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Session 1  - Prophylaxis of Claw Diseases

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INTRODUCTION

Today’s dairy cows face many different environmental and management challenges than the cows of the past. High energy rations, confinement on concrete, constant exposure to corrosive conditions, conformation defects, and perhaps even increased body size are some of the risk factors that increase the probability of lameness. However, despite an increased awareness of these factors, high levels of lameness in dairy herds have persisted into the 21st century, and continue to be one of the largest financial drains to the dairy industry. Worldwide research indicates that as many as 60% of a herd may become lame at least once a year. Lameness also presents a specific animal welfare issue of concern, since pain and discomfort associated with lameness can be prolonged. It has been recognised that lameness has a negative impact on milk yield, both before and after diagnosis of the insult. Furthermore, a growing body of research suggests that early-lactation lameness, i.e. lameness that begins during the first 30 days of lactation hurts reproductive performance. Therefore, prevention of lameness will have a big impact on production and sub-fertility.

Over the past 20 years, there have been a number of studies based on survey information, which have attempted not only to quantify the extent of the lameness problem, but also to identify the most important lameness-causing conditions, and to define the major causal factors. There is a multitude of suggested causal factors associated with bovine lameness, which can be broadly classified into environmental (e.g., nutrition, infectious agents, management) and genetic (e.g., conformation) factors. When attempting to control lameness on a herd basis, there is a need to consider and, if so required, to pay attention to all these factors.

THE LAMENESS PROBLEM - AN OVERVIEW

The Amount of Lameness

Worldwide, numerous surveys have been carried out determining the incidence rates of lameness in dairy herds. Lameness incidence is usually calculated on an annual basis from the records of individual lameness treatments. Farm records are sometimes limited to lameness cases that require only antibiotic therapy, and those cases that are treated by claw trimming are often not recorded (Whay et al, 2002). Surveys based on cases treated by veterinarians have reported a lower incidence of lameness, indicating that not all lame cows receive veterinary treatment. For example, on many farms in Australia and New Zealand all or most of the lameness cases are dealt with by the farmer or herdsman, and therefore these numbers underestimate the problem. Some reported incidence rates are:

- Australia: 7% (0-50%); Victoria (Harris et al, 1988)
  2.7% (vet treated only); Queensland (McLennan, 1988)
  2.5% (vet treated only); Victoria (Jubb & Malmo, 1991)
- New Zealand: 14%; (Dewes, 1978)
  20.7% (2-38%); (Tranter & Morris, 1991)
- United Kingdom: 36% (1-94%); (Esslemont & Spencer, 1993)
  55% (11-170%); (Clarkson et al, 1996)
  38% (4-69%); (Kossaibati & Esslemont, 1999)
  69% (32-112%); (Hedges et al, 2001)
- USA: 46% (40-52%); New York (Warnick et al, 2001)
  31% (one herd only); Florida (Hernandez et al, 2002)

These figures indicate that there is a large range between farms, districts and countries, that there is a lot of lameness about, and that the incidence of lameness is probably increasing. Certainly there is a heightened awareness, and appropriate steps are now being taken by veterinarians in many dairying countries in an attempt to reduce the existing lameness problem. This often entails a multidisciplinary approach, with the involvement of a nutritionist and farm building engineer.
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The Types of Lameness

Most cases of lameness are due to claw lesions (up to 90%), the remainder being associated with (upper) limb problems. On average, approximately 80% of lame cows are lame in the hind limb(s). Since the cow takes about 60% of her weight on her front limbs, one would expect a greater percentage of front limb lameness. However, the hind limbs are also involved in propulsion, which causes much more stress and friction compared with only weight bearing. Also, hind claws have a smaller ground area than front claws, further exacerbating any stress.

Almost 75% of all claw lesions in the hind limb are found on the outer claw. This is due to the fact that the outer claw commonly carries far more weight than the inner claw, that the outer claws are often larger, and that there is a need for the hind limbs to circumvent the udder during walking.

In Australia and New Zealand, a relatively larger number of cows (especially first-lactation heifers) may be lame in the front limb(s) due to lesions in the inner claw. This may reflect the low ranking of heifers in the herd's social hierarchy of dominance. Heifers are usually milked last and, therefore, spend more time in the holding yard. To avoid confrontation with the more dominant, older cows, heifers are constantly backing off. By doing so, excessive force will be put on the inner front claws. Soiled concrete surfaces are extremely abrasive, and movement of animals over these surfaces is accompanied by harsh grinding noises. These effects are exaggerated during pushing and crowding of the herd (excessive use of the backing gate, which is often electrified), and by bulling cows.

The Common Types of Claw Lesions

The various disorders of the ruminant digit have been ascribed Latin terms, though other names are more often used in the field. The most common types of lesions vary between countries. For example:

- United Kingdom (Murray et al, 1996) - sole ulcer (36%), white line disease (22%), digital dermatitis (8%), interdigital necrobacillosis or proper foot rot (5%)

- New Zealand (Tranter & Morris, 1991) - bruising/excessive wear (42%), white line disease (39%), septic pododermatitis (under-run sole or sole abscess) (9%)

- Victoria, Australia (Jubb & Malmo, 1991) - axial wall crack (22%), septic pododermatitis (21%), interdigital necrobacillosis (13%), white line disease (7%), sole ulcer (4%)

- Victoria, Australia (Malmo, 2002: unpublished data) - white line disease (34%), septic pododermatitis (29%), axial wall crack (17%), interdigital necrobacillosis (9%), sole ulcer (6%)

Thin soles due to excessive wear are one of the most prevalent lameness problems in extensive grazing systems, such as in New Zealand and parts of Australia, and in large free-stall barn systems in North America. In the latter, much of the problem is clearly due to excessively abrasive concrete, wet feet, and use of sand bedding. It may also be due to overzealous functional and corrective claw trimming (Van Amstel et al, 2002), which is routinely carried out once or twice each year. In year-round, pasture-based grazing systems (Australia), a major factor is the distance that cows have to walk, especially in the all-important peri-partum period, when horn growth stops and wear increases. Also, more lameness occurs in seasons with high rainfall, and a high number of lameness cases usually follow periods of heavy rain.

During the last decade, axial wall cracks and lesions associated with laminitis (i.e. poor claw horn quality, yellowish, waxy and soft), sole haemorrhages, sole ulcer and white line disease have become more prevalent, both in Australia and New Zealand.

The Cost of Lameness

Lameness in modern confined dairy herds has joined infertility and mastitis to become the third most important health problem in dairy production (Dürr et al, 1997). Overall, reproductive problems are the major cause of culling, and lameness will contribute indirectly to those culls. Clinical lameness causes direct and indirect economic losses. Direct losses are associated with the costs of treatment and the withholding of milk due to antibiotic therapy, prevention of lameness, premature involuntary culling, and increased replacement costs. Indirect losses are incurred through decreased milk production, reduced body condition and reproductive performance, and increased risk of mastitis. The veterinary or treatment costs are only a minor item in comparison to reduced fertility, production and cull costs.

A recent UK study showed that clinical lameness had a significant impact on milk production both before and after the diagnosis of the insult (Green et al, 2002). The total mean reduction in milk yield per 305-d lactation was approximately 360 kg or 1.2 kg per day. Similarly, research from Cornell University (New York, USA) showed that milk production losses due to lameness can be as high 1.5 l per day (Warnick et al, 2001). In another American study (Florida), interdigital phlegmon was associated with a 10% decrease in milk production (Hernandez et al, 2002). Lame cows with claw lesions or digital dermatitis also produced less milk than healthy cows.

Researchers at Michigan State University developed a five-point system to evaluate herd lameness (Sprecher et al, 1997). This Locomotion Scoring System assigns a score from 1 to 5 depending on the cows' gait and back posture. University of California (Davis) research (Robinson, 2001) has shown the following milk losses per score:

- Locomotion Score 3 (moderately lame) - 5.1% milk loss;
A survey of 13 Dutch dairy herds indicated that there exist no relationship between lameness and reproduction (Bakerma et al., 1994). However, other studies have contradicted these findings, i.e. cows experiencing lameness had more reproductive problems, i.e. more days open (= longer calving to conception interval), lower conception rates and more ovarian cysts. Overall, lame cows have between 11 and 28 more days open than cows that are not lame (Argaez-Rodriguez et al., 1997; Collick et al., 1989). A University of Florida study (Hernandez et al., 2001) found that lame cows with claw lesions were only 0.52 times as likely to conceive as healthy cows. The median time to conception was 40 days longer and the number of services per conception significantly higher, when compared with healthy cows. According to another University of Florida study (Melendez et al., 2002), lameness also impacts fertility by reducing first-service conception rates, increasing the incidence of ovarian cysts, and decreasing pregnancy rates. A growing body of research suggests that early lactation lameness hurts reproductive performance the most. More than 30% of the cows that were lame during the first 30 days post-partum were culled before any reproductive event, compared to only 5.4% of the control cows. Research also indicates a direct correlation between locomotion scores of greater than 2 and reproductive problems, i.e. higher scoring cows show fewer heat signs.

The proportion of cows culled for locomotor disease may be as low as 2.7% in studies in France (Seegers et al., 1998). However, after reviewing the literature, Malmo and Vermunt (1998) estimated that approximately 5% of cows were being culled because of lameness. A survey in the USA by the National Animal Health Monitoring System (1996) reported that 15% of all dairy cow culling was directly due to lameness or injury. Lameness also contributed indirectly to reproductive failure and subsequent involuntary culling. Lame cows have been shown to be more susceptible to other diseases, such as mastitis (Peeler et al., 1994). This association is likely to be indirect, because lame cows are lying down more often and for longer.

Results of these studies indicate that the more severe the lameness, the greater the economic loss. Various authors have calculated the total cost of lameness, including costs arising from loss of milk, loss of condition, reduction in fertility, cost of treatment, and culling. Examples of the average total cost of a single case of lameness are:

- Australia - Victoria: Aust $43 (Harris et al., 1988)
- United Kingdom: £250 (Kossaibati & Esslemont, 1997)
- USA - New York: US $302 (Guard, 1997)

Put another way, in the United Kingdom, annual losses caused by lameness have been estimated to be about £90 million annually (Bennett et al., 1999). In the Netherlands, lameness in dairy cattle accounts for an estimated loss of 4% to 5% of the typical dairy farm income (Enting et al., 1997).

The Animal Welfare Implications

There is a widespread belief amongst the general public that cattle are relatively insensitive to pain (O'Callaghan, 2002). However, clinically lame cows suffer from behaviour-modifying pain and prolonged discomfort, which is a major welfare issue associated with modern dairy farming (FAWC, 1997). For example, Tranter and Morris (1991) found that the average duration of lameness to be 27 ± 19 days!

For lame cattle, indications of pain are obvious in the changed gait of an animal, and the greater the disruption of normal movement, the more intense the pain is likely to be. The degree of pain, however, remains unknown. Welfare aspects are not easy to measure, but attempts have been made to highlight some of the changes in behaviour of lame cows. Studies have shown that:

1. Lame cows spend more time lying down and show abnormal behaviour patterns of eating, ruminating and interactions with other animals (Singh et al., 1993a). They spend less time eating and graze more slowly, as measured by the bite rate (Hassall et al., 1993). Also, lame cows have a significantly lower number of meals each day compared with non-lame cows (Margerison et al., 2002). All of this means that they will lose weight, which is illustrated by the strong negative correlation between locomotion scores and body condition scores; condition scores decrease as locomotion scores increase (i.e. lame cows are thinner).

2. Lame cows are more sensitive to pain (Whay et al., 1997; 1998), which suggests that they are suffering considerably.

These observations clearly indicate that lame cows are badly affected by lameness. In addition to causing considerable pain, it is detrimental to production and fertility.

THE CAUSAL FACTORS

A shift in the causes of lameness in cattle has occurred over the past two decades, but progress in understanding the various causes of lameness has been slow and is still incomplete. Management, housing and feeding systems have changed to accommodate an increasing herd size and the production potential of the modern dairy cow. Cubicles (free stalls) are favoured over tie stalls and straw yards, and concrete has taken the place of pasture. There is a growing awareness of the importance of investigation, diagnosis and control of herd lameness. As is the case with most production diseases, the cause of the problem is likely to be multi-factorial and often difficult to identify with total conviction.
THE MULTI-FACTOR CONCEPT

It is only in the last 25 years that the principles of preventive medicine have been applied to control cattle lameness. Also, there has been recognition that little was known of the risk factors that are associated with lameness. Over the last two decades or so, several epidemiological studies have identified the key factors contributing to lameness. A number of causal factors are thought to influence, either alone or in conjunction with one another, the severity and the prevalence of lameness. Recognising which factor(s) may be causing problems in an individual herd requires a systematic approach to the on-farm investigation, so relevant data are going to be collected and analyzed (Greenough & Vermunt, 1994). The ideal epidemiological methodology would evaluate potential stress in the animal, as well as the degree of exposure to the causal factor.

The various causal factors and their order of importance vary somewhat between countries. For example, in the United Kingdom, claw shape, genetics (breeding), claw trimming and nutrition rank high, whereas farm tracks and behaviour are further down on the list. In Australia, where dairy cows are pasture fed all-year-round, tracks (raceways), dairy shed design (especially the holding yard) and herd management are considered to be the most important causal factors. However, the role of nutrition is increasingly recognised as a contributing factor in the aetiology of herd lameness (Westwood et al, 2003). The more important factors are discussed below and recommendations, which may be of assistance in the control and prevention of herd lameness, are listed.

COW COMFORT

Numerous authors have stressed the importance of housing in the initiation of claw lesions. Clinical studies of herds affected by lameness have allowed a number of predisposing factors to be elucidated. These include, amongst others, sudden introduction to cubicles and concrete walking surfaces, lack of bedding and exercise, and poor cubicle and housing design.

Concrete The concrete surface on which cows walk and stand has received a great deal of attention. When smooth, it is slippery making footing tenuous, and when rough enough to give reasonable grip, it is very abrasive and causes damage to the horn. Rough concrete has been associated with higher levels of lameness than well-textured concrete (Wells et al, 1995). Severe problems of excessive wear may arise on new concrete, which is often extremely abrasive. Also, compression of the sole corium is directly related to the amount of time that cows spend standing, in particular where surface conditions are unyielding, as with concrete. To counteract the problems associated with concrete, the installation of rubberised walking surfaces in feed alleys and passageways has found some favour in modern dairy barn design. However, the benefits of this have yet to be proven (Vokey et al, 2002).

