

SUBJECTIVE AND OBJECTIVE ASSESSMENT OF PAIN AND DISCOMFORT DUE TO LAMENESS IN DAIRY CATTLE

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Abstract

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Pain experienced by lame cattle is often masked by their instinctive stoicism, leading to delayed detection and treatment of lameness. This paper investigates the usefulness of posture scoring during locomotion and the evaluation of daily activity levels as indicators of pain and discomfort resulting from lameness in dairy cattle. In this study, 345 lactating cattle were observed over a seven-month winter housing period. The posture of each cow was scored twice weekly using a subjective five-point numerical rating scale. Daily activity levels were measured objectively using pedometers. The effect of lameness on behaviour was addressed. Increased posture scores were associated with the presence of foot lesions ($P < 0.001$) and with reduced daily activity levels ($P < 0.001$). In comparison to sound cows, lame cows showed lower daily activity levels ($P < 0.001$). These results improve understanding of pain-related behaviours in cattle, and such an approach may assist future development of welfare assessment systems.

Keywords: *animal welfare, behaviour, cow, lameness, pain, pedometer*

Introduction

The assessment of pain experienced by animals is a crucial aspect of veterinary medicine and animal welfare research. However, pain is an individualistic experience and its measurement is extremely difficult. Behavioural observations are valuable for gaining insight into how an animal copes with its environment and with imposed stresses, and such observations are the parameters most often used to assess animal pain (Morton & Griffiths 1985; Welsh *et al* 1993; McGeown *et al* 1999; Mellor & Stafford 1999). Between-species and within-species variation in pain tolerance must be accommodated. The observer must be aware of the full behavioural repertoire of the species under investigation for meaningful inferences to be obtained.

Lameness in cattle is a debilitating condition in which the affected animal attempts to reduce the weight borne by a particular limb. Foot lesions are associated with approximately 90% of cattle lameness (Murray *et al* 1996). Pain, a serious component of lameness, is often masked by the stoical nature of cattle; this leads to delayed detection of lameness by farmers and often results in treatment without consideration of the pain experienced by the cow.

Locomotion scoring systems have been used to quantify lameness prevalence and to grade severity (Manson & Leaver 1988; Kestin *et al* 1992; Whay *et al* 1997). However, simple systems may fail to detect subtle changes in posture and weight bearing which might relate to pain experienced by the individual animal. This study investigates the value of posture scoring during locomotion and of changes in daily activity levels as indicators of pain resulting from lameness.

Materials and methods

Data were collected from a single commercial herd of 345 lactating dairy cattle, between October 2001 and April 2002. All cattle were housed in a single cubicle building. Pedometers were fitted at the metatarsus of a hind limb of each cow to allow daily activity monitoring for oestrus detection within the farm management system; the daily activity level of each cow was stored on the farm computer in Afimilk 9.00 (Fullwood Fusion Electronics 1999). After initial validation of the posture scoring system, all cows were assessed twice weekly. The feet of all cattle were trimmed by one author (KO) according to the Toussaint Raven (1985) method. All foot lesions were classified as either acute (digital dermatitis/foul) or chronic (sole ulcer/white line disease). The lesion type and severity was recorded.

Posture scoring system

A sound cow walks with a level spine. The hind feet almost exactly trace the placement of the fore feet. The gait appears comfortable and the cow walks at an even pace. Feet point in the direction of travel. A posture scoring system was devised to assess deviations from normal posture adopted by cattle during locomotion. An overall locomotion score and five individual postures were selected, each scored using a five-point Numerical Rating Scale (NRS 5):

- 1 = Good/normal
- 2 = Imperfect
- 3 = Mildly abnormal
- 4 = Moderately abnormal
- 5 = Severely abnormal

Cows were observed walking past and then away from the observer on a level concrete surface. The behaviours scored were:

- Overall locomotion assessment
- Spine curvature — the degree of spinal arching
- Speed — ease/comfort of gait
- Tracking — hind feet on fore feet positions
- Head carriage — extent of movement and level of carriage
- Abduction/adduction — rotation of feet from the direction of travel

During the first week of the study, the sensitivity, repeatability and validity of the posture scoring system was evaluated. Comparing the five posture scores against the widely accepted overall locomotion score assessed sensitivity. Intra-observer and inter-observer repeatability was assessed by calculating the percentage agreement and near-agreement between scores attributed to cows by a single observer on three successive days, and between two observers scoring on a single day, respectively. Near-agreement was defined as being within one score on the 1–5 scale. Posture scores were validated as indicators of digital pain by comparing foot lesion records against the score before foot trimming. Lameness was defined as two or more postures scoring 3 or above.

