herds (Evans et al. 2011, Holzhauser 2008). Dairy farms endemically affected by digital dermatitis have to deal with this „new" problem when the infection with treponemes spread to the corium for example in sole ulcers, white line abscesses, toe necrosis or double sole. The description of such claw lesions presupposes this type of lesions to represent a very resistant form of digital dermatitis. This resistance to therapy is demonstrated by the failure of established ways of trimming and load relief, including blocking and bandaging of lesions.

In case of any ulcer the claw needs additional weight relief during trimming normally leading to recovery of the affected corium. However, in case of the aforementioned DD associated claw lesions these measures are insufficient. This is the reason for the term "non-healing". Typical sole and wall ulcers sometimes show a surface resembling velvet or the affected corium proliferates out of the open horn capsule. Sometimes the skin superficial to the ulcer is affected by DD showing a characteristic smell. The deep changes of horn growing on affected corium often remain unrecognized at first onset. Lameness is mostly mild to moderate. In ulcers at the tip of the toe with DD primarily dermal necrosis can be found, followed by the affection of the pedal bone. Without adequate treatment (removal of affected corium) the necrosis proceeds with simple horn trimming being insufficient to resolve the problem.

Case:

In a herd of 80 Brown Swiss dairy cows with endemic DD several animals showed "non-healing bovine hoof horn lesions" with moderate to severe lameness.

No trimming had been carried out for two years. After the first visit of a hoof trimmer a veterinarian was consulted to diagnose and treat the recorded lesions.

As a representative case for this herd a 5 year old cow has been showing an increasing lameness for 8 weeks (locomotion score 4) before first trimming:

- left hind foot with severe lesion on medial claw
- classical DD lesion at heel area
- horn wall seemed unaffected
- complete deformation of the sole dermis led to loss of sole horn
- necrosis of tip of toe with pedal bone being affected
- typical smell
- corium embedded in abnormally growing horn presenting itself like straps (lamella-like)

Treatment:

Under anaesthesia the remaining sole and heel horn were removed. The necrotic corium and the necrotic bone tissue at the tip of the toe were ground under visual control until no necrotic tissue was detectable in the corium or the pedal bone either.

The cow received NSAIDs (Ketoprofen, 3 mg/kg) for three days and β -lactam antibiotics (amoxicillin, 7 mg/kg) for seven days. A block was fixed on the lateral claw. A bandage with an approved salicylic acid paste was applied. The applied bandage was changed after 24 hours, salicylic acid paste was applied to the amputated tip and the corium of the sole and heel. The single use of tetracycline spray had failed in treating previous cases, because the corium started to overgrow without the use of salicylic acid and had to be removed repeatedly. For 5 weeks every 7 days the bandage was renewed (with fresh salicylic acid) until the corium was completely covered by horn. The block was removed after that time with some haemorrhages found in the model area. The cow showed a locomotion score of 2.

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CONTINUING POSTGRADUATE EDUCATION: THE MUNICH-VIENNA APPROACH TO HOOF DISEASES IN CATTLE

Effective herd controlling in terms of prophylaxis and therapy of hoof diseases affords an increasingly specialized knowledge of veterinarians for cause analysis. Concerning the economic impact of hoof diseases the veterinarian must be able to diagnose and treat appropriately (Zeddies, 1996; Vermunt and Twiss, 2002; Bell and Weary, 2002).

Once the diagnosis has been made appropriate treatment of individual animals must be carried out (Fiedler et al., 2003). Hoof trimming as well as treatment with approved drugs are measures to treat digital dermatitis. Therapeutic trimming, combined with sufficient relief (eg blocking) is mandatory in case of typical sole or wall ulcers. Surgical measures are necessary in case of severe/perforated ulcers and ulcers associated with DD (Fiedler et al., 2003; Kofler et al, 2015). Regular medical aftercare has to take place.

The successful combination of diagnostic and therapeutic measures needs the close cooperation of well-educated hoof trimmers and knowledgeable veterinarians both using a uniform, unambiguous nomenclature as has been established by the ICAR Claw Health Atlas (Egger-Danner et al. 2015). Consequently functional hoof trimming as a basis for any diagnosis must be mastered by the veterinarian to be able to take subsequent therapeutic measures:

- use of correct medication: Digital Dermatitis/interdigitalis
- anaesthetic and surgical techniques (resection, amputation): severe ulcers like sole ulcer, white line abscess, necrosis of the tip of the toe etc.; DD associated ulcers; severe interdigital hyperplasia.

For training sequential modules as courses lasting several days are provided aiming at veterinarians. These are partly being complemented by hoof trimmers.

Module I is designed as a two-day module combining lectures by experts in this field with practical exercises on cadaver feet, complemented by practical sessions on farm. During theoretical lectures the diagnosis, the joint punctures, retrograde intravenous regional anaesthesia (RIRA) and antibiotics as well as surgical treatment of severe ulcers are presented. The peri- and postoperative care (dressings, pads, NSAID's, antibiotic therapy) is discussed in detail. The practical exercises include functional hoof trimming for diagnosis and conservative treatment. The use of

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relieving blocks as well as protective, cushioning and support bandages is practiced. The practice of anaesthetic methods (nerve blocks or RIRA) on cadaver feet includes anatomical demonstrations of the respective structures. Under guidance of experienced surgeons frequent operations can be practiced (resection of tip of toe, resection of DD associated ulcers, "tyloma-resection").

Module II allows the routine use of functional claw trimming as part of a one-day intensive seminar. Under close monitoring various hoof care measures are carried out, selected cadaver feet with severe hoof problems are corrected by trimming. Conservative treatment measures are trained to improve trimming and diagnostic skills.

Module III is intended for veterinarians who want to improve their knowledge of surgery on cattle feet. The module combines lectures by experts and practical exercises on cadaver feet. During theoretical lectures the diagnosis of severe, perforating ulcers, tendinitis and aseptical/septical tendosynovitis, puncture of joints, RIRA and surgical treatment of severe ulcers are the main issues. Additionally the peri- and postoperative care will be discussed in detail (dressings, pads, NSAID's, antibiotic therapy). The practical exercises are intended to train the surgical interventions on the cattle foot (amputation of claw, resection of joints, resection of deep digital flexor tendon) guided by experienced surgeons to be able to apply the skills in practice immediately.

(References available from A. Fiedler: dr.andrea.fiedler@t-online.de)

LOCAL ANESTHESIA IN OVINE LIMBS: APPLICATION OF RETROGRADE INTRAVENOUS REGIONAL ANESTHESIA

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Introduction:

Animal welfare being an issue with increasing significance in farm animals it is important for the practitioner to know about methods allowing for a painless procedure during surgical treatment. In ruminants local anaesthesia in combination with sedation is the method of choice in order to guarantee painlessness as surgical procedures under general anaesthesia are problematic in these species. The retrograde intravenous regional anaesthesia (RIRA) is the preferred method in the limbs. While plenty of information is available on RIRA in cattle, hardly any information can be found concerning the sheep. It was the objective of this study to give an exact instruction on the RIRA in sheep.

Material and Methods:

An animal experiment on RIRA was performed on front and hind limbs of 15 (10 experimental animals tested twice and 5 control animals) sheep of the race "Weißes Bergschaf". Anaesthesia has been performed analogous to the approach described in cattle.

Results:

After congestion of the digital venous system by applying a tourniquet the V. digitalis palmaris communis II or the V. digitalis propria IV abaxialis were used in the front limb, while the V. digitalis dorsalis communis III was preferably used in the hind limb. An average of 4 ml local anaesthetic (procaine hydrochloride 2%) was injected having released

the blood from the congested veins. The onset of analgesia occurred about 3-4 min after injection. After removal of the tourniquet, sensitivity returned within an average period of four minutes. No problems in terms of inflammations or thrombosis were observed.

Conclusions:

The RIRA is a little more difficult in the sheep compared to cattle. With some practice the RIRA is a reliable and an easy to apply method to produce analgesia of the digits.

This experiment has been evaluated and approved by the Ethical Committee of the Government of Upper Bavaria.

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EVALUATION OF RISKS OF VIOLATIVE MILK RESIDUES FOLLOWING EXTRA LABEL TOPICAL ADMINISTRATION OF TETRACYCLINE FOR DIGITAL DERMATITIS IN DAIRY CATTLE

Introduction:

Digital dermatitis (DD) is a commonly found foot lesion in cattle at the time of hoof trimming (Cramer et al., 2008). In North America DD is commonly treated with topical tetracycline antimicrobials at varying doses. This usage of topical tetracycline is extra-label drug use, and limited data is available to evaluate the risk of violative milk residues. Previous work that has evaluated the risk of violative milk residues only looked at 1 dosing regimen and used a tetracycline formulation that is currently not widely used in the industry (Britt et al., 1999). The objective of this project was to determine if 2 different application methods and 3 different tetracycline dosages would result in tetracycline residue levels in milk.

Methods:

Fifty cows from 2 commercial farms were enrolled if cows had 2 feet affected with active DD. Farms were recruited for participation based on history of DD problem. Prior to enrolment cows were screened for DD and pre-treatment milk samples were collected from all potential DD cows. Cows were evaluated to determine DD status in a hoof trimming chute. Only active M2 stages (Berry et al., 2012) were enrolled in the study and randomly allocated to 1 of 5 treatment groups: 2WRAP(2000 mg tetracycline hydrochloride (TETHCL) under a bandage), 2PASTE (2000 mg TETHCL as a paste), 5WRAP and 5PASTE (5000mg TETHCL) and 25WRAP (25,000 mg TETHCL). Bandages were removed from cows at 48 hours and cows were re-evaluated for lesion progression after 120 hours. After enrolment, milk samples were taken from all enrolled cows after udder preparation at approximately 8, 24, 32, 48, 56, 72, 96, 120,144 and 168 hours post treatment. In addition pre udder preparation teat wash samples were taken from 3 cows in each treatment group. Milk samples were immediately frozen and frozen milk samples were analyzed for tetracycline residues using a commercial immunoassay (CHARM ROSA) and liquid chromatography–mass spectrometry (LC-MS). Blood samples were also take from all cows on days, 0 and 5. Additional blood samples were taken daily from the 25WRAP group. The CHARM ROSA had a detection limit of 10-30 ppb and the LC-MC test had a detection limit of 1 ppb and a limit of quantification of 10 ppb. For the analysis samples were considered positive if a residue was detected greater than the limit of quantification and violative if the residue level exceeded the current maximum residue limit for tetracycline of 100 ppb in Canada.

Results:

Five cows had detectable levels of TETHCL at enrolment and were removed. At the first sampling time post treatment,

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5/45 cows had residues above the Canadian maximum residue limit. Three of these cows were in the 25WRAP group with the others in the 2PASTE and 2WRAP groups. Furthermore, 105/442 samples had detectable levels of TETHCL and these detectable levels occurred in all 5 treatment groups. The majority (70/105) of these detectable levels were below the maximum quantifiable level of LC-MS. With the CHARM ROSA test only 13 samples tested positive with 9/13 occurring 8 hours post treatment. Detectable levels of TETHCL were found in all 15 teat wash samples 24 hours post treatment. Six of the 15 cows with detectable TETHCL in teat wash at 24 hours had detectable levels in milk.

Conclusion:

Based on these results it is clear that there is a high risk of a positive test on CHARM ROSA in individual animals when tetracycline is applied a high doses to acute DD lesions. If significant numbers of animals are treated in a herd with these high doses the risk of a positive bulk tank CHARM ROSA tetracycline residue exists.

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A DESCRIPTIVE STUDY ON HOOF TRIMMING METHODS USING CADAVER FEET

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Introduction: Hoof trimming is a common procedure for dairy cows and is widely recommended as a preventative practice for lameness (Shearer and van Amstel, 2001). Surprisingly almost no data exists to determine appropriate trimming methods. In the literature, functional hoof trimming is commonly described as the method of choice (Shearer and van Amstel, 2001). However, other methods are commonly reported in the field. This has resulted in a continuous debate within the hoof health industry with respect to what is the appropriate trimming method (Blowey and Inman, 2012). To address this question there is a need for more research on the prevalence of different trimming methods, the effect of these methods on key hoof measurements and ultimately on the welfare of the cow. The objective of this study was to describe the effect of different trimming methods on key hoof measurements taken on cadaver hind feet of dairy cattle.

Methods: Cadaver feet from 220 legs were obtained from a slaughter house and measurements were made on the lateral and medial hooves. The measured feet were uniquely identified and 40 hoof trimmers that attended the Hoof Trimmer Association annual meeting were asked to randomly trim 5 feet. The trimmers filled out a descriptive survey pre-trimming to collect background information. The trimmers did not have any prior knowledge about the feet; they were asked to trim them like they routinely would trim feet. Post-trimming feet were re-measured and cut in a sagittal plane to determine sole thickness and length of P3. Data was described based on pre and post trimming measurements and across descriptive characteristics.

Results: Pre-trimming, the average angle of the medial and lateral hoof was 51.0° (95% Confidence interval (CI): 50.1-51.9) and 51.5° (95% CI: 50.6-52.4) respectively. Post trimming, the average angle of the medial and lateral hoof was 51.1° (95% CI: 50.3-51.7) and 49.7° (95% CI: 49.0-50.5). The average pre-trimming length of the dorsal wall 15 mm from the interdigital space of the medial and lateral hoof was 82.8 mm (95% CI: 81.6-84.1) and 83.3 mm (95% CI: 82.3-84.4) respectively. Post trimming the average dorsal wall length was 80.3 mm (95% CI: 79.4-81.2) for the medial hoof and 80.1 mm (95% CI: 79.5-81.2) for the lateral hoof. At the same location as the dorsal wall measurement, the average length of P3 was 59.6 mm (95% CI: 59.0-60.3) and 59.0 mm (95% CI: 58.3-59.6) respectively for medial and lateral hooves. Average sole thickness post trimming was 8.7 mm (95% CI: 8.4-9.1) for the lateral hoof and 8.5 mm (95% CI: 8.1-8.9) for the medial hoof. With the 44 trimmers that volunteered, the average number of cows trimmed per week was 234 cows. Over 55% of the trimmers used the functional method of trimming, 17.5% used the white line, 12.5% used the Kansas method, and 15% used a combination of all three. For the measures reported in this study no significant differences were found between descriptive characteristics of the hoof trimmers and hoof measurements.

Conclusion: This study provides an initial description of hoof trimming methods used by North America hoof trimmers. For the measurements such as sole thickness and dorsal wall length no significant differences were found between trimming styles or training. The length of P3 reported was similar to another report in UK (Blowey and Inman, 2012). Based on these findings it appears that hoof trimmers in this study provided sufficient protection of the corium and P3.

