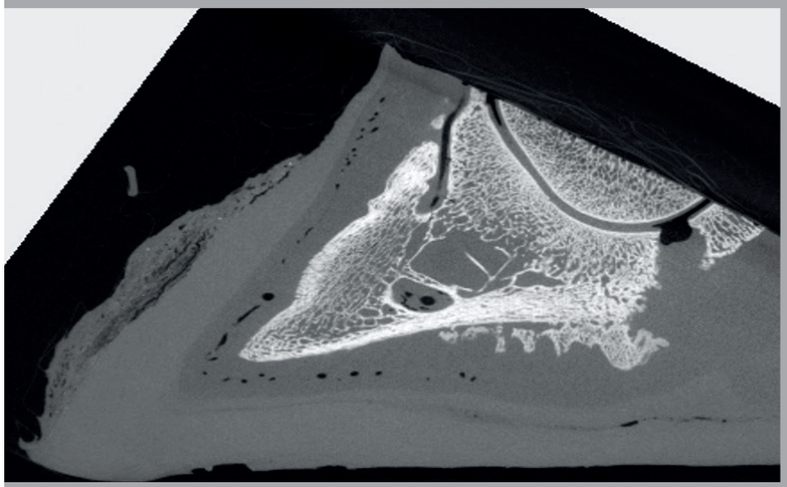
UK-VET Livestock

Dairy cattle lameness: a roundtable discussion



Nick Bell • David Bacon • Emily Craven • Steve Crowe • Reuben Newsome • Georgios Oikonomou • Sara Pedersen • Jon Reader • James Wilson

Sponsored by Ceva

The Panel:

Nick Bell
MA VetMB PhD PG cert Vet. Ed. FHEA DipECAWBM(AWSEL) MRCVS

Nick is an independent herd health veterinary consultant based in Dorset, UK and Honorary Associate Professor at Nottingham University. He grew up on a small sheep and beef farm in Herefordshire, qualified from Cambridge University in 1999. In 2002 he took on a PhD project at Bristol on dairy lameness control programmes in 2002–6 followed by the Healthy Feet Project in 2007 and then the Cow Tracking project at the Royal Veterinary College in 2011. He is a member of the European Board of Veterinary specialists, RCVS recognised specialist. He has interests in claw trimming approaches in dairy cows supervising a Dartington Cattle Breeding Trust project (Sophie Mahendran masters student) and the latest AHDB funded project (Sara Pedersen PhD). He also has an interest in automatic monitoring of cow behaviour and welfare working with researchers at Writtle College, Essex University and Exeter University in the Cow Tracking project and more recently IceRobotics and CattleEye. He still enjoys nothing more than treating a lame cow and fixing a cubicle shed.

David Bacon

David has been a dairy farmer on the family farm in Nottinghamshire for 16 years, he's a partner and herdsman at the business and a special interest in lameness control. He was a participant in Nottingham's trial as part of James Wilson's PhD

Emily Craven
MA VetMB CertAVP PgCertVPS MRCVS

Emily is the ruminant clinical director at Oakwood Veterinary Group, part of the Vet Partners network. She is particularly interested in mobility and leads the Vet Partners mobility special interest group.

Steve Crowe
BVMS CertAVP MRCVS

Steven Crowe is a partner at Nantwich Farm Vets in Cheshire. He has a particular interest in cattle lameness, and enjoys farmer education and training, helping to run the popular 4-day Dairyland foot trimming course in Nantwich.

Reuben Newsome
BVMBVS PhD MRCVS

Reuben Newsome leads the Park Vet Group's farm department, a team of 10 servicing Leicestershire and the surrounding counties. While studying at Nottingham University, he undertook a PhD intercalated into his veterinary degree, researching claw horn disruption lesions in dairy cattle. After graduating in 2017 Reuben moved to Synergy Farm Health, first as an RVC clinical training intern and then as a veterinary surgeon and researcher. He moved to Park in 2019, where he enjoys incorporating his interest in mobility management into a diverse array of cattle veterinary work.

Georgios Oikonomou
DVM PhD FHEA MRCVS

Prof Georgios Oikonomou is Professor of Cattle Health and Welfare at the Institute of Infection, Veterinary and Ecological Sciences, University of Liverpool. He graduated from the School of Veterinary Medicine, Aristotle University of Thessaloniki, and during his PhD studies, he investigated the genetics of energy balance and fertility in Holstein cows. He spent a few years managing a 600 cow dairy herd in Greece before moving to the USA where he worked as a research associate at Cornell University and got involved in various research projects on dairy cattle lameness, mastitis and reproductive diseases. He was a co-Project Director on a USDA-funded project studying the dynamics of the mammary microbiome and is currently studying dairy cattle lameness using genomic and microbiomic approaches and funded by BBSRC, the Wellcome Trust, the Animal Welfare Foundation and the Academy of Medical Sciences. The overarching objective of his research is the improvement of the welfare of dairy cattle and of the sustainability of dairy farms.

Sara Pedersen
BSc(Hons) BVetMed CertCHP DBR MRCVS

Sara graduated from the Royal Veterinary College in 2005 and has worked in the farm animal sector ever since. Before she returned home to South Wales in 2014, she spent time in farm practice in a number of different areas of the UK. During this time she gained her RCVS Certificate in Cattle Health and Production, Diploma in Bovine Reproduction and became an RCVS Recognised Specialist in Cattle Health and Production. She now runs Farm Dynamics Ltd, a consultancy business that provides training and advisory services on topics relating to cow welfare, with a specific focus on cattle lameness. Alongside this, she is doing a part-time PhD with the University of Nottingham on foot trimming technique.

Jon Reader
BVSc DCHP FRCVS

Jon Reader is Managing Director of Synergy Farm Health, a 41 farm animal only veterinary practice in the South West of England. He is an RCVS recognised specialist in Cattle Health and Production. Jon has a particular interest in lameness and works closely with the 13 foot trimmers working within Synergy. In 2015, Jon was involved with setting up the Cattle Lameness academy.

James Wilson
BSc(Hons) PhD

James is a Foot Health Consultant based in Cornwall (UK) working with Herd Health Consultancy. After graduating from The University of Nottingham with a degree in Agriculture and Livestock Science, he went to work in dairy herd management. Following this, he undertook a PhD in the treatment and prevention of claw horn lesions at UoN's vet school, which he completed in 2021. During his PhD, James spent a large proportion of his time trimming, both as part of his trial work and also commercially. He is keen to ensure that all farmers and foot trimmers have the knowledge and skills required to used best practice, evidence-based approaches to tackling lameness.

