WHERE THE RUBBER MEETS THE ROAD: ADVENTURES AT THE CLAW-FLOOR INTERFACE

Nigel B. Cook MRCVS
Clinical Associate Professor in Food Animal Production Medicine
University of Wisconsin-Madison
School of Veterinary Medicine

Introduction
Current estimates of lameness in dairy herds in North America suggest that at any one time, 20-25% of cows are clinically lame. The peer-reviewed literature suggests that the lactational incidence of lameness varies widely between herds around the world from around 1.8% to 69%. However, these data are deeply flawed and fail to appreciate the limitations of incidence data captured on farm. We know that farmers do not recognize as many lame cows in their own herds as trained independent observers, while veterinarians see very few of the cows that are actually lame. In many herds, where the hoof-trimmer provides most of the lameness treatments, the incidence rate of lameness is perhaps more related to the frequency of trimming visits than the rate of new lesion development. It is also clear that it is commonplace to find several cows that get treated each visit for the same recalcitrant lesion, while other cows are never treated for lack of recognition, lack of time and resources, and lack of organization of the recording system.

Over the last few years we have developed a plan to organize lameness recording and the recruitment of lame cows on small and large dairy herds. The basis for the plan is to clearly define and separate routine TRIM events from clinically LAME events.

A System for Identifying Lame Cows
An overview of the recording, recruitment and organization of TRIM and LAME events is shown in Figure 1. The plan has 5 main components:

1. LAME cows are recruited through routine locomotion scoring – at intervals specific to individual herd requirements. Because treatment is usually limited to periods when the trimmer visits, we must be very careful to avoid over recruiting lame cows, particularly when we start developing the system. If we identify 60% of the herd as ‘lame’ on the first day, the system for handling these cows will be overwhelmed. Therefore, it is best to use the higher locomotion scores to define lameness initially, and once the program is up and running to then use the observation of any abnormal gait to recruit lame cows for treatment.

2. TRIM cows are created by listing cows at a certain stage of their lactation cycle – at dry-off, pre-calving for heifers and in mid-lactation. These cows should not have been treated for lameness in the previous 4 months to avoid over-trimming.

3. Hoof lesion information from the hoof-trimmer is entered into the appropriate event – TRIM or LAME, where the most important lesions are recorded along with the affected limb(s) and treatment, and four actions are taken:
   a. Cows requiring a wrap removal are listed for 3 days after treatment
   b. Cows requiring a block removal are listed for a recheck at 30 days
   c. Other cows that need to be rechecked after 30 days are identified
   d. Cows that have been treated for several months (typically three) for similar hoof lesions, which are failing to heal or are slow to heal must be identified and a decision made whether to cull the cow, or whether it will be possible to trim the cow frequently and keep her in the herd. These are the ‘90 day cows’ – so called because we will present them for TRIM every 90 days. They will no longer be entered as a new case of lameness.


4. All cows treated for LAME are examined and/or locomotion scored 30 days after treatment to determine whether there has been improvement in the severity of the lesion or gait abnormality. This may be done at a hoof-trimmer visit, or the cows may be locomotion scored at a fertility visit or at some other convenient time.

5. LAME cows that have failed to improve locomotion score are re-examined as a new lame event at the next visit after 30 days.

Once the herd is frequently being surveyed for abnormal gait, the number of cows submitted for routine trimming may diminish. The TRIM event therefore becomes our default category, so that we make sure that all cows are routinely trimmed at least once a year at dry-off. This is a good time to review the cow history and to check that a cow wasn’t neglected throughout her lactation.

Incidence or Prevalence Monitors
The LAME event, as described above, is used to manage the treatment and recruitment of cows for new examination and re-examination, and as such does not measure ‘incidence’ particularly well. In fact, in most herds using the system described above, the rate of LAME events usually increases. A much better monitor of the extent of lameness in a herd is the proportion of cows with abnormal locomotion scores over time – and such scoring is the starting point of any lameness investigation.

Four or five point systems of locomotion scoring are now commonplace, based on identifying easy to recognize changes in the gait of the cow. The new 5-point system from Zinpro Corporation aims to combine features of lameness related to arching of the back, with differences in weight-bearing between the limbs measured by the degree of observed sinking of the dew claws to the ground, as an easy to identify reference point. Table 1 presents the proportion of cows scored at each locomotion score level for an average herd and for a target herd (upper quartile cut-off).