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EXPERIMENTAL INDUCTION OF BOVINE DIGITAL DERMATITIS LESIONS IN NAÏVE DAIRY CALVES

Bovine digital dermatitis (DD) is an important cause of lameness in dairy and beef cattle. Due to its negative impact on welfare, there is a significant need to identify evidence-based approaches to controlling and limiting the lameness associated with digital dermatitis in commercial cattle operations. While "on-farm" interventions are widely practiced, there are a very limited number of well designed and controlled prospective trials available to utilize in making evidence based medicine decisions on treatment interventions. In large part, this lack of literature is due to the enormous time and financial cost associated with doing well-controlled field studies. The availability of a reliable and efficient means of experimentally inducing a large number of bovine digital dermatitis lesions would provide an additional tool to study the pathogenesis and efficacy of treatment interventions in the control of digital dermatitis. In order to achieve this goal, and develop a reliable experimental induction model of bovine DD, we have systematically evaluated 21 different modifications of induction protocols as part of 5 different experiments. In total, we have attempted induction on 504 feet belonging to 126 calves. In order to assure that the animals are naïve to DD, we utilize weaned dairy calves as opposed to older animals that may have had a previous history of DD exposure or disease. The final consensus protocol resulted in successful DD lesion induction on 42 of 44 feet (95%) in less than 1 month. On a larger scale, we have successfully induced 108 of 120 feet (90%) in the same time frame. The induced lesions are morphologically and histopathologically indistinguishable from mature naturally occurring DD lesions and occur in the typical location for naturally occurring DD lesions. This protocol allows for the rapid and efficient induction of DD lesions in a controlled experimental setting. We anticipate that the model will provide a useful tool for comparing treatment interventions, evaluating vaccine development efforts and studying the pathogenesis of digital dermatitis.

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EVALUATION OF THE IMMUNE RESPONSE TO BOVINE DIGITAL DERMATITIS ASSOCIATED BACTERIA FOLLOWING EXPERIMENTAL INDUCTION OF DISEASE AND SUBSEQUENT RE-CHALLENGE

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to calves without prior exposure to DD organisms. Based on these results, a complete assessment of the humoral and cell mediated immune response is in progress. If the complete immune assessment corresponds with the clinical picture we will have some of the first evidence of some level of protective immunity occurring as a result of infection.

The ability to reliably induce bovine digital dermatitis (DD) in naive calves provides a unique opportunity to evaluate the immune response of the calves to infection by DD associated organisms. By using recently weaned dairy calves with a known history of lacking prior lesions, we are able to assess pre- and post-lesion immune responses with minimal immunologic noise and background. In this study, pre- and post-lesion antibody titers to a variety of DD associated organisms were compared between a set of negative control calves and calves that developed lesions following DD induction. Eight negative control calves were sham induced with sterile media, from which none developed DD. The eight infected calves all developed lesions following exposure to macerated DD tissue consistent with clinical DD. Serum samples collected prior to induction and at the conclusion of the initial induction were compared to assess humoral immune responses to a battery of DD associated organisms. To further evaluate the potential for the development of natural protective immunity against DD, all of the calves (n=16) were re-challenged with macerated DD tissue after the initial DD lesions had completely healed in the infected calves. Thus in this round of induction, the initial negative control calves acted as the positive controls while the previously exposed calves were the treatment group designed to evaluate protective immunity. Induction was performed identical to the first round and the animals were observed for development of DD. Preliminary results identify a trend in which calves with previous exposure to DD induction were less likely to develop DD lesions when compared

METAGENOMIC EVALUATION OF THE DAIRY FARM ENVIRONMENT AND FACILITIES FOR EVIDENCE OF DIGITAL DERMATITIS ASSOCIATED BACTERIA

Bovine digital dermatitis is a common polybacterial disease process and a leading cause of lameness in dairy and beef cattle. Mature lesions are associated with a very high abundance of *Treponema* spp. organisms, while developing lesions have a larger diversity with different populations of organisms. This study was designed to utilize 16S-based phylogenomics to evaluate a variety of environmental samples obtained from various areas of a dairy farm for the presence of bacterial organisms associated with digital dermatitis lesions. In total, 204 different samples were collected from a single digital dermatitis positive dairy farm, and an additional nine samples were collected from alley flush water or manure lagoons of other farms known to have digital dermatitis. Samples were collected from various anatomic locations on cattle (rectal, udder sores, gingiva), bedding, feeding, heavy equipment, hoof-trimming equipment, and a variety of farm worker environments (offices, computers etc.). The samples were processed for sequencing of the V3-V4 region of the 16S ribosomal gene and each sample was barcoded with a unique DNA tag. The samples were multiplexed and run on a single lane of an Illumina MiSeq next generation sequencer. In total, just over 10 million joined reads were obtained of which 9.6 million passed initial quality filtering. Following demultiplexing and OTU calling there were just over 7 million unique reads representing 206 samples (7 samples failed to amplify). In order to normalize the data, the samples were rarified to a count of 9000 reads and compared. Of the 17,882 taxonomies identified in environmental samples, 139 taxonomies were identified that overlapped with digital dermatitis lesions from metagenomic studies performed on this same dairy. Digital dermatitis associated taxa were identified in a large variety of environmental sampling types. With regards to *Treponema* spp, 141 of the samples were identified to contain at least one read from a *Treponema* spp. that has previously been identified in digital dermatitis lesions. However when one considers the top 13 *Treponema* spp. that are most abundant in digital dermatitis lesions, only 24 of the samples contained one or more of these *Treponema* spp. *Treponema* positive samples were typically found in higher numbers and in a larger prevalence from animal associated samples and hoof trimming equipment, whereas samples derived from

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animal bedding, equipment and the farm worker environments were much less likely to have DD associated *Treponema*. Several non-treponemal species that are closely associated with digital dermatitis lesions showed similar trends. The results of this study provide unique insights into the ecology of digital dermatitis associated bacteria and help identify potential reservoirs of infection that can be targeted in disease control measures.

DEEP SEQUENCING METAGENOMIC ANALYSIS OF EXPERIMENTALLY INDUCED BOVINE DIGITAL DERMATITIS LESIONS

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samples be analyzed with a mean depth of 37630 sequences. Data analysis revealed similar changes in bacterial microbiota to those previously observed in 16S based sequencing of naturally occurring DD lesions and provides additional insights into the pathogenesis and etiology of bovine digital dermatitis.

Bovine digital dermatitis is a leading cause of lameness in both dairy and beef cattle of the United States and much of the world. Previous work by our laboratory, and others, has demonstrated that metagenomic analysis of naturally occurring digital dermatitis biopsies yields evidence of a complex polymicrobial disease process. We have demonstrated that lesions develop through a systematic progression of morphologic changes that are each associated with significantly different microbial communities. While these studies have provided insights into the pathogenesis of the disease process they are often complicated by confounding associated with temporal differences in the time or season of biopsy collection, chronicity of the lesion and the lack of baseline metagenomic data for each foot prior to lesion development. The goal of this study was to utilize a recently developed and highly reliable experimental lesion induction model of digital dermatitis to collect a large number of metagenomic samples with minimal confounding. For the study, 36 Holstein steer calves with known DD naïve status were utilized. Skin biopsies were obtained from each of the calves prior to induction of DD. DD was induced using macerated digital dermatitis lesions obtained from naturally infected dairy cattle. Following experimental induction, the feet of each calf were again biopsied for histopathology and 16S metagenomic analysis. In total, 293 biopsies were multiplexed onto a single lane of Illumina MiSeq. The sequencing run yielded 15104019 reads, of which 13685124 passed initial quality filtering and had barcodes that matched one of the 298 samples. Nine samples were excluded due to low sequencing depth resulting in 289

IMPACT OF EARLY DETECTION AND TREATMENT OF MODERATE LAMENESS ON DISEASE PROGRESSION AND COW PERFORMANCE

Introduction: Early lameness detection and prompt treatment it is expected to result in better clinical cure and reduction of lameness prevalence (Leach, 2012). However, very limited studies evaluated the implication of early hoof trimmer intervention on lameness progression and cow production. We hypothesized that early detection and treatment would decrease the prevalence and severity of lameness. Thus, the objective of this study was to evaluate the impact of early detection and treatment of moderate lameness on disease progression and milk yield.

Materials and Methods: Enrolled dairies were free-stall facilities with automated milk yield data collection located in close proximity in Tulare County, California. Dairy A milked 2,374 cows twice a day in a herringbone parlor whereas Dairy B milked 2,800 thrice a day in a rotary parlor. Locomotion-score (LS) 3 cows were identified as they exited the milking parlor based on Sprecher et al. (1997). Cows with more than 180 d carrying calf, more than 350 days in milk, more than five lactations, or yielding less than 10 kg/d at trial onset were removed from the data analysis. Cows observed with LS 3 were randomly assigned to control group [(C) no intervention] or treatment group [(T) evaluated and treated by the same hoof trimmer under researchers observation]. Control group was blind to the dairy. All cows were subject to the standard herd management protocol for lameness identification and treatment throughout the six wk data collection period. The following information was collected:

- Daily milk yield data by Afifarm software (Afimilk Ltd, Israel) from -1 wk to 6 wk relative to intervention.

- Type and severity of lesions was recorded on intervention day (T) and as well as T and C lame cows identified by farm personnel up to 6 weeks. Lesion severity was scored using a modified abc lesion scoring system described by Burgi and Cook (2006).

All milk yield data outside 2.33 SD was considered an outlier and it was removed. The final data set comprised 146 (Dairy A) and 187 (Dairy B) cows. Milk yield data was analyzed for Dairy A and Dairy B using a multivariable linear regression model with repeated measurements including the effects treatment, time and treatment by time interaction. Data was coveriately adjusted by yield at -1 wk relative to intervention.

Results: Most prevalent lesions found at hoof trimmer

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intervention were non lesion and thin soles (50.0% Dairy A; 52.6% Dairy B). White line disease, sole hemorrhage, and vertical fissure represented 39.7% and 36.8% of treated cows on Dairy A and B respectively. However, most (70%) lesions were classified as mild (score 1 of 3). During the data collection period 18 (C) and 9 (T) lame cows were selected by farm employees for treatment. On Dairy A milk yield was similar ($P = 0.7$) for C (41.1 kg/d) and T (41.3 kg/d) whereas on Dairy B it was higher ($P = 0.037$) for C (43.5 kg/d) than T (42.2 kg/d). On both dairies there was a significant effect of time with milk yield decreasing over the study period but treatment by time interaction was not significant.

Discussion and Conclusions: Although enrolled dairies had similar management, early lameness identification and treatment had no impact on milk yield on Dairy A but decreased milk yield on Dairy B. Hoof trimmer intervention could have resulted in an undesirable reduction of sole thickness, increasing susceptibility to hoof lesions or hoof pain specially when cows were walking to the parlor thrice a day (Dairy B).

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HOOF TRIMMER PERFORMANCE ON CALIFORNIA DAIRIES BASED ON HOOF MEASUREMENTS BEFORE AND AFTER THERAPEUTIC TRIMMING

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Introduction: Lameness on dairies is an important issue with implications on animal welfare and herd production level. Functional and therapeutic hoof trimming can serve to prevent and treat lameness and hoof lesions. On large California dairies hoof trimming tasks are performed by in-house employees, outside service providers or both. However, most hoof trimmers (HT) lack formal education on trimming techniques and their performance is often unsupervised. Thus, the objective of this study was to describe HT performance based on hoof measurements before and after lame cow treatment on California dairies.

Materials and Methods: Enrolled dairies (n=19) ranged from 800 to 10,000 cows. Dairy workers (n=11) or outside service providers (n=8) performed trimming tasks. Rear hooves measurements were collected before and after HT intervention from ten (n=16) or nine (n=3) lame cows per dairy. Non-injured hooves were measured [dorsal wall length (DWL), hoof angle (HA), heel height (HH), and abaxial groove length (AGL)] with a 20 cm goniometer (HiRes™, UK). Reference values for hoof measurements were: a) $\geq 7 - \leq 8.5$ cm for DWL (Hahn MV et al., 1984), b) 45° to 50° for HA (Shearer et al., 2006), c) 3.4 to 4.4 cm for HH (Hahn MV et al., 1984), d) 3.8 to 4.5 cm for AGL (Shearer and Van Amstel, 2013). Data collected was entered into spreadsheets for data analysis (Microsoft Office Excel; 2010). Descriptive statistics was conducted with PROC MEANS, PROC UNIVARIATE and PROC CORR of SAS 9.4.

Results: Lesions were observed on 81.8% of enrolled cows most often on lateral claws (73%). The three most common lesions (67.2%) identified were sole ulcer, white line disease and digital dermatitis. Overall, before and after HT intervention DWL avera-

ged 9.4 cm and 8.5 cm, HA 45.6° and 45.5° , and HH 4.8 cm and 4.5 cm respectively. The difference between adjacent hooves before HT intervention was ≥ 0.5 cm for DWL (64.6%), ≥ 0.5 cm for HH (74.7%), and $\geq 3^\circ$ for HA (64.1%).

After intervention the frequency of hoof measurements within reference were at least 70% (7 HT) or less than 30% (4 HT) for DWL, at least 70% (4 HT) or less than 30% (2 HT) for HA, and at least 70% (0 HT) or less than 30% (3 HT) for HH. Eight HT had 32 to 7% more hooves with an angle outside the reference value after than before intervention whereas seven had 24 to 6% more hooves within reference. All HT improved the number of hooves within reference values for DWL and HH. However, at least 70% of the time adjacent hooves differed in DWL by ≥ 0.5 cm (2 HT), HA by $\geq 3^\circ$ (5 HT), and HH by ≥ 0.5 cm (12 HT).

Abaxial groove length was ≥ 4.5 cm on 94.8 and 90.9% of the hooves before and after HT intervention respectively. Although there was a significant correlation between heel height and abaxial groove length (P < 0.0001) the correlation coefficient before (r = 0.20) and after (r = 0.59) was low.

Discussion and Conclusion: Proper trimming techniques are important to reestablish appropriate claw weight bearing surface and minimize future hoof lesions. However, our data indicates that frequently hoof trimmers failed to properly adjust claw dimensions based on reference values. The weak correlation found between AGL and HH before intervention rendered AGL as an inadequate proxy for HH. Overall, HT performance on California dairies can be improved. Educational efforts should be conducted to train HT on how to reach reference values for DWL and HA as soon as make a properly balance between adjacent hooves.

Keywords:

Lameness
Hoof trimmer
Hoof measurements

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HOOF TRIMMER PERFORMANCE ON CALIFORNIA DAIRIES BASED ON OBSERVED PRACTICES DURING THERAPEUTIC TRIMMING

Introduction:

Lameness on dairies is an important issue with implications on animal welfare and herd production level. Functional and therapeutic hoof trimming can serve to prevent and treat lameness and hoof lesions. On large California dairies hoof trimming tasks are performed by in-house employees, outside service providers or both. However, most hoof trimmers (HT) lack formal education on trimming techniques and their performance is often unsupervised. Thus, the objective of this study was to describe HT performance based on observed practices during lame cow treatment on California dairies.

Materials and Methods:

Enrolled dairies (n=18) ranged in size from 800 to 10,000 cows. Dairy workers (n=11) or outside service providers (n=7) performed trimming tasks. Researchers collected information from rear hooves before and after HT intervention from ten (n=15) or nine (n=3) lame cows per dairy. The following practices were observed: a) anatomical location where trimming starts, b) non therapeutically removal of abaxial, axial or dorsal wall, c) proper axial sole slope (Shearer J and S. Van Amstel, 2013), d) undertrimming toe sole (toe white line connection not visible), e) block placement (based on its slope and placement relative to the weight bearing surface), and f) wrapping open wounds. Also, the flatness of weight bearing surface (including hoof wall, 2 cm of adjacent sole, and heel pad) and sole surface (from heel to toe) was evaluated using a knife handle. Descriptive statistics was conducted with PROC MEANS, and PROC UNIVARIATE of SAS 9.4. (SAS Institute Inc., Cary, NC).

