Lameness in UK dairy cows: a review of the current status

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Lameness in dairy cattle has been reported as a concern for welfare and economic reasons for over 20 years. This concern has been expressed from across the industry and has prompted the launch of a number of initiatives to address the problem. This article reviews the current status of lameness in dairy cows in the UK, outlines the current understanding of the condition and its impacts on welfare and productivity, and highlights areas where evidence is still lacking.

Classification of lameness

The term lameness is used to describe the clinical presentation of impaired locomotion, regardless of the cause. Most cases of lameness in dairy cows are associated with a painful foot lesion on the hindlimb. Sole ulcers, white line disease, foul-in-the-foot and digital dermatitis have been shown to be the predominant lesion types (Box 2). Claw horn defects associated with sole ulceration and white line disease usually occur in the outer claw of the hindlimb. Digital dermatitis lesions are also most commonly identified in hindlimbs.

The true extent of the lameness problem in UK dairy herds is unknown but can be estimated from groups of herds that have participated in research studies. Herd level lameness incidence has been recorded as ranging from 5 to 170, with typical average values being around 50 limb cases per 100 cow-years (see Box 1). Based on mobility scoring, lameness prevalence has

Box 1: Published lameness incidence in the UK

**Definition**

Incidence rate measures how many new cases of lameness develop in a group of at-risk individuals over a specified time period. It is usually expressed as limb cases per 100 cow-years. It can also be calculated for specific foot lesions or limb disorders.

\[
\text{Limb cases per 100 cow-years} = \frac{\text{Number of new cases}}{\text{Time in herd spent not lame}*} \times 100
\]

*Where information on the duration of cases is unavailable, the denominator is often approximated by the average number of cows in the herd over the time period considered (ie, cows present at the start and end of the assessment period). This may lead to an underestimation of the true incidence where lameness detection is poor or cases persist

**Lameness incidence data from treatment records**

| Limb cases per 100 cow-years* | Reference |
|-------------------------------|-----------|
| 7.3 (0 to 32)                 | Eddy and Scott (1980) |
| 5.5                           | Russell and others (1982) |
| 25 (2 to 55)                  | Whitaker and others (1983) |
| 17 (8 to 28)                  | Collick and others (1989) |
| 17.4                          | Esselmont and Kossaibati (1996) |
| 23.7                          | Whitaker and others (2000) |
| 22.5 to 37.3                  | Kelly and Whitaker (2001) |
| 20.7 to 23.3                  | Whitaker and others (2004) |

**Lameness incidence data when an encouragement to record was used**

| Limb cases per 100 cow-years* | Reference |
|------------------------------|-----------|
| 30                           | Prentice and Neal (1972) |
| 54.6 (10.7 to 170.1)         | Clarkson and others (1996) |
| 68.9                         | Hedges and others (2001) |

*Range reported in brackets when available. The data show a general increase in lameness incidence over time, large ranges across farms (where given) and the effect of surveillance method or cost of treatment on lameness reporting. The last point is consistent with the fact that farmers tend to underestimate lameness prevalence, which has been reported in other studies.
also been shown to range widely (0 to 79 per cent), with typically expected values of 23 to 37 per cent depending on the farms involved (Box 3).

In the absence of an objective method for identifying a case of ‘lameness’, diagnosis remains a subjective assessment that relies on the experience and expertise of the observer. The sensitivity of detection varies considerably between individuals and variability is greatest in milder cases. UK farmers have been shown to underestimate lameness prevalence in their herds by at least a factor of four (3 per cent versus 22 per cent [Whay and others 2002] and 4.8 per cent versus 25 per cent [Huxley 2003] in two separate studies). Farmers estimating prevalence tended to focus on severely lame cows only. Similarly, there was no correlation between farmers’ estimates of lameness incidence and the inci-

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**Box 2: Four common lesions associated with lameness in dairy cows**

**Sole ulcers**
- Caused by disrupted sole horn production following repeated or continuous injury to germinal cells within the sole corium under the palmaro/plantarodistal edge of the distal phalanx. This results in chronic inflammation and eventually pathological exposure of the corium, which classically appears several months after calving. Thought to be due to a disruption of the suspensory apparatus in the claw at or around calving, and descent or movement of the distal phalanx combined with contusion from standing on concrete and inflammation within a compartment (the claw capsule). Contusion is worsened by claw horn overgrowth. The result is degradation of the extensor process of the distal phalanx becomes inflamed, leading to disruption in horn growth. A reduced digital cushion is believed to be a compounding factor in heifers and thin cows. Are not considered to be directly associated with acidosis or inflammation of the laminae. Hence, corium rather than laminitis is the more apt term for the disorder leading to sole ulceration. This distinction reduces confusion because, while laminitis probably does exist as a condition, albeit less commonly, it is most likely to have a dietary aetiology.
- Managed by improving cow lying comfort and reducing standing times on concrete. Early detection and treatment is likely to aid recovery but affected animals will be vulnerable to recurrence in future. In some cases, treatment or rest can successfully restore keratinisation before the corium becomes exposed and infected at the sole surface.
- Expert foot trimming on a routine basis is likely to restore foot angle and reduce loading at the site of the sole ulcer, but it is important to ensure a correct Dutch 5-step technique (following training) is used. This ensures that the feet are cut to the correct length (step 1), level (step 2) and shape (step 3), and that the outer claw of the hindlimb or the inner claw of the forelimb is relieved of weightbearing if a lesion is present (step 4) and any loose or under-run horn is removed (step 5).