Foreword

Lameness in dairy cattle is a high prevalence condition with significant negative impact on the welfare and economics of the dairy herd. Most lameness is attributable to four main conditions: sole bruising (also referred to as sole haemorrhage), sole ulcer, white line disease and digital dermatitis. Understanding of the pathogenesis of major claw horn diseases has undergone a transformation in the last 20 years, with a shift from a primary nutritional aetiology to a biomechanical one. This has led to significant research into factors relating to claw biomechanics and interventions targeting the inflammatory process. Even for infectious conditions, the benefit of non-steroidal anti-inflammatory drugs to cow welfare and recovery cannot be underrated. In this roundtable discussion, the panel explore the clinical relevance of the findings of research exploring biomechanics and managing inflammation.

Nick Bell, David Bacon, Emily Craven, Steve Crowe, Reuben Newsome, Georgios Oikonomou, Sara Pedersen, Jon Reader, James Wilson

10.12968/live.2022.27.S1.115

Published by: MA Healthcare Ltd, St Jude's Church, Dulwich Road, London SE24 0PB, UK
Tel: +44 (0)20 7738 5454 Web: www.markallengroup.com
Associate publisher: Colin Williams
Editor: Georgina Grell
Writer: David Rendle

Cover images: clockwise from top left – stock.adobe.com/smspsy, James Wilson, stock.adobe.com/lisica1, Reuben Newsome

This article was distributed in Livestock | Volume 27 No 3 | May/June 2022

www.magsubscriptions.com/uk-vet-livestock

Dairy cattle lameness: a roundtable discussion

Lameness is a considerable welfare challenge in the dairy industry and has a major economic impact through reductions in milk production and longevity (Green, 2002; Reader et al, 2011; Randall et al, 2016). Lameness in dairy cattle is highly prevalent (Griffiths et al, 2018; Randall et al, 2019) and frequently results in chronic recurrent lesions (Leach et al, 2012; Groenevelt et al, 2014) that are associated with considerable pain (Whay, 1997). Historically, farmers and veterinary surgeons have focused on the treatment of overtly lame animals; however more recently there has been a move toward more prompt intervention as evidence indicates that delays in treatment is associated with lower rates of healing (Thomas et al, 2015, 2016) and higher rates of recurrence (Groenvelt et al, 2014). Furthermore, the disease processes that ultimately result in lameness in older cows may start early in life prior to lactation, indicating a need to address management practices of replacements and heifers to reduce lameness in the herd. Unfortunately, with traditional approaches, the pathology associated with claw horn lesions (sole ulcers, heel ulcers and white line lesions) is frequently irreversible by the time the lesions are identified (Bergsten et al, 2015) (*Figure 1*). As awareness and attitudes among consumers evolve, the welfare of dairy cows rightly assumes ever-greater importance and the industry comes under increasing pressure to reduce the prevalence of lameness, which likely sits upward of 20% and may be over 30% in some herds (Bergsten et al, 2015; Bell and Randall, 2021). This article presents current thinking on how progress can be made in the prevention and management of dairy cattle lameness.

Figure 1. Early detection and treatment of deep sole bruising can catch lameness at a stage more amenable to treatment and less likely to result in scarring of the digital cushion or development of irreversible bone exostoses on the distal phalanx. Note the sole bruising in this photograph has probably been detected and treated just in time before progressing to a more severe sole ulcer.

Aetiopathogenesis of claw horn lesions in dairy cattle

Claw horn lesions may involve pathology of the digital cushion (Newsome et al, 2017a), the third phalanx (Newsome et al, 2016) and possibly the corium (Evans et al, 2011), with extreme cases potentially extending to joints and tendon sheaths (*Figure 2*). Many of the changes that ultimately lead to claw horn pathology are related to normal physiological changes in the digital cushion. The digital cushion comprises three cylindrical fat pads (*Figure 3*) that dissipate concussive forces through the foot, with lesions developing when the function of the digital cushion is compromised through reduction in volume. Digital cushion thickness (DCT) has been shown to be an important factor in the development of lameness (Bicalho et al, 2009; Bicalho and Oikonomou, 2013), with a recent study also demonstrating that the volume of the digital cushion was negatively associated with the number of lameness events. Cows with a body condition score (BCS) above 3, those culled later in lactation, or those with greater body weight were more likely to have a

Figure 2. A cross section of a bovine hoof with the distal phalanx, suspensory apparatus, and digital cushion highlighted. The distal phalanx is suspended from the dorsal wall of the hoof by the laminar corium, and the digital cushion functions to support the bone to protect the sensitive tissues beneath from concussive forces.

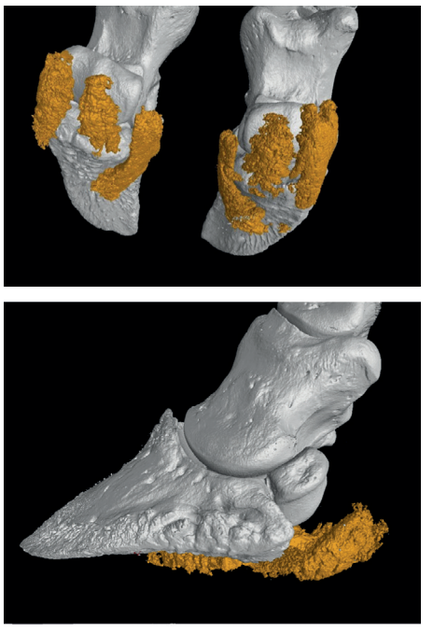


Figure 3. Images of the digital cushion. Agriculture and Horticulture Development Board (AHDB) and the Dairy Herd Health Group at University of Nottingham.

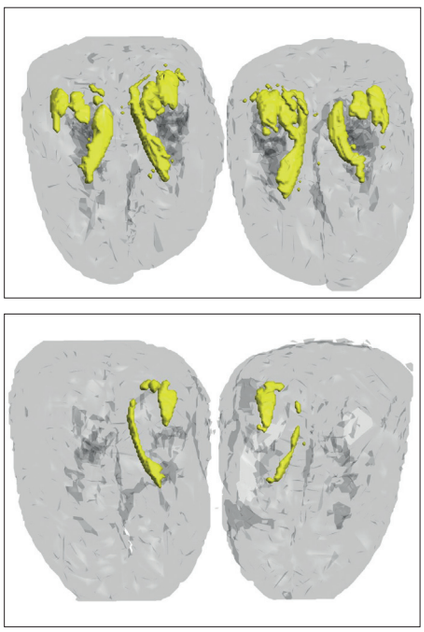


Figure 4. Two magnetic resonance imaging scans described by Wilson et al. (2021) demonstrating the differences observed in digital cushion volume. These reconstructions show the plantar aspect of the foot, with the digital cushion being represented by the yellow regions. The cow with more digital cushion had no history of claw horn lesions, the cow with little digital cushion had been treated repeatedly throughout life for claw horn lesions.

higher volume of digital cushion in the lateral claws (Wilson et al, 2021).