For optimum slip-resistance, concrete floors for dairy cattle should be finished so that they have parallel grooves 10 mm wide running perpendicular to the main walking direction of the cattle and spaced at 40-mm intervals (Dumelow & Albutt, 1990). If the walking direction of the cattle is difficult to predict, a pattern of hexagons with 46-mm sides formed by 10-mm grooves is best. A simple and equally effective grooving widespread in the UK is a rectangular pattern about 50 to 60 mm square and 10 mm deep (Bickert & Cermak, 1997). A smooth, slippery concrete floor can be improved by either a new, roughened surface or by cutting grooves as mentioned above. A recent Dutch study showed that cows in straw yards had by far the lowest number of claw disorders when compared to cows housed on solid concrete floors, slatted floors or managed in a zero-grazing system (Somers et al, 2003).

Cubicle Design The use of cubicles is related to their comfort. Holstein-Friesian cows on pasture need 240 cm x 120 cm lying space and a lunging space for rising of at least 60 cm (Faull et al, 1996). By these standards of space requirements the majority of cubicles may be either too short, too wide or too narrow. Therefore, resting time will be adversely affected in situations where cubicle partitions are poorly designed and/or cubicle dimensions do not meet the space requirements of the animal. The occupancy rate of the Newton Rigg cubicles by in-calf heifers was less than observed for the Dutch Comfort cubicles and, after calving, claw health deteriorated less rapidly in the animals housed in the latter (Leonard et al, 1994). Proposals for adequate cubicle dimensions have been suggested by Bickert and Cermak (1997). Length of the cubicle is probably the most important dimension and should be relative to the size of the cow and her dynamic space requirement. These authors reported that a 600 kg Friesian dairy cow has a forward space demand of 0.7 to 1.0 m to allow her to lunge forward when rising. A large dairy cow needs a cubic length of 2.4 m. Width requirements are, to a certain extent, dependent on the cubicle design, as narrow cubicles can be partly offset by divisions which allow “space sharing”. Such cubicles provide three areas of free space, i.e. for the head, ribcage and the loin-rump area. Ideally, the width of the cubicle should be 115 cm for heifers and 120 cm for mature cows. The material used for the base and bedding of the cubicle also has a profound effect on the lying time of the cow (see below).

Bedding The importance of a soft resting area in relation to lameness has been well recognised. There is a growing body of evidence that increased lying times have a beneficial effect on lameness prevalence and claw health. If a cow can lie and rise easily, and its bed is comfortable, it will more likely use cubicles. Soft bedding results in longer resting times and less lameness, thus supporting the importance of the burden factor (compressive stress or loading). Broom and Galindo (1997) suggested that dairy cows should lie down for 9 to 14 hours per day, whether at pasture or housed in free stalls. More
recently, it has been reported that lying times of cattle on pasture ranged from 10.9 to 11.5 hours per day. Therefore, a lying time of around 11 hours per day would seem to be an appropriate target, and cows that lie down for shorter periods are more likely to become lame. Cows lie down for longer in straw yards and on pasture than in cubicles, particularly if the cubicles have inadequate bedding (Singh et al, 1993a; 1993b; 1994). The use of straw bedding in cubicles has been abolished or greatly reduced on many farms, mainly because of its incompatibility with liquid-manure (slurry) handling. Rubber mats, mattresses, sand, sawdust, shavings, shredded newspaper and rubber tyres, or rice hulls are satisfactory alternatives to straw. With appropriate management, virtually any of the current cubicle bedding options will help to reduce lameness and encourage cows to get off their feet. In fact, cows will tolerate many inadequacies in cubicle design to lie on a cushioned surface. A combination of straw yard and concrete area (70:30 ratio) adjacent to the feeding area has many advantages for cows’ comfort, but is expensive in bedding and labour costs associated with daily topping-up and removal of old bedding one or more times during the winter period. At least 4.5 square metres of bedded area per cow should be provided (Bickert & Cermak, 1997).

Passageway Design The crucial issue is to ensure that animals are free to move around and pass each other unhindered. Areas that are particularly intensively used by cows are the alleys between rows of cubicles, around water troughs, and at other prime sites within the building such as feeding areas, collecting yards, and entries and exits from the milking parlour (Potter & Broom, 1990). Therefore, the space available in these “strategic sites” must be generous to ease movement and avoid aggressive confrontation. Very narrow passageways may create a problem for subordinate cows. The competitive use of space and an underlying level of social aggression, promoted by social hierarchy of cows, often results in sudden actions of avoidance, causing these animals to turn and twist on unyielding and abrasive surfaces. This can lead to claw horn damage, especially of the white line. The width of the passageways between feed bunks and curb of the cubicles should be 3 to 3.5 m when the feed fence is an integral part of the cubicle barn (Bickert & Cermak, 1997). This allows two cows to pass each other while others are feeding.

Most investigators believe that adverse housing conditions and changed patterns of behaviour result in an increased incidence of lameness. Certainly, some of this lameness is the direct result of injury. However, it is also thought that animals that are stressed are more prone to claw diseases. Careful observation of the animals for aggressive behaviour and the amount of time spent resting or standing, may provide a useful indicator of the importance of this environmental factor.

Exercise Locomotion maintains adequate blood circulation in the claws, supplying nutrients and oxygen to the keratin-producing tissues. In intensive dairy systems, cows are maintained in relative physical confinement (over-crowded) and have limited opportunity for exercise. A significant reduction in the amount of exercise decreases the rate of blood perfusion of the corium. This state reduces the rate of toxin removal, causes anaoxia, and increases intra-ungular pressure. Cows confined to tie stalls or pens move less than cows in loose housing systems (cubicles), and locomotion of cows in a cubicle facility is reduced when the walking space (loafing or exercise area) is 3.0 square metres or less per cow (Bickert & Cermak, 1997).

Recommendations:
- Keep concrete surfaces clean and in a fit state of repair; make sure they are non-abrasive, but not slippery.
- Provide comfortable (resilient and dry) resting areas; straw yards are better than cubicles. Cubicles must have plenty of bedding and the correct dimensions.
- Provide adequate numbers of cubicles (i.e. a cubicle for each cow in the herd) to prevent competition for lying space.
- Design cubicle rows and passageways in such a manner that cows can move and walk freely and avoid aggressive confrontation.
- Make sure that slurry does not accumulate in the passageways.
- Separate dry cows from the milking herd and keep them on dirt or grassed areas.
- Allow lactating cows as much exercise as practicable, preferably outdoors on pasture, as well as a loafing area or a dirt lot.

NUTRITION

The role of nutrition and feeding management in the development of lameness has received much attention. Despite the possible overemphasis on nutrition, it has become clear that feed input is a factor in herd lameness. Feeding diets that result in a significant and prolonged drop in rumen pH will result in a dramatic increase in lameness. Laminitis is regarded as a major predisposing factor in lameness due to claw lesions such as white line disease, sole ulcers and sole haemorrhages. Laminitis is a multi-factor disease, nutrition supposedly being an important factor in its aetiology (Vermunt & Greenough, 1994). Understanding of causal factors is embryonic. It is known that a disturbed circulation is essential to the development of laminitis, but its exact role is still unclear.

Carbohydrate Subacute rumen acidosis (SARA) plays an important role in the initiation of laminitis and subsequent lameness. Excessive grain or non-structural carbohydrate (NSC) feeding, slug feeding of grain, feeding sources of NSC that are rapidly fermented in the rumen, and feeding finely chopped silage are common factors in the development of laminitis because of their propensity for inciting SARA. The risk of SARA developing is less when the concentrate to forage (C:F) ratio of the diet is kept under 60:40.

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Westwood and Lean (2001) examined the potential for
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Nutritional factors to contribute to the high incidence of claw lameness in New Zealand. They proposed that the high digestibility, high concentration of rumen degradable protein (RDP) and the low effectiveness of neutral detergent fibre (NDF) in lush pasture diets result in suboptimal rumen function, which in turn increases the risk of laminitis / lameness.

Fibre Dairy cows require a minimum amount of effective fibre and forage in their diet for proper chewing and rumination activity, for proper rumen function, and to maintain rumen pH above 6.2. They need to chew (masticate and ruminate) 10 to 12 hours/day to maintain normal rumen function (Shaver, 1997). The effective fibre of a feed is directly related to the chewing time and, therefore, saliva production associated with that particular feed (Allen, 1997). High-fibre diets, e.g. hay and coarsely chopped silage, stimulate rumination, which in turn increases saliva flow. Saliva is rich in bicarbonate, which acts as a buffer by neutralising the acid produced in the rumen. Fine chopping reduces the effective fibre content of forages. Adding buffers to rations containing finely chopped silage may help if saliva production is low. The addition of buffers at 0.75% of total ration dry matter is common with maize (corn) silage-based rations. Sodium bicarbonate should not be fed at levels greater than 1% of the ration otherwise its palatability will be affected. Under US feeding systems, it is recommended that the diet contains a minimum of 25% NDF. This recommendation, however, may be inadequate for diets in which pasture is the predominant forage (Westwood et al, 2003). One reason rumen pH may be low on high quality pasture is that NDF in pasture is not as effective as NDF in silage and hay. In this situation, adding a small amount of straw to the diet may be beneficial.

Protein It has been suggested that feeding excess protein (particularly RDP or degraded intake protein) to dairy cattle may cause laminitis (Vermunt, 1992). However, little research information is available to indicate the level of dietary protein that may be of concern or the mode of action that protein plays in the disease development process. It is assumed by some that products of protein degradation in the rumen may be responsible for the increased incidence of lameness. Offer et al (1997) found that the source of dietary protein (either a proprietary protein supplement of animal origin or soybean meal) in the concentrate from week 3 to week 27 of lactation had no effect on locomotion, lameness, lesion formation, or any other claw measurement. Whether or not the high protein content of pasture is contributing to increased lameness in pasture-fed cattle needs further investigation. It is known that sulphur-containing amino acids contribute to the sulphur bonds that give horn tissue the strength and resilience needed to minimize lameness. However, studies in which the amino acid L-methionine was fed to improve horn flexibility and claw durability, and to reduce lameness found no advantage from the use of such proteins (Logue et al, 1989).

Silage Poor quality silage has long been recognised as a potential risk factor for lameness. A recent study investigated the effect of forage type on claw horn lesions in dairy heifers from 3 months of age until 6 months after calving (Offer et al, 2003). Both white line and sole lesions were significantly worse in animals that were fed a wet, fermented grass silage-based diet compared to those that were receiving a dry, unfermented straw and concentrate-based diet.

Recommendations:

- Provide a steam-up ration 2 before calving, with cows receiving concentrate up to 0.5% to 0.7% of BW or 3.5 to 5.0 kg per cow daily.
- Gradually increase concentrate (grain, maize silage) intake during the first 6 weeks of lactation. Never feed more than 4 kg of concentrate at one time.
- Do not exceed 35% NSC in the ration.
- Be careful with feeding NSC sources with high rumen degradability, such as barley, wheat and wet, finely ground high-moisture corn. The latter should not be fed if the moisture content is greater than 35%.
- Ensure that there is enough fibre in the diet. Rations should contain a minimum of 21% NDF from forage.
- Provide adequate, “effective fibre” in the diet; long-stem roughage is best. Formulate rations to include 30%-40% forage in the dry matter.
- Silage should be chopped to contain 25% of the particles more than 5 cm long. If chopped too finely, feed 2 to 4 kg of long or coarsely chopped hay per cow daily.
- Supplement dietary buffers in early lactation; e.g., sodium bicarbonate at 0.75% to 1% of total ration DM.
- Consider feeding a complete-diet or total mixed ration feeding to control the C:F ratio.
- Avoid excesses of the energy (starch or carbohydrate) and protein components in the ration.
- Always make all feed changes slowly.
- Young stock diets should not be heavily based on wet grass silage (< 25% DM).

HERD MANAGEMENT/STOCKMANSHIP

In early lactation, dietary intake is unable to meet the demands of high milk production. Dairy cattle, therefore, enter a period of negative energy balance (NEB), which leads to mobilisation of body reserves to balance the deficit between energy intake and milk energy production (Bauman & Currie, 1980). Consequently, body condition scores (BCS) decrease to compensate for the NEB. Wells et al (1993) reported that, phenotypically, increased lameness was associated with decreased BCS. In a study that evaluated clinical lameness in 24 herds, it was found that lameness was most common during the first 50 days of lactation (Boettcher et al, 1998), when NEB would be most severe. Similarly, in a more recent study, increased locomotive problems were found to be associated with longer and more extreme periods of NEB (Collard et al, 2000). The implications from these studies are clear. Cows with the greatest dry matter intakes in early lactation are those that produce more milk, loose less weight,
and have fewer lameness problems.

A study on lameness in dairy cows conducted by the University of Liverpool considered amongst others the factor of stockmanship in claw lameness (Clarkson et al., 1993). When herding cows, some farmers let the animals amble along at their own speed, while others encourage them by shouting, using sticks, dogs, or motor bikes. It has been shown that the more the cows get pushed the more lameness there will be (Chesterton et al., 1989; Clarkson & Ward, 1991). When the stockman was impatient, lameness was higher and in the majority of the high lameness incidence herds a biting dog was used to bring in the cows for milking.

Another study found that the amount of lameness was closely related to each of the following aspects: knowledge, training and awareness (Mill & Ward, 1993). Those farmers who knew most, had most training, were most aware of lameness and consulted their veterinarians, had the least lameness problems. From this, it can be concluded that there is a need to improve the level of knowledge that farmers have about lameness. This includes recognition of lameness, the causes of lameness, recording and early treatment of lameness cases, and the principles of prevention of lameness in dairy cattle.

Recommendations:

- Start providing a transition ration 2 to 3 weeks before calving to encourage food intake.
- Provide a well-balanced, palatable diet that meets the cows’ metabolic needs as soon as possible after calving.
- Use patience while assembling and herding cows, and drive cows gently over tracks and through gateways; the herd should be allowed to drift to and from the milking shed (a herd walking speed guideline is 45 m/min or 2.7 km/h).
- Do not use a biting dog, motorbike, or tractor to herd cows.
- Use separate herds for heifers and older cows, especially on farms with large herds (more than 200 cows).
- Encourage farmers and stockpersons to acquire extra training to increase their awareness and to enable them to recognise and deal with lameness problems.

