The incidence of lameness remains unacceptably high in the national dairy herd

Factors associated with lameness in dairy cattle

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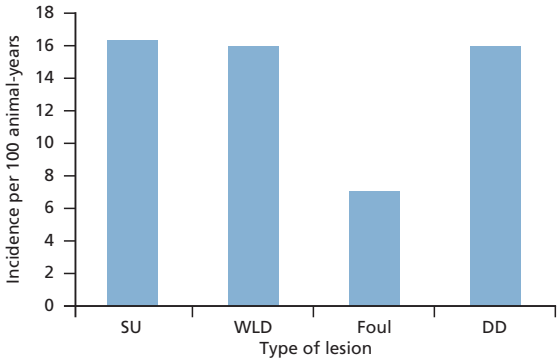
MANY studies have shown that, despite years of research, the incidence of lameness in dairy herds in the UK remains unacceptably high. This is partly due to the impact of digital dermatitis, which was first reported in the UK in 1986 and now accounts for some 15 to 20 per cent of lameness cases in cows. More generally, increases in herd size and yield – factors which are themselves associated with an increased prevalence of lameness – have outstripped efforts in control. Lameness is most likely to result from pain in the limb, usually within the foot, and hindfeet are more commonly affected than front feet. It is not the purpose of this article to describe the range of lesions involved and their pathogenesis. Rather, the focus is on management factors involved in the aetiology of lameness, particularly as they relate to cow comfort, nutrition and routine husbandry.

PRINCIPAL CAUSES OF LAMENESS

An intervention trial by Hedges and others (2001) studying 1109 cow-years, in which every lame cow was examined and recorded by a veterinary surgeon, determined the four main causes of lameness to be sole ulcers, white line disease, digital dermatitis and interdigital necrobacillosis ('foul' or 'foot rot') (see graph on the right). Sole ulcers and white line disease are defects of the hoof and, as such, are the result of disruption to the corium (ie, laminitis or, more correctly, coriosis), whereas foul and digital dermatitis are infectious disorders of the epidermis and dermis, respectively. For discussion of the pathogenetic mechanisms involved, see standard texts (eg, Blowey 2004).

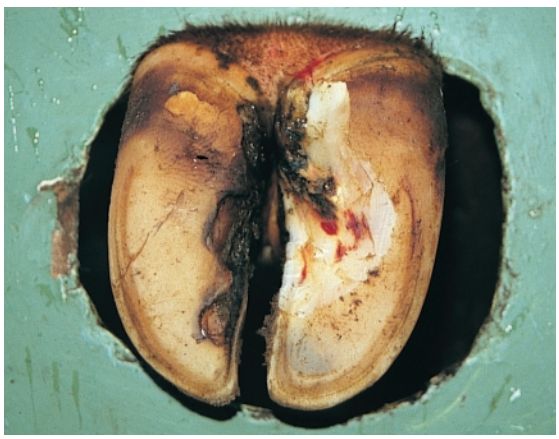


Incidence of the four most common causes of lameness in dairy cows. SU Sole ulcer, WLD White line disease, DD Digital dermatitis. From Blowey and others (2004)

INFLUENCE OF CHANGES IN THE PERIPARTURIENT ANIMAL

The increase both in hoof lesions and infectious causes of lameness seen in the cow after calving is striking (see graph on page 155). This suggests that understanding of the causes of lameness would be enhanced by studying the intrinsic changes that occur in, and the husbandry practices that affect, the periparturient animal. The principal factors affecting the cow at calving are:

- Reduced horn growth;
- Increased movement of the pedal bone within the hoof;
- Increased hoof wear;
- Immune suppression and increased risk of periparturient diseases;



Sole ulcer

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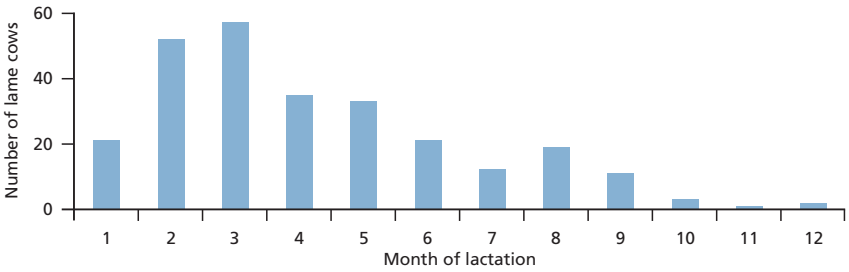


Number of lame cows, by month of lactation.
From Blowey and others (2004)

- Decreased lying times;
- Diet;
- Housing and floor surfaces;
- Animal management and social integration.

These factors, which affect all periparturient cows, appear to have a marked impact on the corium, producing horn of reduced strength and, hence, at increased risk of damage.