Results:

Eight HT washed hooves before starting their work, mostly to prevent excessive disk wearing. Hoof trimmers never measured dorsal wall length, hoof angle and sole thickness before or after their intervention. Trimming did never start by the apex of the claw (9 HT). Hoof wall was removed without therapeutic intention on at least 70% of the hooves (13 HT). Seventeen HT improperly performed axial sole slope on most (> 70%) hooves. Toe hoof sole was undertrimmed at least on 20% of the hooves (4 HT). Blocks were used on 30% to 100% of the cows treated, but

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almost 55% of the time they were placed improperly, specially relative to the weight bearing surface. All HT except one used flexible wraps for open wounds on 10% to 56% of the treated cows. After HT intervention, weight bearing surface of non-lesion hooves was uneven on at least 70% of the hooves (14 HT). At least 70% of the times, after HT intervention, sole surface (from heel to toe) was left either uneven (12 HT) or flat (5 HT). One HT opened 20% of the wounds solely using the disk.

Discussion and Conclusions:

Improper performance of hoof trimming techniques such as unnecessary wall removal, improper block placement, inadequate axial sole slope could potentially deceive the purpose of therapeutic trimming and increase lameness. There is an opportunity to improve HT performance on California dairies through education.

Keywords:

Lameness
Hoof trimmer
Dairy cow

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SURVEY OF LAME COW MANAGEMENT PRACTICES ON CALIFORNIA DAIRIES

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Introduction: Lameness is one of the main diseases on dairy farms (Cha et al., 2010) causing annual losses of up to \$ 75 per cow (Bruijnjs et al., 2010). Consequently, early lameness identification and treatment could decrease lameness prevalence (Leach et al., 2012). The objective of this study was to describe lame cow management practices on California dairies.

Material and methods: Thirteen free-stall and four dry-lot dairies were enrolled in the study. Most (n=16) enrolled herds were Holstein and ranged in size from 1,000 to 10,000 cows. Researchers filled-out a survey tool through observations and a semi-structured interview process with managers, hoof trimmers and dairy employees involved on lame cow identification. On enrolled dairies, therapeutic hoof trimming was performed by in-house employees (n=11) or outside service providers (n=6). Data collected was entered into spreadsheets for data analysis (Microsoft Office Excel; 2010).

Results: Lame cow identification took place every day (n=7), less than five days a week (n=7) or two times a month (n=3). Pushers (n=13), hoof trimmers (n=9), milkers (n=5) and breeders (n=2) were involved on lame cow identification. On seven dairies, either the pusher (n=4) or the hoof trimmer (n=3) were the sole responsible for lame cow identification. All cows selected for therapeutic trimming showed claudication. Other lameness indicators observed were short steps (68.8%), back arch (56.3%), abnormal claw (43.8%), or head bouncing (18.8%). On three dairies, claudication was the only lameness indicator evaluated whereas on seven dairies four of the aforementioned indicators were observed.

Most dairies serviced by an in-house hoof trimmer (81.8%) moved cows to a holding lameness pen for treatment as soon as they were identified. On all other dairies lame cows were treated on scheduled days (n=7). Cows stayed in the holding pen [mean (range)] 5.9 (1 to 24) hours before trimming intervention. The lame cow holding pen was located near the milking parlor and provided cows with: a) shade, water and feed (n=4); b) shade and water (n=5); c) only shade (n=3); d) only water (n=2), e) or nothing (n=2). Hoof trimmers perceived that the three most common reasons for lameness were: a) stepping on sharp objects such as nails, needles or stones (n=12), b) heat stress (n=9), c) abrasive floor surface and excessive claw humidity (n=9). Proposed solutions to reduce lameness prevalence were: a) removing sharp objects from pens and walking alleys (n=12), b) increase the frequency of lameness identification and hoof trimming work (n=10), and c) improve cow comfort (i.e. heat abatement, better bedding, rubber mats on walkways; n=10).

Discussion and Conclusions: Our results indicate that lame cow identification relies greatly on pushers. However, the pusher can only perform a good evaluation of the last group of cows walking to the parlor. In-house hoof trimmers were able to provide therapeutic trimming with more frequency than outside service providers. Removal of sharp objects on walkways and feed lanes might be an important strategy to reduce lameness prevalence on some dairies.

Keywords:

Lameness identification
Dairy cattle
Lameness perception

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HOOF TRIMMER TRAINING AND SAFETY HAZARDS ON CALIFORNIA DAIRIES

Introduction:

Lameness and hoof lesions are important economic and animal welfare issues on dairies. Preventive and therapeutic trimming is a common management practice performed by outside service providers or in-house dairy employees. The objective of this study was to describe hoof trimmers training and safety hazards on California dairies.

Materials and Methods:

Nineteen hoof trimmers (HT) from 17 dairies were enrolled in the study. Participants were in-house dairy employees (n=12) or outside service providers (n=7). A survey was designed with questions organized in themes: a) prior training and experience, b) trimming tools and drugs, and c) safety hazards and injuries sustained while trimming. Researchers completed the survey by interviewing hoof trimmers and observing their practices at work.

Results:

Trimming was a skill that most (n=15) learned from another hoof trimmer (in-house or outside service), two learned at a workshop and two HT were self-taught. Continuing education events were attended by eight HT. Among HT, years of experience ranged from 1 to 5 (n=6), 5 to 10 (n=9), and > 10 (n=4). All outside HT had more of 5 years of experience. Dairy employees performing trimming had additional responsibilities such as milking, facilities maintenance or operating equipment.

All HT used tilt tables, except one in-house HT that had hydraulic standing chute table. Single blade knives (for both hands) and 11,000 rpm electric grinder were tools used by all HT. However, while 13 HT used chipper wheel disc, six outside service providers used sand abrasive disc and/or carbide disc. Hoof trimmers were inconsistent on their use soluble powder tetracycline on open wounds either alone (n=7), mixed with 7% Iodine (n=7), 70% alcohol (n=1), vegetable butter (n=2), propylenglycol (n=1) or liquid oxytetracycline (n=1). Bleeding lesions were frequently cauterized with a hot iron (13 HT). The type of blocks used were wood (11 HT, mostly oak), plastic (1 HT) or wood and plastics (5 HT). Only six HT had blocks of various sizes. None of the HT used injectable drugs. Nine HT cleaned their knives at the end of the day, but only four

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used disinfected solution (70% alcohol or 7% iodine). Most (n=13) hoof trimmers used protective glasses or masks during trimming (69.2% in-house and 30.8% of outside), whereas protective gloves were only wear by eight HT (37.5% in-house and 62.5% of outside service providers). Nine HT reported to be injured (mostly by cuts in hands and arms) at least one time while performing trimming tasks. Six outside service providers reported to be injured at least 10 times. Four trimmers sustained injuries that required a leave from work for 2 weeks (n=2) or for one month (n=2). All severe injuries were sustained after a cow kick. Three of them were in-house dairy employees.

Discussion and Conclusion:

Although most HT learned trimming skills from another colleague, continuing education events were still of interest to many of them. Cleaning knives between cow treatments is a practice scarcely implemented, that could increase the risk of infectious disease transmission. Better protective measures should be used for reduce sustained during trimming. Criteria to apply tetracycline were not consistent within and across trimmers.

Keywords:

Hoof trimmer

Dairy cattle

Hoof trimming equipment

FOOTBATH DIMENSIONS AND MANAGEMENT ON CALIFORNIA DAIRIES

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Introduction:

Lameness is a common disease found on dairies with important economic and animal welfare implications. Digital dermatitis is one of most common infectious causes of lameness (Laven, 2001). Footbaths (FB) are commonly used on California dairies to prevent infectious foot diseases. The objective of this study was to describe footbath dimensions and management practices on California.

Materials and Methods:

Footbaths on 21 dairies were evaluated. Enrolled dairies were located in the San Joaquin Valley of California, and ranged in size from 800 to 10,000 cows. The length, width and depth of FB were measured with a plastic rule. Researchers collected information on the type of solution and the frequency of fresh solutions added through interviews with hoof trimmers and dairy managers. Data collected was entered into spreadsheets for data analysis (Microsoft Office Excel; 2010).

Results:

Nineteen dairies had FB (1 to 4 per dairy, total 39). One dairy had FB but it was not used and another dairy lacked FB. Four dairies had pre-baths separated by less than 30 cm from the FB. On one dairy, dry cows walked through a FB once a week. A front and rear spray FB was observed on one dairy. The frequency of FB was seven (n=2), five (n=6), four (n=4), three (n=4) or two (n=1) days a week. On two dairies no information was obtained on FB frequency of use. Cows walked through the FB at one (n=12), two (n=6) or three (n=1) milkings per day.

The maximum FB length was 1.5 to < 2 m (18%), 2 to < 2.5 m (38%), 2.5 - < 3 m (10%). Width measures were < 1m (39%), 1 to < 2 m (20%) and ≥ 2 m (41%). FB solution depth ranged from 5.4 to 15 cm (average depth was 10.0 cm). Solution volume ranged from 109 to 1095 liters (average: 399 liters), most of FB (66%) contained between 150 to 500 liters of solution. All dairies used chemical disinfectants on their FB. Dairies used as a FB solution only CuSO₄ (n=3), ZnSO₄ (n=2), or formaldehyde (n=3). However, other dairies used a combination of CuSO₄ and formaldehyde (n=9), CuSO₄ and chlorine (n=1) or CuSO₄ and glutaraldehyde (n=1). The number of cows walking through the FB prior to adding a fresh solution ranged from 185 to 2000 cows (average: 921 cows).

Discussion and conclusion:

Across dairies there was a wide variation on design and management of FB. Further research is needed to establish the implications of various management practices and FB designs on hoof health.

Key words:

Footbath
Claw disease control
Dairy cows

References:

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LAME COWS BENEFITS FROM BEING HOUSED IN RECOVERY PENS

Introduction:

Lameness is associated with pain and discomfort and is considered one of the most important welfare problems. Housing lame cows in recovery pens, providing softer surface and easier access to feed and water, can be a part of normal husbandry procedures. However, there is only limited information on how to house lame cows. Lying has high priority among dairy cows and lying behavior of lame cows has been found to differ from lying behaviour of non-lame cows, indicating discomfort associated with lameness. We aimed to investigate the effect of recovery housing of lame cows on lying behaviour.

Material and methods:

From the dairy herd of Aarhus University, we selected 24 unilaterally lame Danish Holsteins (later excluding two) with a diagnosed hoof lesion and matched each lame cow with a non-lame control cow without any diagnosed hoof lesions, by using parity, body condition and lactation stage as blocking criteria. Cows underwent corrective trimming and treatment of claw lesions and one IceQube™ (IceRobotic Ltd., Edinburgh, Scotland) was attached to the cannon of each hind leg for continuously recordings of lying data. The following day, each pair of cows was randomly allocated to either a recovery pen (6 x 7.8 m, deep straw bedding, four head lockers at feeding table, easy access to food and water) together with another pair of familiar cows or in a 49 cows cubicle pen with familiar cows (49 cubicles and head lockers, canvass mattresses bedded with pellet, heated manure, rubber floorings with automated scruber systems) for three weeks. Feeding and milking did not differ between housing treatments. The within-pair difference in total daily lying time, daily lying bout frequency and average lying bout duration was used to analyze for effect of housing.

Results:

Estimated total lying time (min/d) did not differ between lame and control cows (766 (± 21) vs. 731 (± 21), $p=0.3$) and was not modulated by housing treatment ($p=0.2$). In the cubicle pen, the frequency of daily lying bouts differed between lame and control cows (8.3 (± 0.9) vs. 9.7 (± 0.8), $p=0.02$), but no difference was found in the recovery pen (14.3 (± 0.9) vs.

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13.7 (± 0.8), $p=0.3$). The effect of housing was significant ($p=0.006$). Average lying bout duration differed between lame and control housed in the cubicle pen (93.8 (± 5.3) vs. 73.5 (± 4.0), $p<0.001$), but no difference was found in the recovery pen (60.3 (± 5.3) vs. 59.8 (± 4.1), $p=1$). The effect of housing was significant ($p<0.001$).

Discussion and Conclusion:

In the recovery pens, the softer bedding may have provided a higher compressibility and friction for the hoofs to stand firm in the process of getting up or lying down, and a reduced physical impact on the claws resulting in less provoked pain from the claw lesions, during the process of getting up or lying down, thus promoting increased frequency of lying bouts and shortened bout duration. Further, due to the absence of partitions and neck rails the lying and rising behavior could be performed more freely. To conclude, the absence of difference in lying behavior between lame and control cows in the recovery pens indicated that discomfort related to lameness was reduced by housing in the recovery pens.

EFFECT OF TOPICAL TREATMENT WITH OXYTETRACYCLINE SOLUBLE POWDER OR COPPER SULFATE POWDER ON HEALING OF CLAW LESIONS

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According to a recent US survey on treatment of claw lesions, topical treatments were applied by 59% of veterinarians and 53% of hoof trimmers. The medication used most frequently was the soluble powder form of tetracycline or oxytetracycline (48% by veterinarians and 81% by hoof trimmers) followed by copper sulfate for veterinarians and ichthammol ointment (a sulfurous, tarry compound with mild antiseptic properties used primarily as a drawing agent) for trimmers. These compounds, particularly tetracyclines and copper sulfate, have properties which are deleterious to the healing of lesions. Tetracyclines are known to cause significant tissue irritation when used parenterally, copper sulfate is corrosive to the skin and eyes and both compounds are readily absorbed through cutaneous tissues and open lesions. We believe that the pathogenesis of claw lesions coupled with what is known about wound healing suggests that topical treatment may not be advisable. Healing of claw lesions occurs by second intention; that is, lesions are not sutured but left open to heal by the process of granulation tissue formation, contraction of the wound edges and eventually re-epithelization. Wound healing of open lesions by second intention is generally delayed because of the time needed to generate a sufficient volume of connective tissue to fill the defect. Topical treatments with low pH and corrosive properties cause cellular toxicity which interferes with cellular migration and epithelial cell proliferation in the early stages of wound healing. The result is granulation tissue formation and inhibited epithelization and wound contraction. On the other hand, since there is no epidermal barrier

in the early stages of wound healing, the risk of an infection is significantly higher in these wounds. This is presumably the logic that most use in treating claw lesions. The purpose of our study was to assess the effect of topical treatment with tetracycline and copper sulfate on the rate of wound healing as determined by the presence of granulation tissue and evidence of re-epithelization at day 21 post treatment. Eighteen cows were randomly divided into a treatment group: treated topically with oxytetracycline soluble powder (7) or copper sulfate powder (3) and a bandage; and control group: no topical treatment and a bandage. Photos of lesions at day 21 were presented to 2 independent observers who scored the lesions for the visual presence of granulation tissue and evidence of re-epithelization. Based upon observer scores at day 21, lesions topically treated with oxytetracycline or copper sulfate were more likely to have granulation tissue ($p > 0.0054$) and less likely to have evidence of re-epithelization ($p > 0.0553$). Although the number of observations is small, these data suggest that topical treatment with oxytetracycline or copper sulfate may delay wound healing.