FARM TRACKS/RACEWAYS

During the summer when cows are at pasture and in countries such as New Zealand and Australia, where year-round grazing is practised, housing is not a factor in the aetiology of lameness. However, lameness is still a major cause for concern. In a ground-breaking epidemiological study in New Zealand, factors associated with the movement of animals along farm tracks to the dairy shed explained 40% of the variance with regard to the lameness prevalence level (Chesterton et al., 1989). The importance of the track may be due to the fact that in New Zealand (as well as in Australia) cows have to walk the distance between the paddocks and the shed 4 times a day. In these situations, lameness is associated with the length, width, site, quality, construction, maintenance and use of the farm track, with the handling and movement of animals on the track, and with herd size (Harris et al., 1988; Chesterton et al., 1989; Clarkson & Ward, 1991; Hemsworth et al., 1995). The two factors most strongly linked to lameness are:

1. The maintenance state of the track, and
2. The patience of the herdsman handling the cows on the track.

Proper construction and regular maintenance of the track, especially the first 300 to 500 metres closest to the milking shed, are important in reducing lameness in dairy herds (Bridges, 1985; Malmo & Vermunt, 1999). Farms where track maintenance is poor or where the herdsman has less patience with the herd on the track are more likely to have a high number of lame cows. A poorly maintained track will not only cause injury to the claws of the cows (direct effect), it will also slow the herd down, making the herdsman less patient (indirect effect). Furthermore, lame cows most often walk at the back of the herd and therefore are more affected by an impatient stockman.

Recent observations show that dairy cows have a very strong preference for a softer (woodchips) track surface in comparison with a conventional hard-core track surface (Gregory & Taylor, 2002).

Recommendations:

- Ensure that the width of the main track is at least 5 m for herds of 200 cows or more.
- Use fine, non-abrasive or easily crushable material (e.g., sand, pumice, limestone, sandstone or woodchips) rather than coarse gravel on the surface of the track.
- Ensure that the track is firm, correctly crowned to promote drainage from the centre of the track, and well drained along the sides.
- Fill holes and repair any broken section by grading, rolling, or both.
- Avoid steep slopes and eliminate any areas of potential bunching of the herd (e.g., sharp corners, narrow entrance into the yard, narrow bridges and underpasses).
- Ensure that excellent underfoot conditions are maintained year-round at gateways and drinking troughs.
- Remove adjacent hedges or keep them well trimmed to enable the sun and wind to dry out the track.
- Direct track expenditure toward those parts nearest to the shed when improvements are necessary.
- Avoid the use of farm machinery (including motor bikes) on the cattle tracks.
- Physically walk all the farm tracks as part of a herd lameness investigation.

THE DAIRY SHED/HOLDING YARD

Milking as such should be a pleasant experience for cows, and - everything else being normal - cow flow to
Factors associated with characteristics of the milking process explained 24% of the variance with regard to the lameness prevalence level (Chesterton et al, 1989). Among the risk factors for lameness in the dairy shed, the presence of a biting dog was the most important one. A poorly designed shed will also affect the normal flow of cows through the yard and in to the shed. Cows do not like physical contact, and a lot of pushing, turning and shuffling may occur if the yard is too small. This may cause cows to slip and to have less control over where they place their feet, thereby increasing the risk of claw injury - especially if stones and gravel are carried in to the yard.

Recommendations:

- Have the entrance to the holding yard wide enough, and avoid acute turns into the yard.
- Keep concrete surfaces clean and in a fit state of repair; make sure that they are non-abrasive, but not slippery.
- Eliminate factors that make cows reluctant to enter the holding yard and milking shed (e.g., shadows, slippery concrete, electrified backing gate, a dog chained to the gate, and stray voltage).
- After every milking, clean the yard and the concrete apron linking the main track with the yard; ensure that slurry does not accumulate at the yard entrance.
- Ensure the holding yard is big enough (i.e. 1.5 m²/cow or more).
- Consider bail feeding to improve cow flow into the shed.

CONFORMATION

Much of the variability in claw health is associated with environmental effects, including differences in housing, nutrition and management. However, research has also revealed genetic sources of variation (Huang & Shanks, 1995), indicating that selection can be used indirectly to select for resistance to lameness. It has been shown that the daughters of some bulls were more likely to suffer claw lameness than those of other bulls (Russell, 1988), and it would be sensible to select bulls on the basis of clinical lameness. A large UK study found that cows with long toes or with abnormally low or high heels had a higher prevalence of lameness (Clarkson et al, 1993). McDaniel (1994) concluded from three separate comprehensive studies that higher claw angles were positively correlated with increased herd life. Boettcher et al (1998) reported that among the various conformation type traits analyzed, claw angle and rear leg - rear view had the strongest associations with lameness. Low claw angle and hocking-in were associated with clinical lameness. In other words, bulls that transmitted higher claw angles and straighter limbs from the rear view had fewer daugh-

The mean lying time for cows housed indoors is less than at pasture (Galindo & Broom, 1993). A similar observation has been reported by Singh et al (1993b). Several authors have suggested that behaviour is a factor to consider in lameness (see Vermunt & Greenough, 1994). Modern, intensive dairying systems have important consequences for the social behaviour of the animals. Several studies (e.g., Galindo & Broom, 1993) have shown that aggression is increased and the synchrony of behaviour disrupted when cows are housed at high density. Reduced space and constant regrouping of cows causes increased aggression, partly because cows have to compete more for eating and lying places (Wierenga, 1991). Under these conditions, some animals will be more successful than others at gaining access to feeding or lying places. A behavioural study found that low-ranking animals, such as heifers, whose movement is restricted by social factors, spend less time lying and more time standing still in passageways and standing half in cubi-
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cles (Galindo & Broom, 2000). As the total time spent standing increased, so did the number of cases of lameness. The survival rate to lameness for low-ranking cows was significantly lower than for higher-ranking animals. Similarly, Chaplin et al (2000) reported that more severe claw lesions in early lactation heifers were associated with reduced lying, less idling, increased standing in cubicles, and more disturbed lying behaviour. A New Zealand study showed that a relationship exists between dominance ranking and lameness incidence in year-round, pasture-grazed dairy cows (Sauter-Louis et al, 2004). The dominance ranking of lame cows is significantly lower in herds that have a high incidence of lameness compared with herds that have a low incidence.

The cubicle to cow ratio generally recommended is 1:1. However, this does not mean that all cows in a group will have a lying place guaranteed and that they will be able to lie for the length of time they want. Therefore, the number of cubicles should exceed the maximum number of cows in the herd (Vermunt & Greenough, 1997).

Recommendations:

• Ensure at least one cubicle per cow and, if passage fed, one feed space per cow. This minimises confrontation between dominant cows and those lower in the social hierarchy (mainly heifers).
• Always have a spare number of cubicles to provide options for lying to those cows reluctant to use specific cubicles or that are displaced more frequently from certain areas.
• Run separate herds of similar classes of cattle (such as first-calling cows), especially in large herds on pasture.
• Handle first-calf cows carefully during the first 60 days of lactation.

FUNCTIONAL CLAW TRIMMING

The primary purpose of claw trimming is to re-establish normal function by correcting claw horn overgrowth, thereby restoring appropriate weight bearing within and between the claws of each limb. Studies have shown that horn wear is decreased and horn growth increased by claw trimming (Manson & Leaver, 1988; 1989). The explanation may be that artificially removing horn from the sole stimulates a natural compensatory reaction of increased horn production, thereby balancing wear. The new horn may even be of better quality than that removed. Therefore, regular claw trimming to stimulate the growth of healthy horn may help in the control of lameness (Vermunt, 1999). For example, a recent Swedish study found that autumn-trimmed cows at spring trimming had significantly lower odds of lameness, haemorrhages of the sole or white line, sole ulcer and white line disease or double sole (Manske et al, 2002). Also, urgent claw treatment between claw trimmings was less common in the autumn trimmed cattle. "Functional claw trimming", carried out once or twice yearly according to the Dutch standard (Toussaint-Raven et al, 1989), is now regarded as an integral part of any lameness management and control programme.

On the other hand, inadequate or unskilled claw trimming are recognised factors, which may cause lameness. In the University of Liverpool study it was found that claw trimming may be a risk factor of lameness unless done correctly and at the correct time (Clarkson et al, 1993). The conclusion reached was that: "Foot-trimming can be beneficial, but not always. It would seem that correct training in the correct technique is essential".

In a recent study (Paulus & Nuss, 2002), the sole thickness on the medial and lateral claw was compared. It was found that if the two claws were trimmed to equal size (conventional wisdom for Dutch claw trimming), then the sole of the lateral claw was on average 1.6 mm thinner than on the medial claw and in some areas up to 4.1 mm thinner. This almost led to exposure of the corium. Therefore, to achieve equal sole thickness it is necessary to leave the lateral claw larger than the medial.

Recommendations:

• Provide regular claw care (i.e. inspection and trimming).
• People who trim claws should be trained to use the correct technique.
• Do not trim just before turn-out or calving; one recommended time is at drying off.
• Heifers should have their claws trimmed only lightly before entry into a loose-housing system or confinement on concrete.
• Dairy cattle veterinarians should attend short courses or workshops to learn proper claw care (including claw trimming).

ENVIRONMENT (especially rainfall and heat stress)

In New Zealand, the peak incidence of lameness occurs during the late autumn/winter in autumn-calving herds and during the late spring in spring-calving herds (Tranter & Morris, 1991). Practical experience from both New Zealand and Australia tells us that more lameness occurs in seasons with high rainfall, and that a high incidence of lameness usually follows prolonged periods of heavy rain. Also, numerous studies have shown an association between wet weather conditions and the onset of lameness. Wet underfoot conditions will result in:

• An increase in claw horn moisture ==> horn becomes softer (esp. the sole) ==> greater wear and more chance of sole penetration.
• Concrete being more much more abrasive ==> more wear of the weight bearing surface.
• The soil being washed off the surface of the tracks ==> exposing stones and other sharp material ==> increased risk of trauma.
• Tracks getting very muddy ==> cases of infectious conditions causing lameness (e.g., interdigital necrobacillosis).

In North America, heat stress has also been associated
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with an increased incidence of lameness (Spencer, 2001). Heat stress alters the animals' breathing rate (it may double), heart rate, immune response (reduced) and behaviour (e.g., cows are standing for longer periods of time, which promotes pooling of blood in the digits). Reduced feed intake, a preference for concentrates rather than forage, a loss of salivary buffering from increased respiratory rates and drooling, and a reduction in the total buffering pool all contribute to a greater potential for subacute rumen acidosis (SARA) during periods of hot and humid weather. This may explain in part, why some herds experience more acidosis and lameness despite being fed properly formulated rations.

OTHER FACTORS IN LAMENESS:

Management of Replacement Stock Studies on the effect of age on lameness have shown that young, first-calving heifers are more likely to be severely affected both in term of the lesions observed as well as in their reaction to it (Logue et al, 1993). Early in the housing period, first-lactation animals (heifers) lie down for a significantly shorter period than adult cows. Such a shorter lying time is significantly related to sole lesions (Singh et al, 1993c). Heifers housed in free stalls during the year before parturition - having already experienced the use of cubicles - will likely demonstrate a higher rate of cubicle use as first-lactation cows. Segregating first-lactation cows from older cows in a separate group will result in less bullying by the older animals. This practice also makes sense from a nutrition point of view, because adequate dry matter intakes are more likely being maintained, with animals experiencing fewer health-related problems, including laminitis. Growth rate is another factor that has been considered. Greenough and Vermunt (1991) concluded that rapid growth (greater than 800 grams per day) in young heifers during their second year and prior to calving at 24 months, coupled with the sudden mixing of these pregnant heifers with older cows, played an important role in the occurrence of sole haemorrhages, which often preceded sole ulceration.

Recommendations:

• Start at breeding age to train heifers to the system that they will join after parturition.
• Heifers should be put in a separate area of the building with deep-strawed cubicles where they can learn to use the cubicles.
• In systems requiring housing, allow heifers to adapt (for about 8 weeks) to reduced exercise and to walking on a concrete surface prior to introducing them to the main herd.
• Avoid introducing single heifers to the main herd; transferring heifers in groups of four or five may reduce the amount of bullying.
• Monitor the growth rate of heifers, particularly during their second year.

Previous Lameness -- Cows with a history of prior inci-

defs of lameness are more likely to go lame again (Alban et al, 1996). A French study showed that cows lame in one lactation had an increased risk of becoming lame in the next (Calavas et al, 1996). Therefore, prevention of lameness in first and second-calf cows is of paramount importance, and detailed records should be kept of lame cows, lesions, treatment etc.

Production (Milk Yield) High production is often associated with undesirable conformation, which indicates that breeding solely for production traits will increase the risk of lameness. For example, Alban et al (1996) reported a significant association between average herd yield and lameness. In another study, breeding values for first-lactation claw trait scores were generally negatively correlated with those for milk production (Brotherstone et al, 1991). Analysis of the Liverpool data (Clarkson et al, 1993) showed that cows, which were lame in their second lactation had yielded more milk in the first than cows that were not lame in the second lactation (Ward & French, 1997). The risk of lameness increased in each lactation from the first/second up to the seventh. A recent Dutch study found that high milk yield on the first herd test after calving was a reliable indicator of an increased risk of lameness (Heuer et al, 1999). As part of a bioin intervention study, it was found that cows that went lame were, on average, higher yielding than cows that never went lame (Green et al, 2002). However, when cows did go lame they lost all that yield advantage of 350 litres. Interestingly, the yield reduction started four months prior to the onset of lameness. It is tempting to speculate that the initial reduction in yield is associated with the original insult (e.g., subclinical laminitis), which could be from a variety of causes. This is then later translated into a claw horn defect or lesion.

Age and Stage of Lactation The influence of age on the incidence of lameness varies, depending on the lesion. Excessive wear (thin soles) and bruising occur most commonly in young cows (heifers) and natural service bulls. White line disease and sole ulcer are more often observed in older cows, and for these lesions the risk of lameness increases with age. The prevalence of lameness is highest during the first 3 to 4 months of lactation, which coincides with a high level of energy intake and negative energy balance. Vaarst et al (1998) found a strong positive association between 61 and 120 days post-partum and the presence of claw disorders.

