TRIGGER FACTORS FOR LAMENESS AND THE DUAL ROLE OF COW COMFORT IN HERD LAMENESS DYNAMICS

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Introduction

Current estimates of lameness in dairy herds in North America suggest that at any one time, 20-25% of cows are clinically lame when locomotion scored on a single visit to the farm. Farmers are becoming very aware of the costs of lameness and the importance of cow comfort in controlling the problem. This article addresses the trigger factors for lameness and provides insights into herd level lameness management.

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 subdivided into those affecting the claw horn and those which are infectious. Lesions such as corns (interdigital hyperplasia) should be considered as 'other', but they rarely cause lameness on their own without infection. Table 1 lists the conditions in each category.

Table 1. Hoof lesion classification system

Claw Horn Lesions	Infectious Lesions	Other Lesions
Sole hemorrhage	Digital Dermatitis (Heel Warts)	Interdigital Hyperplasia (Corn)
Sole ulcer	Interdigital Phlegmon (Foot Rot)	
Toe ulcer	Heel Horn Erosion	
Heel ulcer (Sole fracture)		
White line disease		
Hemorrhage		
Fissure		
Abscess		
Horizontal fissure		
Vertical fissure		

Trigger Factors

Digital dermatitis (DD or heel warts) is by far the most common infectious lesion found in dairy herds. It has been brought into most expansion herds through the purchase of cattle and is controlled through herd biosecurity, leg hygiene and footbath programs.

The most common claw horn lesions are sole hemorrhage, sole ulcer and white line disease. These conditions are often associated with the term 'laminitis' – which is traditionally viewed as a nutritional disease. 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

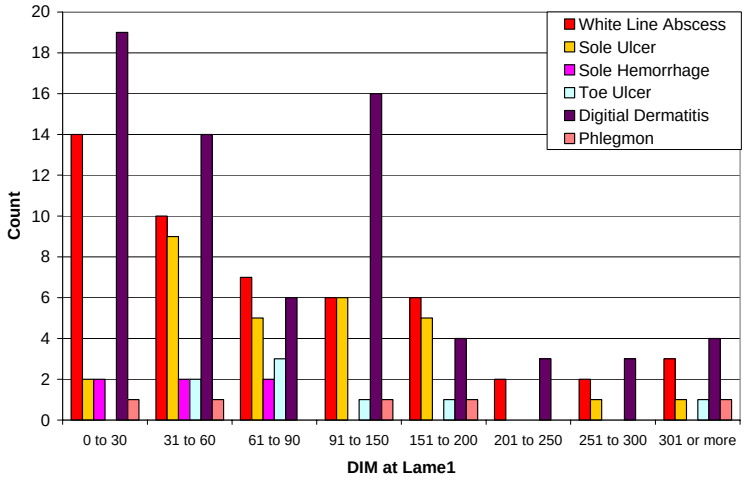
The timing of the onset of the first case of lameness may help us focus our attention on one or more trigger factors.

1. It is very common to see a large number of new DD lesions in early lactation (Figure 1). 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 footbathing program during the dry period. This may be remedied by footbathing 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.

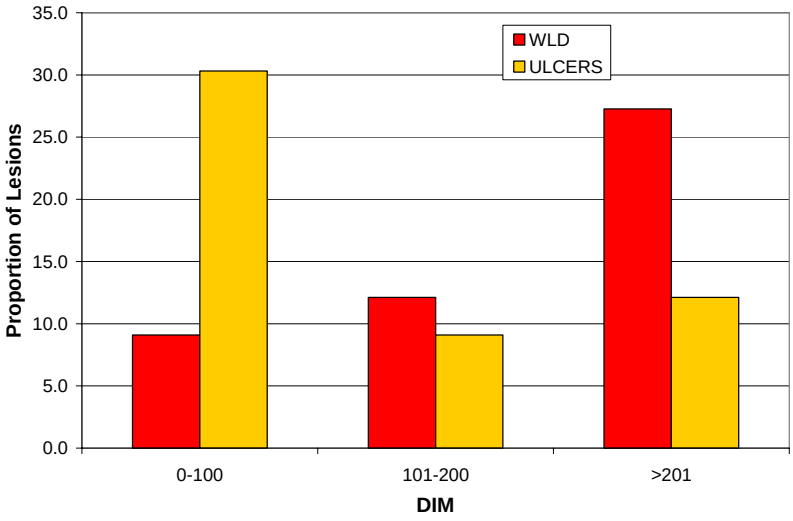
Figure 1. Examination of the first case of lameness for the mature cows in this 1400 cow dairy shows problems with digital dermatitis and white line disease in early lactation.