CORRELATION BETWEEN THE DORSAL WALL LENGTH AND THE CORONARY BAND WIDTH OF THE BOVINE HOOF

Introduction:

According to Dutch method, you have to cut the dorsal wall 7.5 cm long. But the number is quite vague. Each cow should have her own claw size. The coronary band produces the wall horn as a shape of the coronary band itself to make a capsule of the claw. And the shape of the capsule is a kind of cylinder not like an equine hoof. The objective of this study was to examine the feasibility of predicting the dorsal wall length (DWL) from the coronary band width (CBW).

Materials and Methods:

Measurements of the CBW are highly repeatable, but we cannot measure the DWL correctly in the living animal. So 280 hind cadaver legs were examined. First the CBW was taken with a caliper and also width of the lateral and medial claws were taken individually. Then each claw was cut longitudinally with a band saw. DWL from the beginning of the wall horn to the apical part of corium was measured also with a caliper. Because the top of corium represents the end of DWL, the real DWL will be 5mm longer than this.

Results:

CBW (min87.5mm<mean104.5mm<max129.8mm)
 Width of the lateral claws (46.2mm<55.0mm<75.4mm)
 DWL of the lateral claws (58.9mm<70.8mm<90.3mm)
 Width of the medial claws (41.8mm<50.6mm<61.5mm)
 DWL of the medial claws (56.5mm<70.0mm<84.3mm)
 Correlations between CBW and width of the lateral claws, DWL of the lateral claws, width of the medial claws and DWL of the medial claws were 0.599 0.508 0.671 and 0.418 respectively. A correlation between the width and the DWL of lateral claws was 0.453 and a correlation between the width and the DWL of medial claws was 0.412.

Conclusion:

Correlation between CBW and DWL was not high enough to estimate the real DWL of the claw accurately. But it is good enough to make a new method to decide the DWL.

Discussion:

The length of the medial weight-bearing-surface

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(WBS) will be as long as the width of the coronary band. The bulb is not flat but in a case of medial claw a straight line from the planter end of the WBS to the coronary band is parallel to the dorsal wall. So we can cut medial claws first and then cut lateral claws as long as medial. When we use up-right chutes it's rather difficult to measure the length of the dorsal wall. But this method is much easier and more correct than 7.5cm. And this study showed us when there was a big difference in size between medial and lateral claws you'd better cut a lateral claw a few millimeters longer than a medial claw.

A COMPARISON OF HEEL-SKIN MICROBIOMES FROM DAIRY COWS WITH DIGITAL DERMATITIS TO THOSE FROM A DISEASE-FREE HERD

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The objective of this research is to evaluate and compare the foot-skin microbiome of dairy cows from herds affected by digital dermatitis (DD) to those from a disease-free herd. Recent research suggests that *Treponema* spp. do not predominate in early lesions (Krull et al., 2014). A comparison of microbiomes present in early-stage lesions with those from the heel skin of cows from DD-free facilities is necessary to better understand the role of different bacterial species in disease progression. We hypothesize that the heel-skin microbiome of cows from DD-free herds is significantly different than the microbiome in early-stage DD lesions of cows from endemic herds. All experimental procedures were conducted in accordance with guidelines of the Canadian Council for Animal Care and were approved by the University of Saskatchewan Animal Care Committee. Participating herds were first selected through a survey sent to every registered dairy farm in Saskatchewan (SK), Canada by the provincial milk board (SaskMilk). Of the 163 SK producers contacted, 37 returned the survey. Of these, 24 volunteered to participate in this study. From each of the participating farms, up to 10 cows with lesions staged as A1, A2, B1, or B2 using a published DD scoring system (Krull et al., 2014) were subjected to a 3 mm biopsy. The biopsy site was blocked with 3 ml of 2% lidocaine (without epinephrine) by a line block above the heel cleft. Environmental samples were taken from the mouth, body and feces of each biopsied cow in addition to general slurry from each farm. Sample collection was ongoing at the time of abstract submission. Genomic DNA extraction will be achieved with commercial

kits (DNeasy® Blood & Tissue kit, DNeasy® Fecal kit, QIAGEN, Toronto, ON, Canada). Genomic DNA will be sequenced using high-throughput sequencing. Sequences will be grouped according to species and similarity to previously identified genera then compared according to herd disease status. If appropriate, microbiomes will also be compared between lesion stages. If specific microbes are consistently identified from staged lesion biopsy specimens of endemic herds and not from those of the DD-free herd, these microbes may be important in the progression of DD. Our results will allow us to better understand the progression of DD in dairy herds and allow future studies into novel treatment and control strategies.

THE ASSOCIATION BETWEEN ACID pH IN CuSO₄ FOOTBATHS WITH PREVALENCE, SEVERITY AND CHRONICITY OF INFECTIOUS CLAW DISEASES IN A WISCONSIN DAIRY HERD

Introduction:

Footbathing protocols are used to disinfect feet of cattle with the aim of preventing infectious claw diseases such as digital dermatitis (DD) and Foot Rot (interdigital phlegmon). Very often the pH of footbaths is advised to become extremely acidic, but this practice may increase damage to the digital skin and result in increased prevalences of infectious claw diseases in cattle. This practice is not based on evidence or data. It was hypothesized that changing the pH of the foot bath from very acidic to a range close to the skin pH of the cows skin could reduce the number of DD lesions and foot rot significantly.

Materials and Methods:

Trimming records from a single 375 lactating cow dairy in Wisconsin were collected by one hoof trimmer from August of 2011 until January of 2015. All cows to be trimmed, all lame cows and rechecks from previous claw trimming sessions were presented to the same hoof trimmer and all lesions and normal findings were recorded electronically. Routine rechecks on all lesions treated were performed after 2, 4, 8 or 12 weeks time intervals. On September 1st, 2013, the pH of the footbath containing CuSO₄ was changed from <1.4 to >3.0. All other parameters were kept the same on the farm with regards to claw health management. We investigated as to whether the prevalence of digital dermatitis (DD) or other claw lesions changed, whether the severity of DD changed (graded using the M-stages M0, M1, M2, M3, M4, and M4.1), whether the number of proliferative DD lesions changed and as to whether the number of repeat cases per cow changed after the switch of the footbath pH took place. Data were analyzed using measures of association such as Relative Risk and multiple variable logistic regressions.

Results:

Results showed that among the claws presented for treatment compared to the number of normal claws presented for trimming before compared to after the switch, the prevalence of DD decreased significantly and the same was true for the number of corns, hairy attacks, heel horn erosions, foot rot and axial wall fissures.

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The number of antibiotic treatments decreased significantly resulting in less antimicrobials applied under wraps and therefore less risk for antimicrobial residues post treatment. Overall, the number of therapeutic trims decreased significantly after the pH of the footbath was changed into less acidic. Severity of DD lesions after the change in pH saw a significant decrease in number of M2, M1, and M4.1 lesions while the number of M4 increased significantly compared to the number of M0 stages. Number of proliferative DD before compared to after was significantly reduced. Particularly the number of M4 lesions that were proliferative were significantly reduced while the number of proliferative M4.1 lesions were marginally significantly reduced ($P < 0.09$). The number of Normal claws with proliferation presented to the hoof trimmer after the switch was significantly less compared to before.

Discussion and Conclusions:

We conclude that on this one farm and using a historical control, the switch of the pH of the footbath was associated with improved claw health, particularly the reduction of DD. The practice of advising extremely acidic pH for footbaths in cattle has to be revisited and supported by more data in the near future.

DETERMINATION OF LAMENESS PREVALENCE IN DAIRY COWS AND LESION TYPE IN DAIRY HERDS FROM BUENOS AIRES PROVINCE ARGENTINA

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Introduction:

Lameness is one of the most important problems affecting dairy cattle. This affection, caused by several claw diseases, can lead to huge economic losses by threatening milk yield, increasing the culling rate and the costs of treatment. In Argentina there are not studies referring to lameness prevalence and hoof pathologies rates. The aim of this work was to evaluate the prevalence of lameness and the characterization of claw lesions found in dairy farms located at Buenos Aires Province, Argentina.

Materials and Methods:

Twelve dairy farms under grazing conditions were evaluated. These farms were milking a range of a hundred to eight hundred cows. 2960 Holstein milking-cows ranging from 1 to 6 births were assessed for lameness using a mechanic hoof trimming chute. 634 cows were diagnosed lame and examined for lesion recognition and treatment. The affected hoof was also registered in order to establish the injury ratio between front and rear limbs.

Results:

Out of the 2960 cows in study, 634 (21.42%) showed an abnormal mobility being diagnosed lame. In this subset sixteen different kinds of lesions were scored, most of the animals harbored not an only type of lesion. Digital dermatitis was the most common lesion 19.95% (233/1168). The second lesion in appearance was sole abscess 13.10% (153/1168) and in the third place was the White Line Disease 12.93% (151/1168).

Most of the claw lesions were found in the rear-limbs 86.99% (1016/1168) and only 13.01% in the fore-limbs.

Discussion:

The lameness prevalence results obtained are congruent with others studies realized around the world (Green 2010, Katsoulos 2009). Higher prevalence of affected rear claws is also coincident with the ratios reported by other studies (Confalonieri 2008).

In this work overgrowth was not included in the analysis because this pathology would be overestimated on account of most of the visited farms trim their cows for the first time and most of them were with this problem.

Digital dermatitis was the most important lesion detected, as it was shown by other studies under grazing conditions in New Zealand and Europe.

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HOOF PATHOLOGIES PREVALENCE IN BULLS HOUSED IN AN ARTIFICIAL INSEMINATION CENTER

Introduction:

There are only a few studies reporting bulls hoof pathologies worldwide. But it is a fact that their hooves are affected by many diseases, caused by multifactorial disorders, rendering in a reduction of the jump rate due to pain.

The aim of this work was to determine the claw pathologies prevalence affecting different breeds of bulls housed in an artificial insemination center.

Materials and methods

This work took place at Eolia, a cattle genetic center, placed in Marcos Paz, Buenos Aires province, Argentina. In a fourteen month period, 35 bulls from different breeds, Aberdeen Angus (20/35), Polled Hereford (1/35), Brangus (3/35), Braford (7/35), Holstein (4/35) were evaluated. All of them housed in individual paddocks and fed with an oat and hay diet.

The bulls included in this work were diagnosed lame or have their claws overgrown. Once they were in the trimming chute, the pathologies and the affected limb were registered.

Results:

153 lesions were found within the 35 bulls under study, corresponding to 12 pathologies. The 54.2% (83/153) of the clinical diagnoses were at the front limbs and 45.8% (70/153) to the rear limbs.

The most common pathology determined was overgrowth (58.8%), followed by white line disease (8.5%), double sole (7.2%), sole hemorrhage (5.2%).

Discussion:

The affected claw lesion distribution shows that the front limbs are more prone to have problems than rear ones. This is consistent with previous reports (Petri 2013), it might occur because of the impact of the front claws when the jump is conclude, which is consequent with the overload carried on these limbs.

The overgrowing can be a consequence of the poor activity of this bulls housed in individual paddocks, and also to the soft floor where the bulls stands on. With these results we consider that establishing a trimming routine to prevent or decrease the number of hoof diseases is a very important practice to look after in this kind of productive environment.

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RECORDING OF CLAW AND FOOT DISORDERS IN DAIRY CATTLE: CURRENT ROLE AND PROSPECTS OF THE INTERNATIONAL HARMONIZATION INITIATIVE OF ICAR

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Introduction: Foot and claw disorders are often accompanied by pain and are therefore a major animal welfare issue. Routinely collected conformation data of claw disorders can be used to increase the reliabilities of estimated breeding values (EBVs) (Chapinal et al., 2012). Standardization of the terminology of foot and claw disorders within and across countries supports activities including genetic evaluation. Establishing an international working group with international experts on claw health and assessing the situation in the different countries was an obvious first step towards global harmonization. An ICAR Working Group for Functional Traits (ICAR WGFT) was established and international claw health experts began working on the harmonization of descriptions of foot and claw disorders in October 2014 and this global collaboration concluded with the publication of the ICAR Claw Health Atlas in June 2015.

Education and training of claw trimmers: An on-line survey to all ICAR member countries (reply from 18 countries) revealed that claw trimmers are the main source for the collection of information and events on these specific dairy cattle disorders. It is estimated that 40 - 60 % of claw trimming is done by professional claw trimmers in most of the countries (Austria, Canada, Germany, Italy, Netherland, Norway, Sweden, United Kingdom).

Recording practices: The conditions and circumstances of claw care recording differ widely across countries, including individual free-text notes, standard forms with reference to the key for claw health on paper sheet reports, forms on mobile electronic devices, and herd management software. A key aspect of the successful initiatives to build routine genetic evaluations for claw and leg health is the development of an infrastructure for electronic documentation and recording of claw trimming data (Kofler et al., 2013).

Status of genetic evaluation for claw health: Routine genetic evaluations for claw health have been implemented in Denmark, Sweden, and Finland since 2010, and since 2014 they have published genomic breeding value for claw health. Norway has published breeding values for claw health since 2014. The Netherlands have published breeding values for claw health since 2010 and Spain and France have successfully managed to set up an infrastructure to capture claw trimming data.

International harmonization of foot and claw disorders: The broad range of recording practices and documentation schemes with mixture of descriptive and etiological codes has suggested a need for a standardized, practice-oriented approach. This motivated the ICAR WGFT to prioritize foot and claw health and to invite internationally recognized experts (claw health experts, claw trimmers, bovine practitioners, geneticists) to collaborate in the development of best practices for data recording, focusing on the standardization and harmonization. Descriptive trait definitions are used to ensure that accurate classifications are made, which will support the collection of comparable and high-quality data (e.g. for genetic evaluation purposes).

ICAR Claw Health Atlas: After the harmonized descriptions of foot and claw disorders were agreed upon by the international experts and members of the ICAR WGFT, the next step was the collection of representative photographs of each lesion in the key. The most representative examples were selected by voting. Harmonized descriptions, photographs, and other descriptive information were assembled to create the first ICAR Claw Health Atlas (Egger-Danner et al., 2015). This Atlas, published in English, will be available for translation by any country that would like to distribute it to its professionals and/or farmers. An on-line English-language version is available on the ICAR website: http://www.icar.org/Documents/ICAR_Claw_Health_Atlas.pdf.

Conclusion: The excellent cooperation of international experts on claw health enabled the ICAR Functional Traits Working Group to succeed with the ambitious plans of making available this new ICAR Claw Health Atlas. To provide better services to farmers and to facilitate the genetic improvement of farmed livestock, particularly dairy cattle, is the focus. List of references can be obtained from the first author upon request.