Reduced horn growth

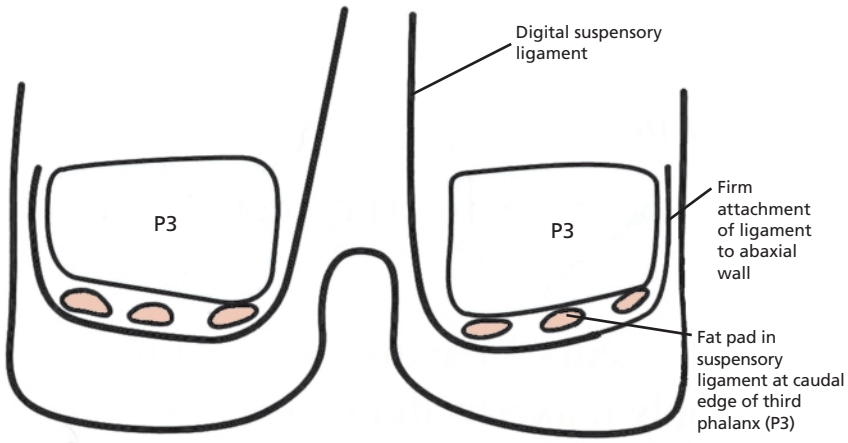
The rings on a cow's horns, one for each calving, are said to be a reflection of the natural disruption in horn formation that occurs at calving.

In a study of first lactation heifers (Leach and others 1997), the peak incidence of white line disease occurred nine weeks after calving, while sole ulcers peaked at 14 weeks, indicating that these lesions may have a slightly different aetiology. In multiparous cows, the peak incidence of both conditions occurs a little later. Livesey and others (2000) suggested that there is reduced incorporation of amino acids into hoof horn at the time of parturition, presumably associated with a repartition of nutrients (sulphur amino acids) towards milk production. Hirst and others (2000) reported that cows that develop lameness in their first lactation are more likely to become lame in subsequent lactations, and suggested yield as being a contributory factor. A study by Green and others (2002) showed that high-yielding cows were more likely to become clinically lame than lower yielding animals. Furthermore, in the affected group, lame cows produced 396 litres per animal less milk than their non-lame counterparts. Interestingly, a reduction in yield could be detected up to four months before the lameness was observed, suggesting that the changes that eventually produced the defective hoof lesions occurred well in advance of the lameness.

Rings on a cow's horn – one for each calving – are thought to reflect the natural disruption in horn formation that occurs at calving

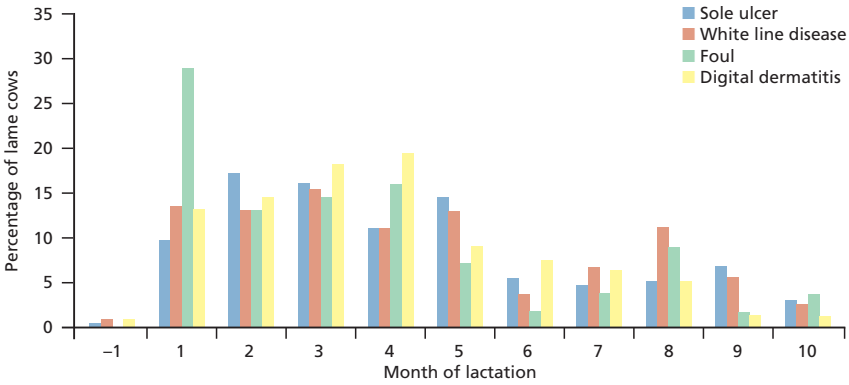
Increased movement of the pedal bone within the hoof

The pedal bone is suspended within the hoof by attachments to the laminar corium on the axial and, in particular, abaxial wall, and by a pedal suspensory apparatus within the hoof that supports the rear of the bone.



Suspension of the pedal bone within the hoof.
From Blowey (2004)

White line disease, together with sole ulcer (see page 154), is one of the most common causes of lameness in dairy cows



Percentage of lame cows by month of lactation.
From Blowey and others (2004)

Increased levels of an enzyme, referred to as 'hoofase', can be measured within the hoof during the two weeks before and two weeks after calving, and this leads to increased flexibility of the suspensory system. In turn, there is increased movement of the pedal bone and a greater risk of bruising of the corium.

Increased hoof wear

Many of the changes that occur in or affect the periparturient cow lead to an increase in standing and, as a result, an increase in hoof wear. The thickness of the sole at any one time is determined by the rate of growth minus the rate of wear. Hence, increased wear combined with the decreased growth that commonly occurs at calving (so-called negative net growth) will lead to thinning of the sole. Thin soles exacerbate the risk of bruising of the corium and subsequent formation of poor quality hoof. Indeed, in some animals – especially those moved into a new facility in total confinement systems – the sole becomes so thin that this in itself is the cause of lameness. If all four feet are affected then culling often ensues.

Even when calving takes place outside in a field, cows (especially heifers) will spend far more time standing than lying down for the first few days postpartum. It is not known whether the decreased lying times are due to inherent nursing behaviour (attending to the calf), perineal discomfort, an enlarged udder or some other factor.