**Foul-in-the-foot**
- Caused by an infection in the interdigital skin and subcutis with *Fusobacterium necrophorum* (biotypes A and AB) and potentially other bacteria such as *Prevotella melaninogena*, *Porphyromonas asaccharolytica* and *Porphyromonas levii*.
- Often associated with injury to the interdigital space and opportunistic infection. Most commonly affects cattle in the first two months of lactation.
- Clean and dry cow tracks, free of stones and other foreign bodies help to prevent the problem. Rushing freshly calved cows through muddy gateways containing rubble, particularly on warm autumn days, is commonly associated with outbreaks.
- Interdigital skin maceration through continual exposure to wet conditions may also be a risk factor. Hence, standing cows in contaminated pools of water or deep slurry during the housing period should be avoided. Walking cows through spent footbaths full of slurry may contribute to infection and spread.
- Once confirmed, is easily treated with suitable antibiotics. However, it is important that the interdigital space is examined in suspected cases. A foreign body will often be discovered as the inciting factor, any necrotic lesion should be cleaned and treated with an appropriate topical antibiotic. Occasionally, opportunistic infection potentially involving several different bacteria can contribute to peracute foul-in-the-foot, also known as ‘super foul’. Complications during an outbreak of super foul can result in high rates of involuntary culling.
- Management usually involves improving underfoot conditions. Regular footbathing of the herd, particularly transition and freshly calved cows, with a suitable disinfectant may also be effective in preventing new cases.

**White line disease**
- The aetiology of white line disease is poorly understood, but is thought to be caused by a breakdown of the horn joining the sole and wall horn. This can allow foreign material to be tracked into the white line. White line horn quality may be compromised by calving stress or white line bruising. Physical forces may also play a role in the aetiology, either indirectly through bruising or directly via shear forces associated with flight movements or uneven walking surfaces such as grooved concrete or rough and stoney tracks.
- Cows that are sent out to pasture by day and housed by night can be exposed to wet climatic conditions, rain washed tracks, uneven walking surfaces and loose stones, all of which can cause soft claw horn. This, combined with standing on concrete and the shearing forces of a changing herding routine, can result in bruised white lines. White line disease is therefore often more common at these times, particularly during autumn.
- Diet supplementation with 20 mg biotin per head per day has been shown to reduce clinical incidence. Increasing the use of non-ensiled forages in the diet while increasing dry matter content may also achieve a similar response, potentially by increased synthesis of biotin in the rumen or other mechanisms.
- Prevention can be achieved by maintaining good cow tracks to reduce the risk of foreign body penetration, maintaining even concrete surfaces and minimising standing times on concrete. However, ensuring smooth cow flow, minimising bully cow interactions, not rushing cows and allowing cows plenty of space may also help.
- If caught early, individuals respond well to treatment. Uncomplicated white line separation can be successfully treated using the Dutch 5-step foot trimming system discussed above for sole ulcers, with any loose wall horn being removed in step 5. Topical antibiotics should be applied to exposed corium. White line abscesses require draining, with sufficient horn removed to ensure the drainage hole remains patent following treatment. Severe infections of the corium (wall ulcer) may require more intensive and repeat treatment with antibiotics and blocks over many months.

**Digital dermatitis**
- Several *Treponema* species have been associated with digital dermatitis lesions (Carter and others 2009). *Treponema pedis* has been repeatedly isolated from foot lesions, but has yet to be isolated from slurry. The route of infection is believed to be environmental although this has not yet been demonstrated experimentally.
- Digital dermatitis should be managed as for any infectious disease, with special consideration to sources of infection, routes of spread, risk factors and susceptible animals. Early treatment should minimise the reservoir of infection. Improving the hygiene of conditions underfoot will reduce spread as will biosecurity and biocontainment. The more vulnerable the animal or group (eg, freshly calved heifers are more likely to acquire a severe infection), the more important this becomes.
- Good hygiene is key in managing digital dermatitis, together with footbathing using antibiotics, formalin, copper sulphate or organic acids at the appropriate concentrations. In the authors’ experience, footbathing can worsen digital dermatitis if performed incorrectly. Use of a prewash bath is advised before cows walk through a medicated bath. The solutions should be changed when grossly contaminated.
- Most cases respond well to an appropriate topical antibiotic applied to a clean, dry, debrided lesion. Treatment should be continued daily for at least three days for best results.
Box 3. Published estimates of lameness prevalence based on mobility scoring