EFFECTS OF PRE-PARTUM DIGITAL DERMATITIS ON FIRST LACTATION PERFORMANCE

The objective of this study was to describe and quantify the effect of pre-partum digital dermatitis (DD) on first lactation performance. A cohort of 719 pregnant heifers was monitored for DD for a period of 6 mo before calving. The heifers were classified by the number of DD events diagnosed as Type I, Type II and Type III (no DD, one DD event, and multiple DD events, respectively) during this period. After calving, health during initial 60 days in milk (DIM), reproductive and hoof health outcomes, and milk production were compared between the three group types. Multivariable logistic and linear models were adjusted for age, height, and girth circumference at enrollment, as well as type of trace mineral supplementation during the pre-partum period. Overall, cows experiencing DD during the rearing period showed inferior production and health outcomes compared to healthy heifers during the first lactation. The percentages of assisted calvings, stillbirths, culls before 60 DIM, and diseased cows during the fresh period were greater in Type III compared to Type I cows. However, none of these differences were statistically significant at the 95% confidence level. Significantly lower conception risk at first service (OR [95% CI] = 0.55 [0.33, 0.89]) and increased number of days open (mean [95% CI] = 24 d [5.2, 43]) were observed in Type III compared to Type I cows. In relation to hoof health, a significantly increased risk of DD during first lactation was found in Type II and III cows (OR = 5.16 [3.23, 8.29] and 12.5 [7.52, 21.1], respectively), as well as the earlier occurrence of DD post-calving (mean [95% CI] = 59 d [20, 96], and 74 d [37, 109]). In comparison to Type I cows, significantly decreased milk production during initial 305 DIM was estimated at 199 and 335 kg for Type II and III cows, respectively. This difference was due to a greater decline in rate of production (less persistence) after peak yield ($P < 0.01$). In addition, milk production was significantly affected by the trace mineral supplementation strategy during the pre-partum period, with an increased 191 kg of milk during the initial 305 DIM in cows fed with the organic trace mineral strategy (Availa®Plus, Zinpro, Eden Prairie, MN) therefore, the results presented here have been accounted for this effect during the statistical evaluation. Given the long-term effects of DD on health, reproduction, and production, priority should be given to efficient DD prevention and control programs during the rearing

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period of dairy heifers. Such intensive intervention programs are expected to increase overall well-being and farm profitability, based on active long-term DD surveillance, mitigation of risk factors, and prompt treatment.

Keywords:

Digital Dermatitis, Milk Production, Heifer, First Lactation

PREVALENCE OF LAMENESS AND TYPE OF INJURIES IN 1351 DAIRY COWS OF 12 DAIRY PROPERTIES IN SOUTHERN CHILE

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Results:

The prevalence of lameness in dairy farms was of 11,8%. From a total of 1351 cows revised, 395 cows (29,2%) only needed a corrective paring. The number cows that required more attention were 955 units. Pathology with more prevalence was the White Line Sickness with 34,1% followed by Digital Dermatitis with 19,1%. Bleeding sole and plantar ulcer had 18,7% and 16,5%, respectively. Hinder legs predominated with a 69,1% of the total cases.

Introduction:

It is well known that lameness together with mastitis and fertility are pathologies that cause much pain, animal impairment, production loss and finally early elimination from the herd. Preventive work is an essential tool to prevent the lameness in dairy cattle. National lameness fluctuation at farm level ranges from 9,1% to 46,6%. (Borkert, 2010)

Objectives:

Description of type and prevalence of foot injuries found in 1351 dairy cows of 12 dairy farms between the communes of Rio Negro and Rio Bueno.

Materials and Methods:

The 12 farms are distributed between the commune of Río Bueno (Region XIV) and the commune of Rio Negro (RegionX) . Information was gradually lifted during regular visits between the months of January and June 2015 to determine the types of injuries. All of these properties have different realities in terms of infrastructure such as roads and milking and production rooms, all of them are under grazing systems.

An appropriate area for foot assessments (Locomotion Score) was chosen in each farm so as to observe a good movement of the batch in production. Then the venue staff carried out their work, reviewing all four legs of each cow. The simple scale of 3 degrees was used. Figure 1.-

Records were compiled in an EXCEL 2007 program, where you entered: date, affected member, foot pathology and treatment carried out.

Conclusions:

- Dairy farms must have personnel commissioned and duly prepared to detect the different degrees of lameness.
- Dairy farms must establish a program of preventive clipping to ensure the compliance with the ultimate goal of maintaining levels of lameness as lowest as possible.
- Early diagnosis of foot pathologies is essential for success in the healing and prevention of lameness in dairy cows.
- If you lack of trained personnel for this function you must contract external services to maintain rates as low as possible.

DESCRIPTION OF CLAW LESIONS IN DAIRY CATTLE FROM ONE HERD OF THE WESTERN SAVANNAH OF BOGOTA, COLOMBIA

Introduction: Lameness is one of the greatest economic concerns in dairy cattle. The effects of lameness include pain, distress, loss in production, a negative impact on reproductive performance, and an increased risk of culling (O'Callaghan 2002). Lameness incidents occur due to claw lesions in about 90 – 99% of the episodes (Hernandez et al 2002, Van Amstel & Shearer 2006). There is a few information about lameness in Colombia. Despite of this, many farmers invest in cattle-hoof care. This study was designed to identify claw lesions and locomotion score in 81 cows of one herd of the western savannah of Bogota.

Materials and methods: One dairy farm from the western savannah of Bogota, Colombia was visited from December 11th until December 15th of 2013. There were assessed 81 cows: 76 Holstein, 4 Jersey and 1 crossbreed. There were recorded all the injuries presented in the claws. A hooftrimmer performed the clinical approach. The results were registered in an excel sheet. Descriptive statistics was executed. Results – 39 cows presented at least one lesion. The other 42 cows (51,8%) did not present any injury; 11 cows (13,6%) presented lesions in one claw; 16 (19,6%) had lesions in 2 claws; 3 (3,7% of the cows) has lesions in 3 claws; 8 (9,9%) with lesions in 4 claws; and 1 cow with lesions in 5 claws. There were 89 injuries. Locomotion Score (LS) results were: LS 1: 22 cows (27,3%); LS 2: 47 (58%); LS 3: 8 (9,8%); not registered: 4 (4,9%). The most prevalent lesion of the claws was sole hemorrhage (77 findings: 86,5%); white line disease (4: 4,5%) and heel erosion (2; 2,25%). The most affected were the lateral claws from the hind limbs (51 lesions vs 8 lesions in medial claws). The medial claws from the forelimbs presented 24 lesions vs 6 lesions of the lateral claws.

Discussion: The most typical lesions found in this study were sole hemorrhages (86,5%). These lesions belong to the group of *laminitis and associated claw horn lesions, and *lesions caused by excessive hoof wear and/or trauma. (Guard 2000, Nordlund et al., 2004).

Talukdar et al (2005) reported that medial hooves of the forelimbs and lateral hooves in the hind limbs are the most affected. In this report, the findings were similar.

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There are no reports about the number of claws affected. Despite this, in this study only 13,6% of the cows presented lesions in one claw, so is recommended to check and verify all the claws to determine the real health status of this tissue.

Conclusions: Medial hooves of the forelimbs and lateral hooves in the hind limbs are the most affected. The most frequent lesions are linked to laminitis. LS 2 was the most prevalent (58%). It is essential to check all the hooves to prevent lameness.

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PREVALENCE OF BOVINE DIGITAL DERMATITIS IN COMMERCIAL DAIRY HERDS IN SOUTH EAST QUEENSLAND, AUSTRALIA

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Introduction: Bovine digital dermatitis (BDD) is a contagious disease of the feet associated with variable degrees of lameness in dairy and beef cattle worldwide [1]. The disease is characterised by ulcerative lesions of the skin around the heel bulbs and interdigital cleft which become proliferative resembling the characteristic wart-like appearance. BDD was reported for the first time in Italy in 1974 and subsequently in most regions of the world resulting in significant economic losses and animal welfare issues[2]. The first reported case of BDD in Australia dating back to 1996 revealed the presence of spirochaetes in a skin biopsy [3]. However, a subsequent nationwide survey for BDD in Australia failed to detect spirochaetes in skin biopsies from suspected lesions sent for laboratory diagnosis[4]. The current study was designed to determine the prevalence of digital dermatitis in commercial dairy herds in South East Queensland, Australia.

Materials and Methods: Dairy farms serviced by the University of Queensland (UQ) veterinary practices were enrolled in the study. The study started in June 2015 and is expected to be completed by December 2016. Lactating cows from participating dairy herds were assessed for the presence of digital dermatitis lesions on the rear legs during routine milking [5]. Cows with active clinical lesions were subsequently restrained in a cattle crush and affected legs were lifted and secured for biopsy collection. Biopsy sites were gently cleaned with water and anaesthetized by injecting 10–15 mL of 2% lignocaine (Lignomav, MAVLAB™) subcutaneously. One 6 mm full skin thickness punch biopsy (Biopsy Punch, Paramount Surgimed) from a representative area of the lesion was collected and placed in 10% neutral buffered formalin and submitted for histopathological evaluation using haematoxylin-eosin and Warthin Starry Silver staining [2].

Results: Three dairy herds were evaluated between June and August 2015, herd 1 (n=185), herd 2 (n=180)

and herd 3 (n=262). The overall prevalence of digital dermatitis lesions in these herds was 42.3%, while the herd level prevalence was 75.2%, 52% and 0% for herds 1, 2 and 3 respectively. Additionally, 29% of the lesions were classified as M1, 39.8% as M2, 22.5% as M3 and 8.7% as M4. A total of 20 biopsies were collected from herds 1 and 2 (13 and 7 correspondingly). Histopathology findings revealed a hyperplastic epidermatitis and dermatitis with intra-epidermal pustules, characterised by diffuse, moderate to marked epidermal hyperplasia. The marked hyperkeratosis is predominantly orthokeratic. In some sections, approximately 5-10% of the epidermis is affected by multifocal intra-epidermal pustules and areas of intracellular oedema containing a moderate to dense population of karyorrhectic neutrophils. These are sometimes associated with dense mats of elongate bacteria. These pustules are found in all layers of the epidermis. There are often large numbers of mixed surface bacteria. Within the dermis, there is a perivascular to coalescing, moderate population of plasma cells, lymphocytes, eosinophils and macrophages. Furthermore, spirochaetes were detected in the horny columns of the stratum spinosum of skin biopsies collected from herds 1 and 2.

Conclusions: This study is the first attempt to determine the prevalence of digital dermatitis in South East Queensland, Australia. The preliminary findings of this study indicate that digital dermatitis is present in dairy herds in the region but more farms need to be evaluated in order to provide an accurate prevalence. A recent study screening for BDD lesions in 224 dairy herds in New Zealand found a prevalence of 64% (Chesterton 2015, personal communication). Such findings and the results of this study indicate that the disease is emerging in pasture based dairy herds and therefore it is critical to determine the true prevalence to implement appropriate prevention and control measures.

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THE APROCAL ROLE IN THE ARGENTINIAN HOOF DISEASE PREVENTION

Introduction:

APROCAL is a thirty year old Argentinian non-profit agency that struggle to obtain high quality milk standard, healthy and long-lived cows; working on several areas of the dairy industry like mastitis, animal welfare, milk quality, human resources, milking technologies, environmental impact and recently has create the newest commission to work on hoof diseases. The aim of this commission is to develop strategies, extension educative articles, stimulate to create scientific exchange, to organize congresses, seminars, conferences and every activity to improve the quality of milk and their products and prevent hoof pathologies, targeted to the members of the Argentinian dairy sector, including veterinarians, dairy producers and hoof trimmers, to show to the entire dairy chain to be conscious of the hoof problems.

Materials and methods:

The APROCAL's Hoof Affections Commission had been created in December 2014, formed by eight veterinarians who works like hoof trimmers, supported also by National Universities. This commission had meetings once a month to create reports to show at the community like brochures, articles in dairy journals, theoretical and hands on meetings with farmers, veterinarians and hoof trimmers, working in more than 30 dairy farms within more than 10,000 cows at milking.

Results:

In these eleven months of work the commission had made several conferences and field days to communicate to the dairy society some key points to fight against the claw problems, and to stablish different situations to control, routines to have and basically to get in conscious that a lame cow is a huge problem. It is close to publish some articles in magazine of the dairy industry and all the Members are compiling data about claw disorders with the objective of get an idea about the dimension of this issue in Argentina, and once for all to start the battle against it. These preliminary results shown a 21.7% of lame cows prevalence and also shows that Digital Dermatitis (25%) and White Line disease (13%) were the most common problems found.

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Discussion:

Nowadays the Argentinian dairy situation needs lots of work to be done respect to the hoof problems, we think that the role of this kind of agency is essential to get an idea about the real impact that a lame cow cause to the entire system, in the Argentinian environment who combines many farms under grazing livestock production and other ones under confined production system.

IMPACT OF LAMENESS ON REPRODUCTIVE PERFORMANCE OF GRAZING DAIRY COWS

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Introduction:

The objectives were to study the influence of timing of lameness case occurrence on lactation on lactational and reproductive performance in grazing dairy cows.

Material and Methods:

A four-year retrospective longitudinal study was conducted in one commercial dairy farm in Argentina (35°37' S, 61°22' W). Eleven thousand and sixty one cow records were included in the study. Records were retrospectively divided in four groups according to time in lactation when the first lameness case was reported: control or healthy cows (G0), first lameness case prior to first postpartum AI (G1), first lameness case between first postpartum IA and pregnancy diagnosis (G2), and first lameness case after diagnosed pregnant (G3). Data were collected from cows that calved and were dried between January 2010 and December 2014. Lameness cows (G1-G3) did not have other concurrent disease at the same time during lactation (lameness, uterine infections, anovulatory conditions, and mastitis).

The statistical models included the fixed effect of Group (0 through 3), year (2010-2014), season of parturition (spring, summer, fall, and winter), parity (1, 2, 3+), and their second-order interactions. The lameness effect on the risk for being inseminated by 80 days in milk (DIM, [AI80]), pregnant by 100 DIM (PR100), and open by 200 DIM (OP200) were evaluated. Modeling was performed using a manual backward elimination method with an exclusion criteria set at $P > 0.2$. The GLIMMIX, PHREG and LIFETEST procedures of SAS were used (3).

Results: The risk for AI80 was affected by Group since the odds ratio (OR) were 0.34 (0.26-0.44) for G1, 0.59 (0.47-0.74) for G2, and 0.48 (0.40-0.57) for G3 compared to G0 cows ($P < 0.001$). The risk for PR100 was also affected by Group since the odds ratio (OR) were 0.47 (0.40-0.61) for G1, 0.37 (0.30-0.46) for G2, and 0.68 (0.57-0.80) for

G3 compared to G0 cows ($P < 0.001$). The risk for OP200 was affected by Group since the odds ratio (OR) were 1.58 (1.23-2.04) for G1, 1.46 (1.18-1.81) for G2, and 0.95 (0.79-1.14) for G3 compared to G0 cows ($P < 0.001$). Finally, the median days to conception were 96 for G0 cows, whereas they were 126, 158 and 128 for G1, G2 and G3 cows ($P < 0.001$). Conversely, Group had no effect on the hazard ratios (HR) for pregnancy ($P = 0.801$) given that the HR were 0.90 (0.66-1.22) for G1, 0.83 (0.67-1.03) for G2, and 0.93 (0.76-1.14) for G3 cows.

Conclusions and Discussion:

Lame cows have lower risk of being inseminated by 80 DIM and pregnant by 100 DIM, and higher risk of still being open by 200 DIM. In addition, the time at which the cow became lame is also important given that its negative impact is greater when it occurs before conception. Our data is in agreement with previous results in pasture-based dairies (1-2). In conclusion, lame cows under grazing conditions have worst reproductive performance than non-lame herd mates.

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POST MORTEM MORPHOMETRY OF THE OVINE CLAW

Introduction: Bovine morphometry and biomechanics is well understood and was essential to elucidate the ethio-pathogenesis of classical sole ulcer (Kümper 1997). The understanding of claw quality was necessary to lay the foundations of modern claw selection principles (Politiek et al. 1986), but very few articles address the healthy ovine claw conformation (Lambertz et al. 2014). We were not able to find literature about the sensitive laminae of the ovine corium.