The volume of the digital cushion is not static and can be influenced by a number of factors:

- Age (Räber et al, 2004)
- Genetics (Oikonomou et al, 2014)
- Exercise and adaption to hard surfaces (Gard et al, 2015)
- Stage of lactation (Newsome et al, 2017a)
- Body condition (Newsome et al, 2017b; Wilson et al, 2021)
- The presence of haemorrhage and inflammation (Newsome et al, 2017b)
- Lameness history (*Figure 4*) (Wilson et al, 2021).

Body condition

There is a direct relationship between BCS and the volume of the digital cushion (Newsome et al, 2017b; Wilson et al, 2021), and a positive correlation also exists between back fat thickness and DCT (Bicalho et al, 2009) (*Figure 3*). It has been debated whether loss of weight causes lameness or lameness results in the loss of weight, and there are no experimental trials, only observations studies, so the findings at this stage remain correlation rather than causal in nature. Nonetheless, looking at all factors influencing digital cushion integrity, BCS remains an important factor to monitor and potentially manage. Recent work demonstrates that the number of adipocytes in the digital cushion does not change but the volume of cells changes, suggesting that fat is deposited and mobilised within the digital cushion (Newsome et al, 2021).

KEY POINTS

- Digital cushion thickness has been shown to be an important factor in the development of lameness.
- The volume of the digital cushion is influenced by age, genetics, the rearing period, stage in lactation, lameness history and body condition.
- Poor management of body condition score is associated with the onset of claw horn lesions.
- Lameness could be associated with irreversible anatomical changes that increase the risk of future lameness.
- The experience of the heifer through rearing and transition into the first lactation are becoming the major focus for managing and extending foot health in later life.

Stage of lactation

Around calving there is an upregulation of matrix metalloproteinases and relaxation of collagen, which facilitates parturition but also results in slackening of the suspensory apparatus and greater loading of the sole corium for several weeks after calving (Tarlton et al, 2002). Digital

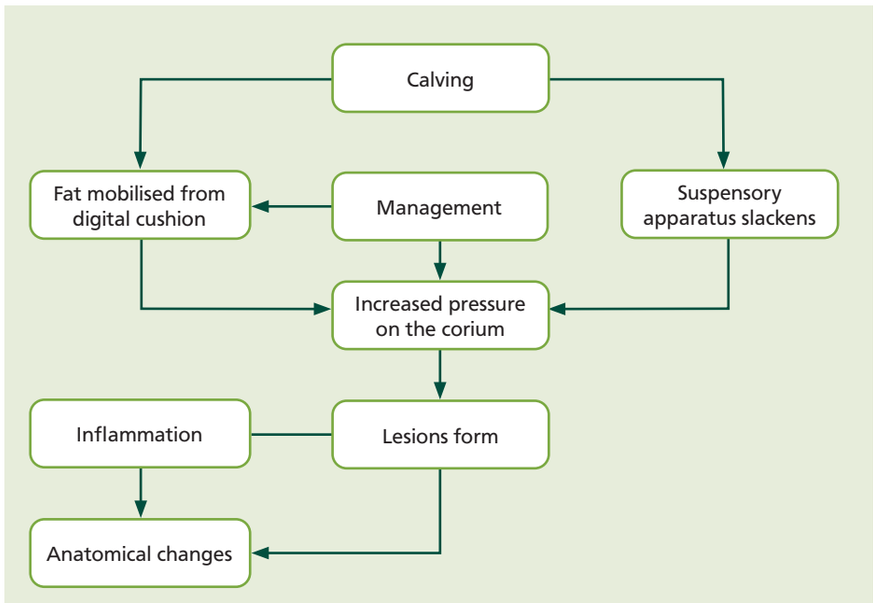


Figure 5. A summary of the pathogenic pathway that leads to claw horn lesions. Figure courtesy of James P Wilson.

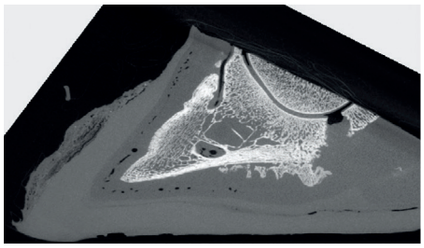


Figure 6. X-ray computed tomography scan of a bovine foot, displaying the distal phalanx/pedal bone with large exostoses protruding downwards towards the germinal epithelium of the sole. This is the end-stage of a degenerative inflammatory process.

cushion thickness reaches its thinnest a week after calving (Newsome et al, 2016; Bach et al, 2021), and given the fast rate of change this is most likely through compression by a sinking PIII rather than fat mobilitisation, with recovery taking place slowly through early lactation.

When the foot is at its most susceptible, heifers are often subject to changes in management and are exposed to more time on concrete, compounding the increase in loading on structures of the sole. They may also be introduced to new housing or cubicle systems and spend less time recumbent, further increasing the risk of damage. Housing on straw yards for 4 weeks prior to anticipated calving, until 8 weeks after calving, has been associated with reduction in lesion scores and prevention of sole ulcers (Webster, 2002). Housing on straw yards can be more challenging because of the associated costs and increased mastitis risk. A compromise may be reached by keeping heifers as a distinct group to reduce bullying, deeply bedding cubicles and reducing milking times (Bergsten et al, 2015).

Development and adaptation

It is often assumed that heifers calve down with healthy feet; however sub-clinical disease often goes unrecognised (Randall et al, 2016) and lameness in heifers associated with sole lesions may be assumed to have other causes. A growing body of evidence highlights the importance of calf and heifer management in preventing lameness later in life. The digital cushion was shown to be 37% larger in calves that were walked on rough tracks (Gard et al, 2015), and mild lesions found at the time of first calving (probably a consequence of insults indured weeks early in the rearing environment) appeared beneficial to foot health and longevity (Randall et al, 2016). On pasture, the claw presses into the surface and load is distributed across the wall of the foot; by contrast, on concrete load is concentrated at the back of the foot (Telezhenko, 2019). Weight is also distributed less evenly on concrete, with 70–80% of loading going through the lateral claw compared with 60–65% of loading going through the lateral claw on pasture (Telezhenko, 2019). Managing heifers separately and providing them with additional comfort around calving may protect against subsequent lameness. Alternatively, management of stocking density and time away from the cubicles has major impacts on lying behaviour (Charlton et al, 2014); compromised lying behaviour has, in turn, major consequences for subsequent lesion risk (Leonard et al, 1994, 1996). When first introduced to cubicles, heifers will spend less time lying down (von Keyserlingk et al, 2011). Cubicle training prior to calving has been associated with marked reductions in lesion score (Logue et al, 2004). Maintaining optimal BCS (Randall et al, 2015) in line with normal BCS targets for fertility, e.g. Agriculture and Horticulture Development Board (AHDB) targets — lose no more than 0.5 from calving to peak lactation, may also promote digital development.