**Definition**
Prevalence is the proportion of cows that are lame in the total population at risk at a particular point in time. It is a fraction between 0 and 1, or is more commonly expressed as a percentage. Mobility scoring of herds can be used to provide this estimate.

\[
\text{Prevalence} = \frac{\text{Number of lame cows}}{\text{Total number of cows}}
\]

**Mean lameness prevalence**

| Prevalence* | Reference | Comments |
|-------------|-----------|----------|
| 20.6% (2.0 to 53.9) | Clarkson and others (1996) | 37 herds from the Wirral, Cheshire, Wales and Somerset |
| 22.1% (0 to 50.0) | Whay and others (2003) | 53 herds from the Midlands and south west England. 28 herds were recruited from the RSPCA Freedom Food scheme |
| 24.2% (6.8 to 55.6) | Huxley and others (2004) | 15 organic herds based in south west England |
| 25% (6.8 to 74.2) | Huxley (2005) | 28 organic herds based in south west England |
| 15% (grazing) 39% (zero-grazed) | Haskell and others (2006) | 37 herds assessed in a study of zero-grazing |
| 36.8% (0 to 79.2) | Barker and others (2010) | 227 herds from the Midlands, Wales and southern England (winter) |

*Range given in brackets. Estimates increase over time and the ranges are large – that is, some farms have few lame cows, while the proportion of lame cows is high on other units

Box 4. Changes in the UK dairy industry and demands on milking cows

- The UK dairy herd has decreased by an estimated 552,000 head (22 per cent) over a 10-year period to 2008, with around 1.9 million cows kept on 17,060 holdings. The number of dairy farms in England and Wales, Scotland and Northern Ireland has decreased by 46, 31 and 32 per cent, respectively, over the same period.
- The human population in the UK was an estimated 61 million in 2007 and is growing. The demand per capita per annum for milk products is stable. With minimal raw milk imports (currently 0.2 per cent of the 13.2 billion litre UK milk market), increased milk production per cow is required to meet this demand (see graph below for the trend in the UK). Average annual milk yield per cow in 2008 was 6885 litres having peaked at 6990 litres in 2005. Overall, falling cow numbers have contributed to UK milk production dropping by 857 million litres (6.4 per cent) per year over a decade to an all time low in 2008 of 12.9 billion litres. Although curtailed in the EU by the quota system, milk production in the UK has been below this threshold since 2001. At present, the cost of quota at less than 0.5 pence per litre is not a limiting factor to efficient dairy farming.
- A UK dairy cow giving 28 litres of milk per day is performing at three times maintenance requirements for energy. This can reach five times maintenance requirements at 50 litres per day.
- In the future, further efficiency gains may be needed to limit environmental impacts such as slurry production and greenhouse gas emissions.

![Milk yield in the UK over time](image)

Mobility scoring

Mobility scoring refers to a structured subjective system for the assessment of a cow’s gait, designed to reduce variations between observers. The background to the terminology has recently been reviewed (Bell and Huxley 2009) and a standard scoring system, which provides case definitions for both lame and severely lame cows to aid in early diagnosis, has been adopted by the industry-funded body DairyCo (Table 1). Training in the application of the scoring system is very helpful to improve repeatability within and between observers.

Mobility scoring can be used to assess lameness prevalence on a farm at a particular point in time (Box 6).

Box 5: Mobility scoring requirements highlighted in milk buyers’ contracts in the UK

- Members are required to score their herd every two months and record their details.
- Members will be required to produce an improvement plan based on their data as part of their veterinary health plan.
- Members must fund and arrange for an independent suitably qualified person to visit their farm and score their herd on an annual basis.
- Members are strongly advised to use their recording agency to capture herd mobility information.
### Table 1: Standard scoring system for lameness diagnosis

| Category of score       | Score | Description of cow behaviour                                                                 | Suggested action                                                                 |
|-------------------------|-------|-----------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------|
| **Good mobility**       | 0     | Walks with even weightbearing and rhythm on all four feet, with a flat back Long fluid strides | No action needed<br>Routine (preventive) foot trimming when/if required<br>Record mobility at next scoring session |
| **Imperfect mobility**  | 1     | Uneven steps (with regard to rhythm or weightbearing) or shortened strides<br>Affected limb(s) not immediately identifiable | Could benefit from routine (preventive) foot trimming when/if required<br>Further observation recommended |
| **Impaired mobility**   | 2     | Uneven weightbearing on a limb that is immediately identifiable and/or obviously shortened strides (usually with an arch to the centre of the back) | Lame and likely to benefit from treatment<br>Foot should be lifted and examined to establish the cause of lameness before treatment<br>Should be attended to as soon as practically possible |
| **Severely impaired mobility** | 3 | Unable to walk as fast as a brisk human pace (cannot keep up with the healthy herd) and has signs of score 2 | Very lame<br>Cow will benefit from treatment<br>Cow requires urgent attention, nursing and further professional advice<br>Cow should not be made to walk far and should be kept in a straw yard or at grass<br>In very severe cases, culling may be the only possible solution |

