Environmental and Nutritional Causes of Lameness

Nigel B. Cook BVSc, Cert CHP, DBR, MRCVS
Clinical Assistant Professor in Food Animal Production Medicine
University of Wisconsin-Madison
School of Veterinary Medicine

In this paper, I will share some of the research and field experiences at the UW School of Veterinary Medicine over the past three years, related to cow comfort and lameness.

Lameness in Dairy Cows

Lameness prevalence reported in a number of studies throughout the world has documented a wide range of prevalence from 0 to 55% of the herd affected. This variation may be due to a combination of many factors, including breed types surveyed, genetic selection, conformation characteristics, nutrition and feeding practices, amount of milk production, manure handling systems, presence or absence of certain types of infectious disease, and factors related to the environment in which we keep dairy cows.

In the last major survey in North America, which involved 17 dairy herds in the Midwest, the prevalence of lameness was 13.7% during the summer and 16.7% during the spring. Mean herd size was 50 cows, and 14 of the 17 herds used stanchion or tie-stall housing. It was our impression that the situation had worsened – particularly in the freestall barns that we were visiting when herd troubleshooting.

We have recently completed a lameness survey of 30 Wisconsin dairy herds, half tiestall and half freestall housed. Lameness was determined using a 4 point system of locomotion scoring and all the cows on each farm were scored once in the winter and once in the summer. The system of scoring used is given in Table 1.

We determine ‘clinically lame’ as all cows scoring 3 and 4 using this system. Score 2 cows are not included, but are cows with developing or healing lesions that walk with a slightly abnormal gait. On average, about 22% of the cows in a herd are clinically lame. Table 2 outlines targets for use when making comparison of scores between herds. The top 25th percentile of herds achieved less than 15% clinically lame in summer and winter. This therefore is our target lameness prevalence. Interestingly, these top herds did not have any score 4 severely lame cows. Thus, the finding of one or two severely lame cows in a herd is a good predictor that lameness is a problem.

Table 1. Locomotion scoring system used to determine prevalence of lameness in herds of dairy cows

Locomotion score	Criteria
1 (no gait abnormality)	Walks rapidly and confidently, making long strides with a level back.
2 (slight lameness)	Walks more slowly, making shorter strides with an arched back. Stands with a level back and does not appear to favor a limb.
3 (moderate lameness)	Often thin. Walks slowly, making deliberate short steps with an arched back, may favor a limb. Makes frequent stops. Encounters difficulty turning. Stands with an arched back and frequently lifts affected foot.
4 (severe lameness)	Usually very thin. Moves slowly, making frequent stops to rest affected limb. Only partially weight bearing. Frequently salivates. Encounters extreme difficulty turning. Stands and walks with a pronounced arched back.

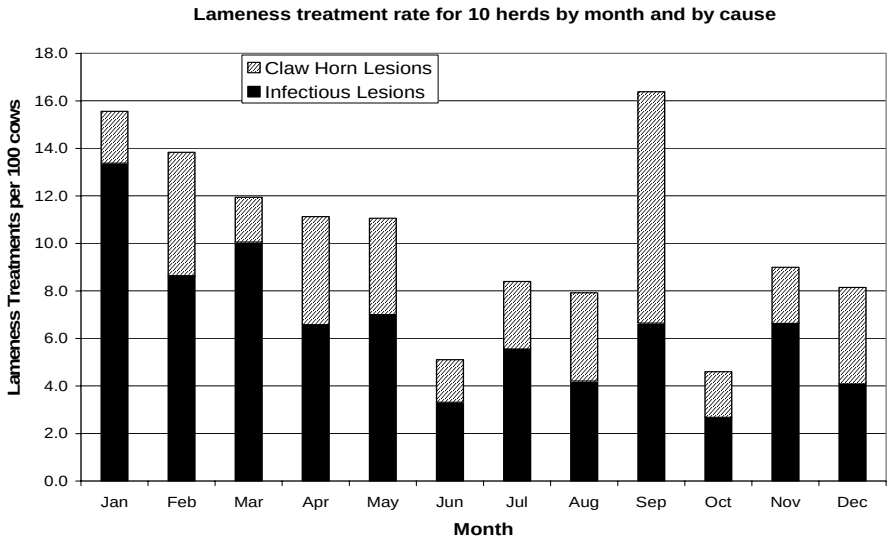
Lameness prevalence averaged 19.6% in tiestall barns in both summer and winter – a little higher than had been previously reported. Prevalence was higher still in freestall barns at 22.8% in the summer and 27.8% in the winter, confirming our suspicion that lameness in freestall barns was worse than had previously been documented.