Ensuring that the feet are in optimal shape and condition before calving may be protective but needs to be balanced carefully against the risk of over-trimming, which can paradoxically increase the risk of lameness (Mahendran et al, 2017).

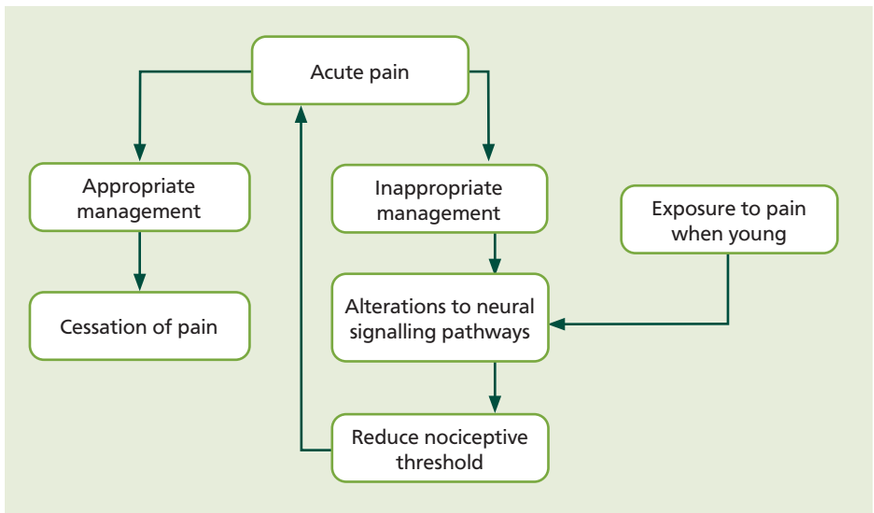


Figure 7. A basic summary of the pain management pathway associated with long-term nociceptive threshold reduction. See also Table 1. Figure courtesy of James P Wilson.

Metabolism

Poor nutrition has been associated with hoof claw lameness. The mechanism is unknown, but may be a result of poor biotin synthesis, wet faeces, deficiency of macrominerals (Bell and Randall, 2021) or the association with fat mobilisation from the digital cushion. Historically, ruminal acidosis and laminitis were implicated, but there is scant evidence to link ruminal acidosis and claw horn lesions. Interest has shifted toward potential roles for inflammation or metabolic changes (and particularly lowered glucose availability) on keratinocyte growth and laminar attachment (Mulling, 2019).

Previous lameness

It has long been recognised that lameness is frequently associated with the development of irreversible anatomical changes that increase the risk of future lameness (Hirst et al, 2002; Tsuka et al, 2012; Randall et al, 2016). In response to increased loading, exostosis of the distal phalanx develops (*Figure 5 and* 6). Bone development increases with age, previous lameness and a history of claw horn lesions (Newsome et al, 2016). Exostosis permanently damages other structures of the sole, further compromising the normal function of the foot predisposing to further lameness and a spiral of perpetual suffering (*Figure 5*).

Interventions in heifer management that may help to reduce the development of lameness are summarised in *Figure 7* and *Table 1*.

The importance of genetics in dairy cattle lameness

Dairy cattle lameness is primarily influenced by environmental factors, but there is a herit-

Table 1. Interventions to minimise the development of lesions causing lameness in heifers and later life (order according to typical stages applied in the heifer's life)

Foot health intervention	Examples of practical applications and rationale	References
1. Genomic selection of resilient heifers	Applying genomics to weaned heifers to cull (or sell for beef) heifers with a higher risk of lameness	Surprising there is only one peer-reviewed publication on genomic selection for lameness in dairy heifers (Barden et al, in press). Liverpool University are currently investigating this. AHDB provide a sire selection index called Lameness Advantage, which is based on an average heritability of 4% (Anon, 2020)
2. Rearing heifers free from digital dermatitis	Keeping rearing facilities biosecure so heifers do not encounter digital dermatitis prior to first calving. This might involve ensuring no mature animals are brought to the heifer rearing site, using automatic scrapers, making sure no trimming equipment is shared and people wear dedicated personal protective equipment for the heifer rearing site	Bell (2006) Gomez et al (2015)
3. Cubicle training prior to first calving	Rearing heifers on cubicles. Sand could predispose to acquired corkscrew claws	Logue et al (2004) von Keyserlingk et al (2011) O'Connell et al (1993) Kjæstad and Myren (2001a, 2001b)
4. Developing the digital cushion with exercise and hard floor/track surfaces	Scraped concrete feed passage during rearing period. Housing autumn block calving heifers 2 months before calving or housing when over 8 weeks into lactation	Bergsten et al (2015) Gard et al (2015)
5 Feeding high dry matter rearing diets	Rearing diets based on straw/hay and concentrate reduces claw horn lesions	Webster (2001) Webster and Tarlton (2001) Offer et al (2001) Logue and Offer (2001) Offer et al (2003) Leach et al (2005)
6. Trimming pre-calving	Trim heifers with long toes 7–8 weeks prior to expected calving	Mahendran et al (2017) found trimming increased the prevalence of lameness compared with no trimming. However, initial trimming took place as heifers entered transition and the lactation environment was a high risk for high wear rates
7. Heifer transition and fresh group	Parity 1 transition and milking groups	Cross et al (1999)
8. Protecting the weakened laminar attachment around first calving with a heifer straw yard group for 12 weeks (C-4 to C+8)	Straw yards for 4 weeks before calving, until 8 weeks after calving, would appear to be the gold standard, but deep bed cubicles with appropriate dimensions could achieve a comparable level of lying time and behaviour. Rubber matting (like quarry belting) along feed barrier to cushion feet. Small fresh group for short pen times for milking and other activities	Webster (2002)
9. Trimming heifers 60–100 days in milk	Conservative foot check at 60 days in milk. Focus mostly on the large and deep model (Stoddard, 2018), and treatment of lesions causing lameness	No good evidence supporting this. There have been two trials which found no reduction in lameness with a 100 day check (Mahendran et al, 2017) or improvement in productivity with an 80 day foot check (Maxwell et al, 2015). Liverpool research suggests this may have been too late in lactation to have a protective or corrective benefit (Griffiths et al, 2018, and unpublished data)
10. Fortnightly mobility scoring with prompt, effective treatment	Every 1–2 weeks the person responsible for cow health and welfare watches milking groups walk past them at a milking and selects animals for trimming and treatment. Best practice for claw lesions involves the proactive use of a block and non-steroidal anti-inflammatory drug for claw horn lesions and topical antibacterial treatment with or without a bandage	While trials have not reported heifer groups separately, this intervention would appear to apply well to heifers (Groenevelt et al, 2014; Thomas et al, 2015). Mahendran et al (2017) used the fortnightly scored heifer group as their control group which performed better than the trimmed groups