Body Weight and Body Condition Score (BCS) Both these factors have been associated with clinical lameness in some dairy herds (Wells et al, 1993). Each 100-kg increase in body weight was associated with a 1.9-fold increase in the odds of clinical lameness. A lower BCS was correlated strongly with clinical lameness. However, this may be the result of, rather than a cause of, lameness.
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ADDITIONAL RECOMMENDATIONS

• All lame cows should be examined and treated as soon as possible.
• The claws of all cows should be examined and trimmed (if necessary) at least once annually.
• Footbath use as part of a regular claw care programme is essential, because it reduces a number of infectious conditions affecting the area between the claws.
• Consider using a Treponema vaccine (if available) to control digital dermatitis in problem herds, rather than relying on footbaths containing chemicals.
• Clean floor surfaces and alleyways as required, to remove collections of urine, water and manure that contribute to constant wetting of the claws.

Early diagnosis and treatment of lesions is essential for controlling lameness in dairy herds by minimising the severity and potential long-term implications of lameness. Most of this can be done at the time of routine claw trimming. However, surveys have found that only about 20% to 30% of healthy cows have their claws trimmed regularly.

Footbaths are used to remove dirt and abrasive material, and to bring claws and interdigital skin in contact with a disinfecting, astringent chemical solution. The use of permanent (concrete) footbaths has declined in favour of portable equipment. Formalin, copper sulphate and peracetic acid are the most widely used agents, all showing equal efficacy in treating digital dermatitis (Raven & Hunt, 2002). Other chemicals such as iodides and creosols rapidly fail owing to the organic matter in the washing liquid.

A large survey of dairy herds across North America concluded that 43.5% of herds were affected with papillomatous digital dermatitis (Wells et al, 1999), and it appears that the incidence of this condition is increasing rapidly (Cook, 2002). Footbaths containing antibiotic solutions are also used in the control and treatment of digital dermatitis. The antimicrobial activity and concentration of these products decrease significantly after a herd has used the bath, possibly because of absorption by faeces and soil particles (Van Keulen et al, 1992).

• Use Locomotion Scoring as an integral part of any lameness prevention programme.

Locomotion Scoring centres on prevention rather than treatment, because the system will detect many lesions in the very early stages. Therefore, it can be used to identify at-risk cows for possible treatment. Early detection and intervention is essential for minimising the severity of lameness. Lame cows receiving prompt treatment lose less than 1% of lactation potential compared with cows neglected for two or three days, which can lose up to 20% of production/lactation. Locomotion Scoring is an easy, sensitive and relatively accurate method of detecting subclinical lameness within a herd. The cow’s gait (locomotion) is assessed visually with special emphasis on her back posture. Researchers at the University of Liverpool showed that the curvature of a cow’s spine can be used to predict the presence of a claw lesion (O’Callaghan et al, 2002). With this system, cows are ranked from 1 (normal) to 5 (very lame). Scores of two or three indicate subclinical lameness. Identifying these animals allows for early intervention (examination) and correction (trimming) before lameness becomes more severe and costly. Once lame animals have been identified and treated, preventative strategies can be implemented for the types of lameness common to a particular herd.

In the future, detecting lameness may well become more automated. For example, by using a force-plate system positioned at the entrance or exit of the milking shed, lame cows can be recognised early and the affected limb(s) identified (Rajkondawar et al, 2002).

• Consider feeding biotin in problem herds.

Biotin (vitamin H) is a water-soluble vitamin, which is essential for the formation and integrity of keratinised tissues such as skin and horn. Biotin supplementation (above requirement) is of value for improving the quality of claw horn in pigs, hoof horn in horses, and foot pad epithelial tissue in poultry. Under normal conditions, the developed rumen is considered capable of synthesizing adequate amounts of biotin. However, it has been suggested that rumen synthesis of biotin is not significant in cattle (Frigg et al, 1994). Evidence exists that acidic rumen conditions can reduce microbial biotin synthesis (Da Costa et al, 1998). Therefore, cattle fed high grain or high-quality pasture diets may develop a subclinical biotin deficiency. Cows suffering from laminitis have lower blood biotin concentrations and a higher moisture content of sole horn than normal cows (Huguchi & Nagahata, 2001). Furthermore, the biotin demand is increased during periods of stress and blood biotin levels found in lame cows are lower than normal (Smart & Cymbaluk, 1997).

Recently, biotin supplementation has received much interest for improvement of claw health in dairy cattle. Several controlled studies have shown that lameness is significantly decreased in cows supplemented with biotin (Rovimix H-2; Hoffmann-La Roche Ltd, Basel, Switzerland) at a rate of 20-40 mg of active biotin/cow per day. Midla et al (1998) reported significant improvements in claw health in primi-parous dairy cows following biotin supplementation. In a recent study, the risk of lameness caused by white line disease was halved (Hedges et al, 2001). These positive effects of biotin supplementation on white line disease appeared to be greater in cows than in heifers. Fitzgerald et al (2000) reported that the response to supplemental biotin was a reduction in claw lesions and better locomotion scores. In another study, a significant improvement in histological horn quality was found in biotin-treated animals, indicating that biotin exerts a positive influence on the healing of sole ulcers (Lischer et al, 2002a).

• Consider feeding trace mineral complexes in at risk cows or problem herds.

Trace minerals are essential for the production of good-
quality claw horn, and an inadequate intake may compromise claw health. Zinc (Zn) and copper (Cu) are the "popular players", but cobalt (Co), selenium, molybdenum and manganese (Mn) are also important in claw horn formation. Zn and Cu deficiencies have been implicated in lameness, and supplements are commonly used worldwide. Trace minerals have traditionally been added to ruminant diets in the form of inorganic salts. However, in recent years, there has been considerable interest in organic forms of trace minerals, which are claimed to have superior bio-availability (Miles & Henry, 1999). These organic forms, or chelates, are stable in the digestive tract and are protected from forming complexes with other dietary components that would otherwise inhibit their absorption (Spears, 1996). Improvements in claw integrity have been observed when Co-glucoseheptonate and specific amino acid complexes of Cu and Mn were added to diets of cows already containing specific amino acid complexes of Zn (Nocek et al, 2000). A recent US study found that replacing Zn, Mn, Cu and Co from sulphates with complexed sources (Availa-4; Zinpro Corporation, Eden Prairie, Minnesota, USA) decreased the percentage of dairy cows with claw disorders at 75 d after calving (Ballantine et al, 2002).

SO, WHERE TO FROM HERE?

It is well recognised that herd lameness is a problem associated with high production, intensive feeding and confined conditions, and that the increasing incidence of lameness needs to be addressed and reduced. However, herd lameness is a multi-factor problem; the causal factors are complex, interrelated, and not always well understood. Finding the ideal control strategy is like piecing together a jigsaw puzzle, with each piece revealing only a small part of the complete picture. Innovative research has filled in some areas of the puzzle, but other parts still remain unclear. Most studies report a high incidence of lameness in early lactation (2 to 16 weeks after calving). The event of calving and its associated problems during the early post-partum period appear to be particularly important, but their exact role is not clear as yet. The many changes in management, feeding, environment and social grouping to which animals are subjected during the peri-partum period are likely to trigger a considerable level of stress. This occurs at a time when body metabolism is also changing rapidly during the transition from late gestation to peak lactation and beyond, perhaps more so than at any other point during lactation. These processes are of particular significance in heifers calving for the first time. Presently, a large body of international research is working on the hypothesis that systemic events associated with calving and the onset of lactation may set in motion the chain of events that leads to development of claw horn lesions in dairy cows.

Laminitis is generally regarded as a major predisposing factor for many lameness-causing claw lesions, particularly sole haemorrhages, sole ulcers and white line dis-ease. The precise aetiology and pathogenesis of laminitis are incomplete. However, it appears that, similar to equine laminitis, a systemic and local digital inflammatory process occurs in bovine laminitis (Belknap et al, 2002). For many years, and in analogy to the horse, the most commonly accepted hypothesis has been that of insults (vaskostriction and ischaemia) to the peripheral vascular system of the corium, resulting in a reduced digital capillary perfusion, particularly through the lamellae and papillae (see Vermunt, 1992; Vermunt & Greenough, 1994; Ossent & Lischer, 1998). It is hypothesised that the ischaemia results because blood is shunted away from the capillary circulation through dilated arteriovenous anastomoses (AVAs).

However, recent research has provoked some debate regarding the role that AVAs and the micro-circulation play in the initial stages of laminitis and the subsequent development of claw lesions. For example, it has been suggested that loss of integrity of the epidermal-dermal junction does not play such a significant role in the development of laminitis-associated lesions (Lischer & Ossent 2002; Lischer et al, 2002b). It is more likely that other biomechanical mechanisms are involved as a result of changes in the connective tissue of the distal phalanx' suspensory apparatus (Tarlton, 2003). It has been shown that there is an increased laxity of the distal phalanx' suspensory apparatus around the time of calving, leading to a decreased load bearing capacity (Tarlton & Webster, 2002). This means that the distal phalanx can move up and down in the claw to a certain degree, potentially causing trauma to the corium (dermis). It has been proposed that, if the properties of the connective tissue in this area are sufficiently disturbed, the fibres may stretch enough to allow the third phalanx to sink within the claw capsule, subsequently producing the characteristic lesions of laminitis at the sole surface (Ossent, 2000). Some people suggest that this phenomenon may be the causal link between calving and lameness. Based on these recent findings, several theories have been advanced regarding the origin of the increased laxity of the connective tissue. One favours the central role of matrix metalloproteinases and their activation by a novel 52kDa protease, called "hoofase". This gelatinolytic p52ase is present at high levels in heifers up to two weeks pre-calving, then declining at four and 12 weeks post-calving (Tarlton, 2003). Another theory favours the effects of certain hormones, particularly relaxin (Holah et al, 2000), which are present in the peri-partum period. Neither of these theories, however, can explain the frequent occurrence of laminitis-associated lesions in bulls and steers. Also, these typical lesions are relatively rare in year-round, pasture-grazed dairy cows in New Zealand and Australia, even more so in first-lactation heifers. Therefore, could it be more likely that the breakdown of the dermal-epidermal lamellar connection is facilitated by the action of a Streptococcus bovis exotoxin (Mungall et al, 2002), released during an acidicotic event? Alternatively, could it be that histamine - produced by ruminal conversion of the amino acid histidine - is a bigger contributing factor to perturbed supply of nutrients to the horn-producing tissues than is commonly thought? A histamine-producing bacterium has been identified that
may be implicated in the pathogenesis of laminitis (Russell & Garner, 2003). Clearly, these hypotheses warrant further investigation.

It has become clear that calving and early lactation are important as far as the initiation of lameness is concerned. The best prospects for control lie in a preventative management programme, which addresses among others cow comfort, nutrition, management, behaviour, environment, claw care and conformation. Minimising external stresses to the claws during these critical periods may significantly reduce the development and severity of lameness-causing lesions. Continued research into identification of causal factors of lameness will be invaluable in providing useful tools for more effective control of herd lameness. It is essential that future funding in the subject of lameness is maintained, not only because of an increasing consumers' awareness that it is a major welfare issue associated with modern dairy production systems, but also because it will help to increase our understanding of causes and mechanisms involved in herd lameness. This in turn will allow us to develop sound, research-based recommendations for prevention and control.

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EVALUATION OF A DUTCH CLAW HEALTH SCORING SYSTEM IN DAIRY CATTLE.

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Abstract

To determine the optimal moment for claw-trimming of dairy cows, a scoring system was developed by the Faculty of Veterinary Medicine of Utrecht University, The Netherlands: the leg score. The leg score is a three-point scoring system, based on the external rotation of the hind feet relative to the spinal column. By calculating the percentages of leg score 1 to 3 per herd, herd claw health is summarized in a single variable. Per scoring event and dependent on the cut-off values used in practice, the advice is given to have the herd claw trimmed or not. Although the leg score is widely used in practice, there has not been a quantitative evaluation of its repeatability and its reproducibility. The study was performed as a first step towards evaluation of this diagnostic tool.

To assess the repeatability, the score was performed twice with a scoring-scale and twice without such scoring scale by 11 observers on 52 cows in a dairy herd and kappa values were calculated.

To assess reproducibility, the score was performed twice, once...
with and once without a scoring scale on 2 dairy herds with 62 and 50 cows by 8 observers. Concerning the reproducibility, the kappa value varied from 0.170-0.658 for scoring with the scoring scale and from 0.121-0.577 for scoring without the scoring scale and only 11% of cows were assigned the same score by all 8 observers. Evaluating the advice to the farmer: in the investigated herd the trimming advice to the herdsman, based on over 20% of the animals showing score 3 and when scoring with the scale, was consistent for 3 out of 11 observers. When scoring without a scale, the advice to have the dairy cows trimmed was consistent for 4 of 11 observers. The advice to have the dairy cows not trimmed, when scoring with a scale, was consistent for 6 of 11 observers. When scoring without a scale, the advice to have the dairy cows not trimmed was consistent for 5 of 11 observers. The advice of 2 observers was inconsistent for both scoring with or scoring without a scale. It was concluded that the repeatability of the leg score performed with or without a scoring scale, varied from good to bad depending on the observer and that the scoring scale had no additive value. In a first step to evaluating the leg-score further research is needed about the reasons for differences of scoring in relation to the (in)consistency of the exo-rotation based score of the hind legs and what changes are needed to improve the quality of this diagnostic instrument.

Introduction

Lameness and claw-health are of increasing importance in herd-health management. Lameness is an increasing problem, comparing recent studies on the prevalence of lameness in dairy cows (e.g. Somers et al, 2003). In The Netherlands it is estimated that in about 60% of the dairy herds all lactating cattle are trimmed twice a year by a professional claw-trimmer. These trimmings are usually performed at the end of the winter period and at the end of the summer/ grazing period, and are independent of the claw health condition.

For assessing the optimal moment of “herd trimming”, the leg-score was developed (J.J. van Amerongen, personal communication).

The leg-score is determined during square standing by the angle of the spinal column and the interdigital space of the hind claws. The leg-score is divided into 3 classes. If the observed angle is between 0-17 degrees, it is scored as 1, an angle between 18-24 degrees is scored as 2 and an angle scored >24 degrees and any lame cow is scored as 3 (Fig.1).

The distribution of the percentages of scores 1, 2 and 3 (= the herd score) is recommended as a tool for an “objective” determination of the best moment for claw trimming the whole dairy herd.