**Key benefits of mobility scoring**

- Every cow is regularly assessed for the early signs of poor mobility, thus prompting foot trimming and action lists
- Mobility trends can be monitored to identify new problems at an early stage
- Provides figures for benchmarking performance
- Increased awareness of general foot health
- Motivates farm staff to improve herd mobility and therefore overall herd health

**Box 6: How to score a herd for mobility**

- Ideally, check the herd at least once a month
- Choose a time and a place that will allow you to observe cows, preferably on a hard (ie, concrete), non-slip surface. Monitor each cow individually allowing animals to take between six and 10 uninterrupted strides. Watch cows from the side and the rear, and, if possible, ensure the cow turns a corner as part of its test
- Record the identity of the cows scoring 2 or 3, and schedule treatment with regular checks to ensure its efficacy
- Keep a tally of the cows that score 0 and 1
- If you are uncertain about the exact score of a cow, repeat the test. If you are still unsure, examine the cow’s feet

**In Practice**

November/December 2010 | Volume 32 | 492–504

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Practical guidelines for consistent mobility scoring are given in Box 7. Mobility scores can then be used to benchmark groups of similar herds (Box 8). As there are usually more differences than similarities between farms and their management, it is more useful to benchmark herds against themselves by repeatedly scoring the same cows at regular intervals (eg, monthly or bimonthly) using the same observer. Herd dynamics can be used to monitor lameness control plans (Box 9). Dynamic analysis can only be applied if the identity of all cows is recorded while they are being scored and provided they are scored on at least two occasions in a consistent manner. Regular screening by a vet or an associated paraprofessional has been proposed as a useful means of monitoring lameness (Clarkson and others 1996).

**Box 7: Guidelines for consistent mobility scoring in practice**

- Use a single observer for an individual farm
- Observe cows walking on a flat, straight, non-slip, concrete surface in accordance with their normal routine
- Ensure cows are not pressured so they pass at a gentle walking pace
- Try to avoid using areas that may interrupt cow flow (eg, water troughs en route to a feed fence)
- Ensure accurate identification by scoring animals with the herdsman. With assistance, push all cows to one section of a shed and allow them to walk back past you
- Alternatively, score at milking time so that freeze brands can be noted while cows are milked and their mobility observed as they exit the parlour
- Avoid scoring at the same time as other procedures that are likely to interfere with calm, uninterrupted walking (eg, tuberculosis testing, vaccination or footbathing)
- Use a voice recorder for recording data when cow flow is rapid
- Consider training a paraprofessional on how to carry out mobility scoring

**Box 8: Use of benchmarking in a sample of UK dairy herds**

Mobility scoring data collected in practice can be benchmarked against the data shown in the graphs and table in this box, or compared with data collected from practice farms. Benchmarking can help motivate change and demonstrate what can be practically achieved.

**Effect of lameness**

**Welfare**

The fact that animals alter their gait in response to discomfort indicates that lameness is a painful condition. This has been confirmed by previous work that demonstrated that lame cows were more sensitive to pain (allodynia) (Whay and others 1997, 1998).

In a number of recent surveys investigating the attitudes of respondents to pain in cattle, both farmers and vets subjectively scored lameness as painful. Digital dermatitis was considered to be 5 or 6 on a 10-point pain scale, while white line disease with a subsole abscess was thought to be 6 or 7 (Table 2).

### Table 2: Estimated level of pain associated with two causes of lameness on a 10-point pain scale

|                | Respondents* | Median | Mode† |
|----------------|--------------|--------|-------|
| **Digital dermatitis** |              |        |       |
| UK vets (615)    | 6            | 5      |       |
| UK farmers (939) | 5            | 5      |       |
| European vets (2659) | 6      | 5      |       |
| **White line disease with subsole abscess** |              |        |       |
| UK vets (615)    | 7            | 7      |       |
| UK farmers (939) | 6            | 8      |       |
| European vets (2659) | 7      | 8      |       |

*Number of respondents in brackets, †Most frequently given answer

Respondents were asked to estimate the level of pain experienced by animals suffering from two causes of lameness on a 10-point pain scale where ‘1’ is no pain at all and ‘10’ is the worst pain imaginable. While the results are subjective assessments, they are the combined estimates of a large number of individuals with considerable practical experience of bovine lameness (Huxley and Whay 2006, 2007, Huxley and others 2008).
Box 9: Dynamic analysis of mobility scores

The step-by-step method of analysis discussed below has been adapted from somatic cell count analysis and is recommended for analysing serial mobility score data (Archer and others 2009).

**Step 1. Record mobility scores**

| Mobility scores | Values used for dynamic analysis |
|-----------------|----------------------------------|
| 0 and 1 (Not lame) | 0 |
| 2 and 3 (Lame) | 1 |

**Step 2. Assign categories**

| Change in disease state | Category |
|-------------------------|----------|
| 0 to 0                  | Not lame |
| 0 to 1                  | New case |
| 1 to 0                  | Recovered case |
| 1 to 1                  | Chronic case |

**Step 3. Monitor the proportion of animals in each category over time and observe trends**

In this example, the herd experienced a reduction in chronic cases, which was possibly associated with the installation of a new parlour and the fact that cows were spending less time standing on concrete.