KEY POINTS

- There is a heritable component to claw horn lesions, and with better data recording it may be possible to select for lower lameness risk, through using tools such as the AHDB Lameness Advantage Trait.
- Early detection and prompt effective treatment (EDPET) based around fortnightly mobility scoring has been shown to be effective in reducing rates of lameness.
- Automated mobility scoring shows promise as part of a holistic approach in herd lameness management.
- Clinical lameness derived from claw horn lesions damages the anatomy of the foot in a manner which predisposes the individual to future lameness, while mild contusions appear protective.
- Ensuring that lameness is prevented where possible, and promptly treated when it occurs may minimise, if not prevent these changes to anatomy occurring.

able component to claw horn lesions (Heringstad et al, 2018). Current estimates suggest that the heritability of different conditions is low to very low, however the poor quality of lameness data recording may disguise a greater heritable component than appreciated currently. For example, when foot lesions were recorded consistently by a research team and for a whole production cycle the heritability of sole haemorrhage, sole ulcer, and white line lesion resistance was found to be 0.20, 0.29 and 0.06, respectively (Barden et al, 2021). With better data recording it may become possible to select for lower risk of lameness.

Applying lameness detection and treatment protocols

A sole ulcer is a failure of management and a failure of detection. Early detection of claw horn lesions is essential in preventing chronic recurrent lameness and the associated welfare and economic impacts. Currently there are large discrepancies between farmer-observed (and recorded) lameness and the rates of lameness that are identified by trained operators performing mobility scoring (Leach et al, 2010). A lack of accurate farm-level data hampers decision making and has prompted the development of an AHDB Healthy Feet App, which includes features on mobility scoring and lesion recording.

In order to be successful, implementation of an early detection and prompt effective treatment (EDPET) regimen on farm should include:

- Accurate and sensitive mobility scoring to detect cows in the very early stages of lameness
- Correct therapeutic trimming techniques
- Adherence to treatment protocols, including the use of non-steroidal anti-inflammatory drugs (NSAIDs).

EDPET based around fortnightly mobility scoring has been shown to be effective in reducing rates of lameness (Groenvelt et al, 2014). This requires that:

- Scoring is focused on early detection of all lame cows accepting that some may be false positives
- Strict evidence-based protocols are implemented for treatment (*Figure 1*)
- Where therapeutic trimming is required, this is implemented to a high standard to avoid over-trimming or poor techniques which can be detrimental to recovery. Poor techniques of too much toe can be detrimental
- There is re-examination of treated cases at pre-determined intervals to ensure that recovery is as expected
- Inspection criteria are determined based on mobility score analysis and all cows are inspected when eligible

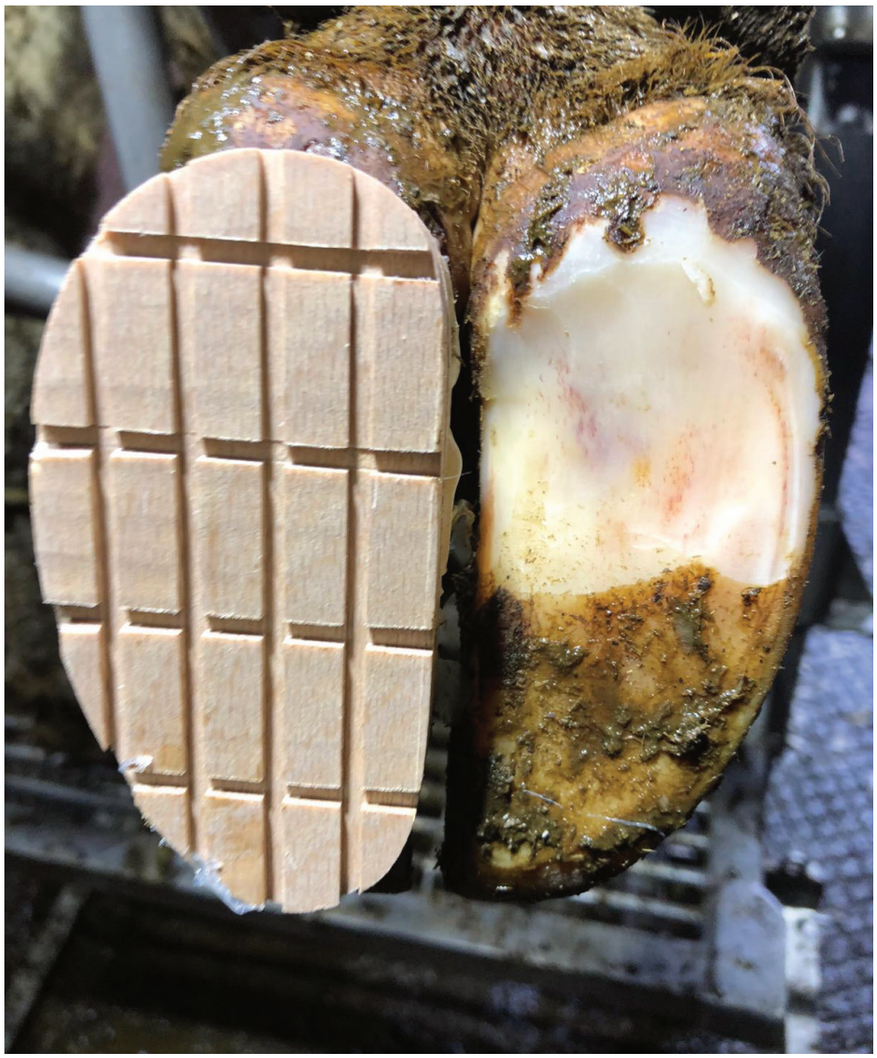


Figure 8. An image showing a deep bruise (haemorrhage) which was initially detected using hoof testers. Following the application of a wide and deep model, the lesion became visible. This animal received a therapeutic trim, orthopaedic block and a course of non-steroidal anti-imflammatory drugs.

- Data on lameness incidence and recovery rates is constantly monitored and protocols altered accordingly
- There is effective communication, transparency and understanding between all those involved — farmer, veterinary surgeon and trimmer.

The ability of EDPET to reduce rates of lameness may be two-fold in origin; first, the 'downwards spiral' illustrated in *Figure 5* may be minimised, preventing animals from being predisposed to claw horn lesion pathogenic mechanisms. Second, the pain management pathway illustrated in *Figure 7* may be appropriately handled, where the nociceptive threshold of animals is not lowered, meaning they are less likely to experience pain in the future than those animals managed without appropriate management (*Figure 8*).

Automated methods of mobility scoring such as 'CattleEye' and 'CowAlert' have been trialed. In work performed to date the 'CattleEye' was shown to be at least as effective at mobility scoring as a trained scorer, and may even prove to be better (Anagnostopoulos et al, 2021). Larger trials with more farms are warranted with further refinement of the algorithms around specific lesion data. Automated mobility scoring shows promise as part of a holistic approach in herd lameness management.