Material and methods

Animals and data collection

For the estimation of the reproducibility, the leg-scores were recorded twice in two dairy herds (farm A and farm B, with respectively 62 and 50 cows > 2 years, breed Holstein Friesian). When recording, the cows were fixed to the feed bunk. Between recordings cows were re-mixed. The leg-scores were performed once with a scale and once without by 8 trained observers at the end of the housing period (March 2003), about 2 months after the whole milking herd was trimmed. For estimation of the repeatability, the leg-scores of all cows > 2 years were recorded twice with and twice without a scoring scale in farm B by 11 trained observers, one month after the scoring for estimation of the reproducibility (April 2003).

Statistical analysis

At animal level, the reproducibility of the leg score was estimated by comparing the 2 results (score once with and once without a scoring scale) on 2 herds (farm A and farm B) of the different observers. As a proportion of agreement between scores the kappa value was estimated (Noordhuizen et al.,2002). The analyses were performed using Winepiscope 2.0 and Statistix 7.

The repeatability at animal level was assessed by comparing the 2 results of scoring with scale and the 2 results of scoring without a scale. This was again expressed by computing the kappa value. In addition, the absolute differences (0, 1 or 2) of the leg-scores between the duplicates were calculated for the recordings with and without the scale. These differences were reduced to one dependent variable y: y = 0 if the absolute differences were null and y = 1 if the absolute differences were 1 or 2 (binom-
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Initial distribution). The probability p of y = 0 was estimated taking the factors: cow (random, n = 52), observer (fixed or random, n = 11) and scoring method (fixed, n = 2) into account. The dispersion was kept fixed at 1. For this analysis the GLMM-procedure (for single effect observer and method) was used whereas the IRREML-estimation technique was used for the interaction of observer*method. The analyses were performed using Winepiscope 2.0 and Genstat.

The repeatability of the claw score at herd level was assessed by the McNemar symmetry test based on different cut off values for leg score 1 to 3, while the Chi-square was used to evaluate the effect of the method and observer (Statistix 7).

Results

Reproducibility: the resulting equal outcomes of the leg score (with and without a scale) and the numbers of animals involved are presented in Table 1. Kappa values for all possible pairs of observers are presented in Table 2.

Table 1: Reproducibility of the leg-score based on the unanimous and different scores estimated with and without the scale as performed by 8 veterinarians.

<table>
<thead>
<tr>
<th>Herd</th>
<th>Scoring-scale</th>
<th>Same score (%)</th>
<th>2 different scores (%)</th>
<th>3 different scores (%)</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Yes</td>
<td>9.1</td>
<td>61.8</td>
<td>29.1</td>
<td>55</td>
</tr>
<tr>
<td>2</td>
<td>Yes</td>
<td>10.9</td>
<td>54.3</td>
<td>34.8</td>
<td>46</td>
</tr>
<tr>
<td>1</td>
<td>No</td>
<td>5.2</td>
<td>60.3</td>
<td>34.5</td>
<td>58</td>
</tr>
<tr>
<td>2</td>
<td>No</td>
<td>19.1</td>
<td>55.3</td>
<td>25.5</td>
<td>47</td>
</tr>
</tbody>
</table>

Table 2: Reproducibility outcomes (kappa’s) between the different observers on herd 2; at the left side of the table the values for scoring with a scale and at the right side for scoring without a scale

<table>
<thead>
<tr>
<th>Observer</th>
<th>W ith scale</th>
<th>2 d if ferent</th>
<th>3 d if ferent</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.216</td>
<td>0.382</td>
<td>0.251</td>
<td>0.485</td>
</tr>
<tr>
<td>2</td>
<td>0.181</td>
<td>0.351</td>
<td>0.276</td>
<td>0.182</td>
</tr>
<tr>
<td>3</td>
<td>0.343</td>
<td>0.165</td>
<td>0.221</td>
<td>0.285</td>
</tr>
<tr>
<td>4</td>
<td>0.239</td>
<td>0.181</td>
<td>0.204</td>
<td>0.300</td>
</tr>
<tr>
<td>5</td>
<td>0.264</td>
<td>0.197</td>
<td>0.239</td>
<td>0.343</td>
</tr>
<tr>
<td>6</td>
<td>0.101</td>
<td>0.105</td>
<td>0.133</td>
<td>0.345</td>
</tr>
<tr>
<td>7</td>
<td>0.314</td>
<td>0.027</td>
<td>0.089</td>
<td>0.107</td>
</tr>
<tr>
<td>8</td>
<td>0.354</td>
<td>0.178</td>
<td>0.177</td>
<td>0.114</td>
</tr>
</tbody>
</table>

Repeatability: the estimated kappa of the leg-score, estimated on herd 2 in April (twice scoring with and without the scale) and the number of animals involved are presented in Table 3.

Table 3: Repeatability of the leg-score estimated for scoring with the scale (kappa 1) and estimated for scoring without the scale (kappa 2). Nr. of animals is the number of animals scored twice with or without with the scale.

<table>
<thead>
<tr>
<th>Observer</th>
<th>profession</th>
<th>W ith scale</th>
<th>2 d if ferent</th>
<th>3 d if ferent</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>vet</td>
<td>0.36</td>
<td>0.43</td>
<td>0.41</td>
<td>45</td>
</tr>
<tr>
<td>2</td>
<td>vet</td>
<td>0.18</td>
<td>0.46</td>
<td>0.33</td>
<td>46</td>
</tr>
<tr>
<td>3</td>
<td>student</td>
<td>0.66</td>
<td>0.43</td>
<td>0.45</td>
<td>42</td>
</tr>
<tr>
<td>4</td>
<td>vet</td>
<td>0.28</td>
<td>0.39</td>
<td>0.45</td>
<td>40</td>
</tr>
<tr>
<td>5</td>
<td>vet</td>
<td>0.39</td>
<td>0.45</td>
<td>0.37</td>
<td>46</td>
</tr>
<tr>
<td>6</td>
<td>vet</td>
<td>0.17</td>
<td>0.43</td>
<td>0.33</td>
<td>42</td>
</tr>
<tr>
<td>7</td>
<td>vet</td>
<td>0.51</td>
<td>0.31</td>
<td>0.43</td>
<td>42</td>
</tr>
<tr>
<td>8</td>
<td>vet</td>
<td>0.41</td>
<td>0.24</td>
<td>0.41</td>
<td>41</td>
</tr>
<tr>
<td>9</td>
<td>vet</td>
<td>0.33</td>
<td>0.58</td>
<td>0.45</td>
<td>42</td>
</tr>
<tr>
<td>10</td>
<td>vet</td>
<td>0.43</td>
<td>0.12</td>
<td>0.31</td>
<td>31</td>
</tr>
<tr>
<td>11</td>
<td>vet</td>
<td>0.37</td>
<td>0.37</td>
<td>0.44</td>
<td>44</td>
</tr>
</tbody>
</table>

Reasons for missing values in the data set were "double I&R numbering" in the same herd, missing scores, mis-coding of numbers and other human errors.

In general kappa values are interpreted as no agreement between observations when kappa is equal to 0 and perfect agreement when kappa value is equal to 1. For practical use kappa values between 0.4 and 0.5 are indicated as moderate, values between 0.5 and 0.6 as sufficient and values between 0.6 and 0.8 as good.

The probability of the same result for each observer is presented in Table 4. These probabilities were comparable for scoring with and without a scale. On average, the probability of a same result was 0.61. The probability of the same result was not significantly different between the methods of scoring, the observers scoring or the interaction between observer*method (c²-tests, all P > 0.10).

Table 5. The probability of a same result between duplicates (n= 52 cows)

<table>
<thead>
<tr>
<th>Observer</th>
<th>Probability on a same result between duplicates</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Vet</td>
</tr>
<tr>
<td>2</td>
<td>Vet</td>
</tr>
<tr>
<td>3</td>
<td>Trained student</td>
</tr>
<tr>
<td>4</td>
<td>Vet</td>
</tr>
<tr>
<td>5</td>
<td>Vet</td>
</tr>
<tr>
<td>6</td>
<td>Vet</td>
</tr>
<tr>
<td>7</td>
<td>Vet</td>
</tr>
<tr>
<td>8</td>
<td>Vet</td>
</tr>
<tr>
<td>9</td>
<td>Vet</td>
</tr>
<tr>
<td>10</td>
<td>Vet</td>
</tr>
<tr>
<td>11</td>
<td>Vet</td>
</tr>
</tbody>
</table>

Advice at herd level.

The derived advice for the herdsman to have the dairy cows trimmed or not is presented in Table 5 for the option leg score 3 ≥ 20% (with and without scale). Evaluating the advice to the farmer: in the investigated herd the trimming advice to the herdsman, 2 months after the last herd trimming and when scoring with the scale, was con-
Discussion

As a first step in evaluating the leg-score, the repeatability and the reproducibility were estimated. The results of the repeatability (Table 2) are in agreement with the results of Boisot et al. (2002). In that study the repeatability of objective measurements (length and angles) on the rear legs of dairy cows was estimated to see whether higher repeatability estimates could be obtained compared to the corresponding linear score. In the study of Boisot, the repeatability for the angles was even lower (0.00-0.24). The probability of a same result was in our study 0.61 and this should be increased before this method of scoring is suitable for practical application having a good impression about the claw condition. One possibility for improvement could be the period between standing at the feed-bunk and moment of scoring; another could be the relation between the observer and the scored dairy-cows (more or less restless).

Based on a single observation, the resulting advice of the leg-score (Table 4) to the herdsman to have or have not the milking-cows trimmed was not consistent when scoring with and without a scale. When scoring without a scale, the advice to have the dairy cows not trimmed, when scoring with a scale, was consistent for 3 out of 11 observers. When scoring without a scale, the advice to have the dairy cows not trimmed consistent within 5 of 11 observers. The advice of 2 observers was not consistent when scoring with as scoring without a scale.

Table 5. The advice for the herdsman to have or have not the milking-cows trimmed, based on the results of the leg score with and without the scale.

<table>
<thead>
<tr>
<th>Border value/Observer</th>
<th>Leg score 3 &gt; 20% with a scale</th>
<th>Leg score 3 &gt; 20% without a scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Nb (14.0)</td>
<td>Yes (22.2)</td>
</tr>
<tr>
<td>2</td>
<td>Nb (13.0)</td>
<td>Nb (12.4)</td>
</tr>
<tr>
<td>3</td>
<td>Yes (37.0)</td>
<td>Yes (38.6)</td>
</tr>
<tr>
<td>4</td>
<td>Yes (20.5)</td>
<td>Yes (29.8)</td>
</tr>
<tr>
<td>5</td>
<td>Yes (29.8)</td>
<td>Yes (28.9)</td>
</tr>
<tr>
<td>6</td>
<td>Nb (9.5)</td>
<td>Nb (15.9)</td>
</tr>
<tr>
<td>7</td>
<td>Nb (13.3)</td>
<td>Nb (19.1)</td>
</tr>
<tr>
<td>8</td>
<td>Nb (9.8)</td>
<td>Nb (11.9)</td>
</tr>
<tr>
<td>9</td>
<td>Nb (9.9)</td>
<td>Nb (11.9)</td>
</tr>
<tr>
<td>10</td>
<td>Nb (15.2)</td>
<td>Nb (4.3)</td>
</tr>
<tr>
<td>11</td>
<td>Nb (11.3)</td>
<td>Yes (24.4)</td>
</tr>
</tbody>
</table>

Results (unanimous)

Yes= 3, Nb= 6

Yes= 4, Nb= 5

To conclude, further longitudinal research is needed to investigate the reason for different scoring results within the same cows within 30 minutes (time in this investigation measured between 2 scores), and to investigate additional criteria (mentioned above) that can improve the quality of this instrument to have objective criteria for the optimal moment for herd trimming and to quickly have information about the claw’s condition.

Above that, research to investigate the variations of the leg-score in relation to different claw-lesions is advisable.

Literature


Thrusfield, M. Veterinary Epidemiology, second edition 1995, page 135

Abstract

In a field study the changes in formalin concentration in walk-through footbaths in 18 dairy herds (n = 66.8, [40-140]) were determined by sampling 3 consecutive days. The footbaths were sampled just after preparation and every time, immediately after the dairy cows had passed the footbaths. The concentration was estimated by sampling, immediately filtering and analysing (gas-chromatography) the formalin-concentration in the samples from the walk-through footbaths. The initial concentration was reduced by 50% after 2,4 days and this is in this study comparable with 300-320 cow passages. The milking cows’ enthusiasm for walking through the footbaths did not influence the decrease of the formalin concentration.
1. Session: Prophylaxis of claw diseases

Introduction

Healthy feet and legs are of paramount importance to the cow for optimal productivity, health and animal welfare (Brand et al., 1996). Lameness is foremost associated with claw-problems (Weaver, 2000). Epidemiological research on claw disorders in dairy cattle indicates that the main infectious claw diseases resulting in hoof lesions and lameness, are digital and interdigital dermatitis (e.g. Somers et al., 2003). Since the use of antibiotics in footbaths is banned, many farmers are advised to use chemical disinfectants in footbaths like Copper Sulphate, Zinc Sulphate, formalin and their combinations for the prevention and treatment of (infectious) claw-problems. In spite of some disadvantages (for example irritation of the conjunctivae and epithelium of the respiratory tract of the farmer/milker) formalin-footbaths have been advised ever since Toussaint-Raven (1989). A lot of these original recommendations, especially the walk-through baths are still practised although the herd management has changed and the size of the dairy herds has increased enormously. The objective of this field study was to estimate the changes in formalin concentration in walk-through footbaths in dairy herds by sampling before and every time immediately after the last dairy cows had passed the footbaths. The influence of the milking cows’ enthusiasm of walking through the footbaths was also evaluated.

Material and methods

Selection and sampling.

Between December 2000 and September 2001, 18 dairy herds with cubicles and a walk-through footbath with a formalin disinfectant, near the Animal Health Service (AHS) in Deventer, were visited and sampled 7 times. During the herds’ first visit the capacity of the bath was calculated, the number of animal passages and the behaviour of the cows while walking through the footbath were observed. A first sample for measuring the formalin concentration was taken immediately after preparation by the farmer/milker) formalin-footbaths have been advised ever since Toussaint-Raven (1989). A lot of these original recommendations, especially the walk-through baths are still practised although the herd management has changed and the size of the dairy herds has increased enormously. The objective of this field study was to estimate the changes in formalin concentration in walk-through footbaths in dairy herds by sampling before and every time immediately after the last dairy cows had passed the footbaths. The influence of the milking cows’ enthusiasm of walking through the footbaths was also evaluated.