A range of management factors also contribute to increased standing times – and therefore increased hoof wear – after calving. Once milk production starts, the animal must wait in the collecting yard to be milked. In the case of the freshly calved heifer, which is often the last to enter the parlour, standing times are even more prolonged. If cows produce milk, they eat more food and so must stand longer to eat – and once again it will be the freshly calved heifer that may be forced to wait for the others to finish before consuming her ration. This is particularly the case if there is insufficient feeding space (eg, <0·6 m per cow), or blind-ending, narrow passageways that the heifer is reluctant to enter because of bullying.

Immune suppression and increased risk of periparturient diseases

Many diseases, such as peracute toxic mastitis, are more common around the time of calving, despite the fact that the udder contains high levels of colostral antibody. This is a reflection of the immune suppression that occurs in every periparturient animal. Two possible reasons for this phenomenon have been suggested. First, the fetus is antigenically different to the dam and there would be the risk of an anaphylactic reaction if any fetal fluids leaked into the maternal circulation as a result of trauma during parturition. Secondly, the dam might over-react to any degeneration in her own tissues resulting from trauma in the birth canal.

Disease, in itself, increases the fragility of the corium and, in extreme cases of toxic mastitis for example, leads to total cessation of horn production. This manifests as hooves with hardship lines and horizontal fissures. Heifers are likely to be most severely affected – partly because, in many large dairies, they will have been reared completely separately from the main herd, and may therefore lack immunity to the infectious agents within that herd. These animals are then exposed to a whole range of new infections immediately postpartum, during the period of maximum immune suppression, and this further depresses horn formation.

Immune suppression is one possible reason for the marked postpartum increase in digital dermatitis and foul referred to later.

INFLUENCE OF LYING TIMES

Ideally, in her 'time budget', a cow should spend around 14 hours each day lying down. Anything that leads to a decrease in lying times, especially in the immediate postcalving period when the corium is in its most fragile state, will increase the incidence of hoof defects such as sole ulcers and white line disease. As discussed above, the effect may be compounded by an increase in hoof wear. In addition, if cows spend longer standing, the feet will be wetter and dirtier, and the risk of infectious conditions such as digital dermatitis and foul will increase. Certainly, the increase in both of these conditions in the postcalving cow is striking (see graph, above left).

In one study, heifers were deliberately housed in an overstocked cubicle building (17 cubicles for 35 heifers) immediately after calving (Leonard and others 1996). Although the average lying time of the heifers was 10 hours, some animals lay down for as little as five hours each day. The animals with shorter lying periods showed the highest incidence of lameness and quite severe haemorrhage persisted in the sole horn for up to four months after calving. As discussed above, in most dairy systems, heifers are forced to spend longer on their feet after calving. They stand while waiting to be milked and they spend longer standing to feed, because they are often last to feed and need to eat more as lactation proceeds. Given that they will have been recently mixed with the main herd, they will be having to compete with older cows and may be fearful of entering the cubicle shed, especially if they are of low social dominance and have had no previous cubicle training.

Webster (2002) compared sole haemorrhage in heifers that were transferred into cubicles four weeks before calving with haemorrhage in heifers that were kept in straw yards until eight weeks after calving. Although there was no difference in the degree of lameness between the two groups, there was a significant increase in haemorrhage in the cubicle group, demonstrating the importance of increased lying times afforded by straw yards.

Excessive standing may be bad for the immediate postpartum cow, but standing still is even worse. If the

animal does not move, the vascular pumping mechanisms of the heel and digital cushion become impaired. Vascular stasis predisposes to anoxia and damage to the corium, with resulting poor horn formation. It is therefore essential that cows are provided with adequate loafing areas to enable them to walk around freely. Overcrowding should be avoided, even in collecting yards, as animals that are packed tightly together have little option but to stand still. Adequate loafing areas also help to improve oestrus expression and hence fertility.

It follows that the incidence of sole ulcers and white line disease will be reduced if animals are encouraged to maximise lying times in the immediate postcalving period – for example, during the first two to four weeks after calving. This is often achieved by providing a comfortable area for these animals such as a straw yard or, alternatively, an area of high comfort, low-stocking density cubicles. Animals should be transferred from this maternity group into the main herd by four to five weeks after calving to give them time to adapt to their new surroundings before they are served.

Experience from such systems indicates that, in heifers especially, a postcalving period of loose housing leads to:

- Increased yields;
- Decreased incidence of lameness;
- Improved cubicle acceptance when the animals are eventually transferred from the yard to the cubicles.

This third factor is perhaps the most surprising. It might be expected that cows and heifers that had become used to a straw yard would be very difficult to retrain to use cubicles. The fact that the reverse is true suggests that parturition is a stressful experience and that only when animals have fully recovered are they able to withstand the rigours of the cubicle system. The major problem with straw yards is the associated increased risk of environmental mastitis. Possibly, therefore, the ideal situation would be to have a 'maternity group' housed in a low-stocking density system of luxury cubicles.