Once the prevalence of lameness has been determined in a herd, we can use records to determine the predominant cause.

Claw Horn Lesions or Infectious Lesions?
An examination of lesion records for TRIM and LAME events can determine the prevalence of lesions which are predominantly sub-clinical and those which are associated with lameness. Lesions may be simply sub-divided into those affecting the claw horn and those which can be viewed as infectious. Lesions such as corns (interdigital hyperplasia) should be considered as ‘other’, but they rarely cause lameness on their own without infection. Table 2 lists the conditions in each category.

Trigger Factors
Digital dermatitis (DD or heel warts) is by far the most common infectious lesion found in dairy herds and is controlled through herd biosecurity, leg hygiene and foot-bath programs.

The most common claw horn lesions are sole hemorrhage, sole ulcer and white line disease (which consists of a group of conditions affecting the white line including hemorrhage, fissure and abscess). These conditions were associated with the condition known as ‘laminitis’, however it is now clear that these lesions are merely ‘clinical signs’ observed on the surface of the claw, triggered by a variety of different factors.

The three main trigger factors that must be considered where claw horn lesions predominate include:

1. Calving – the bond between the pedal bone and the claw horn capsule is loosened by the activation of metalloprotease enzymes in the corium of the claw, leading to pedal bone instability

2. Nutrition – various changes associated with over-feeding of the carbohydrate fraction of the ration, or other components of the ration, also result in an increase in pedal bone instability

3. Trauma – either due to excessive removal of horn (due to the walking surfaces or due to overzealous trimming), or over-growth of horn, resulting in damage to the corium

These three trigger factors, combined with poor cow comfort may result in very similar lesions on the claw surface. The timing and lesion type of the first case of
lameness in a lactation can give us some clues as to which trigger factors are more important.

The First Case of Lameness
The timing of the onset of the first case of lameness is an important measure which may help us focus our attention on one or more trigger factors.

1. It is very common to see a large number of new DD lesions in early lactation (Figure 2). Transition cows appear to be most susceptible to new infection probably due to a combination of lowered immunity, a changing environment and the absence of any foot-bathing program during the dry period. This may be remedied by foot-bathing the close-up cows once a week.

2. In most herds, sole ulcers should be 1.5 to 2 times more prevalent than white line disease. Ulcers appear to develop in the first 30-60 days post-partum most commonly, suggesting calving is the predominant trigger. If the peak in first ulcer case treatments is closer to peak yield, then a nutritional trigger may be worthy of investigation.

3. Where heifers are reared optimally we should see very few lame animals throughout the first lactation. In herds where heifers are suffering DD lesions, consider risk factors associated with poor hygiene and mixing with infected mature cows. Where claw horn lesions are occurring, cow comfort and poor feeding in the transition period are most commonly to blame. Fewer problems are seen where heifers are reared with exposure to concrete prior to calving, where overgrown claws are trimmed pre-calving, where heifer groups are split from mature cow groups pre and post-partum and where heifers are provided excellent cow comfort in the form of bedded packs or well designed free stalls.

4. In herds where white line disease is as prevalent or more common than sole ulcers, floor surfaces should be examined as a potential cause of trauma. While loosening of the connection between the pedal bone and claw capsule may make the claw more susceptible to white line disease, other forces related to the standing and walking environment appear necessary to create white line lesions. Where the peak is early in lactation, consider the flooring throughout the transition cow facility – slatted floors in particular, as a risk factor (Figure 2). Where the peak occurs later in lactation, excessive hoof wear maybe an additional problem, leading to low heel height (Figure 3). Look for areas where cows must make sharp turns and are being hurried – such as the exit lanes from the parlor and crossovers next to water troughs in the free stall pens, or the walking lanes in grazing herds.

5. Sole fractures or heel ulcers are commonly seen in the midst of the summer heat stress period. Where they occur on the medial claws of the rear foot they are often associated with prolonged daily standing times.

6. Claw horn lesions occurring on the front feet, rather than the rear are unusual. Where these predominate over a short period of time, a nutritional trigger, or a dramatic reduction in cow comfort may be the cause.