Analysis of the samples.

Before taking the samples out of the bath, the contents of the footbath were homogenised as much as possible. The sample-bottle was filled completely, to minimise possible gas production. As the footbaths contain many particles (faeces, sawdust and so on), which may influence the concentration, the samples were filtered immediately. In spite of removing the solid matter, the formaldehyde could still react with other agents present, which might also influence the concentration. To inhibit the production of formaldehyde radicals, 1 ml methanol was added to the filtered sample. While the morning samples were delivered within 2-3 hours to the laboratory for further analyses, the evening samples were stored at room temperature and delivered the next morning (after 14-16 hours).

Developing the method of analysis.

The method used for analysis and determination of formaldehyde concentration was developed in the AHS laboratory. With a gas-chromatographic technique, the present components in the samples were separated at an apolar capillary column and were shown and quantified with a flame-ionisation with an auto sampler. Before the experiment this method was validated for the field study. Eventually disturbing components that would influence the analysis were not found.

Validation of the technique included, for example, the production of para-formaldehyde and the possible conversion of para-formaldehyde into formaldehyde during analysis. These phenomenon were checked in the analytical method and could not be measured.

Statistical analysis.

The data were analysed by using Sigma Plot (Sigma Plot for Windows 4.01, SPSS Inc.). The half value time \((t = \frac{1}{2})\) was estimated based on the equation: \(y = f(a x e (-bx))\), of which \(y\) is the formalin concentration in % and \(x\) is the time since preparation of the bath. \(f, a\) and \(b\) are constant values based on the results.

Results

The contents and type of footbaths (disposable (d) or not disposable (nd)) and the behaviour of the cows while going through the baths (very quiet (v), quiet (q) and unquiet or restless (u)) is shown in Table 1. Table 2 shows the formalin concentration measured in the different samples and time (in min.) after preparing the footbath. Figure 1 demonstrates the formalin concentration (with deviation) related to the moment of sampling. Based on this figure, a half-value time can be estimated as 2,40 days (=3460 min.). This means that after this time under average conditions the initial concentration had decreased to under 50%. Table 3 demonstrates the formalin concentration related to the behaviour of the cows through the footbath. In relation to the low number of herds \((u\ and\ v)\) it was not possible to draw further conclusions.
Table 1. An overview of the contents (in litres) and type (d = disposable and nd = not disposable) of the used footbaths, the number of cows passing the footbath and the behaviour of the cows while walking through the footbath (Q = quiet, U = unquiet and V = very quiet) in the different dairy herds.

<table>
<thead>
<tr>
<th>Herd</th>
<th>Content of bath (l)</th>
<th>Kind of bath</th>
<th>Number of cows passing the bath</th>
<th>Behaviour</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>200</td>
<td>nd</td>
<td>40</td>
<td>Q</td>
</tr>
<tr>
<td>2</td>
<td>400</td>
<td>nd</td>
<td>51</td>
<td>U</td>
</tr>
<tr>
<td>3</td>
<td>600</td>
<td>d</td>
<td>50</td>
<td>Q</td>
</tr>
<tr>
<td>4</td>
<td>370</td>
<td>d</td>
<td>60</td>
<td>U</td>
</tr>
<tr>
<td>5</td>
<td>270</td>
<td>nd</td>
<td>65</td>
<td>Q</td>
</tr>
<tr>
<td>6</td>
<td>382</td>
<td>nd</td>
<td>64</td>
<td>Q</td>
</tr>
<tr>
<td>7</td>
<td>240</td>
<td>d</td>
<td>57</td>
<td>V</td>
</tr>
<tr>
<td>8</td>
<td>168</td>
<td>d</td>
<td>65</td>
<td>Q</td>
</tr>
<tr>
<td>9</td>
<td>200</td>
<td>nd</td>
<td>50</td>
<td>Q</td>
</tr>
<tr>
<td>10</td>
<td>930</td>
<td>nd</td>
<td>103</td>
<td>U</td>
</tr>
<tr>
<td>11</td>
<td>257</td>
<td>d</td>
<td>58</td>
<td>Q</td>
</tr>
<tr>
<td>12</td>
<td>170</td>
<td>d</td>
<td>58</td>
<td>Q</td>
</tr>
<tr>
<td>13</td>
<td>160</td>
<td>nd</td>
<td>73</td>
<td>Q</td>
</tr>
<tr>
<td>14</td>
<td>290</td>
<td>nd</td>
<td>85</td>
<td>Q</td>
</tr>
<tr>
<td>15</td>
<td>110</td>
<td>nd</td>
<td>140</td>
<td>Q</td>
</tr>
<tr>
<td>16</td>
<td>150</td>
<td>nd</td>
<td>62</td>
<td>Q</td>
</tr>
<tr>
<td>17</td>
<td>144</td>
<td>nd</td>
<td>40</td>
<td>Q</td>
</tr>
<tr>
<td>18</td>
<td>131</td>
<td>d</td>
<td>85</td>
<td>Q</td>
</tr>
</tbody>
</table>

Table 2. The measured formaline concentration in the different samples in relation to the time after preparing the footbath.

<table>
<thead>
<tr>
<th>Time of sampling (in min.)</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.7</td>
<td>2.7</td>
<td>15</td>
<td>2.2</td>
<td>810</td>
<td>1.7</td>
<td>1140</td>
</tr>
<tr>
<td>2</td>
<td>1.6</td>
<td>2.6</td>
<td>75</td>
<td>2.7</td>
<td>875</td>
<td>2.3</td>
<td>1480</td>
</tr>
<tr>
<td>3</td>
<td>1.6</td>
<td>3.1</td>
<td>120</td>
<td>3.1</td>
<td>900</td>
<td>3.1</td>
<td>1560</td>
</tr>
<tr>
<td>4</td>
<td>4.5</td>
<td>6.9</td>
<td>105</td>
<td>5.4</td>
<td>745</td>
<td>6.3</td>
<td>1440</td>
</tr>
<tr>
<td>5</td>
<td>3.6</td>
<td>5.3</td>
<td>210</td>
<td>3.2</td>
<td>980</td>
<td>3.0</td>
<td>1650</td>
</tr>
<tr>
<td>6</td>
<td>2.0</td>
<td>1.2</td>
<td>600</td>
<td>1.6</td>
<td>1260</td>
<td>1.3</td>
<td>2070</td>
</tr>
<tr>
<td>7</td>
<td>4.3</td>
<td>3.8</td>
<td>180</td>
<td>3.5</td>
<td>900</td>
<td>3.3</td>
<td>1560</td>
</tr>
<tr>
<td>8</td>
<td>3.2</td>
<td>2.4</td>
<td>90</td>
<td>1.9</td>
<td>630</td>
<td>1.0</td>
<td>1451</td>
</tr>
<tr>
<td>9</td>
<td>1.8</td>
<td>3.4</td>
<td>120</td>
<td>3.1</td>
<td>855</td>
<td>2.8</td>
<td>1560</td>
</tr>
<tr>
<td>10</td>
<td>3.4</td>
<td>2.6</td>
<td>180</td>
<td>2.1</td>
<td>630</td>
<td>1.5</td>
<td>1185</td>
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<td>78</td>
<td>3.5</td>
<td>796</td>
<td>3.2</td>
<td>1488</td>
</tr>
<tr>
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<td>2.7</td>
<td>2.8</td>
<td>75</td>
<td>2.2</td>
<td>765</td>
<td>2.4</td>
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<td>135</td>
<td>2.8</td>
<td>885</td>
<td>1.6</td>
<td>1575</td>
</tr>
<tr>
<td>14</td>
<td>5.5</td>
<td>5.9</td>
<td>120</td>
<td>3.9</td>
<td>810</td>
<td>3.4</td>
<td>1560</td>
</tr>
<tr>
<td>15</td>
<td>5.5</td>
<td>3.3</td>
<td>180</td>
<td>1.7</td>
<td>960</td>
<td>1.0</td>
<td>1650</td>
</tr>
<tr>
<td>16</td>
<td>2.9</td>
<td>2.6</td>
<td>150</td>
<td>2.2</td>
<td>900</td>
<td>1.9</td>
<td>1560</td>
</tr>
<tr>
<td>17</td>
<td>5.0</td>
<td>4.7</td>
<td>145</td>
<td>4.3</td>
<td>905</td>
<td>3.7</td>
<td>1580</td>
</tr>
<tr>
<td>18</td>
<td>4.5</td>
<td>3.5</td>
<td>120</td>
<td>2.9</td>
<td>975</td>
<td>2.0</td>
<td>1580</td>
</tr>
</tbody>
</table>

Table 3. The formaline concentration related to the behaviour of the cows while walking through the footbath.

<table>
<thead>
<tr>
<th>Behaviour</th>
<th>Mean values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quite (n=14)</td>
<td>3.6 3.2 2.8 2.4 2.2 2.0 1.9</td>
</tr>
<tr>
<td>Unquiet (n=3)</td>
<td>3.9 4.0 3.8 3.4 3.1 3.0 2.5</td>
</tr>
<tr>
<td>Very Quite (n=1)</td>
<td>4.3 3.8 3.5 3.3 3.1 2.1 2.3</td>
</tr>
</tbody>
</table>

Discussion

The results of this field study, with a 50% decrease of the initial concentration after 2-40 days (300-320 cow passages) are comparable with other studies (e.g. Berry et al., 1997), which also advised renewal of every footbath after 200-300 passages. This means that under normal circumstances in the Netherlands (medium herd size 57 cows (CBS, 2002)), every 2 days (4 cow passages) the bath had to be renewed, to guarantee enough activity.

Based on the results of the footbath volume (Table 1) and the concentration in the first samples just after preparing the bath (Table 2) much attention must paid to the dimensions and the initial concentration. Fifty percent of the footbaths had a capacity of less than 250 litres, which means the baths were usually too short or not high enough.

The great differences in decrease of the footbath concentration could probably be related to the cleanliness of the hooves at the start of the footbath and the amount of defecation in the bath. In the Netherlands it is uncommon to make use of two footbaths (e.g. Blowey, 1993), when a first bath can clean the claws and the cows can defecate. When cows go through the second bath, disinfection is more effective and there is less change in the concentration. So a dual foot-bath is probably advisable.

To conclude, under the present Dutch circumstances (medium herd size of 57, cows on a slatted floor) attention must be paid to the initial concentration and it is advisable to refresh the footbaths after 200-250 cow passages.

References


In order to get the most reliable data we wanted trimmers to volunteer for the study. Unfortunately only four trimmers wanted to participate. The claw trimmers collected data from all the herds they trimmed and which fitted the required characteristics during the study period. Only the routine trimmings of a large part of the herd were included. This resulted in a total of 52 herds and 6500 cows. The datasheet used for collecting claw data included lameness score, but only severely lame cows were recorded because of the conditions and limited space around the trimming chute. The trimmers recorded all skin and horn lesions related to the distal part of all four limbs. This included heel horn erosion (HHE), solar haemorrhage (SH), sole ulcer (SU), interdigital dermatitis (ID), digital dermatitis (DD), white line disease (WLD), abscess, interdigital hyperplasia (IH), and double sole (Dbs). The lesions and abnormalities were evaluated during and at the completion of trimming. We thus obtained records of both new and older lesions.

In each of the 52 dairy herds, milk quality advisors employed by the Danish Dairy Board collected farm level information at herd visits. The information collected on the farm was largely detailed. However, only limited information could actually be used in the analysis because of too little variation in the data. Housing and management factors included in the analysis were: type and amount of bedding, hygienic condition of the floor and the cubicles, feeding routines, the size of the herd, footbathing routines, trimming routines, and whether the cows were grazing or not.

Housing factors included were: new housing system build within the last 5 years, uncomfortable cubicles, and type, structure and quality of flooring. Data were analysed by means of a multilevel random effects logistic regression model and common factor analysis.

Results and discussion

The main results of our study are presented in tables 1 to 2.

Table 1. Across-herd prevalence of claw lesions in 6240 loose housed Danish Holsteins

<table>
<thead>
<tr>
<th>Variable</th>
<th>Proportion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lameness</td>
<td>0.02</td>
</tr>
<tr>
<td>Heel horn erosion</td>
<td>0.54</td>
</tr>
<tr>
<td>Solar haemorrhage</td>
<td>0.59</td>
</tr>
<tr>
<td>Sole ulcer</td>
<td>0.06</td>
</tr>
<tr>
<td>Interdigital dermatitis</td>
<td>0.25</td>
</tr>
<tr>
<td>Digital dermatitis</td>
<td>0.22</td>
</tr>
<tr>
<td>Interdigital dermatitis</td>
<td>0.05</td>
</tr>
<tr>
<td>Abscess</td>
<td>0.01</td>
</tr>
<tr>
<td>White line disease</td>
<td>0.05</td>
</tr>
<tr>
<td>Double sole</td>
<td>0.06</td>
</tr>
</tbody>
</table>
1. Session: Prophylaxis of claw diseases

Table 2. The prevalence of claw disorders in Danish Holsteins - the distributions of the no. of recordings and herd-level prevalence and variance components associated with the herd level (random herd effect estimated from logistic regression).