Cubicle design

Cubicle design is clearly important. Ideally, cubicles should be big enough (1·15 m wide and 2·4 m long) to accommodate the larger Holstein cow, with sufficient space at the front to allow the animal to lunge forward 1 to 2 m as it stands up. If there are two facing rows of cubicles, a length of 2·2 m is adequate. Because cows naturally sit with their head facing to one side, cubicle divisions that allow a side lungeing space at the front are also advantageous in terms of comfort. Cantilever-type divisions are ideal, as there is then no vertical upright at the rear to cause trauma as the cow is rising to stand or lowering to lie.

The cubicle base should have a 10 cm fall from front to rear to facilitate drainage, and a step of no more than 18 cm down into the dunging channel. Provided they have been trained, heifers soon learn to use quite high steps; if the step is too low the cubicle bed is more likely to become soiled. Cows actually prefer a rear lip on the cubicle, like a bedding retaining board, because they can then use a hindfoot to position themselves before stepping off the curb. Although many of these were removed in an attempt to keep the beds cleaner, there is now a trend for them to be replaced. A brisket rail at the front of the cubicle, 1·7 m from the curb, prevents the cow from shuffling too far forwards, but at the same time provides ample space for lungeing as she stands up. Cubicles with high top rails (eg, 1·4 m) have also become popular, as they provide even more space for the cow to lunge when standing.

When attempting to stand, a cow will lunge forward 1 to 2 m, or to the side, before lifting herself first onto her hindfeet, and then up onto her front feet. When she is lying down or half standing (see picture below), therefore, much of her weight is taken on her knees. If the floor surface is hard, and particularly if it is also rough, cubicle acceptance will be low. The worst possible cubicle floor is a stone base that is poorly compacted and with insufficient straw. In an attempt to get comfortable, cows will shuffle forwards until they are so close to the wall they are unable to lunge to stand. On farms where a proportion of the cows are unable to stand because they are too far forward in the cubicles, cubicle comfort should be seriously questioned.

Most cubicle bases are made of concrete. This is fine provided that it is deeply bedded, although it is often difficult to retain a well-matted straw bed on concrete. Straw use will vary, but at least 2·5 to 3 kg per cow per day is needed if straw alone is to produce a good bed. (Note that this represents a considerable saving on the 10 kg per cow per day required for straw yards.) A variety of mats and mattresses are available and these are certainly a much better option than concrete alone. However, some bedding should still be used, otherwise hock sores will develop. Where a moderate amount of bedding is used, this has the advantage that some will be pulled out into the dunging channel and will dry up excess moisture and reduce the risk of digital dermatitis; it also cushions the hoof if the cow is standing with her hindfeet in the passage and front feet in the cubicle. A disadvantage of rubber mats is that it is difficult to get large amounts of straw bedding to adhere, although the cows enjoy standing on them.

Cubicles lined with a deep layer (eg, 150 mm) of sand work well and also reduce the incidence of mastitis. Around 7 to 10 kg of sand per cow per day is required. Although sand represents a cheaper, easier to use and more hygienic option, its effects on the slurry disposal system, and eventually on the land where it is spread, must be considered. A study by Cook and others (2004) reported that, for cows housed in the same type of cubicles, there was a lower incidence of lameness on sand than on mattresses. This was thought to be due to the fact that mildly lame cows found it easier to get up and lie down on sand bedding. As a consequence, they lay down for longer and lameness did not progress to the same extent.

The correct type of sand (eg, with a low clay content that does not compact and consolidate) is essential for sand-bedded cubicles

Ultimately, the best cubicles are comfortable cubicles. While design and dimensions are important, comfort is of even greater significance. Another factor not to be overlooked is cubicle training: it is vital that heifers are exposed to cubicles at some point during their rearing phase so that they do not have to learn how to use them during the traumatic periparturient period.

INFLUENCE OF DIETARY CHANGES

High starch/low fibre diets that lead to rumen acidosis undoubtedly predispose to coriosis and subsequent lameness, especially if fed both pre- and postpartum. In a study comparing high starch (wheat-based) rations with equal energy, high fibre (sugar beet pulp) rations, fed pre- and postpartum to 48 multiparous cows, the author and colleagues found that sole haemorrhage scores at 24 weeks postpartum were significantly higher in the high starch group (Blowey and others 2000b). In an earlier study, Livesey and Flemming (1984) showed that 64 per cent of cows on a low fibre diet developed sole ulcers compared with only 8 per cent of animals receiving a high fibre ration.

Acidosis can be recognised by a range of clinical signs including loose faeces, an increased incidence of digestive upsets, poor rumination, low butter fat, weight loss in early lactation, cud regurgitation and a sweaty coat. It is not known precisely why rumen acidosis leads to poor hoof formation. Absorption of toxic amines, the production of histamine (eg, from histadine by the rumen organism *Allisonella histaminiformans*) and biotin deficiency have been proposed as possible contributory factors.