**Step 4. Calculate the net lameness index (NLI)**

Net lameness index (NLI) = \( \frac{\text{New cases}}{\text{Recovered cases}} \)

**Step 5. Interpretation.** If NLI <1, lameness is improving. If NLI >1, lameness is deteriorating.

**Limitations of dynamic analysis of mobility scores**

| Problem | Solution |
|---------|----------|
| Intervals between scoring sessions can be variable and can often be as long as six months | Encourage regular (ie, at least monthly) mobility scoring |
| Only includes cows that were clearly identifiable on any two consecutive occasions | Identification is most easily confirmed by checking collar readings in the parlour with the person milking the cows, or, if scoring is performed at a time other than milking, having the herdsman present to confirm identities |
| Does not include animals not present at milking (eg, dry cows, young stock, recumbent cows) | Use in conjunction with herd calving, drying off and culling records. Check health records and make inquiries at the health visit |
| Does not consider ‘acute’ cases of lameness that are treated between scorings | Consult farm treatment records if they exist or make inquiries at the health visit |
Lameness is considered by many in the industry as the most significant welfare issue affecting dairy cattle in the UK because of the level of discomfort caused, the numbers of animals affected and the average duration of clinical episodes (found to be 27 ± 19 days in one study).

**Milk yield**

Most studies on the effect of lameness on milk yield have investigated the impact of cases of ‘clinical’ lameness. A clinical case of lameness has been shown to have a significant adverse effect on milk yield both before and after a cow is diagnosed as lame. The effect of different lesion types varies (Box 10). Research has shown that the adverse effects of lameness on milk yield can last for up to nine months, so the early diagnosis and treatment of lameness is vital from an economic as well as a welfare perspective.

Recent research using the DairyCo mobility scoring system has also shown delayed reductions in milk yield associated with lameness (Archer and others 2010). Consistent with previous work based on clinical lameness, cows never identified as lame by serial mobility scoring gave around 1 litre/day less milk than their lame herd mates; high milk yield is a risk factor for lameness, which explains the higher prevalence in multiparous compared with primiparous cows. It is important to emphasise that any reduction in yield associated with lameness may not be tangible at the herd level because cows that suffer with lameness are higher yielding than the herd average. At cow level, this study demonstrated that a reduction in milk yield associated with a case of lameness may not occur for several months. The results help validate the use of regular mobility score assessment for the diagnosis of lameness at cow level as well as for herd level monitoring (Box 11).

**Economic impact of lameness**

As with any disease, the costs associated with a case of lameness can be split into the direct costs apparent at the time of the event and indirect costs that tend to be ‘hidden’ (Table 3). It has been estimated that an initial case of lameness costs around £323.47 (Willshire and Bell 2009). Such figures should be used with caution as they may not be relevant to current prices or systems of management on a given farm. Box 12 outlines the cost of ‘lost milk’ and culls in today’s prices.

As lame cows tend to be high yielding and owing to the high cost of replacements, farmers may be reluctant for animals to be culled based on lameness alone, particularly if they are pregnant and there are other priorities for culling. This emphasises the importance of implementing preventive strategies on farms and monitoring the outcome.

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**Box 10: Impact of clinical lameness on milk yield**

Studies on UK farms have shown that cases of clinical lameness were associated with a decreased milk yield from up to four months before diagnosis until five months after, resulting in a mean reduction of 357 litres (95 per cent confidence interval: 163 to 552 litres) per 305-day lactation. Sole ulcers and white line lesions were associated with a reduction in milk yield of 570 litres and 330 litres, respectively. A case of digital dermatitis was not associated with a decrease in milk yield (Amory and others 2008, Green and others 2002).

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**Box 11: Impact of monthly mobility scores on milk yield**

Table 3: Components of the economic cost of individual cases of lameness

| Direct costs* | Indirect costs† |
|---------------|-----------------|
| Treatment costs | Increased calving to conception interval |
| Time | Increased risk of calving |
| Opportunity cost | Increased risk of further lameness |
| Veterinary and medicinal costs | Increased risk of secondary diseases |
| Discarded milk | (eg, displaced abomasa) |
| Reduced milk yield at the time of treatment | Reduced milk yield through subclinical, treatment and recovery phases |
| Depreciation on foot trimming equipment | Depreciation on foot trimming equipment |

*Costs that can be attributed to each case of lameness that may be specific to the farm and individual case. †Operational costs that are not easily attributable to a single case of lameness but are more easily imputed by generalisations at herd level. ‡Time is a valuable commodity and always has an ‘opportunity cost’ as alternative uses are foregone (eg, time spent dealing with a lame cow may make less time available for preventive foot trimming).