<table>
<thead>
<tr>
<th>Variable</th>
<th>10th Pctl</th>
<th>25th Pctl</th>
<th>50th Pctl</th>
<th>75th Pctl</th>
<th>90th Pctl</th>
</tr>
</thead>
<tbody>
<tr>
<td>Herd size</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lameness</td>
<td>0.00</td>
<td>0.00</td>
<td>0.02</td>
<td>0.04</td>
<td>0.06</td>
</tr>
<tr>
<td>Heel horn erosion</td>
<td>0.04</td>
<td>0.16</td>
<td>0.44</td>
<td>0.80</td>
<td>0.92</td>
</tr>
<tr>
<td>Solar haemorrhage</td>
<td>0.23</td>
<td>0.31</td>
<td>0.57</td>
<td>0.70</td>
<td>0.89</td>
</tr>
<tr>
<td>Sole ulcer</td>
<td>0.00</td>
<td>0.02</td>
<td>0.05</td>
<td>0.08</td>
<td>0.14</td>
</tr>
<tr>
<td>Interdigital dermatitis</td>
<td>0.02</td>
<td>0.08</td>
<td>0.20</td>
<td>0.42</td>
<td>0.54</td>
</tr>
<tr>
<td>Digital dermatitis</td>
<td>0.00</td>
<td>0.07</td>
<td>0.16</td>
<td>0.28</td>
<td>0.38</td>
</tr>
<tr>
<td>Interdigital hyperplasia</td>
<td>0.00</td>
<td>0.01</td>
<td>0.03</td>
<td>0.06</td>
<td>0.12</td>
</tr>
<tr>
<td>Abscess</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>White line disease</td>
<td>0.00</td>
<td>0.01</td>
<td>0.03</td>
<td>0.06</td>
<td>0.11</td>
</tr>
<tr>
<td>Double sole</td>
<td>0.00</td>
<td>0.02</td>
<td>0.04</td>
<td>0.07</td>
<td>0.12</td>
</tr>
</tbody>
</table>

The random herd effects (Table 2) indicate the contributions from the herd factors including claw trimmer to variability in the occurrence of claw lesions. The table shows that the occurrence of heel horn erosion is particularly influenced by risk factors on herd-level and that horn related lesions like sole ulcer primarily are related to cow-level risk factors. In this analysis the cow characteristics have not been included. A factor analysis of the data showed a moderately strong relationship between slippery, wet floors and heel horn erosion. There was a relationship between new stalls and solid concrete floors and between large herds (>121), zero grazing and automatic concentrate feeding.

The prevalence of herds with digital dermatitis in this study is 79% (7 of 52 herds did not have any cows with clinical DD lesions). This shows that digital dermatitis has spread throughout Denmark since the early eighties (Blom 1996, Enevoldsen et al 1991a). Infectious diseases like digital dermatitis and interdigital dermatitis are becoming more common and cause serious lameness in Danish herds.

We expect that the type of flooring in loose housing systems affects the prevalence of claw lesions. However, the results from this study do not show significant and clear relationship between diseases and between diseases and all herd-level risk factors. Consequently, most of the claw diseases probably are more affected by cow-level factors than by herd-level factors. This indicates a need for analysis of cow-characteristics like lactation stage, age and production level.

Acknowledgement

This study was part of a PhD, funded by the Danish Agricultural Advisory Service, National Centre in Aarhus, Denmark and The Royal Veterinary and Agricultural University, Frederiksberg, Denmark. We would like to thank the trimmers, milk quality inspectors and the farmers participating in this study.

References

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1. Session: Prophylaxis of claw diseases

EFFECT OF PRESENCE OF CLAW LESIONS IN HEIFERS PRIOR TO FIRST PARTURITION ON RISK OF DEVELOPING CLAW LESIONS DURING LACTATION

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INTRODUCTION

According to the 2002 National Animal Health Monitoring Systems (NAHMS) survey, 16% of cattle are culled due to lameness. However, this survey may underestimate this number as cows culled for low production (19%) or reproductive failure (27%) may actually have been lame. Lameness has been shown to reduce milk production (Guard, 1997; Robinson et al., 2003) and fertility (Sprecher et al., 1997; Hernandez et al., 2000; Melendez et al., 2002). Furthermore, dairy producers tend to underestimate extent and severity of lameness within their herd (Whay et al., 2002). Literature also indicates that previously lame cattle are more prone to future reoccurrences (Peterse, 1986; Raven, 1989; Enevoldsen et al., 1991). Therefore, preventing animals from becoming lame must be a key management objective. However, there is limited data on incidence and severity of claw lesions in calves and heifers. Data is also limited on the impact of claw lesions during the rearing phase on reoccurrences of claw lesions during lactation. The objective of this study was to determine the incidence and severity of claw lesions in heifers from 12 months of age to calving and the impact of claw lesions during the rearing phase on reoccurrence of claw lesions.

MATERIALS AND METHODS

Claws of 572 dairy heifers at a commercial heifer rearing facility were evaluated at 12 months of age, one month prepartum and two months after parturition. Heifers originated from one of four source dairies and were housed at the commercial heifer rearing facility in groups of approximately 100 animals in open, earthen-mounded lots without overhead protection. Concrete feed platforms and manure alleys integral to the open mound lots were scraped twice per week and mounds were bedded with coarse bark when needed as determined by the operator of the commercial heifer rearing facility. During the rearing phase, heifers were fed a TMR consisting of (DM basis) 42% corn silage, 30.2% haycrop silage, 25.5% hay, 0.4% soybean silage, 0.5% corn gluten meal, 0.2% high moisture corn, 0.3% urea and 0.9% vitamins and minerals. Two dietary treatments were used: a control diet, and a treatment diet with the same ingredient composition as the control diet except for the addition of a complexed trace mineral additive. Results regarding dietary treatments will be reported in another paper at this conference. Mean chemical composition of diets is reported in Table 1.

<table>
<thead>
<tr>
<th>Chemical component, DM basis</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Crude protein, %</td>
<td>15.3</td>
</tr>
<tr>
<td>Acid detergent fiber, %</td>
<td>29.8</td>
</tr>
<tr>
<td>Neutral detergent fiber, %</td>
<td>40.3</td>
</tr>
<tr>
<td>Calcium, %</td>
<td>1.0</td>
</tr>
<tr>
<td>Phosphorus, %</td>
<td>0.36</td>
</tr>
<tr>
<td>Magnesium, %</td>
<td>0.28</td>
</tr>
</tbody>
</table>

Table 1. Average chemical composition of diets fed to heifers

After completion of the claw evaluation at one month prepartum, heifers were returned to the source dairy. At the source dairy, heifers were housed in naturally ventilated free stall barns, fed similar total mixed rations (TMR) with respect to the source dairy and were milked thrice daily. Claws were evaluated by one claw trimmer using a clean, light grind. The claw trimmer was a graduate of the Dairyland Hoof Care Institute (Baraboo, WI). Lesions were noted in the 7 zones of the claw (adapted from Greenough, 1997) and each lesion was scored for severity on a scale of 1 to 3 (1=minor, 2=moderate, 3=severe). To assess both incidence and severity of claw lesions, a claw lesion incidence and severity (CLIS) index was calculated. This index was the average number of zones affected per cow multiplied by the average severity score of the lesion multiplied by 10.

RESULTS AND DISCUSSION

The CLIS index integrates frequency and severity measurements. At 12 months of age, sole hemorrhage, white line separation, and heel erosion were the predominant disorders (Table 2).
One month prepartum, heel erosion, sole hemorrhage, and to a lesser extent white line separation were the predominant disorders. More importantly, the effect of the claw status at 12 months of age had a significant effect on the CLIS index one month prepartum for both heel erosion and sole hemorrhage, indicating that the incidence and severity of these two diseases at 12 months of age influence the incidence and severity of the same diseases near the end of the rearing period. In early lactation, heel erosion, sole hemorrhage, and to a lesser extent white line separation, abaxial wall fissure, and digital dermatitis were the predominant disorders. The CLIS status one month prepartum had a significant effect on the CLIS status two months postpartum for heel erosion, abaxial wall fissure, sole hemorrhage, and digital dermatitis.

Heifers that had at least one claw lesion at 12 months of age were 27.7 times more likely (P < 0.05) to have a claw lesion two months postpartum than heifers that did not have a claw lesion at 12 months of age (Table 3). Heifers with abaxial wall fissures and sole hemorrhages at 12 months of age were more likely (odds ratio 5.3 and 2.0, respectively, P < 0.05) to have these lesions present two months postpartum than those who did not have these lesions (Table 3).

Table 2. Least square means of claw lesion and severity (CLIS) index of dairy heifers at 12 months of age, one month prepartum and two months postpartum.

<table>
<thead>
<tr>
<th>Claw Disorder</th>
<th>12 Months of Age</th>
<th>1 Month Prepartum</th>
<th>2 Months Postpartum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dorsal wall ridges</td>
<td>0.4</td>
<td>0.0</td>
<td>1.2</td>
</tr>
<tr>
<td>Heel erosion</td>
<td>6.4</td>
<td>31.9z</td>
<td>35.0z</td>
</tr>
<tr>
<td>Abaxial wall lesions</td>
<td>0.0</td>
<td>0.2</td>
<td>0.0</td>
</tr>
<tr>
<td>Abaxial wall fissures</td>
<td>1.0</td>
<td>0.8</td>
<td>2.5z</td>
</tr>
<tr>
<td>Double soles</td>
<td>0.2</td>
<td>0.2</td>
<td>0.1</td>
</tr>
<tr>
<td>White line separation</td>
<td>8.6</td>
<td>2.9</td>
<td>6.3</td>
</tr>
<tr>
<td>Sole hemorrhages</td>
<td>9.7</td>
<td>13.2z</td>
<td>26.4z</td>
</tr>
<tr>
<td>Sole ulceration</td>
<td>0.0</td>
<td>0.0</td>
<td>0.2</td>
</tr>
<tr>
<td>Digital dermatitis</td>
<td>0.0</td>
<td>1.5</td>
<td>1.9z</td>
</tr>
<tr>
<td>Interdigital dermatitis</td>
<td>0.0</td>
<td>0.0</td>
<td>0.2</td>
</tr>
<tr>
<td>Foot rot</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

Table 3. Effect of the presence of a claw lesion during the rearing phase on the risk of having a claw lesion in early lactation.

<table>
<thead>
<tr>
<th>Claw Disorder</th>
<th>Risk of a claw lesion at 2 months postpartum when animals have a claw lesion at 12 months of age, odds ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Claw lesion</td>
<td>Risk of a claw lesion at 1 month prepartum, odds ratio</td>
</tr>
<tr>
<td>------------------------</td>
<td>---------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Claw lesion</td>
<td>27.7y</td>
</tr>
<tr>
<td>Dorsal wall ridges</td>
<td>3.5</td>
</tr>
<tr>
<td>Heel erosion</td>
<td>1.1</td>
</tr>
<tr>
<td>Abaxial wall fissures</td>
<td>5.3y</td>
</tr>
<tr>
<td>Double soles</td>
<td>1.7</td>
</tr>
<tr>
<td>White line separation</td>
<td>1.2</td>
</tr>
<tr>
<td>Sole hemorrhages</td>
<td>2.0y</td>
</tr>
<tr>
<td>Sole ulceration</td>
<td>0.2</td>
</tr>
<tr>
<td>Digital dermatitis</td>
<td>4.0y</td>
</tr>
<tr>
<td>Interdigital dermatitis</td>
<td>-</td>
</tr>
</tbody>
</table>

ACKNOWLEDGEMENTS

The authors would like to acknowledge Emerald Lane Farms, Miltrim Farms, Quella Farms, Bredl Farms, Badgerland Holsteins, Harlan Tripp, Denise Tripp and Ryan Wernberg for their diligence in carrying out the trial protocol.
FOOT BATHING IN THE HOOF HEALTH MANAGEMENT

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Introduction

Hoof diseases and lameness in bovines account for a big portion of the income loss due to diseases. Various management tools are available that could help reduce these losses. Hoof problems during the animal’s productive life are mostly related to infectious diseases, feeding, housing including the type of floor surface and improper hoof trimming practices and combinations of these factors. Foot bathing is the most commonly used method in the attempt to prevent hairy warts and other hoof diseases.

There is a lack of well documented and reported trials under farm conditions that show the effect of foot bathing when accompanied by proper hoof trimming. Additionally, the available trial data does not always address the full range of hoof diseases. Concern has been expressed (4) about procedures and products used with foot baths and that any perceived benefits must be weighed against direct economic costs, potential risk to human and animal health and environmental considerations (7). Foot bathing procedure recommendations including product selection, product concentration, frequency of use, and number of cow passes before cleaning and refilling are rarely supported by documented clinical trials. The objective of this study was to evaluate the overall effect of a well maintained foot bathing solution, containing no antibiotic, heavy metals or other environmentally hazardous substances on the health and condition of the hooves.

Material and Method

The trial was performed on a dairy farm located in Mt. Vernon, WA (USA). The target population of this study consisted of 190 dairy cows, Holstein breed, that were milked twice a day in a double ten herringbone parlor. The foot bath solution used prior to the trial consisted of 25 pounds of copper sulfate diluted in 50Gal of water. The housing consisted of free stalls with kiln dried shavings as bedding, cleaned every two days and concrete floors. There were no changes in the feeding or management practices throughout the length of the trial. Weather during the trial had the average rainy days and temperature found in this region of WA in late winter and spring. A 55 gallon footbath was located in the alley at the exit of the parlor, preceded by a wash bath containing fresh water. The foot bath containing Double Action® (DeLaval) at 5% and the wash bath were emptied and recharged daily after all 190 cows passed through the bath.

Hooves were evaluated at the start and the end of the trial for incidence of hoof disease. The pre-trial protocol consisted of an examination of all the cows of the herd and trimming as needed. The cows walked through the foot bath solution once a day from Monday through Friday after the evening milking. During the weekends both baths remained clean and empty in their place. The length of the trial was 12 weeks beginning in January 2003 and finishing in April 2003. Cows were surveyed again at the end of the trial and the results recorded. Both surveys were performed by a veterinarian skilled at evaluating hoof condition with the assistance of a professional hoof trimmer. All the cows in the herd were scored but for analysis purposes only those that stayed in the herd throughout the trial period were included in the final results. Temperature and weather data was collected during the course of the trial. Statistical analysis was done using Chi Square test with Statistica software.

Results

Heel erosions, hemorrhages and digital dermatitis (DD) were the most prevalent hoof problems at the start of the trial. A total of 37.5% of hooves were determined to be unhealthy. Foot bathing with 5% Double Action for 12 weeks reduced the number of cows affected with digital dermatitis and interdigital dermatitis. A significant reduction in hooves affected by Heel Erosion, Hemorrhages and Ulcers was observed. These results are summarized in the chart below. The total prevalence of hoof problems was reduced to 17.9%. Weather conditions, temperature and rain, during the trial were average for the season.