Current consumer-led initiatives record percentages of lame cows, which comes with a risk of encouraging under-reporting and may deter the identification of early lameness which is so critical in preventing chronic recurrent disease. Greater transparency and better benchmarking of mobility scoring and lesion types across farms would be helpful in moving the industry forward. There is a need for educational initiatives on the benefits and implementation of mobility scoring and accurate identification and recording of lesions.

Evidence-based treatment protocols need to be constructed with the farm's veterinarian and strictly adhered to by both farm staff and foot trimming contractors alike. These protocols need to be sympathetic to the individual animal, while following the gold standard according to expert consensus on the interpretation of the scientific evidence base, or where that is uncertain, by evaluating outcomes on the farm.

KEY POINTS

- Effective prevention and management of pain and inflammation with non-steroidal anti-inflammatory drugs (NSAIDs) should be central to the control of lameness.
- There is an increasingly strong argument for the administration of NSAIDs to all heifers at first and subsequent calvings.
- It is suggested that routine NSAID administration at first and subsequent calvings, and at lameness will protect the functional anatomy of the foot.
- Treatment of claw horn lesions must include NSAIDs, both to improve cure rate and for welfare purposes.

The role of non-steroidal anti-inflammatory drugs in protecting the digital cushion

Claw horn lesions are associated with significant pain and inflammatory responses that contribute to a downward spiral of deteriorating lameness. In addition to the anatomical and mechanical changes that develop, exposure to pain may alter neural signalling pathways and increase sensitivity to future noxious stimuli (*Figure 7*). Even painful stimuli that occur early in life, such as that associated with dis-budding, can set animals up for greater sensitisation to pain later in life. Effective prevention and management of pain and inflammation with NSAIDs should therefore be central to the control of lameness. Fortnightly monitoring for lameness and the treatment of lame animals with NSAIDs was shown to reduce the incidence of lameness by 10% in a recent study (Wilson et al, in press). The administration of 3 days of NSAIDs to heifers at calving was associated with a further reduction in lameness and a positive return on investment, with every £1 spent on NSAIDs returning £1.66 in reduced costs of lameness treatment. There is an increasingly strong argument for the administration of NSAIDs to all cows at calving, with a compromise being the treatment of all heifers.

The value of non-steroidal anti-inflammatory drugs in treating digital dermatitis

Digital dermatitis is a painful condition but NSAID use is not routine on all farms. Kasiora et al (2021) recently performed a randomised, controlled clinical trial of digital dermatitis cases to assess the effect of ketoprofen on mobility scores and milk yield at 1 week post treatment. Ketoprofen treated cows were 2.57 times less likely to be lame. When only cows that were lame prior to treatment were considered, cows that received ketoprofen were 20 times less likely to be lame and had a significantly higher milk yield (Kasiora et al, 2021).

Conclusions

The major causes of lameness have remained unchanged in the last 30 years, while lameness prevalence has climbed to unacceptable levels, both in terms of welfare and economics. Traditional interventions for lameness as a result of claw horn lesions involved treating progressed end-stage pathology of the bone and digital cushion, leading to chronic and recurrent lameness. Traditional management erroneously focused on nutrition. Therefore, as production has intensified, lameness risk increased, and the deficiency in prevention and treatment strategies became magnified. Recent research has redirected the scientific understanding of the pathogenesis of claw horn disruption towards biomechanical failures, ultimately resulting in focal inflammation of the sole and white line. A major advance has been the control of the initial focal bruising through early detection using mobility scoring, and more effective treatment using NSAIDS, along with hoof blocking. NSAIDs also have a potential role in controlling the bruising and inflammation that occurs in the high-risk period around calving, as well as controlling pain and inflammation associated with lameness as a result of digital dermatitis. Finally, better lesion and lameness recording will have a role in monitoring and managing foot health in dairy herds, and will also be a means of improving genetic indices, with heritability levels comparable to other major production and health traits. LS

References

Anagnostopoulos A, Griffiths B, Neary J, Smith RF, Oikonomou G. Initial validation of an intelligent video surveillance system for automatic detection of dairy cattle lameness. BCVA Congress, 14-15 October 2021, Newport, South Wales

Anon. Lameness advantage [WWW Document]. AHDB. 2020. https://ahdb.org.uk/knowledge-library/lameness-advantage-genetic-index-factsheet (accessed 25 February 2021)

Bach K, Nielsen SS, Capion N. Changes in the soft-tissue thickness of the claw sole in Holstein heifers around calving. Journal of Dairy Science. 2021;104(4):4837-4846. https://doi.org/10.3168/jds.2020-19161

Barden M, Li B, Anagnostopoulos A et al. Can we breed claw horn lesions out of dairy cows? BCVA Congress, 14-15 October 2021, Newport, South Wales

Barden M, Anagnostopoulos A, Griffiths BE et al. The association between a genetic index for lameness resistance and the incidence of claw horn lesions in Holstein cows. Vet Rec. In press

Bell NJ. The alleviation and prevention of lameness in dairy heifers. PhD Thesis. University of Bristol. 2006

Bell N, Randall L. Lameness in dairy heifers:a narrative review of control strategies. UK-Vet Livestock. 2021;26(2):68-76. https://doi.org/10.12968/live.2021.26.2.68

Bergsten C, Telezhenko E, Ventorp M. Influence of soft or hard floors before and after first calving on dairy heifer locomotion, claw and leg health. Animals. 2015;5(3):662-686. https://doi.org/10.3390/ani5030378

Bicalho RC, Oikonomou G. Control and prevention of lameness associated with claw lesions in dairy cows. Livestock Science. 2013;156(1–3):96-105. https://doi.org/10.1016/j.livsci.2013.06.007

Bicalho RC, Machado VS, Caixeta LS. Lameness in dairy cattle: A debilitating disease or a disease of debilitated cattle? A cross-sectional study of lameness prevalence and thickness of the digital cushion. J Dairy Sci. 2009;92(7):3175-84. https://doi.org/10.3168/jds.2008-1827

Charlton GL, Haley DB, Rushen J, de Passillé AM. Stocking density, milking duration, and lying times of lactating cows on Canadian freestall dairy farms. J Dairy Sci. 2014;97:2694–2700. https://doi.org/10.3168/jds.2013-6923

Cross DE, Logue DN, Offer JE, Birnie LM, Lomax MA. Does separate housing of newly calved heifers influence social behaviour and lessen claw horn lesion development? In: Russel AJF, Morgan CA, Savory CJ, Appleby MC, Lawrence TLJ, eds. Farm animal welfare, who writes the rules? Proceedings of an International Symposium, British Society of Animal Science, Edinburgh, UK, 1999. British Society of Animal Science. 1999; 23: 157-158