Table 2. Distribution of locomotion scores during summer and winter for dairy cows in 30 herds in Wisconsin

	Locomotion score							
	Summer				Winter			
Score	1	2	3	4	1	2	3	4
Minimum	18.5	6.7	7.3	0.0	27.2	8.8	9.6	0.0
25th percentile	46.0	19.4	11.2	0.2	46.8	16.9	14.0	0.0
Mean	54.9	23.3	18.0	3.0	55.9	19.0	20.7	3.2
75th percentile	66.6	27.8	24.7	4.7	63.9	21.9	28.0	5.0
Maximum	80.0	31.9	35.2	16.7	79.3	29.4	35.1	12.3

From a subset of the 30 herds, we collected lameness treatment records to determine incidence rate from 10 herds, which averaged 22.2% lameness prevalence. A total of 1155 lameness treatments were recorded and the mean lameness treatment rate was 69.1 limb cases per 100 cows per year. The ratio of incidence to prevalence was 3.1:1, suggesting that in the absence of accurate treatment records, an estimate of incidence maybe made from a prevalence determination using locomotion scoring, by using a multiplier of 3. Heel warts were the most common lesion found, accounting for 56.8% of all treatments. Sole hemorrhage (6.4%), sole ulcer (18.4%) and white line disease (10.4%) were the most common claw horn lesions identified.

Figure 1. Lameness treatment rate (Limb cases per 100 cows) by month for 10 herds.



We looked at lameness treatment rate by month. The rate was higher at the end of winter – probably when herds were not using footbaths and experiencing manure handling problems in cold weather conditions, but the rate was also markedly higher in September – two months after the period of heat stress in Wisconsin. We suspect that heat stress triggers a change in cow behavior, and/or triggers subacute ruminal acidosis (SARA) which leads to claw horn lesions some 2 months later. These are chronic long-term lesions which cows may well carry for much of the winter if left untreated.

Examining the lameness prevalence dataset for risk factors, we noted that stall base type appeared to be significant – in both tiestalls and freestalls. Herds using sand appeared to have much lower lameness prevalence than herds using other types of stall base – including mats and mattresses. In particular, freestall herds with mattress stall bases appeared to be at particular risk of a higher rate of lameness – especially during the winter (Table 3), raising the question of whether there were behavioral or management differences between the two types of barn.

Table 3. Mean prevalence of lameness during summer and winter among lactating cows on 29[†] dairy herds in Wisconsin classified as to housing type (free stalls vs tie stalls) and stall surface (sand vs mat or mattress [non-sand]). From Cook (2003).

	Free stalls		Tie stalls	
Stall Base	Sand	Non-Sand	Sand	Non-Sand
Number of herds	9[†]	7	4	10[†]
Lameness Prevalence				
Summer	18.4	26.8*,[a]	12.2[b]	22.1
Winter	21.2[a]	33.7*,[b]	12.1[a]	21.7[a]

*Values were significantly ($P = 0.007$) different.
[a,b]In each row, values with different letter superscripts were significantly ($P < 0.05$) different.
[†] Includes cow data from one herd with segregated sand free stalls and non-sand tie stalls.

Freestall Behavior and Lame Cows

Our most recent research has investigated possible differences in cow behavior in freestall barns with sand and mattress freestall bases, with relevance to lameness. We have visited 12 expanded dairy herds, averaging 300 cows per herd, six using sand and six using a rubber crumb mattress stall surface. Each herd was locomotion scored and for one 24 hour period the high group mature cow pen was video filmed. 10 cows per farm were color marked and tracked for the entire period recording location (alley, stall or milking parlor), activity (standing, lying, feeding, drinking) and time spent performing each activity.