From Willshire and Bell (2009)
Box 12: Applied economics of lameness

Assessing the value of ‘lost milk’. The potential loss in gross margin alone from a milk yield reduction of 357 litres per case of lameness would be worth £68 based on a margin over purchased feed of 19 pence per litre for year-round calving herds with average annual milk yields of 6885 litres. If the same calculation is performed at herd level using typical incidence rates, lost milk revenue is an estimated £1573 for an ‘average’ 112-cow UK herd with 20·7 lameness cases per 100 cows per year (£23 per cow). For typical UK herds at the time of writing, the cost of lameness for a typical dairy farm can be calculated using the most recent estimates of lesion incidence rates (Barker 2009) and published figures for performance losses. To increase credibility, margins should be used rather than the absolute milk price as feed and other inputs are saved when ‘lost milk’ has not actually been produced.

Example herd

| Herd details | Lameness incidence | Cost of culling |
|--------------|--------------------|-----------------|
| Milk price | Condition | UK average* | Unit | Cost/unit | Total |
| 22.50 pence per litre | Digital dermatitis | 1.7 | Return from sale | 650 | £1.03 | £669.50 |
| 112 | Sole ulcer | 7.2 | Cost of rearing a replacement heifer | 1 | £712.00 | £712.00 |
| 410 (target 400) days | Uncategorised lameness | 6.2 | Lower milk yield from heifer | 1377 | £0.19 | £261.63 |
| 130 (target 120) days | White line disease | 5.6 | Value of smaller calf from heifer | | | £8.00 |
| 60 days | *Cases/100 cows/year | | Total cost of culling | | | £312.13 |
| 350 days | | | |
| 650 kg | | | |
| Value of average calf | | | |
| £120.12 | | | |
| Value/kg of cull cow liveweight | | | |
| £1.00 | | | |
| Margin over purchased feed (MOPF) | | | |
| £0.19 | | | |
| 305-day yield | | | |
| 6885 litres | | | |
| Average cow peak yield | | | |
| 34.43 litres | | | |
| Yield peaks at | | | |
| 42 days postpartum | | | |
| Yield decline of cows per day | | | |
| 0.30% | | | |
| Average yield per cow per day | | | |
| 19.67 litres | | | |
| Feed details | | | |
| Type of feeding system | | | |
| Partly mixed ration | | | |
| Concentrate feeding range | | | |
| 0.29 kg/litre | | | |
| Cost of concentrate/tonne | | | |
| £180.00 | | | |
| Cost of feeding HIGH yielder per day | | | |
| £0.00 | | | |
| Cost of feeding LOW yielder per day | | | |
| £0.00 | | | |
| Labour costs | | | |
| Vet time/hour | | | |
| £70.00 | | | |
| Vet call out fee | | | |
| £17.50 | | | |
| Herdsman’s time/hour | | | |
| £7.42 | | | |
| Cost of service | | | |
| £20.00 | | | |
| Treatment costs | | | |
| Cost of topical antibiotic spray can | | | |
| £5.20 | | | |
| Cost of injectable antibiotic used for treating feet for five days | | | |
| £17.50 | | | |
| Milk withdrawal of injectable used | | | |
| 4.5 days | | | |
| Cost of bandage | | | |
| £1.65 | | | |
| Cost of a block | | | |
| £9.26 | | | |
| Cost of a foot trim (farmer or foot-trimmer) | | | |
| £10.00 | | | |

Cost of extended calving index/calving to conception period if feeding a partly mixed ration

Current costs of calving index
- Total cost of extension to Ca-Con over 365 days: £144.20
- Cost per day of extension to Ca-Con over 365 days: £3.20

Potential savings if targets achieved
- Total cost of extension to Ca-Con over 365 days: £102.21
- Cost per day of extension to Ca-Con over 365 days: £2.27
- Total potential saving: £41.99
- Potential saving per day: £0.93

Results
- Cost of average day extension to Ca-Con: £3.20
- Cost of digital dermatitis: £74.78
- Cost of digital lameness (not white line disease): £187.97
- Cost of interdigital lameness: £151.36
- Cost of sole ulcer: £524.43
- Cost of white line disease: £330.15

Herd results
- Digital dermatitis: £142.39
- Digital lameness (not white line disease): £1305.29
- Sole ulcer: £422.90
- White line disease: £2070.70
- Total cost of lameness in this herd: £7747.41
- Total cost of lameness in this herd: £7747.41

Breakdown of annual cost of lameness for the herd (vet costs = 0%)

| Condition | Unit | Cost/unit | Total |
|-----------|------|-----------|-------|
| Digital dermatitis | | | £142.39 |
| Digital lameness (not white line disease) | | | £1305.29 |
| Sole ulcer | | | £422.90 |
| White line disease | | | £2070.70 |
| Total of cases of lameness on this unit | | | £3341.17 |
| Total cost of lameness in this herd | | | £7747.41 |
| Total cost of lameness in this herd | | | £7747.41 |