Cow Comfort
Cow comfort has a complex role to play not only in interacting with trigger factors to ensure that lesions occur in the first place - resulting in cows that ‘get lame’, but also in the response of the lame cow to the environment once her gait is modified by the pain associated with lameness, which results in cows that ‘stay lame’. This concept is shown in Figure 5.

a. Cow Comfort and ‘Getting Lame’
It is essential that cows around calving time are provided with a comfortable environment in which to lie down. Significant improvements in sole hemorrhages have been shown in first lactation heifers after calving when provided with a straw yard pre and post-partum compared to a poorly designed free stall barn.

Several herds have been documented with significant SARA problems, but without associated lameness problems. These herds are either grazing pasture, or have excellent sand bedded stalls. This suggests that we need poor comfort combined with a trigger factor to damage the claw and develop claw horn lesions and lameness.
The use of rubber floor surfaces have become commonplace in many US free stall barns. They are ideal where cows must walk down excessively sloped lanes, make long walks to and from the parlor, and in places such as the holding area, where we force cows to stand for prolonged periods. In these areas, rubber is primarily making it easier for lame cows to move around, and reducing hoof wear rates.

Whether or not we should spend large amounts of money on rubber flooring in the pens is less clear. Several studies have shown that if stall design is compromised, cows spend more time standing on the rubber floor, and less time lying in the stalls. This is not what we want to do to reduce lameness in dairy herds! Not surprisingly, many farms with rubber floors and poor stalls still have lots of lame cows.

b. Cow Comfort and ‘Staying Lame’
Lame cows modify their stall use behavior compared to non-lame cows in poorly designed stalls. The acts of rising and lying down become incredibly difficult when cows develop a sore foot, and in poorly designed mattress stalls they spend much longer standing in the stall at the start and during a stall use session than non-lame cows. Moderately lame cows in poorly designed mattress stalls remain standing in the stall for up to 6 h/d on average and show a reduction in lying time to only 10 h/d from an average of 12 h/d. In contrast, in deeply bedded, well managed sand stalls, lame cows show no such modification in behavior – they maintain resting times at around 12 h/d and stand in the stall typically less than 2 h/d (Figure 6).

We believe that this difference in lame cow behavior between the two types of stall is related to surface traction. The rear foot is cushioned and gains traction in a deep loose bed of sand, making standing, even with a sore foot, relatively easy (Figure 7).

In contrast on a smooth surface mattress stall, the toe of the weight-bearing rear foot is driven into the surface, making rising much more challenging to a cow with a sore foot (Figure 8).

Although we do not know the time budgets of the cows in the barns that we visit, we can use an index of comfort to tell us whether lameness is a significant problem. The Stall Standing index (proportion of cows touching a stall that are standing half in or completely in a stall) may be measured at 2 hours before the morning or afternoon milking. If more than 20% of the cows are standing, this is associated with herd mean daily stall standing times greater than 2 h/d, which would be abnormal. This index captures prolonged stall standing behavior by lame cows and is therefore associated with the prevalence of lameness and the comfort of the stalls.

We believe that these poor environments in which lame cows struggle to gain appropriate periods of rest result in a failure to cure and extended periods of lameness – effectively making sure that if a cow becomes lame, she ‘Stays Lame’.

Improved stall designs and use of sand bedding may break this cycle of ‘Get Lame – Stay lame’ by allowing lame cows to rest and recover. Stall design must therefore be assessed in free stall barns, with the focus being on ease of use for lame cows. Use of deep sand bedding appears to help compensate for design inadequacies.

The possibility exists that improved mattress stall designs – without obstruction to the lunge and bob movement of the head, which allow a forward stride with the front leg over the top of the brisket locator and which allow the cow more space between the dividers, will make stall use by lame cows easier. However, whatever the stall design, lame cows probably benefit from a recovery period on a bedded pack area, free of the obstructions and challenges of using a free stall.

Time spent standing when the cow would rather be lying down not only occurs where stall design is poor, but in two other situations:

1. During periods of heat stress
2. When there is a mis-match between pen size and parlor capacity and cows are forced to stand more than one hour away from the pen each milking

Heat Stress
Cows modify their behavior when heat stressed. In a recent study in a 3-row free stall pen with fans and sprinklers along the feed bunk, cows spent over 2 h/d more standing in the alley and in the stall in periods of heat stress compared to periods spent within their thermoneutral zone. This observation appears to
justify the placement of fans over stalls to improve air movement while the cows are lying down.