The mean lameness prevalence in the sand herds in this study was 11%, and in the mattress herds it was 24% - confirming the trend we had previously identified. Surely we would find a difference in lying time and total standing time on concrete? Actually, we did not – both groups of herds were similar for these two variables. Of the 120 cows followed, 73 were normal sound locomotion score 1, 37 were slightly lame locomotion score 2 and 10 were moderately lame locomotion score 3. We did not include severely lame cows.

We have found that normal and lame cows behave similarly in sand stall herds. Typically they lie down for 12h/d, milk for 3h/d, feed for 4.5h/d, socialize and drink in the alley for 2.5h/d and stand in the stall (including perching) for 2h/d.

The behavior of normal cows in mattress herds is also very similar – the only significant difference is that they stood in the stall for 44 min longer per day (P=0.048). However, there is a marked difference in behavior in lame cows in mattress freestalls. Slightly lame cows stood for 4.4h/d and moderately lame cows stood for 6.1h/d – significantly different from equivalent cows in sand stalls (P<0.00). This increase in stall standing has effects on the daily time budget – with a compression of other activities, notably standing in the alley, feeding and in moderately lame cows, lying time – which was reduced to 10h/d (Table 4).

Table 4. Effect of Locomotion Score and Stall Base type (Mattress or Sand) on Daily Activity Time Budget

Activity h/d	Locomotion Score					
	1		2		3	
Stall base	Mat	Sand	Mat	Sand	Mat	Sand
Lying time	12.0	12.0	11.7	12.0	10.0	12.8
Standing in Stall	2.4	1.7	4.4	2.1	6.1	1.8
Time standing in alley (including drinking)	2.8	2.3	1.6	2.2	1.4	1.8
Time Up Feeding	4.3	4.7	3.8	4.6	3.5	5.1
Time Up Milking	2.5	3.3	2.6	3.2	3.0	2.7

We speculate that the surface traction provided by sand allows lame cows to rise and lie down more easily, without fear of slipping, thereby maintaining normal lying session behavior in these cows. Lame cows in mattress stalls struggle to rise and lie down for fear of slipping on the stall surface, due to lack of surface traction. This effort causes pain.

Cows appear to strive to maintain a relatively fixed amount of lying time per day – approx 12h/d in this study. However, the desire to lie down is limited by the pain associated with the actual process of rising and lying and the fear of slipping. Lame cows in sand stalls suffer less fear of slipping when rising and probably less pain, consequently they lie down more promptly. Lame cows on a mattress surface suffer more pain and fear of slipping when rising and must wait longer for the pain to subside, or be reluctant to suffer the pain associated with lying back down again. The stall standing is not in place of standing in the alley – it is enforced during a lying session while she prepares to lie down again. Stall designs which fail to allow for adequate lunge and bob increase weight bearing and stress on the rear feet and potentially worsen the situation. Cows on sand appear to compensate for these design faults, cows on mattresses do not.

Extended time spent standing in the stall may be detrimental to claw health, increasing the duration of lameness and explaining the higher prevalence observed in mattress herds.

Improvements we can make tomorrow

So what can we do to reduce lameness rates? Consider the following three points:

1. Reduce the trigger factors for lameness ….. avoid SARA by improving feed management, ensure that the transition into the herd for heifers does not involve dramatic group changes, and simultaneous diet and housing changes, operate an effective foot bath program to control heel warts.

2. Redesign the stalls to current standards; improve surface cushion, remove lunge and bob obstructions, remove concrete and high brisket boards from the front of the stall, allow for side lunging and move neck rails forward.

These changes will mean that cows can rise more normally, reducing stresses on the rear feet.

3. Take lame cows out of the mattress free stall barn and allow them to recover on a dedicated straw bedded pack.

Here they can rise and lie down free from negotiating obstructions to movement. Start with severely lame cows, then move to moderately lame cows if space allows.

In the last twelve months there has been a remarkable improvement in our knowledge of what dairy cows' require of their housing. Veterinarians and ethologists are working with engineers and builders so that new barn constructions do not make the mistakes of old. With better facilities, we have seen associated improvements in cow comfort, health and productivity.

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