Material and Methods: One hundred and twenty one horn shoes of adult female sheep belonging to the university sheep flock were extracted using the method of Ossent & Lischer (1997) after the animals died or were euthanized. All animals were of a mixed (Ile de France x Texel) breed. Afterwards a positive silicone mold was prepared of each claw shoe using a technique described elsewhere (Debas et al., 2015). The length of the axial and abaxial wall of the mold was then measured (cm), the number of the laminae of the corium was counted and the internal (mold) toe angle and the external (claw horn) was measured. From six sheep, we have the correct identification of all claws (anterior, posterior, medial and lateral), whereas from the others we have only the identification if it was anterior (thoracic limb) or posterior (pelvic limb). The measurement values were statistically analyzed (t-Test) comparing the position (abaxial x axial; medial x lateral; thoracic x pelvic).

Results: The numbers of the laminae counted were different ($P < 0,0001$) between the abaxial (mean = $77,87 \pm 16,13$) and the axial wall (mean = $51,18 \pm 11,95$). The axial wall has a mean length of 2,68 cm and the abaxial wall of 4,23 cm ($P < 0,0001$). The internal (mold angle) was steeper ($53,84^\circ$) than the external wall angle ($48,48^\circ$) ($P < 0,0001$). There were no statistical differences between the length of the axial wall of thoracic or pelvic claw, neither of the abaxial wall. The internal angle, measures upon the mold was not different between the four members, but the external angle showed a much steeper angle for the pelvic horn shoe. Also the number of laminae were higher in the thoracic horn shoe (mean = 129,5) compared to the pelvic horn shoe (mean = 131,6) ($P < 0,001$). The thoracic limb, the medial horn shoe has more laminae than the lateral

Discussion and Conclusions: The results show that also the sheep has a stronger supporting apparatus in the abaxial wall, binding the wall to the distal phalanx through the laminar corium much stronger than on the axial wall. The same observations were made in cattle. The mold reproduces exactly the internal structures of the horn shoe of the ovine digit. It could also be used for volume measu-

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rements. The present study is the first analyzing the ovine digit morphometrically in Brazil.

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REPORT OF A RARE CASE OF DIGITAL DERMATITIS ON RUDIMENTARY HOOF OF DEWCLAW IN DAIRY COW

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Introduction:

Bovine digital dermatitis (DD) is recognized as an important and painful infectious disease of the feet in intensively managed cattle, being characterized by circumscribed ulceroproliferative lesions involving the skin near the interdigital cleft at the plantar aspect of the feet. The cause of DD is multifactorial with an essential spirochetal bacterial component (2). On the other hand, the white line disease (WLD) is a common lesion registered on pastured-based systems, defined as a non-infectious condition that occurs when the sole separates from the side wall of the hoof and therefore it should not be present on the rudimentary hoof, however the accurate anatomy of this is unknown (3). These lesions are finding frequently affecting the feet of cows, however this presentation of DD in the dewclaw is uncommon and it has not been described.

Material and Methods:

During December 2014 in a dairy farm located in Purranque, Los Lagos, Chile, a cow (6,800 L/lactation and five years old) with grade 3 lameness an intermittent periods of non-lame was identified using the mobility score of Dairy Co ranging from 0 to 3. This was introduced in a hoof trimming chute where clinical examination was performed to each foot, washing with water and brush to remove the organic material with the help of hoof knife, in order to diagnose the lesions. Treatment consisted in a trichotomy of the affected area up to two centimeter around the lesion and curettage of it, then chlortetracycline in spray was applied until covering the entire lesion.

Results and Discussion:

In the left hindlimb was found a DD accompanied by an infected lesion similar to a WLD located in the rudimentary hoof of outer dewclaw, which it was treated as described. No lesions were found in any of the other members. After a week the cow was revised finding a significant regression of the lesion and not presenting claudication, continuing with the same cleaning and treatment. Finally, it was revised after 25 days from the start of treatment achieved complete remission. The lesions found would have two origins, on the one hand the DD it has infectious origin associated to facilities and farm hygiene and transmission among animals, while the origin of the other lesion it is uncertain. It could be an extension of the infection caused by DD, a strange case of WLD where foreign material would have infected the possible white line region generating an abscess or as a result of trauma in the area, however a second case was registered the following week (1).

Conclusion:

There is a rare presentation of DD on rudimentary hoof of dewclaw in bovine, which it can be successfully treated as described.

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AN OUTBREAK OF TOE-TIP NECROSIS IN ANGUS FEEDLOT CATTLE

Introduction:

"Toe-tip necrosis" or "toe-tip necrosis syndrome" (TTNS) is a condition affecting cattle that refers to the claw apical white line separation, with tissue necrosis and clinical lameness. The typical presentation is a progressive lameness in the first weeks coming off pasture into feedlots. The outer claws of the rear legs are most commonly affected. The condition is still poorly understood but believed to be of traumatic origin, associated with walking on concrete floors, or injuries related with moving through loading ramps, alleys and chutes. Hyper-excitable cattle are apparently at a greater risk of developing toe-tip necrosis, which further points towards a traumatic cause. Bovine Viral Diarrhea (BVD) virus infection has been suggested as a predisposing factor, probably secondary to vasculitis. Reports in the literature on this condition are scarce.

Materials And Methods:

Two, 8-month-old Angus heifers, approximately 300 kilograms weight, were euthanized and submitted for necropsy to CAHFS - Tulare branch with a herd history of rear legs lameness, swelling and occasional sloughing of hooves. Twenty five out of a group of 100 animals were affected. The group had been moved two weeks before the onset of clinical signs from a pasture in the foothills to a feed lot housing approximately 20,000 cattle. Before shipment the animals were gathered in 'rocky hill pastures', an area in the foothills with large numbers of rocks and little grass. The lack of feed and water was the main reason for shipping to a feedlot, which is a common practice in late summer in central California.

Results And Discussion:

During necropsy, similar lesions were detected in both heifers. Affecting the lateral (outer) toe of the right rear leg, small cracks, approximately 5 mm long, were detected on the hoof's white line, creating a minimal separation between the dorsal and solar aspects of the hooves. In one animal, longitudinal section of the affected claw and associated bone demonstrated a small focal area of necrosis in the distal portion of the 3rd phalanx. Moderate amount of necrotic and purulent debris infiltrating the surrounding connective tissue and dissecting between the bone and the hoof (on both, solar and dorsal aspects) were also detected. In the second animal, the lesions were more severe and extensive, with severe swelling of the limb up to the hock, with poorly

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demarcated foci of necrosis, large amounts of fibrin and purulent material expanding the subcutis and infiltrating the digital flexors sheaths. Bacteriological cultures from the necrotic foci demonstrated environmental and opportunistic bacteria. *Trueperella pyogenes*, *Proteus* sp. and Coliforms were isolated aerobically. *Fusobacterium necrophorum*, *Pigmented Prevotella / Porphyromonas* sp., *Peptostreptococcus anaerobius*, *Bacteroides fragilis* group and mixed flora were isolated anaerobically. Heavy metals and selenium screen in liver tissue detected selenium deficiency in both animals. Hepatic selenium levels were determined 0.16 ppm and 0.14 ppm. (ref. interval 0.25 – 0.5 ppm).

Conclusions:

The lesions found in these animals were consistent with the condition in cattle recently named "toe-tip necrosis" or "toe-tip necrosis syndrome" (TTNS). The reason for the outbreak was not determined however, stress and sudden environmental change from foothills to rocky or concrete floors and shipping are suspected to be the predisposing/ triggering factors. These animals had had minimal exposure to human handling before and were described as very strung on arrival to the feedlot. Transportation from rocky grazing grounds, high-strung temperament and hard dirt floor were probably important risk factors. Selenium deficiency might have also contributed as a predisposing cause. The insult to their hooves (if that's the etiology) could have happened jumping out of the chute into concrete floors at processing or running on hard dirt floor pens.

PREVALENCE OF LAMENESS IN 620 COWS AND TYPE OF CLAW LESIONS IN 130 LAME COWS FROM A JERSEY HERD IN SOUTH AREA OF CHILE

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Introduction:

There are few studies in Chile about the prevalence of lameness in dairy cows in the south area. Some authors have reported prevalence between 9.1 and 46.6%. The prevalence of lameness found in other countries (including Israel, New Zealand and USA) vary from 3.8% to 30%.

Objective:

Determinate the prevalence of lameness in 620 cows and the type of claw lesions in 130 lame cows from a dairy farm in south area of Chile.

Material and Methods:

A dairy farm in the XV region of Chile was visited in February of 2015. A veterinary doctor attended and collected the data from 620 cows that was the total amount. The results of the lame cows were used to determinate the prevalence and the type of lesions. In all cows all four feet were examined in an electro hydraulic vertical chute (KVK Hydra Klov 650-Sp2).

Results:

The average prevalence of lameness was 20,96%. It was performed functional trim a total of 620 cows. Of the total of cows who was checked a 53,70% only required a preventive trim, a 25,32 % required a curative trim featuring mild lesions (it was not necessary to use rubber block or bandages). Of the lame cows 12,42% needed a rubber block and a 20,48% of the lame cows needed a cohesive bandage. The three most frequent lesions were overgrowth (20,16%), white line disease (16,13%) and ulcer (15,48%).

Conclusion:

The average prevalence of lameness is similar to recent studies in southern Chile. The overgrowth and white line disease was the most common lesion; this is similar from other results found in southern Chile. The high percentage of overgrowth shows the lack of preventive trim of the dry cows, this may be because this management is not a priority for our milk producers and has not been incorporated as part of an animal health program.

RESULTS OF LOCOMOTION SCORE APPLIED ON THREE DIFFERENT DAIRY HERDS AND LESION FOUND FROM THE MILKING PIT

Introduction:

Locomotion score is a tremendous tool in the prevention and control of lameness. Allows us to diagnose the total number of lame cows in the herds, including the sub acute lame cows, so that farmers can define the goals and objectives to tackle the problem.

Objective:

Implement the allocation of locomotion score with a scale of 1, 2 or 3 to stratify the herd according to their locomotion. Observe all cows from the milking pit to found visible lesions on the feet.

Material and Methods:

Three lactating cow herds of different breed (Jersey, Holstein and Jersey x Holstein) in the XV region of Chile were observed during March and April of 2015 on the way out of the milking parlor.

The feet were observed from the milking pit with the aid of a flashlight and visible lesions like overgrowth and digital dermatitis were recorded. All the observations were performed for the same trained person. The idea was to use a simplified scale to incorporate monthly locomotion score. These cows were classified according to their locomotion score as 1, 2 or 3 (1 = normal, 2 = abnormal movement with arched back, 3 = abnormal movement with evident limb pain and lameness).

Results:

- Jersey herd: Of the 1.109 milking cows 91,79% were classified as grade 1, 1,71% were classified as grade 2 and 6,49% were classified as grade 3. The results of the observation from the milking pit show that 24,8% of the cows present overgrowth and 1,62% presents digital dermatitis lesions.
- Holstein herd: Of the 1.395 milking cows 68,22% were classified as grade 1, 16,49% were classified as grade 2 and 15,27% were classified as grade 3. The results of the observation from the milking pit show that 31,83% of the cows present overgrowth and 5,23% presents digital dermatitis lesions.
- Jersey x Holstein herd: Of the 771 milking cows 64,48% were classified as grade 1, 30,48% were classified as grade 2 and 4,54% were classified as grade 3. The results from the observation in the milking pit

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show that 5,32% of the cows present overgrowth and 4,41% presents digital dermatitis lesions.

Conclusion:

The allocation of locomotion score gives relevant information about evident and sub acute lame cows, so it could be possible to prioritize the evaluation and treatments of locomotion score grade 3 cows and then examine the grade 2 cows.

In the three herds we found percentage of cows grade 3 close to or greater than 5%. In the three herds we found digital dermatitis lesions. In two herds we found overgrowth percentages greater than 20%, this results show the lack of establish hoof trimming routine. Observe the cow feet from the milking pit is a good complement to locomotion score because there are lesions that can be seen with the naked eye for example digital dermatitis, identify the presence and severity of this disease is key to keeping the digital dermatitis under control.

PREVALENCE OF LAMENESS IN ONE HERD OVERO COLORADO BREED IN SOUTHERN CHILE

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Introduction:

Lameness causes pain, deterioration of animal welfare and economic losses. Lameness is considered a multifactorial disorder, where feeding practices, environment, infectious processes, genetics and behavior, both animal and human, are risk factors. In Chile there are few studies about the prevalence of lameness in dairy cows. Some authors have reported prevalence of 46.6% (1986), 11% (1970), 31.3% (1985) and 9.1% (2003), respectively by year. The prevalence indicated for other countries vary from 3.8% to 7% in New Zealand, 5% in Israel and up to 30% in USA.

Objective:

Determinate the prevalence of lameness in 151 cows and heifers of one Overo Colorado breed herd and the prevalence of type of lesions in 95 animals. These 151 cows and heifers were the total of animals of this herd.

Material and Methods:

The Overo Colorado breed it has its origin in northwestern Europe, considered dual purpose breed and one of their characteristics is rusticity. It has an average milk production of 4.500 lts in pasture system.

One seasonal milk production dairy farm in the Los Lagos region of Chile was visited in June of 2015, a veterinary doctor attended and collected the data from 95 animals with lesions to determinate the prevalence of type of the lesions. In all cows all four feet were examined in an electro hydraulic vertical chute (KVK Hydra Klov 650-Sp2).

At the moment of hoof trimming all cows were in the dry period and heifers were pregnant. The herd was composed by 126 cows and 25 pregnant heifers. From the 95 animals with lesions 12 were heifers.

Results:

The prevalence of lameness was 26,49%. The mean of cows with lesions was 62,91%. The four most frequent lesions were white line disease (45,7%), sole hemorrhage (12,6%), double sole (7,3%) and ulcer (4,6%). A 33,8% of the cows only need a preventive trim. A 9,9% of the cows show some kind of lesions who require a rubber block and 23,8% a cohesive bandage. None cow was recommended for elimination. From the 83 cows with lesions, 4,82% needed a rubber block, 24,09% cohesive bandage and 12,05% rubber block and cohesive bandage. In the other hand, from the 12 heifers that presented lesions, 41,66% needed cohesive bandage and 8,33% a rubber block and cohesive bandage.

Conclusion:

The prevalence found is similar to other studies in dairy cows in Chile. A 48% of pregnant heifers present some kind of lesions, for this reason we think is important as a preventive management hoof trim the heifers 60 days before calving.

PREVALENCE OF LAMENESS IN 1700 DAIRY COWS AND THE TYPE OF CLAW LESIONS IN 148 LAME COWS FROM FIVE DAIRY HERDS IN CENTRAL AREA OF CHILE

Introduction:

The productive life of cows in intensive milk production system has become shorter and is now recognized that it is economically unacceptable. High producing cows in intensive environments are dealing at the limit of not achieving their genetic potential for production. In Chile the confinement system is used in the central area of the country, the cows are maintained in barns and have a high level production.

Objective:

Determinate the prevalence of lameness in 1700 cows and the type of claw lesions in 148 lame cows from five dairy farms in central area of Chile.