The increased time spent standing may contribute to the increased prevalence of claw horn lesions observed in the late summer months in many herds (Figure 9).

**Group Size**
Groups should be sized so that no cow spends more than one hour per milking away from the pen. In free stall herds this can be done by sizing the pen according to the capacity and rate of milking cows in the parlor. It is suggested that groups be no larger than 4.5 times the capacity of the parlor as a rule of thumb. Thus for a dairy milking with a double 8 parlor, group size maximum is 72 cows (16 x 4.5).

Standing times in the holding area can be excessive in grazing herds, as the whole herd is typically milked in one group. Parlor design and rapid throughput is therefore a very important component of lameness prevention.

**Conclusions**
A greater understanding of the dynamics of lameness in dairy herds can be obtained from improved record keeping systems and a comprehension of how lame cows interact with the environment. The herd troubleshooter needs to determine the extent of the lameness problem, the predominant causes and their trigger factors, and understand the role of cow comfort and adequate hoof care in resolving existing lameness.
Figure 1. Overview of lame cow recruitment plan.

<table>
<thead>
<tr>
<th>Locomotion Score</th>
<th>% Cows scored at each level</th>
<th>Average Herd</th>
<th>Target Herd</th>
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<tbody>
<tr>
<td>1</td>
<td></td>
<td>55</td>
<td>65</td>
</tr>
<tr>
<td>2</td>
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<tr>
<td>5</td>
<td></td>
<td>3</td>
<td>0</td>
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</tbody>
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Table 1. Locomotion score targets for a 5-point scoring system.
Table 2. Hoof lesion classification system.

<table>
<thead>
<tr>
<th>Claw Horn Lesions</th>
<th>Infectious Lesions</th>
<th>Other Lesions</th>
</tr>
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<tbody>
<tr>
<td>Sole hemorrhage</td>
<td>Digital Dermatitis (Heel Warts)</td>
<td>Interdigital Hyperplasia</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Corn)</td>
</tr>
<tr>
<td>Sole ulcer</td>
<td>Interdigital Phlegmon (Foot Rot)</td>
<td>Heel Horn Erosion</td>
</tr>
<tr>
<td>Toe ulcer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heel ulcer (Sole fracture)</td>
<td></td>
<td></td>
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<tr>
<td>White line disease</td>
<td></td>
<td></td>
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<tr>
<td>Hemorrhage</td>
<td></td>
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<tr>
<td>Fissure</td>
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<tr>
<td>Abscess</td>
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<td></td>
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<tr>
<td>Horizontal fissure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vertical fissure</td>
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</tbody>
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Figure 2. Examination of the first case of lameness for the mature cows in this 1400 cow dairy shows problems with digital dermatitis and white line disease in early lactation – a result of transition cow housing on a slatted floor, with no foot bath program before calving.
Figure 3. This DIM distribution of the two major causes of lameness in a 200 cow dairy shows that sole ulcers are occurring in early lactation, while white line disease is a greater problem in late lactation – due to very rough flooring in the lactating cow barn.
Figure 4. The role of trigger factors and cow comfort in the ‘Get Lame – Stay Lame’ concept.
**Figure 5.** Least squares means time up in stall (TUIS) and time down in stall (TDIS) for cows with different locomotion scores (1-3) in herds with sand free stalls (SAND) or mattress free stalls (MAT).

![Graph showing TUIS and TDIS for different locomotion scores and stall types.](image_url)

**Figure 6.** Sequence showing how the rear foot sinks into a deep bed of sand, facilitating rising.

![Sequence images of a rear foot sinking into sand](image_url)
Figure 7. Sequence showing how the toe of the rear foot is driven into the mattress surface at the rear of the stall – potentially carrying the risk of slipping, and creating pain if the claw is compromised by disease.

Figure 8. Monthly variation in infectious and claw horn lesions in a 350 cow free stall housed Wisconsin dairy herd showing typical peaks in claw horn lesions in October.