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 1). Where the peak occurs later in lactation, excessive hoof wear maybe an additional problem, leading to low heel height (Figure 2). 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.

Figure 2. 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.



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 3.

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. Recent work has shown that there is around a 3h/d increase in daily standing time from 4 days before calving to the day of calving. Heifers are particularly susceptible when they are abruptly transitioned from bedded packs, pasture or dirt lots to poorly designed mattress stalls. 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.

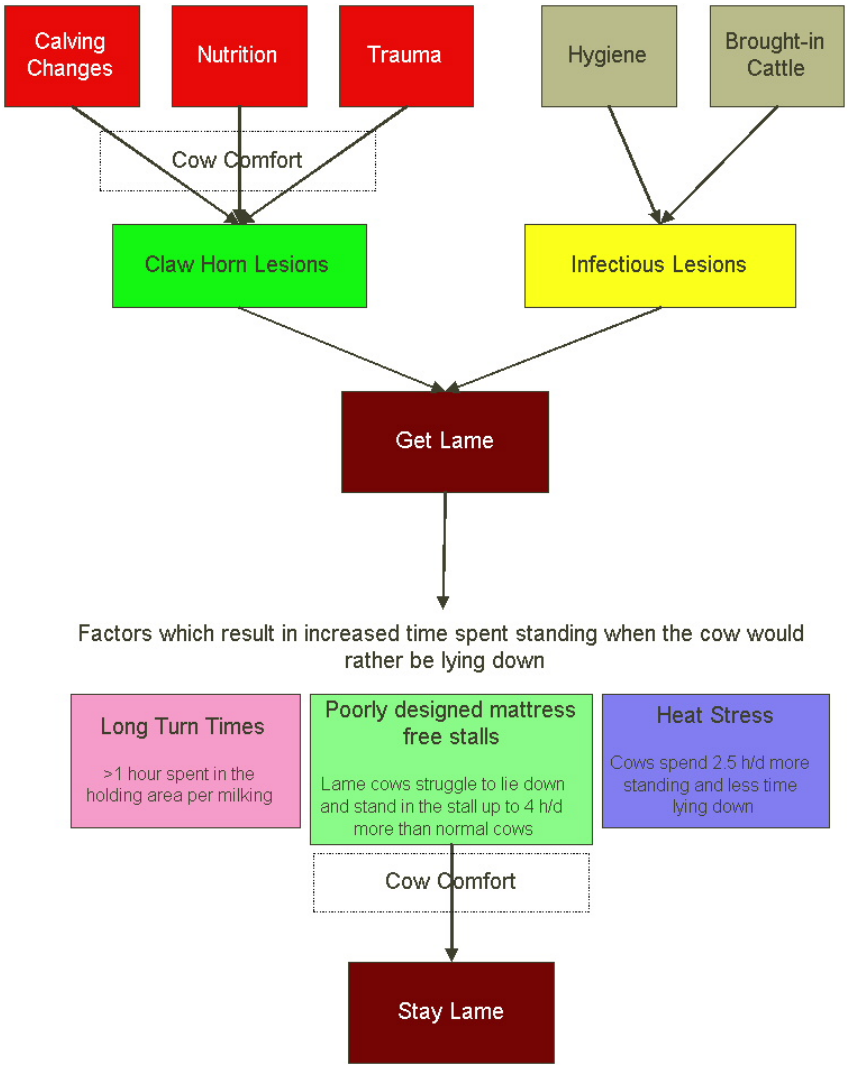
Shifts in daily standing time can occur in two other situations. Herds with small milking parlors and large group sizes often make cows stand waiting to be milked for more than 3h/d. We have documented time away from the pen exceeding 7h/d in several herds. This is potentially detrimental to a hoof already weakened by calving and nutritional trigger factors. Recent research at the UW-SVM has also documented a 2.5h/d increase in daily standing time associated with heat stress. Cows appear to spend more time standing in alleys and stalls when the THI exceeds 68. This increase in standing combined with an increased risk of SARA is probably the explanation for the increase in claw horn lesions seen in US dairy herds in the late summer. Indeed, SARA alone may not result in lameness. We have documented several herds 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 common place 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.