Material and Methods:

Five dairy farms in the metropolitan, V and VI regions (central area) of Chile were visited between May and August of 2015. A veterinary doctor attended and collected the data from 148 lame cows to determinate the prevalence and the type of the lesions. In all cows all four feet were examined in an electro hydraulic vertical chute (KVK Hydra Klov 650-Sp2).

Results:

The average prevalence of lameness was 8,7%. The five most frequent lesions were overgrowth of the horn (54,47%), white line disease (13,2%), double sole (10,45%), digital dermatitis (9,35%) and heel erosion (5,78%).

The hind limb was the most affected in 55,96%. A 4,54% of the lame cows needed a rubber block and a 15,82% of the lame cows needed a cohesive bandage. In a 30,26% of the cows it were only needed a preventive trim. The elimination was recommended in 4 cows due to the severity of the lesions.

Conclusion:

The average prevalence of lameness is similar to recent studies in southern Chile. The overgrowth was the most common lesion; this is different from the result found in southern Chile where the most common lesion was white line disease. This may be explaining in part because in the central area of Chile the cows are maintained in barns and not in pastures, here the

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cows have to walk less and therefore less wear their hooves. Also in the most of the farms of the central area there is not a establish hoof trimming routine.

BAYESIAN ANALYSIS OF CHANGES IN BLOOD BIOMARKERS ASSOCIATED TO LAMENESS IN DAIRY COWS

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Introduction: Lameness in dairy cattle can be defined as a deviation of locomotion in response to pain and inflammation caused in 90 percent of cases by different claw affecting conditions. This is an important problem for the modern dairy industry due to its economic impact and its effects on animal welfare. According to Leach et al. (2012) early identification of lame cattle is necessary in order to improve recovery and decrease lameness prevalence.

Today, the most common methods to detect lameness involve the visual analysis of any component of gait. Several gait-scoring systems exist, nonetheless, these methods are highly subjective and differences between observers may arise. Furthermore, according to Tadich et al. (2010) gait-scoring systems may not be sensitive enough to detect all lesions causing pain and discomfort. Therefore, multiple efforts are currently underway to improve and develop more sensitive and objective measurements that could be used for lameness diagnosis.

Blood biomarkers correspond to well defined and specific biochemical substances which have proven useful in the diagnosis and treatment of different conditions (Marchi et al., 2009). A recent study of our group (Rodríguez, 2014), using frequentist methods showed changes in plasmatic concentrations of norepinephrine (NE), beta endorphin (BE) and substance P (SP) only in cows with mobility score (MS) 3, which does not correlate with pain and lesions diagnosed in animals with MS 1 and 2. The aim of this study was to analyze by Bayesian Estimation of groups (BEST, Kruschke, 2013) the differences between selected biomarkers and their relationship with the mobility scoring, allowing us to suggest a marker for futures studies to improve the early detection.

Materials And Methods: The present study was carried out between June 2013 and January 2014, in 17 dairy farms from Southern Chile located in Los Ríos and

Los Lagos regions. A total of 100 Friesian, Kiwi cross and Jersey cows were used, which were grouped according to their mobility scores (MS 0 – 3: n = 25 per group). Animals were introduced in a crush for clinical examination and to determine the lameness cause and also to discard the presence of concomitant diseases that could alter the plasma concentration of the analyzed biomarkers. From each animal blood (10 ml) was collected and centrifuged for plasma separation. Biomarkers included norepinephrine, beta endorphin and substance P, which were measured using sandwich ELISA validated for bovine plasma (Cusabio Biotech, Wuhan, China). Statistical analyses include Bayesian methods using the software BEST (RStudio ver. 0.98.1091). The level of significance was $P < 0.05$.

Results And Discussion: Using the Bayesian estimation (BEST), we found that the precision of credibility of the parameters of NE, BE and SP for estimates falls 95% HDI (Highest Density Interval) inside the null value (zero), then, there were no significant differences between groups. However, the difference between BE MS 0 and MS 2 (93.7%), MS 1 and MS 2 (93.9%), MS 2 and MS 3 (97.3%); for SP MS 0 and MS 3 (93.1%), MS 1 and MS 3 (92.9%), were over 90% suggesting relationship between the mobility scoring and levels of those biomarkers. Further studies are necessary to improve the biomarker measures due the high variability and standard deviation on data.

Conclusions: Among biomarkers, BE was the most promising biomarker, being found differences between MS groups over 90%, excepting between MS 0 and MS 1. However, due the high variability, for further studies must be necessary to try a more sensitive method for this biomarker.

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RESULTS OF LOCOMOTION SCORE APPLIED ON FIVE DIFFERENT DAIRY HERDS ASSOCIATED WITH PRODUCTIVE AND REPRODUCTIVE INDEX

Introduction:

Lameness is a major cause of elimination and shortening of cow's useful life. Often valuable cows should be early eliminated increasing the replacement rate of the flock. Most lame cows are not eliminated for being lame but rather to associated problems, such as infertility.

Objective:

Implement the massive use locomotion score by milk samplers from Cooprinsem with the simplified scale of locomotion score (1, 2 and 3) as an additional tool to the milk control and cross the information obtained with productive and reproductive index.

Material and Methods:

It was started by making a theoretical training for milk samplers Cooprinsem (private company) about the allocation of locomotion score and lesions that can observe from the milking pit. In a second instance a practical training was conducted on a dairy farm where milk samplers had the opportunity to assign locomotion score and watch the hooves from the milking pit.

From a total of 29 dairy farms that made locomotion score along with Cooprinsem milk control from October 2013 to June 2015, a total of 5 farms were selected, this is equal to 2733 milking cows that had more complete information about the productive and reproductive index. As productive index it was take average milk production according to locomotion score. Furthermore, reproductive indicators as first post calving service (LCFS), calving to conception period (LCC), open days (OD) was collected for cows with score 1 in relation to those with score 2 and 3 together.

Results:

Of a total of 2733 milking cows classified 87.2% present score 1, a 6.6% score 2 and 6.2% score 3, so we can assume that 12.8% of classified cows present any abnormal movement.

Regarding the productive index cows with score 1 has average milk production 23.72 liters, the score 2 22.90 liters and score 3 19.46 liters showing a difference of 4.26 liters between score 1 and 3.

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In relation to the LCFS index for the cows with score one (85.4) it was 7.8 days less than cows with score 2 and 3 (93.2). The LCC was 39.2 days longer for cows with score 2 and 3 (156.4), for cows with score 1 (117.2). The OD were 104.2 more days for cows with score 2 and 3 (172.2) in relation to cows with score 1 (68).

Conclusion:

Simplified locomotion score is a tremendous tool that gives added value to milk control. Provides valuable information when is crossed with productive and reproductive index and exposed very clearly the economic impact on the dairy farmer.

RESULTS OF LOCOMOTION SCORE APPLIED ON 29 DAIRY HERDS AND THE ASSOCIATION WITH PRODUCTIVE INDEX

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Introduction:

A lame cow is less competitive for resources such as water, forages and concentrates, is definitely unproductive because the associated pain reduce the ability of movement and this will have a consequence in her productivity.

Objective:

Implement the massive use locomotion score by milk samplers from Cooprinsem with the simplified scale of locomotion score (1, 2 and 3) and observe all cows from the milking pit to found visible lesions on the hoof as an additional tool to the milk control.

Associating the different hoof pathologies observed from the milking pit and cross the obtained information obtained with production index and milk quality.

Material and Methods:

It was started by making a theoretical training for milk samplers Cooprinsem (private company) about the allocation of locomotion score and lesions that can observe from the milking pit. In a second instance a practical training was conducted on a dairy farm where milk samplers had the opportunity to assign locomotion score and watch the hooves from the milking pit.

From 29 dairy farms that made locomotion score along with Cooprinsem milk control from October 2013 to June 2015, this is equal to 13020 milking cows from a total amount of 56344 samples this corresponds to unique samples or samples taken in more than one occasion. As productive index it was

take average milk production according to locomotion score. The milk samplers collect the information of milk production, fat, protein and somatic cell count (SCC).

Results:

Of a total of 56344 controls in 13020 milking cows resulting in 88.35% show locomotion score 1, a 5.65% score 2 and 5.99% score 3 so we can assume that a 11.64% of the cows were classified with abnormal movements.

Regarding the productive index cows with score 1 has average milk production of 24.64 liters, the score 2 23.80 liters and score 3 20.96 liters showing a difference of 3.68 liters among cows 1 and 3. It was also observed an increase in the SCC associated with locomotion score, scores 1 254, score 2 323 and score 3 416. Fat and protein were unchanged. From all the observations made in the milking pit a 10.55% of the cows had easily identifiable lesions. Of all the lesions identified the 77.50% were overgrowth, digital dermatitis 12.67% and others 9.80%.

Conclusion:

Simplified locomotion score is a tremendous tool that gives added value to milk control. The observation from the milking pit performed by the milk sampler is a good complement to locomotion score. This is because in practice we find many cows do not have an alteration in their locomotion but nevertheless in hoof trimming at the dry period they have lesions that if are not intervened promptly will cause lameness in the next lactation. Also gives us information in relation to hoof care because high percentages of overgrowth observed from the milking pit shows the lack of lack of establish hoof trimming routine in the dry period.

PREVALENCE OF LAMENESS IN 204 HIGHLANDER AND CORRIDALE SHEEP AND TYPE OF CLAW LESIONS

Introduction:

Lameness is one of the most widespread welfare problems in the sheep flock around the world. It is a significant cause of discomfort and pain and is a major source of economic loss to the sheep industry. An animal suffering from lameness is less able to graze and compete for feed. The consequences of lameness include: Decline in body condition, lower lambing percentage, lower lamb birth weight, reduced growth rate in lambs, reduced milk production, lower fertility in rams and reduced wool growth.

Objective:

Determine the prevalence of lameness in 204 sheep and the type of claw lesions in 136 lame sheep from one flock in south area of Chile.

Material and Methods:

A sheep flock in Los Lagos region was visited in September of 2015. A team of 11 veterinary students and one veterinary doctor attended and collected the data from 204 sheep, this was the total flock. 100 sheep correspond to Corriedale breed and 104 correspond to Corriedale x Highlander. The results of the lame sheep were used to determine the prevalence and the type of lesions.

For the hoof trimming the sheep was subject by an assistant, who placed the sheep in sitting position, to expose all four limbs. Each limb was examined individually, cleaning the hoof to show the lesions and then proceeded to trim.

The lesions were classified according to Target lameness for Better Returns booklet (University of Warwick) in the next lesions: interdigital dermatitis, footrot, contagious ovine digital dermatitis, toe granuloma, toe abscess, shelly hoof and overgrowth.

Results:

The average prevalence of lameness was 66,67%. It was performed functional trim a 33,33% sheep. The most frequent lesions were shelly hoof (67,64%), overgrowth (27,20%), contagious ovine digital dermatitis (14 %), toe granuloma (9,55%) and footrot (1,47%).

Discussion and conclusion:

The average prevalence of lameness is similar to recent studies in southern Chile. The shelly hoof and

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overgrowth was the most common lesion; this is similar to other results found in southern Chile, in this study Tadich y col. found 95% of all sheep examined had at least one lesion in one of their feet and 69% of all sheep had more than one lesion. In the same study they found the overgrowth, wall separation and white line lesions were the most common lesions.

Hoof trimming is a management that was not routinely carried out in the flock examined in fact this was the first time that hoof trim was performed; we think this management should be incorporated as part of an animal health program to reduce the presentation and severity of lesions.

PREVALENCE OF LAMENESS IN DAIRY COWS FROM COLOMBIA: A SURVEY OF TEN FARMS IN THE HIGH TROPICAL AREA

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Introduction:

Lameness is one of the most widespread welfare problems in the dairy cow around the world and it is common in dairy cows managed in a variety of different farming systems. There is little information about lameness in Colombia, thus the objective of this study was to determinate the prevalence of lameness in cows from ten dairy herds in the high tropical area of Colombia.

Materials And Methods:

Ten dairy farm located in the high tropical area of Colombia (2600 to 2800 meters above sea level) were assessed. All farms use predominantly Holsteins and managed in a daily rotational grazing system typical for this region. Cows grazed a ryegrass dominant pasture (*Lolium perenne*) and commercial concentrate were fed in the milking parlor during morning and afternoon milking. All animals were milked twice daily. A single veterinarian attended and collected the data on management, facility and stall design. Cows were locomotion scored as they exited the parlor using a 5-point numerical rating system (Sprecher et al., 1996): where 1 = sound and 5 = severely lame. A survey was done with participating farmers, and consisted in questions divided into the following categories: 1) Managing lameness in your herd; 2) Finding lame cows in your herd and 3) Prevention and treatment of lameness.

Results And Discussion:

600 milking cows were evaluated and 10 farmers (one for each farm) respond the survey. Four farms had a herd size of 50 milking cows or less, and

six farms had herds between 511 and 152 milking cows. 30% of herds surveyed currently use a fix milking parlour and 70% use a mobile milking parlour. The average prevalence of lameness was 32.9% (prevalence of cows scored as ≥ 2), with a range between 18,8% and 56%. Of the lame cows 8,49% presented clinical lameness (prevalence of cows scored as ≥ 3) and only 0,16% severe lameness (prevalence of cows scored as = 5). Only 4 farmers assisted to training courses, but none in cattle-hoof care. Eight farm owners indicated that they do not employ a professional hoof trimmer at all. Furthermore, only 3.5% of lame cows were scored as lame by the farmers, indicating that farm owners and farmers in general perceive lower prevalence of lameness.

Conclusion:

The high percentage lameness in the high tropical area of Colombia shows the lack of preventive trim of the cows, mainly because this management has not been incorporated as part of an animal health program by the farmers of the region.

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EFFECT OF LAMENESS ON CULLING OF DAIRY COWS IN THREE HERDS IN THE SOUTH OF CHILE

Introduction:

Lameness is considered as the third cause of culling after fertility problems and mastitis. The objective of this study was to determine the position that lameness occupied as a cause of culling cows in three dairy herds in the South of Chile.

Material and Methods:

Records of the years 2011, 2012 and 2013 from three herds, which had between 340 and 560 milking cows and reliable, complete and individual records, were used. The herds were selected by convenience, considering easiness of access and the desire of producers to participate. To assess the causes of elimination they were grouped by affected systems, in item lameness were considered all foot conditions. In addition, we recorded final destiny of cows, age, number of lactations and duration of the last lactation of cow at the time of being eliminated. Data were analyzed with a computational statistical program R version 3.0.3 for Windows.

Results:

The average culling rate of herds A, B and C was 21.3%, 14.3% and 21.2%, respectively. From these eliminations, hoof conditions accounted for an 18.7%, 16% and 9.7% in the respective herds, being the third main cause of elimination after the reproductive and mammary gland problems. Cows removed by hoof conditions were mainly sold to abattoirs, cattle markets or other farms. The average age of culling because of lameness was between 5.5 and 6.9 years. Between 16% and 50% of culling due to lameness occurred in the first lactation (depending on the year and flock studied). Most of the eliminations by lameness occurred at the end of lactation.

Discussion:

Yet lameness is one of the three main causes of elimination, being similar to national and international studies the order of each cause of culling varied in different years and herds. Though lameness problems in dairy cows has been described to peak at 12 weeks of lactation in our study culling occurred at the end of lactation since producers keep lame cows longer to obtain more milk.