Evans NJ, Blowey RW, Timofte D, Isherwood DR, Brown JM, Murray R, Paton RJ, Carter SD. Association between bovine digital dermatitis treponemes and a range of 'non-healing' bovine hoof disorders. Vet Rec. 2011;168(8):214. https://doi.org/10.1136/vr.c5487

Gard JA, Taylor DR, Wilhite DR et al. Effect of exercise and environmental terrain on development of the digital cushion and bony structures of the bovine foot. Am J Vet Res. 2015;76(3):246-52. https://doi.org/10.2460/ajvr.76.3.246

Gomez A, Cook NB, Socha MT, Döpfer D. First-lactation performance in cows affected by digital dermatitis during the rearing period. J Dairy Sci. 2015;98(7):4487–4498. https:doi.org/10.3168/jds.2014-9041

Green LE, Hedges VJ, Schukken YH, Blowey RW, Packington AJ. The impact of clinical lameness on the milk yield of dairy cows. J Dairy Sci. 2002;85(9):2250-6. https://doi.org/10.3168/jds.S0022-0302(02)74304-X

Griffiths BE, Grove White D, Oikonomou G. A Cross-sectional study into the prevalence of dairy cattle lameness and associated herd-level risk factors in England and Wales. Front Vet Sci. 2018;5:65. https://doi.org/10.3389/fvets.2018.00065

Groenevelt M, Main DC, Tisdall D, Knowles TG, Bell NJ. Measuring the response to therapeutic foot trimming in dairy cows with fortnightly lameness scoring. Vet J. 2014;201(3):283-8. https://doi.org/10.1016/j.tvjl.2014.05.017

Heringstad B, Egger-Danner C, Charfeddine N et al. Invited review: Genetics and claw health: Opportunities to enhance claw health by genetic selection. J Dairy Sci. 2018;101(6):4801-4821. https://doi.org/10.3168/jds.2017-13531

Hirst WM, Murray RD, Ward WR, French NP. A mixed-effects time-to-event analysis of the relationship between first-lactation lameness and subsequent lameness in dairy cows in the UK. Prev Vet Med. 2002;54(3):191-201. https://doi.org/10.1016/s0167-5877(02)00021-1

Kasiora K, Anagnostopoulos A, Bedford C et al. Evaluation of the use of ketoprofen for the treatment of digital dermatitis in dairy cattle: A randomised, positive controlled, clinical trial. Vet Rec. 2021. https://doi.org/10.1002/vetr.977

Kjæstad HP, Myren HJ. Failure to use cubicles and concentrate dispenser by heifers after transfer from rearing accommodation to milking herd. Acta Vet Scand. 2001a;42(1):171–180. https://doi.org/10.1186/1751-0147-42-171

Kjæstad HP, Myren HJ. Cubicle refusal in Norwegian dairy herds. Acta Vet Scand. 2001b;42(1):181–187. https://doi.org/10.1186/1751-0147-42-181

Leach KA, Offer JE, Svoboda I, Logue DN. Effects of type of forage fed to dairy heifers: associations between claw characteristics, clinical lameness, environment and behaviour. Vet J. 2005;169(3):427–436. https://doi.org/10.1016/j.tvjl.2004.03.023

Leach KA, Whay HR, Maggs CM et al. Working towards a reduction in cattle lameness: 1. Understanding barriers to lameness control on dairy farms. Res Vet Sci. 2010;89(2):311-7. https://doi.org/10.1016/j.rvsc.2010.02.014

Leach KA, Tisdall DA, Bell NJ, Main DC, Green LE. The effects of early treatment for hindlimb lameness in dairy cows on four commercial UK farms. Vet J. 2012;193(3):626-32. https://doi.org/10.1016/j.tvjl.2012.06.043

Leonard FC, O'Connell J, O'Farrell K. Effect of different housing conditions on behaviour and foot lesions in Friesian heifers. Vet Rec. 1994;134(19):490–494. https://doi.org/10.1136/vr.134.19.490

Leonard FC, O'Connell JM, O'Farrell KJ. Effect of overcrowding on claw health in first-calved Friesian heifers. Br Vet J. 1996;152(4):459. https://doi.org/10.1016/s0007-1935(96)80040-6

Logue DN, Offer JE. The effect of forage type on foot health in dairy heifers. Vet J. 2001;162(1):7–8. https://doi.org/10.1053/tvjl.2001.0603

Logue DN, Offer JE, Brocklehurst S, Mason C. Effect of cubicle training dairy heifers before first calving on the subsequent behaviour and hoof health. 13th International Symposium and 5th Conference on Lameness in Ruminants. 11-15th February, 2004, Maribor, Slovenia

Mahendran SA, Huxley JN, Chang YM et al. Randomised controlled trial to evaluate the effect of foot trimming before and after first calving on subsequent lameness episodes and productivity in dairy heifers. Vet J. 2017;220:105-110. https://doi.org/10.1016/j.tvjl.2017.01.011

Maxwell OJ, Hudson CD, Huxley JN. Effect of early lactation foot trimming in lame and non-lame dairy heifers: a randomised controlled trial. Vet Rec. 2015;177(4):100. https://doi.org/10.1136/vr.103155

Mulling C. Biomechanics of the bovine foot. Lameness in Ruminants - International Symposium and Conference. July 3 2019, Tokyo, Japan. https://www.ivis.org/library/iclr/lameness-ruminants-international-symposium-and-conference-japan-2019/biomechanics-of-bovine-foot

Newsome R, Green MJ, Bell NJ et al. Linking bone development on the caudal aspect of the distal phalanx with lameness during life. J Dairy Sci. 2016;99(6):4512-4525. https://doi.org/10.3168/jds.2015-10202

Newsome RF, Green MJ, Bell NJ et al. A prospective cohort study of digital cushion and corium thickness. Part 1: Associations with body condition, lesion incidence, and proximity to calving. Journal of Dairy Science. 2017a;100(6):4745-4758. https://doi.org/10.3168/jds.2016-12012

Newsome RF, Green MJ, Bell NJ et al. A prospective cohort study of digital cushion and corium thickness. Part 2: Does thinning of the digital cushion and corium lead to lameness and claw horn disruption lesions? Journal of Dairy Science. 2017b;100(6):4759-4771. https://doi.org/10.3168/jds.2016-12013

Newsome RF, Mostyn A, Wilson JP et al. Morphology, adipocyte size, and fatty acid analysis of dairy cattle digital cushions, and the effect of body condition score and age. Journal of Dairy Science. 2021;104(5):6238-6252. https://doi.org/10.3168/jds.2020-19388

O'Connell JM, Giller PS, Meaney WJ. Weanling training and cubicle usage as heifers. Appl Anim Behav Sci. 1993;37(3):185–195. https://doi.org/10.1016/0168-1591(93)90110-B