Figure 3. The role of trigger factors and cow comfort in the 'Get Lame – Stay Lame' concept.

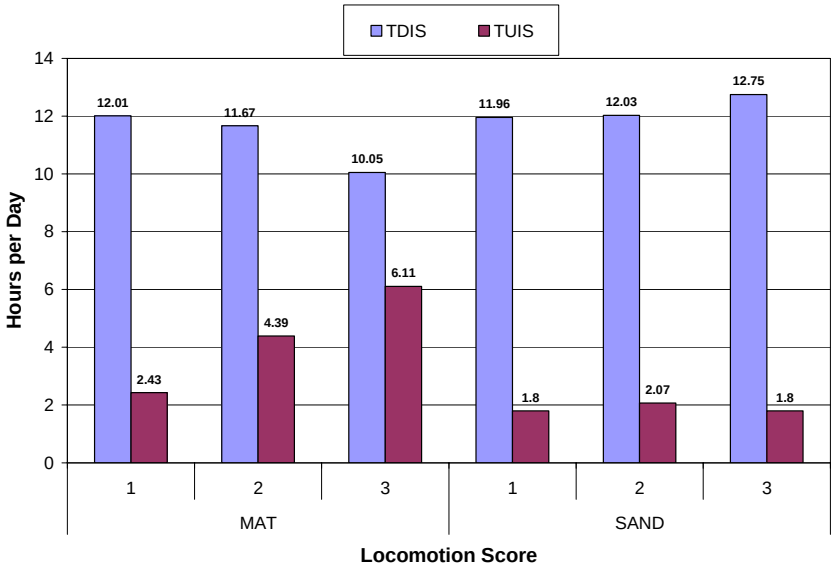


b. Cow Comfort and 'Staying Lame'

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 6h/d on average and show a reduction in lying time to only 10h/d from an average of 12h/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 2h/d (Figure 4).

Figure 4. 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).



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. 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 5).

Figure 5. Note 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.

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'.

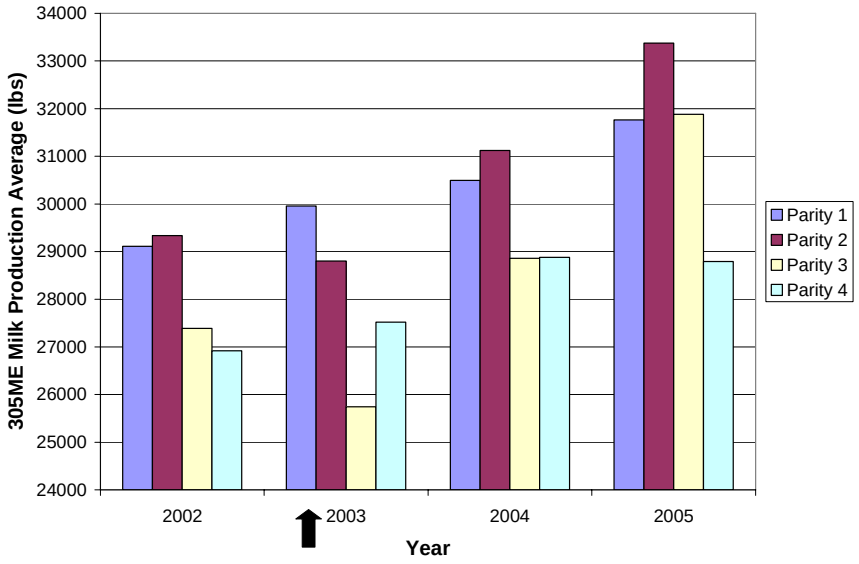
Improved stall designs and use of sand bedding may break this cycle of 'Get Lame – Stay lame' by allowing lame cows to rest and recover. Stall design must therefore be assessed in free stall barns, with the focus being on ease of use for lame cows. Use of deep sand bedding appears to help compensate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

Herd Interventions

Over the past 3 years, several herds have made the decision to improve cow comfort. Some removed rising obstructions and improved existing mattress stalls, while others made the bold step of removing the mattresses and converting the farm over to using sand bedded stalls. Spending money to improve an existing facility has been a hard sell to a banker, and partial budgets are very difficult to construct when we only know the costs and have to guess at the benefits.