Daily activity measures

As each cow entered the milking parlour a stationary antenna recorded both her identity and the pedometer counter value. The time of milking was also recorded. The steps taken between records were the differences between successive counter values. Differences divided by the appropriate time interval yielded the activity level in steps per hour. A daily activity-level profile was constructed over a 350-day lactation (days in milk [DIM]) from the combined data of all 345 cows. Lactation was subdivided into four time intervals: 0–30, 31–90, 91–200 and > 200 DIM.

Data handling and statistical analysis

All data were collated in Microsoft Excel 2000 (Microsoft Corporation 1985–1999), Minitab 13.1 (Minitab Inc 2000) and SAS Version 8e (SAS Institute Inc 1990) software packages were used for the analyses. Spearman's rank correlation tests were carried out between the posture scores and the overall locomotion score, and between the posture scores and activity levels (steps/hour). Cross tabulations and Chi² analyses were used to assess the relationship between posture scores and foot lesions. Percentage agreement and near-agreement within and between observers was used to estimate the repeatability of the subjective scoring system.

Using the 'Means' procedure in SAS, the mean steps/hour values associated with different stages of lactation, time of day, and lameness status were calculated. Analysis of variance (ANOVA) was used to investigate differences in activity levels associated with the categories within each predictor variable and also differences in activity levels associated with the type and severity of foot lesion present. The critical probability level was set at $P = 0.05$.

Results

Posture scoring validation

All correlations between individual posture behaviours and the overall locomotion score were significant at $P < 0.001$. Intra-observer repeatability was greater than inter-observer repeatability. The percentage agreement on scores attributed to cows was relatively low; however, near-agreement percentages were high (Table 1).

There were strong associations between the scores attributed to cows and the occurrence of foot lesions. Chronic foot lesions were more likely to be associated with higher scores than acute lesions (Table 2). Lesion severity had a variable effect on the different posture behaviour scores. Although severe lesions were usually associated with high scores, some cows with severe foot lesions did not show obvious lameness (Table 3).

Table 1 Repeatability assessment of posture scoring system.

Posture	Intra-observer repeatability		Inter-observer repeatability	
	Agreement* (%)	Near agreement† (%)	Agreement* (%)	Near agreement† (%)
Overall locomotion	72 (56)	120 (93)	30 (37)	66 (81)
Spine	63 (46)	118 (87)	40 (49)	74 (91)
Speed	46 (42)	87 (80)	25 (36)	57 (81)
Tracking	46 (46)	94 (94)	24 (39)	50 (81)
Head carriage	50 (60)	74 (88)	23 (43)	47 (87)
Abduction/adduction	43 (52)	76 (93)	17 (33)	43 (84)

* Number of scores in agreement, followed by % of total number of cows scored in parentheses.

† Number of scores in agreement or within one score on the five-point scale, followed by % of total number of cows scored in parentheses.

Table 2 Chi² analysis of the distribution of posture scores, within each behaviour category, associated with the presence of acute (A) or chronic (C) foot lesions.

Posture	Lesion type	Behaviour score					Chi ² value	P value
		1	2	3	4	5		
Overall locomotion	A	0	21	43	39	2	31.23	< 0.0001
	C	0	12	20	31	26		
Spine	A	3	29	31	37	5	32.57	< 0.0001
	C	4	3	18	45	19		
Speed	A	9	26	41	29	37	29.36	< 0.0001
	C	2	14	21	0	15		
Tracking	A	4	6	30	60	4	16.42	< 0.01
	C	2	3	19	42	20		
Head carriage	A	16	38	27	21	0	36.40	< 0.0001
	C	4	11	15	41	7		
Abduction/adduction	A	2	18	42	37	2	18.85	< 0.001
	C	2	11	24	31	18		

Table 3 Chi² analysis of the distribution of posture scores, within each behaviour category, associated with mild, moderate or severe foot lesions.

Posture	Lesion severity	Posture score					Chi ² value	P value
		1	2	3	4	5		
Overall locomotion	Mild	0	8	9	4	0	36.86	< 0.0001
	Moderate	0	17	34	24	6		
	Severe	0	10	30	48	25		
Spine	Mild	4	6	3	8	0	38.49	0.0001
	Moderate	2	16	25	32	6		
	Severe	3	13	23	56	18		
Speed	Mild	0	10	6	5	0	28.69	0.0044
	Moderate	4	22	24	29	2		
	Severe	7	14	37	40	15		
Tracking	Mild	0	2	10	9	0	44.54	< 0.0001
	Moderate	4	3	24	47	1		
	Severe	2	4	24	56	25		
Head carriage	Mild	0	7	9	4	0	45.07	< 0.0001
	Moderate	7	31	22	18	0		
	Severe	11	14	21	50	7		
Abduction/adduction	Mild	0	6	5	10	0	34.05	0.0007
	Moderate	0	16	31	28	4		
	Severe	4	9	37	42	16		

Daily activity measures

The daily activity level profile over a 350-day lactation period is presented in Figure 1. The data points represent the median activity level of cows on each day during the lactation period. ANOVA results indicated that different stages of lactation were associated with different daily activity levels ($P < 0.0001$). Heifers had higher daily activity levels than cows ($P < 0.0001$). Cattle were more active during daytime hours (between morning and evening milking) ($P < 0.0001$). Lameness was associated with reduced daily activity levels ($P < 0.0001$) (Table 4).