Offer JE, Fisher GEJ, Kempson SA, Logue DN. The effect of feeding grass silage in early pregnancy on claw health during first lactation. Vet J. 2001;161(2):186–193. https://doi.org/10.1053/tvjl.2000.0515

Offer JE, Leach KA, Brocklehurst S, Logue DN. Effect of forage type on claw horn lesion development in dairy heifers. Vet J. 2003;165(3):221–227. https://doi.org/10.1016/S1090-0233(02)00171-5

Oikonomou G, Banos G, Machado V, Caixeta L, Bicalho RC. Short communication: Genetic characterization of digital cushion thickness. J Dairy Sci. 2014;97(1):532-6. https://doi.org/10.3168/jds.2013-7212

Räber M, Lischer ChJ, Geyer H, Ossent P. The bovine digital cushion—a descriptive anatomical study. Vet J. 2004;167(3):258-64. https://doi.org/10.1016/S1090-0233(03)00053-4

Randall LV, Green MJ, Chagunda MG et al. Low body condition predisposes cattle to lameness: An 8-year study of one dairy herd. J Dairy Sci. 2015;98(6):3766-77. https://doi.org/10.3168/jds.2014-8863

Randall LV, Green MJ, Chagunda MG, Mason C, Green LE, Huxley JN. Lameness in dairy heifers; impacts of hoof lesions present around first calving on future lameness, milk yield and culling risk. Prev Vet Med. 2016;133:52-63. https://doi.org/10.1016/j.prevetmed.2016.09.006

Randall LV, Thomas HJ, Remnant JG, Bollard NJ, Huxley JN. Lameness prevalence in a random sample of UK dairy herds. Vet Rec. 2019;184(11):350. https://doi.org/10.1136/vr.105047

Reader JD, Green MJ, Kaler J, Mason SA, Green LE. Effect of mobility score on milk yield and activity in dairy cattle. J Dairy Sci. 2011;94:5045–5052 https://doi.org/10.3168/jds.2011-4415

Tarlton JF, Holah DE, Evans KM, Jones S, Pearson GR, Webster AJ. Biomechanical and histopathological changes in the support structures of bovine hooves around the time of first calving. Vet J. 2002;163(2):196-204. https://doi.org/10.1053/tvjl.2001.0651

Telezhenko E. Novel approach for modelling force and pressure distribution inside bovine claws and on different surfaces. Lameness in Ruminants - International Symposium and Conference. July 3 2019, Tokyo, Japan. https://www.ivis.org/library/iclr/lameness-ruminants-international-symposium-and-conference-japan-2019/novel-approach-for-modelling-force-and-pressure-distribution-inside-bovine-claws-and-on-different

Thomas HJ, Miguel-Pacheco GG, Bollard NJ et al. Evaluation of treatments for claw horn lesions in dairy cows in a randomized controlled trial. J Dairy Sci. 2015;98(7):4477-86. https://doi.org/10.3168/jds.2014-8982

Thomas HJ, Remnant JG, Bollard NJ et al. Recovery of chronically lame dairy cows following treatment for claw horn lesions: a randomised controlled trial. Vet Rec. 2016;178(5):116. https://doi.org/10.1136/vr.103394

Tsuka T, Ooshita K, Sugiyama A, Osaki T, Okamoto Y, Minami S, Imagawa T. Quantitative evaluation of bone development of the distal phalanx of the cow hind limb using computed tomography. J Dairy Sci. 2012;95(1):127-38. https://doi.org/10.3168/jds.2011-4316

von Keyserlingk MAG, Cunha GE, Fregonesi JA, Weary DM. Introducing heifers to freestall housing. J Dairy Sci. 2011;94(4):1900–1907. https://doi.org/10.3168/jds.2010-3994

Webster AJF. Effects of housing and two forage diets on the development of claw horn lesions in dairy cows at first calving and in first lactation. Vet J. 2001;162(1):56–65. https://doi.org/:10.1053/tvjl.2001.0569

Webster AJ. Effects of housing practices on the development of foot lesions in dairy heifers in early lactation. Vet Rec. 2002;151(1):9-12. https://doi.org/10.1136/vr.151.1.9

Webster AJF, Tarlton JF. Biomechanical changes in the suspensory apparatus of the pedal bone and development of sole and white line lesions in dairy heifers. Res Vet Sci. 2001;70:34

Whay HR, Waterman AE, Webster AJ. Associations between locomotion, claw lesions and nociceptive threshold in dairy heifers during the peri-partum period. Vet J. 1997;154(2):155-61. https://doi.org/10.1016/s1090-0233(97)80053-6

Wilson JP, Randall LV, Green MJ et al. A history of lameness and low body condition score is associated with reduced digital cushion volume, measured by magnetic resonance imaging, in dairy cattle. J Dairy Sci. 2021;104(6):7026-7038. https://doi.org/10.3168/jds.2020-19843

Wilson J. The effects of routine treatment with non-steroidal anti-inflammatory drugs at calving and when lame, on the future probability of lameness and culling in dairy cows, a randomized controlled trial. Journal for Dairy Science. In press

Notes

Ketofen® 10%

Reduce the pain and lameness associated with digital dermatitis

A recent study[1] concluded that in dairy cows, the addition of Ketofen 10% to protocols for the treatment of pain and lameness associated with digital dermatitis, could be beneficial for animal welfare and productivity.

#wavegoodbyetopain

Ketofen 10% is part of the cattle NSAID trio from Ceva Animal Health which also includes:

Meloxidyl®
(meloxicam) - ideally suited for use in beef cattle and calves

Allevinix®
(flunixin) - in cattle, can be given i/v or i/m

[1]Kasiora K, Anagnostopoulos A, Bedford C,Menka T, Barden M, Griffiths BE, *et al*. Evaluation of the use of ketoprofen for the treatment of digital dermatitis in dairy cattle: A randomised, positive controlled, clinical trial. Vet Rec. 2021;e977. https://doi.org/10.1002/vetr.977

Ketofen® 10% solution for injection for horses, cattle and pigs contains 100 mg ketoprofen per ml. **Meloxidyl® 20 mg/ml** solution for injection for cattle, pigs and horses contains 20 mg meloxicam per ml. **Allevinix®** 50 mg/ml solution for injection for cattle, pigs and horses contains 50 mg flunixin (as meglumine) per ml. **Legal Category for all products:** UK POM-V
Further information is available from the product SPC, data sheet or pack insert.

Use medicines responsibly (www.noah.co.uk/responsible)

Ceva Animal Health Ltd, Unit 3, Anglo Office Park, White Lion Road, Amersham, Bucks HP7 9FB
Tel: 01494 781510 **www.ceva.co.uk** **www.cevolution.org.uk**

cevolution
PRACTICAL INNOVATION IN THE MANAGEMENT OF HEALTH

Ceva