Cost per day of extension to Ca-Con over 365 days
- £3.20
- £2.27
- £0.93

Cost of an average case of lameness on this unit
- £334.17

Total cost of lameness in this herd
- £7747.41

Cost per day of extension to Ca-Con over 365 days
- £3.20
- £2.27
- £0.93

Potential saving per day
- £0.93

From Willshire and Bell (2009)
Lameness control

For the past 40 years, the herd level control of contagious mastitis has been based on a ‘Five-Point Plan’ developed following high quality intervention studies that showed the clinical efficacy of each point before proving its effectiveness in practice. In contrast, there are few comparable experimentally proven herd level control measures for bovine lameness. As a result, one currently has to rely on the ‘received wisdom’ of senior peers and the results of observational studies that offer correlations between risks and disease but provide little indication of direct causality in many areas. This has led to some misunderstanding of the risk factors, pathogenesis and control measures, and many assumptions have become accepted practice without being validated by high quality science.

There are still many areas of lameness control that require further research (Box 13). Nevertheless, there have been a number of initiatives launched recently relating to lameness control (Box 14). Following the multidisciplinary EU Lamecow project, which investigated risk factors in husbandry systems, biomechanics and morphology of the bovine claw, as well as knowledge transfer for best practice, the Healthy Feet Project supported by the Tubney Charitable Trust has developed lots of practical advice and information on control. Similarly, the Proceedings of International Ruminant Digit Symposia provides a wealth of relevant literature. In addition, two UK events, the Cattle Lameness Conference and the National Cattle Mobility Event, which aim to disseminate evidence-based science and practical advice, respectively, have been launched over the past few years.

The emergence of the National Association of Cattle Foot Trimmers as a credible representative body for foot trimmers should be welcomed by the veterinary profession. The use of fully trained and accredited Category 1 foot trimmers should be encouraged and promoted on all farms. DairyCo are committed to addressing lameness in an ongoing programme that commenced in 2010 and which will continue in 2011 with the roll out of a practical lameness control plan. In addition, over the past decade, there have been some substantial changes to our current understanding of the aetiology and nomenclature of foot lesions (see Table 4 on pages 501 to 503).

Box 13: Areas of lameness control where further research is still needed

Foot trimming

Foot trimming is commonly recommended as an important measure for lameness control and, when carried out according to Dutch 5-step principles described in Box 2, corrects claw shape to counteract the excessive growth of horn that occurs in response to excessive wear on exposure to concrete flooring. It is a skilled procedure that requires high levels of training and auditing of all those that undertake it. Overtrimming is a common problem. Recent work has found that farms that employ a foot trimmer have a higher prevalence of lameness than those where the farm staff undertake all foot trimming. This could be because:

- Herds with most lameness have to recruit foot trimmers;
- Lameness becomes the delegated responsibility of the foot trimmer with farm staff becoming deskilled and less interested;
- The time to treatment may be longer where lame cows are left until a foot trimmer visits, leading to poorer outcomes following treatment;
- The technique used by foot trimmers may be worse. This last point is important, as many foot trimmers are not members of the National Association of Cattle Foot Trimmers and operate without any formal training or qualification. The routine use of grinders has been challenged although there is no evidence to suggest that this prevents the safe use of correct claw trimming. The cattle welfare code states ‘if they [stockkeepers] are expected to perform specific tasks on-farm, such as foot trimming, then appropriate training should be given. Otherwise, a veterinary surgeon or, for certain tasks, a competent and trained contractor will be required.’

Footbathing

Footbathing is considered effective in the management of digital dermatitis although controlled clinical trials only support the use of antibiotics, formalin, copper sulphate and peracetic acid. No products are currently licensed for footbathing. This is disturbing as a range of unlicensed chemicals are used in an uncontrolled manner and could have potentially adverse consequences for both public health and the environment. Standard withdrawal periods apply to soluble POM-V (prescription-only medicines – veterinary) antibiotics for off-label use in footbaths.

Occupational exposure to formalin is a risk factor for nasopharyngeal cancer in humans and its use without good evidence may potentially leave vets open to litigation on health and safety grounds if it cannot be demonstrated that appropriate advice on handling formalin has been given.

In practical terms, footbath hygiene is probably more important than the product chosen as all agents are inactivated in the presence of organic matter. Hence, feet should be cleaned before cows walk through the bath, preferably in a separate prewash bath containing straw and water. Footbaths quickly become contaminated during use and could represent more of a risk than a control measure if remedial action is not taken.