Although the ruminant has traditionally been considered to be self-sufficient in B vitamins, recent studies have shown that supplementing high producing cows with B vitamins can produce a range of performance benefits, including increased yields and reduced lameness (Blowey 2002). In vitro studies have demonstrated that, with high concentrate diets producing rumen acidosis, biotin synthesis was reduced from 1·5 to 0·3 µg per day (DaCosta Gomez and others 1998). In an extensive split-herd intervention study involving over 1100 cow lactations in five UK dairy herds, supplementation with biotin at 20 mg/day halved the incidence of lameness caused by white line lesions (Hedges and others 2001). Survival analysis demonstrated that supplementation needed to be carried out for 130 days before any difference between the two groups was seen (see graph below). Elsewhere, the author and coworkers found that only 28 per cent of animals supplemented with biotin required a repeat lameness treatment in the same digit, compared with 72 per cent of unsupplemented controls (Blowey and others 2000a). Other studies have shown that biotin supplementation can reduce the incidence of sole ulcers, improve the rate of healing of hoof lesions (Lischer and others 1996) and reduce the prevalence of vertical fissures in beef cows (Campbell and others 1996). These findings do not necessarily mean that all cows should be supplemented with biotin, but rather that cows should be fed and managed to minimise rumen acidosis. When acidosis cannot be avoided, however, supplementation with biotin at 20 mg/cow/day seems a sensible option.

Ample straw in the ration helps to stimulate rumination and decrease the risk of rumen acidosis, which can lead to the development of poor hoof horn

Concentrate intakes should be built up slowly after calving to reach a peak no earlier than two weeks post-calving for average yielding cows and probably three weeks for higher yielding animals, which peak later. Ideally, no more than 4·5 kg of feed should be given in the parlour. If forage fibre length is short (eg, if precision-chop, high metabolisable energy [ME] grass silage is being fed), then the inclusion of 1 to 3 kg of long-chop straw or, even better, hay mixed well with the ration, helps to stimulate rumination, thereby promoting a good flow of saliva and decreasing acidosis. Total mixed ration (TMR) diets should not be over-mixed as this can reduce fibre length. It is also vital that cows do not get excessively hungry – 'slug feeding' is an important cause of acidosis.

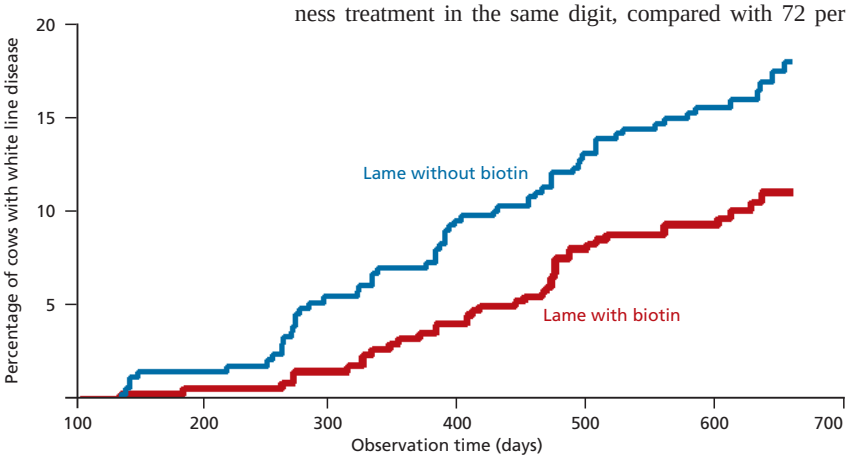
Even feeding during rearing influences the incidence of sole haemorrhage, with heifers fed high levels of concentrate being the most severely affected. High fibre diets are now recommended for rearing dairy heifers.

Although high protein diets have occasionally been suggested as a cause of coriosis, most authorities consider protein to be of less significance than other dietary factors. High intakes of poorly fermented grass silage have also been implicated, although this could be due to toxic amines rather than high protein.

Trace elements and vitamins

Many attempts have been made to improve hoof condition by mineral, vitamin and trace element supplementation. Zinc, particularly zinc methionine, is often promoted as a feed supplement with beneficial effects. If one of the reasons for the production of poor quality horn at calving is a temporary deficiency in sulphur amino acids then logic would suggest that supplementation with zinc methionine might be beneficial at this time, since methionine is a sulphur amino acid and zinc promotes healing. Ensuring optimal trace element levels might also assist in maintaining immune status.

Effect of biotin supplementation on the incidence of white line disease in cows.
From Hedges and others (2001)



INFLUENCE OF ANIMAL MANAGEMENT AND SOCIAL INTEGRATION

Many aspects of management have already been discussed above. The following sections cover a few miscellaneous factors relating to lameness, particularly those which might cause damage to the corium and/or keep the feet dirty, especially in the early-lactation animal.

Social integration

Heifers should be mixed with dry cows prior to calving so that the interactions involved in establishing a social hierarchy have been fulfilled before the trauma of the postcalving period. Heifers also must learn to walk on concrete. This could be done in association with transition feeding (ie, during the period of 'feed integration').