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Conclusions:

This work indicates that lameness was the third major cause of culling dairy cows in three farms in the South of Chile following the same pattern reported in the international literature. Farmers in these three farms culled lame cows at the end of their lactations.

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THE EFFECT OF ESMARCH BANDAGE ON PAIN IN BOVINE DISTAL HIND LIMB ANALGESIA

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Introduction:

Tourniquets commonly use in limb surgeries such as orthopaedic interventions both in lower and upper limbs to provide the appropriate bloodless area for surgical or therapeutic interventions [1]. The application of Esmarch bandage in limb intravenous regional anaesthesia has been the routine and simple effective method in ruminants [2,3,4,5]. On the other hand, the inflation of Esmarch bandage could be painful due to the pressure needed for tourniquet inflation as well as the duration of tourniquet application. Moreover, regarding the generated pain following Esmarch bandage application, another alternative analgesia method could be applied. In this abstract, the effect of Esmarch bandage application on pain in intravenous regional anaesthesia of distal hind limb of dairy cows by measuring metabolic, hormonal as well as cardiovascular elements has been investigated.

Materials and methods:

8 non-lactating and non-pregnant Holstein Friesian dairy cows were used in a cross-over study design. All cows received procasal 2% under either nerve blocks without application of Esmarch bandage or intravenous regional analgesia with Esmarch bandage application to desensitize the distal hind limb of dairy cows. Blood samples (thorough jugular vein catheter to measure Glucose, Lactate, NEFA and Cortisol), arterial blood pressure, heart rate as well as respiratory rate were measured before and after Esmarch bandage inflation as well as before and after deflation of Esmarch bandage.

Results:

The results revealed that there was no effect of inflation as well as deflation of Esmarch bandage on heart rate, respiratory rate and mean arterial blood pressure, plasma lactate, NEFA, glucose as well as cortisol.

Conclusion:

After Esmarch bandage removal, due to shift the blood flow to the distal hind limb and increase of blood volume following release of Esmarch bandage, the existence of pain would be expected. However, in our study any effect of Esmarch bandage application as well as its removal on bovine hind limb pain was not seen. Although, Esmarch bandage application to have a bloodless area in hind limb operation is needed, application of another alternative hind limb analgesia without application of Esmarch bandage such as nerve block anaesthesia could be remarkable.

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QUANTIFICATION OF DETAILED CHARACTERISTICS OF LOCOMOTOR BEHAVIOR IN DAIRY COWS WITH THE NOVEL RUMIWATCH® PEDOMETER ALGORITHM

Introduction:

Change of animal behavior is one of the most important indicators for assessing cattle health and well-being. Parameters of animal behavior can be used to build up an early disease warning system. The objective of this study was to develop and validate a novel algorithm to monitor locomotor behavior of loose-housed dairy cows based on the output of the RumiWatch® pedometer. It was hypothesized that a novel algorithm of the RumiWatch® pedometer device can be developed that provides a high correlation of parameters of behaviour of dairy cows in both upright and lying positions between the output data of the pedometers and the data derived from temporarily staggered video analysis.

Materials and Methods:

Data of locomotion were acquired by simultaneous pedometer measurements at a sampling rate of 10 Hz and video-recordings for manual observation later. The study consisted of 3 independent experiments. Experiment I was carried out to develop and validate the algorithm for lying behavior, experiment II for walking and standing behavior and experiment III for stride duration and stride length. The final version was validated, using the raw data, collected from cows not included in the development of the algorithm. Spearman correlation coefficients (r_s) were calculated between accelerometer variables and respective data derived from the video recordings (gold standard). Dichotomous data were expressed as the proportion of correctly detected events, and the overall difference for continuous data was expressed as the relative measurement error (RME).

Results:

In all experiments, the mean difference between accelerometer data and respective gold standard was between 0% and 17% (depending on the variable of locomotion), and the correlation between respective data ranged from $r_s = 1$ to $r_s = 0.75$.

Conclusions:

The strong to very high correlations of the variables between visual observation and converted pedometer data indicate that the novel RumiWatch® algorithm may markedly improve automated livestock ma-

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agement systems for efficient health monitoring of dairy cows.

Acknowledgements:

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SPOTS AND STRIATIONS OF THE SOLE HORN

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Over the last three years in Germany a new sole horn lesion has been seen which does not appear to originate from the corium. Black spots and striations are evident in various sites. Often nothing abnormal may be seen when the foot is lifted, though sometimes the changes are evident at once. After initial sole trimming the extent is evident, with horn changes ending before the corium is reached. Rarely the corium and tissues below the white line are also involved. The affected sites extend from the toe over the white line to other parts of the sole. The shape is variable, some striations being straight, others very oblique and curved. The "spots" are mostly in the white line, predominantly in the abaxial area adjacent to the toe.

Medial and lateral claws are equally affected, and toe lesions predominate. The axial surface is usually affected with an oblique striation directed axially. Marked inward deviation of the white line is common. Such animals are not repeatedly affected if correct trimming is done, though the inward displacement of the white line persists. Lameness is not seen until the changes reach the corium. The sole thickness is unrelated to development of these changes. Wall and sole are equally involved. The age is not relevant as the overgrown also. By trimming twice a year the cows will mostly not become lame. Due to the variable appearance and distribution of these ridges, it is difficult to sensitise the farmer to check for their occurrence. The same applies to trimmers, especially about the occurrence of the black spots. About one third of German farms are affected to a very variable degree, but up to 15% of a herd may have these changes. Trimming must be done very carefully, first removing each striation and spot, and reducing weight-bearing by the affected claw. Great care is required as the lesion often stops just above the surface of the corium. Especial attention is needed in the toe region, as both claws

are often affected, so that a block cannot be applied. It is suspected that if the lesions cannot be promptly be removed at trimming, then they may progress to poorly healing lesions of the corium with the development of marked lameness. Our symposia have on several occasions already discussed these changes, especially those involving the white line.

Conclusion:

It seems to be we are facing a new type of lesions. Which is very difficult in practice to sensitize the farmer and claw trimmer for it. If not recognized in time the corium and tissues are involved and a very sharp lameness can be expected.



Pregnant heifer kept on slats with sole of lateral claw, claw tip, axial wall of medial claw, and white line affected by striations and spots



The medial and the lateral both shows a striation to the toe. Pijl's rotation is also on the medial claw.

PREVALENCE DETERMINATION OF DICHELOBACTER NODOSUS IN SHEEP FLOCKS FREE FROM CLINICAL SIGNS OF FOOTROT USING A COMPETITIVE REAL-TIME PCR

Introduction:

Footrot is a widespread problem in Swiss sheep farming. The goals of this study were (i) to determine whether flocks which were clinically free from footrot carry virulent strains of *Dichelobacter nodosus*, (ii) to examine whether the competitive Real-Time PCR is helpful in further control programs and (iii) to investigate if new-infections are explainable by epidemiological data. For this purpose the new PCR-diagnostic tool was used, which is able to distinguish benign from virulent *Dichelobacter nodosus*.

Material & Methods:

Nine Swiss sheep flocks were examined three times at intervals of 6 months. Cotton swabs were used to collect samples from the interdigital skin to analyze for the presence of virulent and benign strains of *D. nodosus*. During the selection of the sheep for the study, the goal was, that as many sheep as possible can be sampled three times. Additionally, epidemiological data of the farms were collected at each sampling with the aid of a standardized questionnaire.

Results:

On four farms, benign strains were diagnosed at each visit; in one farm, however benign strains could be detected once only. Two flocks showed at each sampling sheep with a virulent colonization of the feet, but without clinical evidence for the presence of footrot. In two flocks, virulent strains of *D. nodosus* were introduced into the flock during the study period.

Conclusions:

The newly developed competitive RT PCR proved to be more sensitive than clinical diagnosis, because it unequivocally classified the four flocks as virulent, which showed no clinical signs at the time of sampling. In one farm, the clinic of virulent footrot was evident not before two weeks after the positive finding with the PCR. This can be a decisive advantage in a control program. Both infections with virulent strains could be explained by using the results from the questionnaire, as contact with sheep of virulent herds was either proven or likely. A mutation from the "benign" to the "virulent" status seems unlikely. In the light of the potential protective function, eradication

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of benign footrot would be pointless or even counterproductive. Multiple foot baths containing formalin, as it was used in one flock, seems to repress the development of clinical footrot. Based on the results shown, the competitive PCR-based test represents an important tool to be used in future control programs.

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COMPARATIVE MORPHOMETRIC STUDY OF SENEPOL AND NELORE ZEBU CROSSBREED

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Introduction: Industrial crossbreeding between European breeds such as the Senepol and Nelore Zebu has become an important factor in the beef cattle production systems in Brazil (1). Senepol breed, created from two taurine breeds, in addition to the productivity features and quality of the meat, shows tolerance to heat and natural resistance to parasites. Despite the already achieved progress, digital diseases still represent one of the main issues of the locomotor system (2). Regarding Senepol breed, few are the information that establishes a relationship between the morphology of the digits with hoof diseases. Thus, the present study aimed to evaluate the morphometric characteristics of the digits of Senepol and Nelore Zebu breeds.

Material And Methods: Hooves of 50 animals of Senepol breed and 50 Nelore Zebu breed were assessed. The cattle were female, aged between 24 and 36 months. The animals were slaughtered and the distal ends of the right side were disjointed in the carpometacarpal joints and tarsal-metatarsal in order to perform the morphometry, with the help of calipers and digital protractor, following these parameters: (A) dorsal hoof angle, (B) dorsal wall length (C) heel height (D) toe height, (E) hoof length (F) diagonal hoof length (G) lateral digit width (H) medial digit width (I) lateral digit length and (J) medial digit length (3). The results were compared by range analysis followed by Tukey test.

Results: The dorsal hoof angle (A) hasn't shown difference ($P > 0.05$) in the forelimbs in breeds. In pelvic limbs, the medial digits, Senepol breed showed lower angle $53.6 \pm 1.72a$ compared to Nelore Zebu breed, which presented $54.9 \pm 2.24a$. In the lateral digits, Nelore cattle had higher average $57.7 \pm 4.11a$ x $53 \pm 14.72ab$, presenting difference in statistics. There was similarity between the length from the dorsal wall (B) in the medial pelvic limb digit of the two breeds $7.87 \pm 0.32a$ and $7.36 \pm 0.49a$ and also in the lateral

digit $7.59 \pm 0.12a$ $7.28 \pm 0.31a$. Heel height (C) of the medial thoracic digit was higher with Senepol breed ($P \leq 0.05$) when compared with Nelore Zebu breed $4.17 \pm 0.16a$ $3.89 \pm 0.25a$. Lateral digit of the pelvic limb differ between the two breeds $5.38 \pm 0.10a$ $5.25 \pm 0.09a$. However, in the lateral digit Senepol breed showed higher measure than Nelore one $4.34 \pm 0.17a$ $3.85 \pm 0.17ab$. Senepol toe height (D) showed better measure in the four digits (6.54 ± 0.36 e 6.9 ± 0.44^a) differing from the Nelore (6.24 ± 0.19^a e 6.48 ± 0.11^a) ($P \leq 0.05$). Hoof length (E) of Senepol was higher in medial digit pelvic limbs ($10.14 \pm 0.68a$, 9.96 ± 0.70). Lateral thoracic digit showed difference ($P \leq 0.05$) with breeds comparisons ($9.96 \pm 0.80a$ $9.75 \pm 0.74ab$). In the lateral pelvic digit there were differences between Senepol animals, being animals with greater length of the hoof ($9.49 \pm 1.08a$ $8.8 \pm 0.72ab$). There were differences ($P \leq 0.05$) in the diagonal length of the hoof (F) between the two breeds. The lateral pelvic digit of Senepol breed differed from Nelore ($13.54 \pm 0.40a$ x $13.1 \pm 0.34ab$). The length of the lateral digit (I) was higher in thoracic limbs compared with pelvic ones, being proven difference ($P \leq 0.05$) only in the Senepol group (8.52 ± 0.11^a 8.51 ± 0.44^a). Medial digit length (J) indicated differences between the breeds 8.87 ± 0.24^a ; $8.64 \pm 0.40ab$. Width of lateral digit (L) 5.58 ± 0.10^a ; 5.25 ± 0.06^a and width of medial digit (H) 5.10 ± 0.17^a 4.82 ± 0.07^a were similar ($P > 0.05$) between breeds.

Discussion And Conclusions: Heritability, additive genetic variation of disorders and of corneal encasement measures are high enough to provide space for selection, once the morphological measures of corneal encasement are the most useful features for genetic improvement of quality in a progeny test program (4). (DISTL et al, 1990).

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PRESENCE OF NEUTROPHILS EXTRACELLULAR TRAPS (NETS) IN SYNOVIAL FLUID FROM HEIFERS WITH ACUTE RUMINAL ACIDOSIS

Introduction:

Neutrophils extracellular traps (NETs) are a key component of innate immunity released by leukocyte. NETs is composed by DNA strands and antimicrobial peptides (Gould et al., 2015). Synovial fluid is a colorless liquid, devoid of cells that nourishes and bring mechanical support to the joints (Esmonde-White et al., 2009). Acute ruminal acidosis is a metabolic disease produced by high intake of fermentable carbohydrates (e.g. concentrates), causing a decrease of pH in the ruminal fluid below 5.8 (Calsamiglia et al., 2012). During acute ruminal acidosis, an aseptic neutrophilic polysynovitis is observed (Danscher et al., 2009) and increased D- lactic acid are observed (Harmon et al, 1985)

Material and Methods:

Three Holstein heifers (10-18 months), 200 - 250 kg of body weigh, clinically healthy, housed in Veterinary Hospital, Universidad Austral de Chile were used. Acute ruminal acidosis was induced through oligofructose overload according to Danscher et al, 2009. pH of ruminal fluid was recorded with a portable pH meter (Hanna Instruments) after ruminocentesis. Arthrocentesis of tarso-crural joint was performed to assess in the synovial fluid total protein (Bradford method), DNA content using a multiplate reader (Varioskan Flash, Thermo Scientific). Also a cytological analysis (Merk Hemacolor staining kit), and NETs formation by fluorescence microscopy using DNA staining Picogreen (Thermo Fisher) were performed.

Neutrophils isolated from healthy cattle were used to assess the effect of D-lactic acid on the production of NET in vitro, either by electron microscopy or confocal fluorescence microscopy.

Results:

A decrease of pH in the rumen fluid after oligofructose overload was observed. After 24 hour of treatment, the synovial fluid of animals with acute rumen acidosis was cloudy and characterized with the presence of neutrophils and proteins. An increase in the content of DNA, NETs and histone 4 cit were observed. Because D-lactic is increased in this animals we assess its effect in NETs formation. We observed in bovine neutrophils that D lactic acid (5 mM) was able to induce NETs release that colocalize with histone 4 cit.

Discussion and Conclusions:

The synovial fluid of animals that develop acute ruminal

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acidosis presented macroscopic changes, characterized by an increase of neutrophils, total protein and DNA. Also was observed the presence of NETs. Furthermore, we demonstrated that D-lactic acid can increases the formation of NETs in bovine neutrophils isolated from healthy animals.

Therefore it can be concluded that neutrophils and NETs could contribute in the aseptic joint inflammation during acute ruminal acidosis. A possible role of D-lactic acid on NETs release is proposed.

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