Interestingly, if we examine the mean ME305 milk production for first lactation heifers compared to mature cows, we typically see that the first lactation heifers are about 1,000lbs above the mature cows in the average US dairy herd. However, in the herds that have improved cow comfort, we see that the mature cow ME305 climbs rapidly so that within about 1.5 years, it is the same as, or greater than, that of the heifers. Older, larger, mature cows that used to be too big for the stalls, which frequently got lame and injured in the past, are now fit and healthy and giving lots of milk. Figure 6 shows an example herd that widened mattress stalls and moved neck rails in 2003.

Figure 6. Records of ME305 milk production by parity for cows in a 300 cow mattress freestall barn, which made stalls wider and moved neck rails in 2003 (black arrow). Note the dramatic increase in parity 2 cows and parity 3 cows in 2004 and 2005.



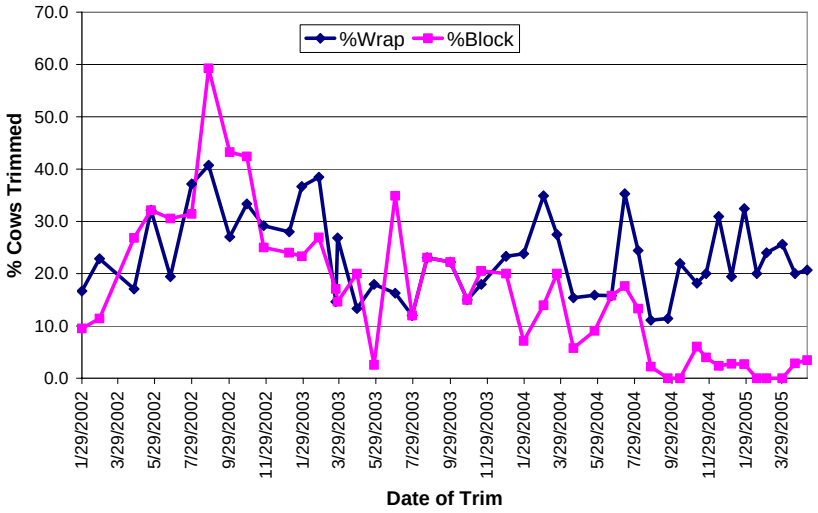
Using this information it is now easy to construct a partial budget for stall changes and facility improvements if we model what would happen over a three year period, if mature cows perform as well as the first lactation heifers. Table 2 below estimates that there would potentially be almost $100,000 return after 3 years, supporting stall improvements that could amount to around $300 per stall for this herd. The calculations are based on ME milk rather than real milk, but in general, they have held up under on-farm conditions. Typically, stall improvements have been paid back within 1.5 years.

Table 2. An estimate of increased milk production and revenue for the herd in figure 6. The analysis assumes that a change in cow comfort allows mature cows to milk to the level of the first lactation heifers.

Parity	Inventory	305ME	Difference from L1	Year 1 Milk	Year 2 Milk	Year 3 Milk
1	104	29957				
2	83	28804	1153	95699	95699	95699
3	37	25743	4214		155918	155918
4	56	27518	2439			136584
Sum increased milk production (lbs)				95699	251617	388201
Milk Price less feed costs ($/lb)	0.13		**Increased revenue ($)**	12441	32710	50466
Cumulative revenue ($ per year)				**12441**	**45151**	**95617**

The reality for this example herd is that rolling herd average has increased by 3,000lbs per cow over the last two years, somatic cell count has fallen below 150,000/ml and the improvements in lameness have resulted in a reduction in the proportion of cows being blocked from around 20% of cows trimmed to virtually none (Figure 7).

Figure 7. Change in proportion of cows receiving hoof blocks and wraps at each visit over the last 3 years.



Conclusions

Herd lameness dynamics can be dramatically impacted by actions which reduce trigger factors and improvements in cow comfort which help lame cows recover. Those herd owners that have embraced new ideas and improved stall design have consistently reaped the rewards. We now understand that improvements in cow comfort reduce lameness rates with the end result being a herd with older healthier cows – that significantly improve milk sales. Improvements up to around $300 per stall can be justified depending on the situation, with payback achieved within 3 years.