Wet conditions

Wet hoof is softer than dry hoof and therefore the sole is more likely to become penetrated or the corium bruised if the feet are damp. Cubicle passages should be scraped twice daily. The addition of small quantities (eg, 50 g/cow/day) of slaked lime to the cubicle beds once or twice a week will help to dry the feet as well as control mastitis. Experimentally, it has only been possible to transmit digital dermatitis when feet are wet (soaked in water for up to 10 days); hence keeping feet dry and clean will also reduce the incidence of infectious causes of lameness. As the average dairy cow produces approximately 50 litres of water each day in urine, faeces, breath and sweat, it is essential that buildings have adequate ventilation. Liberal use of bedding, such that some spills out into the cubicle passage, reduces trauma to the hoof during walking, reduces exposure to slurry, and keeps the passage drier, all of which will help to decrease lameness.

Floor surfaces

Floor surfaces which are too rough, stony or have broken concrete can cause damage to the corium. Conversely, very slippery surfaces can lead to abnormal gait patterns – with the cow placing more weight on the lateral claw – and this further predisposes to lameness. A clear demonstration of the fact that cows do not like walking on concrete is provided by the picture, below right, which shows cows walking from a dirt yard to the milking parlour at a dairy in California. A strip of second-hand rubber belting, approximately 1·5 m wide, has been laid along the centre of a concrete track leading to the parlour. Although the cows could walk anywhere on the track, note how they have all chosen to walk on the rubber belt.

In recent times, there has been a move towards laying rubber belting in cubicle passages and onto flooring in feed areas. Cows walking on rubber adopt a longer and more natural stride, bruising of the corium is reduced, and the animals are more likely to express 'natural' activity such as oestrous behaviour and grooming. With the current trend towards full confinement housing systems, this could become increasingly important. Although an increase in overgrown hooves might be expected on rubber floors, as hoof wear will be decreased, this does not seem to occur in practice – possibly because the reduced trauma associated with walking on the softer rubber surface also leads to reduced horn growth. Indeed, it has been shown that higher quality horn is produced by cows that walk on rubber than cows that walk on concrete.

These cows are choosing to walk along the soft verge, rather than on the stony track

The influence of floor surface on white line disease is interesting. It is commonly stated that cows become lame because of a specific type of stone or gravel in a track, particularly if sharp flints are present. Certainly, if cows are allowed to amble out to a field at their own speed, they usually choose to walk on the soft earth of a grass verge, rather than on stones (as pictured above). (They even place their feet in exactly the same spot each time, making holes in the ground, and creating specific cow tracks.) However, beef cattle could probably walk along the same track without stones penetrating their feet. This strongly suggests that it is the weakening of the white line that is the critical factor, and not the sharpness of the stones. However, once the integrity of the white line has been compromised (as a consequence of coriosis), the presence of stones acting as a wedge will be an important factor in producing further damage.

Animal handling

Rough handling of cows has been shown to have an effect on the incidence of lameness. Clarkson and Ward (1991) found that farms where cows were forcibly rushed along farm tracks by a herdsman, dog or tractor had a significantly higher incidence of lameness than farms where the cows were allowed to walk along at their own speed. This is presumably because in the latter setting the animals chose their own footing, thus avoiding bruising to the sole and corium. When allowed to move at their own pace, cows will lower their heads as they look at the ground surface in front of them for a safe and soft footing. If cows are being driven too fast,

Cows walking on rubber belting. Picture, K. Burgi

or if they are too crowded, then their heads will be carried high, they will be unable to see their footing, and increased lameness may result.

If heifers are introduced into a highly competitive situation, where they are forced to make many sudden turning movements, this increases hoof wear and forces the wall away from the sole, leading to an increase in white line defects. Chesterton (2004) reported a high incidence of white line disease in the hindfeet of cows and in the front feet of heifers. He ascribed this variance to the fact that, when being socially pressurised within a group, mature cows will push themselves into the group using their hindfeet, whereas heifers will push themselves away from the mob using their front feet.

Hoof wear

Both inadequate and excessive hoof wear can cause problems. Heifers reared and housed exclusively on bedded areas (with straw, shavings or sand) may not experience sufficient hoof wear. The toes become overgrown, the foot rotates caudally and the corium may become damaged at the sole ulcer site. The provision of a lightly abrasive concrete feeding area is essential, both to keep the foot in shape and to stimulate sufficient horn production for the thick sole that is needed in the postpartum animal. At the other extreme, cows or heifers (especially freshly calved animals) that are made to walk long distances on gravel or even concrete roads can wear their soles so thin (<5 mm) that they are easily compressible by thumb pressure. This syndrome is common in the grazing systems of Australia, New Zealand and Uruguay, where heifers reared on pasture are often introduced into the dairy herd immediately after calving and expected to walk long distances to and from grazing. This produces maximal wear at a time when hoof growth is minimal, and soft soles with subsequent bruising of the fragile postpartum corium lead to an increase in white line disease and toe ulcers. If heifers are exposed to concrete or some other hard surface for a few weeks before calving, this can stimulate increased thickening of the sole and the severity of the syndrome is reduced.