Box 14: Information resources for lameness control

- EU Lamecow project. http://template.bio.warwick.ac.uk/e+e/lamecow/public_html/index.html
- Healthy Feet Project supported by the Tubney Charitable Trust. www.cattle-lameness.org.uk
- National Association of Cattle Foot Trimmers. www.nacft.co.uk/members_list/a-z.htm
- Proceedings of International Ruminant Digit Symposia. www.lamenessinruminants.org
- Cattle Lameness Conference. www.cattilamenessconference.org.uk
- National Cattle Mobility Event. www.cattle-lameness.org.uk/National-Cattle-Mobility-Event.php

Summary

The current situation relating to lameness in UK dairy cows is not dissimilar to that of mastitis 30 years ago. Robust scientific support of control measures and their economic benefit is urgently needed to follow up on the understanding of potential risk factors and patho-
Table 4: Foot lesions in cattle – recognition and international nomenclature*

| Foot lesion                                                                 | Description of lesion                                                                                                                                                                                                 | Typical appearance |
|-----------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| White line lesion (also known as white line separation, white line disease) | Diseased horn affecting the junction between the sole and the wall, including bruising (haemorrhage), separation (tissuring), abscessation and ulceration                                                                 |                    |
| Sole ulcer (also known as pododermatitis circumscripta, Rusterholz disease)  | Exposed corium at the classic site corresponding to the flexor process of the pedal bone                                                                                                                              |                    |
| Heel ulcer                                                                  | Exposed corium found in the midline of the claw at the junction between the sole and heel. Usually affects medial hind claws                                                                                           |                    |
| Digital dermatitis (also known as hairy heel warts, Mortellaro disease)      | A well circumscribed infection of the skin, usually between the heel bulbs or palmar/plantar pastern area. Lesions generally start as exudative epithelial erosions/ulceration, progressing to granulation, followed by hyperkeratosis and scab formation |                    |
| Foul, footrot or phlegmon (also known as interdigital phlegmon, interdigital necrobacillosis) | An acute bacterial infection of the subcutaneous tissues of the interdigital space characterised by symmetrical swelling, separation of the claws and interdigital skin necrosis yielding a pungent odour                                                                 |                    |
| Condition                                      | Description                                                                 |
|-----------------------------------------------|-----------------------------------------------------------------------------|
| Interdigital hyperplasia                      | Soft tissue masses between the claws                                         |
| Sole haemorrhage (also known as sole bruising) | Bright or deep red discolouration of the sole. Mild bruising can take the form of diffuse pin-prick sized spots or generalised yellowing of the horn |
| Toe ulcer (also known as toe necrosis, apicalis necrotica) | Diseased horn affecting the white line at the toe, usually with a pungent odour. Often called ‘rotten toes’ by farmers |
| Horizontal fissure or hardship groove (also known as horizontal wall fissure, fissure ungulae transversalis) | Linear horn defects parallel to the coronary band affecting the wall horn, causing lameness when the defect extends through to the corium |
| Vertical fissure (also known as sandcrack, fissure ungulae longitudinalis) | Linear horn defects at 90° to the coronary band affecting the wall horn, causing lameness when the defect extends through to the corium |
| Condition                                      | Description                                                                                                                                                                                                 | Image |
|-----------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|
| Axial fissure (also known as axial wall fissure) | Linear horn defects affecting the axial wall horn, causing lameness when the defect extends through to the corium.                                                                                             |       |
| Heel erosion (also known as slurry heel)      | Heel horn loss, often in the form of variable shaped pits or fissures. Does not commonly affect the corium (and therefore is rarely painful).                                                                |       |
| Thin sole                                      | A sole that is less than 5 mm thick and flexes under firm thumb pressure. Usually associated with excessive wear or overtrimming.                                                                               |       |
| Corkscrew claw                                 | Genetic condition resulting in twisting of the claw capsule. Bony swelling deep to the abaxial coronary band is pathognomonic.                                                                                     |       |
| Interdigital dermatitis (also known as scald) | A superficial epithelial inflammation producing a white exudate with a pungent smell similar to foul. Experts disagree about the nature of this condition. Many believe it is a mild form of foul or digital dermatitis between the claws |       |

*Following the 15th International Symposium and 7th Conference on Lameness in Ruminants, international consensus was reached on standardising the nomenclature for foot lesions. Lesions that could be grossly recognised were adopted, avoiding debate over diseases involving uncertain pathogenesis such as coriosis (formerly laminitis). The terms outlined above should be used whenever possible.*
genesis provided by the EU Lamecow project. Repeat studies have shown that clinical episodes of lameness and elevated mobility score both lead to substantial reductions in milk yield, productivity and fertility and adversely affects the welfare of affected animals. This reduction in milk yield is not seen at the herd level as cows that suffer with lameness are the highest yielders and, hence, their milk yield simply reduces towards that for ‘average cows’ that remain sound.

Once lame, farmers tend to retain these high-yielding animals as replacement costs are high and, unlike cows with chronic mastitis, milk quality is not affected and they are often not a risk to other cows (if the lameness is non-infectious). Early and effective treatment following immediate identification of lame cows will deliver cost-effective improvements at farm level while appropriate evidence-based herd level control programmes are developed. There are significant ongoing opportunities for the profession to train the industry on the proper recognition (mobility scoring), monitoring and treatment of lameness in cattle. Training can also ensure that appropriate veterinary intervention is sought in more serious cases and improve the welfare of affected animals.

Acknowledgements

The authors would like to thank the Tubney Charitable Trust for its support through its Healthy Feet Project. Simon Archer’s residency in production animal medicine was partly funded by the RCVS Trust.

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