<table>
<thead>
<tr>
<th>Survey</th>
<th>Initial</th>
<th>Final</th>
<th>Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disease</td>
<td>% of hooves</td>
<td>Incidents</td>
<td>% of hooves</td>
</tr>
<tr>
<td>Heel Erosion (HE)</td>
<td>16.3</td>
<td>85</td>
<td>11.5</td>
</tr>
<tr>
<td>Hemorrhages (H)</td>
<td>10.0</td>
<td>52</td>
<td>1.3</td>
</tr>
<tr>
<td>Digit &amp; Dermatitis (DD)</td>
<td>5.0</td>
<td>26</td>
<td>3.7</td>
</tr>
<tr>
<td>Interdigital Dermatitis (IDD)</td>
<td>0.8</td>
<td>4</td>
<td>0.6</td>
</tr>
<tr>
<td>Foot Rot (FR)</td>
<td>0.4</td>
<td>2</td>
<td>0.4</td>
</tr>
<tr>
<td>White Line Disease (WLD)</td>
<td>1.3</td>
<td>7</td>
<td>0.0</td>
</tr>
<tr>
<td>Ulcer (U)</td>
<td>3.7</td>
<td>19</td>
<td>0.4</td>
</tr>
<tr>
<td>Healthy Hooves</td>
<td>62.5</td>
<td>325</td>
<td>82.1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100.0</strong></td>
<td><strong>520</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>
Previous trials (3,6) have shown that Double Action is effective at reducing the incidence of Digital Dermatitis in herds with a high incidence of DD. The reduction in the prevalence of Digital dermatitis shows that even in a herd with a low number of hooves affected (5%) there is a good chance of reducing the incidence of this disease. In the current trial, Double Action helped control a range of hoof problems when used in a well maintained foot bath. Prior to the trial, hoof care on this farm had consisted of foot bathing with copper sulfate three times a week. The improved hoof health is attributed to the specific preventative product as well as the implementation of an improved foot bathing regime.

The diseases surveyed could be divided into infectious diseases and other hoof problems. The infectious agents responsible for Digital and Interdigital Dermatitis are also believed to play a role in the etiology of Heel Erosion (1, 5). The significant reduction in the number of hooves affected with Heel Erosion along with the reduction in the number of DD lesions would tend to support that belief.

Sub solar hemorrhaging, White line disease (WLD), and sole ulcers are primary indicators of a previous laminitis. While a nutrition factor like rumen acidosis seems to be a key in the development of laminitis, different observations suggest that additional factors must be involved (2). During this trial there was a significant reduction in the prevalence of sub solar hemorrhaging, WLD and sole ulcers. Although there was no change in the feeding routine or diet during the trial, no specific nutritional parameters were monitored and therefore we cannot determine how nutrition affected this reduction. Locally acting factors influence the hoof directly. Overgrowth of the horn is a result of environmental factors exacerbated by predisposing disease factors (2). Functional hoof trimming restores the normal shape of the claw, the angle of the toe and the equalizes weight distribution between the two claws. Claw trimming does not replace other appropriate disease control measures but it is an important component indicating that hoof trimming probably played a significant role in reducing the level of sub solar hemorrhaging, WLD and sole ulcers during this trial.

Conclusion
The results of this study show that Double Action is effective at improving overall hoof condition when used 5 days per week in a herd with a relatively high incidence of hoof disease. Additional studies are suggested to determine if this product can be used less frequently as part of a hoof health maintenance program. Specific recommendations on frequency and concentration for other hoof bath agents like copper sulfate or formaldehyde would need to be determined through clinical trials.
tation heifer has a significant effect on the development of hoof horn haemorrhages and other factors predisposing to lameness. The pertinent records for all of the heifers on previous studies of cattle lameness at ADAS Bridgets were inserted onto a spreadsheet. This contained all the relevant data from these studies, so that the effect of sire could be examined independently of study treatments. The data were investigated using preliminary descriptive statistical techniques, Pearson correlations and Principal component analysis.

Inclusion of assessments

The foot lesion assessments included were:

i. The worst lesion score for each heifer: based on severity and severity/extent

ii. The lesion score at 12 weeks post partum for all heifers: based on severity and severity/extent

White line haemorrhage scores and sole haemorrhage scores were included separately for all animals

For hoof wear, the average wear rate between 0 and 12 weeks post partum were included. For hoof growth, the table included the average growth rate between 0 and 6, 6 and 12, 0 and 12 weeks post partum

The angles of the toe at calving and 12 weeks post partum were included.

The presence or absence of slurry heel at calving and 12 weeks post partum was included.

Sires

Five parameters of sire conformation and performance were included in the analysis. These were toe angle score, locomotion score, legs and feet score, PIN and PLI. In total, 21 sires were represented in the data set of 131 cow cases. For three sires, only one heifer case was present in the data set, whereas four sires were represented by 10 or more daughters.

RESULTS

Pearson correlations for key cow and sire parameters are shown in Table 1. There were no high correlations between any of the cow and sire parameters, indicating the complete absence of any useful prognostic factors. Subsequently, principal component analysis was done in a further attempt to identify potential correlations between cow and sire traits in these data. Pearson correlations of the first eight cow and first three sire principal components are shown in Table 2. None of these correlation coefficients had a magnitude greater than 0.290 and most were less than 0.1, and the resultant conclusion was that there was no significant correlation between sire and cow factors relating to lameness.

1. Session: Prophylaxis of claw diseases

Table 1. Pearson Correlations between cow foot lesion assessments and sire conformation parameters

<table>
<thead>
<tr>
<th>Cow factors</th>
<th>Foot lesions</th>
<th>Hoof wear</th>
<th>Hoof growth</th>
<th>Toe angle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sire factors</td>
<td>W ang case</td>
<td>At 12 weeks</td>
<td>W ang case</td>
<td>At 12 weeks</td>
</tr>
<tr>
<td>Foot angle</td>
<td>-0.126</td>
<td>-0.063</td>
<td>-0.047</td>
<td>0.024</td>
</tr>
<tr>
<td>Locomotion score</td>
<td>-0.212</td>
<td>-0.165</td>
<td>-0.136</td>
<td>-0.050</td>
</tr>
<tr>
<td>Legs and feet score</td>
<td>-0.239</td>
<td>-0.187</td>
<td>-0.151</td>
<td>-0.066</td>
</tr>
<tr>
<td>PIN*</td>
<td>0.114</td>
<td>0.018</td>
<td>0.088</td>
<td>0.077</td>
</tr>
<tr>
<td>PLI**</td>
<td>0.127</td>
<td>0.038</td>
<td>0.072</td>
<td>0.028</td>
</tr>
</tbody>
</table>

Table 2. Pearson Correlations between the first eight cow (PCC) and first three sire (PCS) principal components

<table>
<thead>
<tr>
<th>Cow factors</th>
<th>Sire factors</th>
<th>PCS1</th>
<th>PCS2</th>
<th>PCS3</th>
<th>PCC1</th>
<th>PCC2</th>
<th>PCC3</th>
<th>PCC4</th>
<th>PCC5</th>
<th>PCC6</th>
<th>PCC7</th>
<th>PCC8</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCS1</td>
<td>-0.042</td>
<td>0.067</td>
<td>0.079</td>
<td>0.185</td>
<td>-0.061</td>
<td>0.017</td>
<td>0.156</td>
<td>0.028</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PCS2</td>
<td>-0.057</td>
<td>0.070</td>
<td>0.066</td>
<td>0.028</td>
<td>0.149</td>
<td>0.290</td>
<td>0.031</td>
<td>0.053</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PCS3</td>
<td>-0.008</td>
<td>-0.089</td>
<td>-0.033</td>
<td>0.122</td>
<td>0.003</td>
<td>0.089</td>
<td>0.100</td>
<td>0.102</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

CONCLUSION

None of the sire factors investigated in this study had any significant correlation or association with the observed measures of cow lameness.

USE OF A NOVEL FOOT FOAM IN THE CONTROL OF DIGITAL DERMATITIS

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and Williams M, ECOLAB, Cheadle Hulme, Cheshire

Introduction

Digital dermatitis is a bacterial infection of the epidermal skin of the bovine digit. First reported in Italy in the early 70s, the disease has now spread to most intensive livestock producing countries worldwide, and accounts for around 20% of all cases of foot lameness. This is one probable reason why, despite years of research, the incidence of bovine lameness has not decreased over the past 15 years.

Many publications have shown the value of footbaths, but the majority of products in current use have some disadvantages. Formalin is unpleasant to handle and may have carcinogenic properties. Copper salts do not
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degraded in the environment and there is already concern about the increasing incidence of copper poisoning in UK dairy cattle. Antibiotic footbaths are still used in the UK and some other countries, but there are milk withhold and environmental disposal considerations. Initially antibiotic footbaths were used when there were a significant number of visible lesions present in the herd. More recently this view has been challenged (Blowey 2000) and there is now a growing trend among farmers and vets to disinfect the feet regularly in an attempt to prevent lesions from developing. Prevention of lameness is clearly better than treatment. It is known that there is a considerable increase in incidence of digital dermatitis in the 2-3 months post-calving, (Blowey and others 2004). This is thought to be partly associated with housing conditions and partly associated with immune suppression in the periparturient animal. There is a perception among many farmers that cows do not like walking through footbaths and hence alternatives to a liquid bath have been sought. These include a foam mat, which becomes a footbath when foot pressure is applied to the mat. An alternative, described in this paper, is a novel foam that is sited at the entrance to the milking parlour. This paper describes the use of the foam and the monitoring of foot condition in one trial herd.

Materials and Method

The Kovex™ foam consists of a peracetic acid disinfectant, plus peracetic acid, a patented booster for the peracetic acid. The foam has adhesive properties to improve the adhesion to the hoof and a green dye is added to reduce the glare of the foam, making it less intimidating for the cows to walk through. A skin conditioner is added and a detergent, to assist the foam to penetrate the foot. The foam is deposited at the entrance to the milking parlour, to a depth of 12-14cms. Cows are therefore standing in the foam whilst waiting to enter the parlour, foam is carried into the parlour on their feet and remains on their feet during the milking process. The majority of cows therefore have their feet bathed in foam for some 5-10 minutes.

The recommended dosage regime is for treatment to be carried out at each milking for the first two weeks and thereafter at six consecutive milkings every two weeks. Increased frequency of foam application may be necessary for farms where there is a heavy challenge.

The effectiveness of the foam was monitored in a 140-cow herd in the author’s general veterinary practice. There had been a longstanding problem of digital dermatitis in this herd. Foot bathing had been tried but was found to be very laborious, was not practised frequently and hence was not effective. Before the foam system was instigated, a whole herd foot score was carried out. Feet were examined in a herring bone parlour while the cows were standing to be milked. The heels were cleaned using a volume water hose and then scored according to the following criteria:

<table>
<thead>
<tr>
<th>Size</th>
<th>Colour</th>
<th>Adjacent skin edge</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>0-15mm</td>
<td>Dark/black</td>
<td>Flush</td>
</tr>
<tr>
<td>&gt;15mm</td>
<td>Dark/black</td>
<td>Raised</td>
</tr>
<tr>
<td>&gt;25mm</td>
<td>Red</td>
<td>Raised</td>
</tr>
</tbody>
</table>

A lesion would be given a score on achieving any two or three criteria. Hence if a lesion were greater than 15mm and raised above the adjacent skin surface, it would score as a 3. A lesion that was red and scored greater than 25mm would be scored 4, whether it was a raised proliferating lesion or flush with the adjacent skin, or eroded and hence depressed below adjacent skin. Scoring was carried out prior to the instigation of the foam, then at approximately six-week intervals following the use of the foam. The foam was applied at slightly higher frequency than the manufacturers recommended rate, being used continuous for the first two weeks, then once daily for 5 days each week thereafter.

Results

Mean herd scores based on the average score per foot are given in Table 1. There was a high incidence of digital dermatitis prior to the instigation of the foam, with 33% per cent of cows showing lesions with score 2 and above. Many other cows had mild, hyperkeratosis areas of skin with a score of 1.0. The herd score decreased over the period of the application of the foam, although it was noticeable that individual animals that were badly affected, i.e. with a high score, did not improve significantly. These animals had to be restrained and individually treated. This is in the Manufacturer’s instructions for the foam; i.e. the foam is a preventive, not a treatment.

Discussion

There was a reduction in the incidence of digital dermatitis in this herd in association with the use of the Kovex™ foam. This was not, of course, a controlled trial and hence the reduction in dermatitis may have been due to environmental or other conditions which may have led to an overall reduction in dermatitis. The lesion scoring system did not allow for the scoring of interdigital lesions, nor anterior coronary band lesions. The scores may also have been influenced by the posture of the cow, in that it is less easy to visualise the interdigital cleft area of a cow if the pastern angle is shallow and fetlock is close to floor level. However, it was the subjective feeling of the author that the cows were walking better at the end of the scoring period than they had done for many years beforehand. Whilst individual animals still needed treatment, it was noticeable that heifers entering the herd remained relatively free of the disease. Other studies (Blowey et al, 2004 Maribor Conference proceedings) have previously
shown that digital dermatitis is more common both in heifers and in early lactation animals and hence the finding that heifers are able to enter the herd and remain free of the disease may well be significant. The owner and herdsman felt that the system was easy to use and there was very little adverse effect or fear on the part of the cows. The system currently costs around 2140 Euros (£1500) to install and the chemical cost is approximately 1.42 Euros (£1) per cow/month., or 4.7 cents (3.3p) per cow per day when used at the recommended rate of 6 consecutive milkings every two weeks.

Although the equipment is expensive to install, the reagent costs are less expensive than some of the alternative forms of footbath. For example although 150 litres of 5% formalin, enough to foot bath 150 cows and made up fresh daily, would cost 1.4 cents (2 p) per day, a proprietary glutaraldehyde/copper sulphate foot bath on sale in the UK costs 13.1 cents (9.2 p) per cow per day. Formalin is unpleasant to handle and copper salts may have adverse environmental effects. The Kovex foam used in the current study was pleasant to handle and there was no evidence of any adverse effect on the cows. Many farms would pay a little extra for ease of handling, and the installation of the foam system represents an alternative method for assisting in the control of digital dermatitis.

<table>
<thead>
<tr>
<th>Date</th>
<th>% Cows with score 2 and above</th>
<th>Herd mean score</th>
</tr>
</thead>
<tbody>
<tr>
<td>17-07-03 pretreatment</td>
<td>33</td>
<td>1.6</td>
</tr>
<tr>
<td>20-08-03 5 weeks of treatment</td>
<td>19</td>
<td>0.94</td>
</tr>
<tr>
<td>08-10-03 12 weeks of treatment</td>
<td>15.5</td>
<td>0.75</td>
</tr>
</tbody>
</table>

Figure One: Digital dermatitis foot scores over time

References