A similar 'soft sole' syndrome is seen in young bulls introduced to work in a dairy herd, particularly if the bulls are large and do not use the cubicles. Bulls commonly follow cows in pro-oestrus for up to a couple of days, rather than lying and resting, and this further increases the rate of hoof wear. The soles of their hindfeet, especially at the toe, can wear down to the corium. Ideally, bulls in cubicle systems should be rested in a straw yard – for example, housed in cubicles by day and a straw yard by night, or for alternate weeks in cubicles and straw yards. Bulls soon learn which is to be their period of lying and compensate for the cubicles by resting in the straw yards for long periods of time.

Conformation

An animal's conformation affects the incidence of lameness and, in turn, is influenced by genetics and breeding. Bulls should be chosen to produce heifers with a good depth of heel, an upright angle of the front hoof wall, and legs without excessive sickle hock conformation. This helps to minimise excess weightbearing on the lateral hoof wall.

Foot trimming

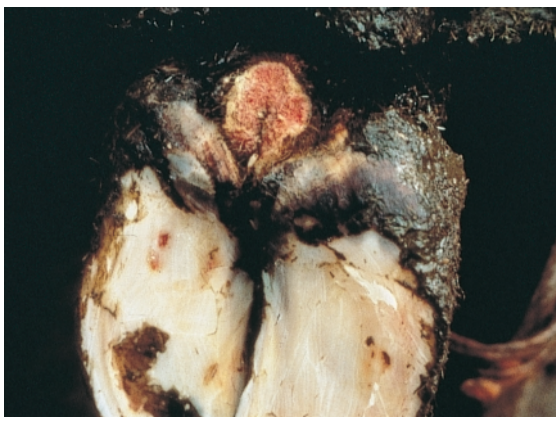
A management factor that has an important influence on the development of lameness is routine foot trimming. Given that parturition is a major period of stress, predisposing to the development of coriosis, feet need to be in optimum shape at calving in order to minimise this effect. This is achieved by foot trimming at drying off, and at any other time when the feet are overgrown. Hooves should be trimmed to restore weightbearing to the correct surfaces, and to allow the cow to stand with a normal posture. For further information, the reader is referred to standard texts on hoof trimming (Toussaint Raven 1985, Blowey 1998, 2004, van der Tol and others 2004).

Footbathing

Footbathing plays an extremely important role in the control of infectious causes of lameness. As with mastitis, control should be based on prevention rather than treatment. An individual clinical case of, say, digital dermatitis should be considered a reservoir of infection and a risk to other cows, and as such needs prompt treatment. All too often, this is not carried out.

The graph on page 156 shows that both digital dermatitis and foul increase dramatically after calving. This may be due to a combination of periparturient immune suppression, and increased standing, leading to wet and dirty hooves. The picture below left shows the hyperkeratinisation of skin around the interdigital cleft that is characteristic of low-grade digital dermatitis in a dry cow. It is at this stage that footbathing should commence in order to prevent these minor lesions developing into the raw open lesion normally associated with the disease (see below right). Disinfectant footbaths can be used but, because disinfectants cause general tissue damage and are not well absorbed into the epidermis (as an antibiotic

Early lesions of digital dermatitis



Typical raw lesions of digital dermatitis

Priorities for lameness investigation and prevention

Care of the cow at calving

This is when the main stressors that predispose to lameness occur. Ensure:

- Heifers are trained to use cubicles
- Some standing on concrete precalving to acclimatise the animals to hard surfaces (ie, environmental integration)
- Social integration (eg, mixing heifers with dry cows)
- Feed integration (eg, transition diets)
- The risk of bullying is reduced. Mixing heifers into the herd in groups, spraying them with cider vinegar and mixing at night have all been suggested as being beneficial

Standing times

Standing times and, hence, hoof trauma can be minimised by ensuring:

- Correct integration of heifers at calving
- Optimal cubicle dimensions and comfort; ideally, there should be 10 per cent more cubicles than cows
- Correct cow flow, to minimise cow standing times at milking
- Adequate feeding space, to reduce standing times and minimise bullying
- Adequate cross passages in cubicles, to improve cow flow
- Adequate feeding space – at least 0·6 m per cow and, preferably, 0·8 m
- Collecting yards are loaded from the rear and not the front

Floor surfaces

Cows should be provided with good, non-slip, but trauma-free, surfaces by ensuring:

- Attention to rough and broken concrete
- Grooving of concrete where surfaces are slippery
- Animals are allowed to walk at their own pace
- Proper cow tracks are constructed that allow rapid and easy movement of the herd to and from pasture
- Cow flow does not involve turning sharp corners, especially if cows step down at the same time
- Consideration is given to the use of alternative flooring materials (eg, rubber belting), where appropriate, such as in feed areas

Foot hygiene

For optimal foot hygiene, ensure:

- Cubicle and feed passages are of adequate width (eg, 3 m and 4·5 m, respectively)
- Regular scraping of passages
- Ample bedding is supplied, such that some falls into the passageway, thereby providing a softer, cleaner and drier walking area for the cows
- Adequate drainage and ventilation of buildings
- Provision of loafing areas
- Regular (ideally daily) disinfectant footbathing, preferably starting with the transition cows

Nutrition

Avoid dietary upsets that disrupt the corium and lead to excess slurry by ensuring:

- Correct concentrate to fibre ratio
- Adequate long fibre in the ration
- Steady increase in concentrate intakes after calving
- Consideration is given to supplementation of transition rations based on their dietary cation-anion balance (DCAB) (see Husband 2005)
- Supplements such as biotin are provided, where necessary, to optimise hoof strength

Treatment

Ensure prompt treatment of lame cows to produce rapid healing with reduced recurrence rates:

- Lift and examine foot when lame
- Perform radical removal of underrun horn to allow drainage of infection
- Apply hoof blocks (eg, Cowslips, Giltspur) to promote healing
- Cover raw digital dermatitis lesions to prevent spread of infection to other cows

might be), footbathing must be conducted on a regular basis to obtain full benefit. The required frequency will depend on the level of environmental challenge, but routines such as five days per week, or nine days on and five days off, are becoming increasingly common. Farms where daily footbathing in disinfectant (usually formalin) is carried out commonly report an almost total suppression of conditions such as digital dermatitis, foul, interdigital skin hyperplasia and slurry heel, and hence a marked improvement in lameness.

The footbath should be sited in the usual cow walkway, after the exit to the parlour but not so close that it obstructs the exit or slows milking. (Anything that slows milking is unlikely to be carried out on a regular basis!) Ideally, there should be enough room before the footbath for cows from at least one whole side of the parlour to exit, thus minimising any disruption to milking. Two footbaths placed in line – the first to wash the feet, the second with the active chemical – are ideal, and cows should of course exit into a clean, scraped yard. The floor of the bath should provide a comfortable walking surface. If high ridges are present the cows will be reluctant to walk through the bath, and this will lead to increased faecal contamination and a risk that the teats will become splashed with disinfectant.

Footbaths with a foam rubber base or similar are sometimes used. When a cow stands on the rubber mat the liquid chemical within the mat starts to form a pool around the foot and this acts as a bath. The system is easy to use but is unlikely to be as effective as a standard footbath simply because, as the depression produced by the cow's foot begins to fill with chemical, the cow starts to move onto the next stride and hence the foot is not soaked as effectively.

A disinfectant foam system is also available (Kovex Foam; Ecolab) which entails cows walking through a 12 to 14 cm layer of foam at the entrance to the parlour. The foam consists of a peracetic acid disinfectant, plus peroctanoic acid, a patented booster for the peracetic acid. It has adhesive properties to improve adherence to the hoof, and incorporates a green dye to reduce the glare of the foam and make it less intimidating for the cows to walk through. A skin conditioner is added, as is a detergent, to assist the foam to penetrate the foot. The cows stand in the foam while waiting to enter the parlour. Foam is then carried into the parlour on their feet and remains on their feet during the milking process. Thus, the majority of cows have their feet bathed in foam for some five to 10 minutes.

Trials have suggested that the foam is effective as a

preventive measure (Blowey and Williams 2004), but the disinfectant seems to have limited efficacy in the treatment of existing digital dermatitis lesions. The system is easy to use and the chemicals are pleasant to handle, with no adverse environmental effects. However, by its very definition, foam is a liquid with holes in it, hence its ability to penetrate the interdigital space must be less than a liquid within a conventional footbath.

A variety of chemicals are used in footbaths, each with their own advantages and disadvantages:

- Formalin (3 to 5 per cent) is cheap and rapidly degraded in the environment, but is unpleasant to handle;
- Copper sulphate (5 per cent) is more pleasant to handle but is not degraded in the environment, and copper poisoning is becoming an increasing problem in dairy cows. Ideally, it should not simply be discarded into the farm drainage system;
- Zinc sulphate, organic acids and disinfectants such as glutaraldehyde and peracetic acid are also effective.

Ultimately, however, it is the method of administration, the frequency of footbathing and the cleanliness of the environment that is more important than the chemicals used. Antibiotic footbaths are used in the UK and some other countries but these should be considered a treatment rather than a control measure (and a seven-day milk withholding period applies). It is the author's belief that within a few years disinfectant footbathing will be almost as common as postmilking teat disinfection.

FOCUS OF A CONTROL STRATEGY

Measures for the control of lameness should start with the dry cows. Minimising the trauma of the periparturient period will help to integrate heifers, in particular, into the milking herd, and regular footbathing from the transition period onwards will assist in controlling infectious diseases. If cows can be kept clean, dry and comfortable, regularly footbathed, in sand cubicles, and with some rubber mats in the passages, it should be possible to reduce lameness from its current high levels.

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