Posture scores and activity levels correlated significantly ($P < 0.0001$). The presence of foot lesions was associated with reduced activity levels ($P < 0.001$). There were no differences between lesion type; however, lower activity levels were associated with increasing lesion severity ($P = 0.0016$).

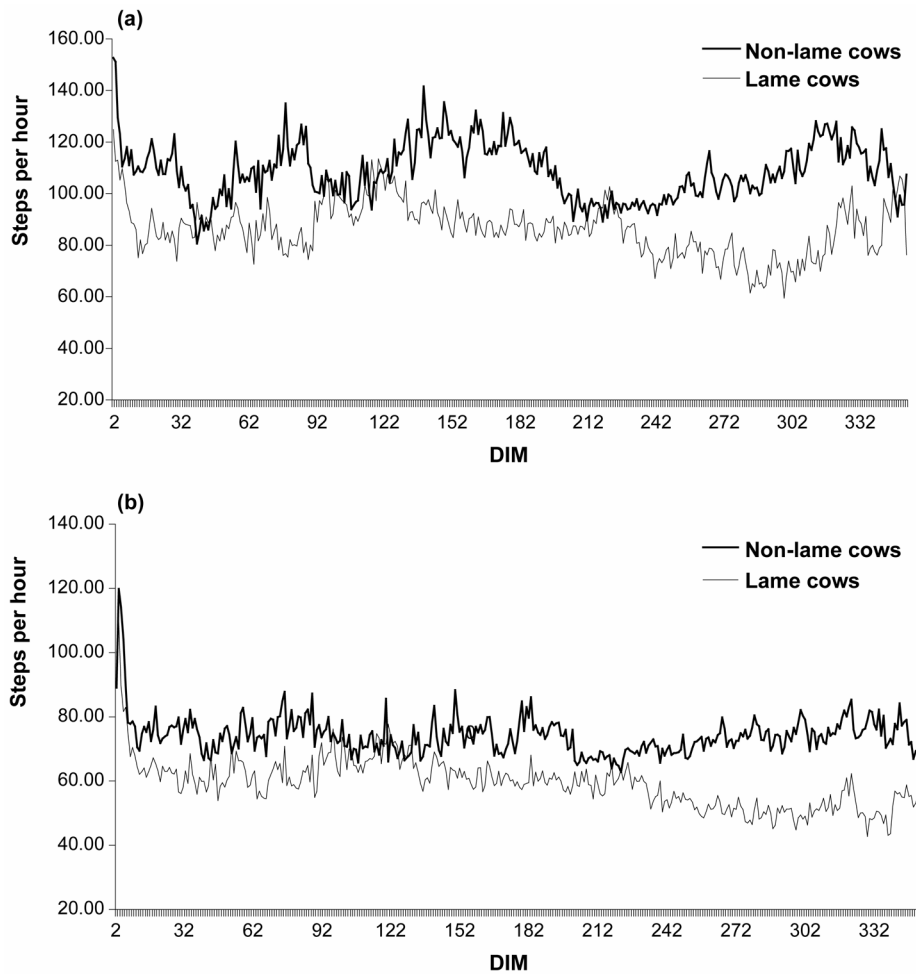


Figure 1 Median activity levels for non-lame and lame dairy cows during (a) the daytime and (b) the night time, according to days in milk (DIM).

Table 4 Average daily activity levels of all cattle according to different parameters.

Variable	Activity (steps per hour)
<i>DIM</i>	
<30	96.5
31–90	91.9
91–200	86.2
>200	79.3
<i>Day</i>	100.6
<i>Night</i>	68.8
<i>Heifer</i>	146.8
<i>Cow</i>	82.1
<i>Lame</i>	71.8
<i>Non-lame</i>	94.3

Significance levels of $P < 0.0001$ were obtained for all tests between the categories of each parameter.

Discussion

Close association between the behavioural parameters observed and the type and severity of foot lesions presented suggest that both the posture scoring system and changes in daily activity are useful indicators of pain associated with lameness. However, as individual variation must be accommodated, measurements over time are more useful than single time-point measures or assessments. Differences in observer training and practice could explain the slightly low inter-observer repeatability results.

Variation in the posture scores recorded for cattle with chronic or acute foot lesions (eg sole ulcer, white line disease/foul, digital dermatitis) provided insight into the pain behaviour of this stoical species. The higher posture scores tended to be associated with chronic lesions, suggesting either that they cause more pain than acute lesions or that the pain is less easy to hide. In comparison, the severity of the foot lesions did not appear to make such a noticeable difference. In contrast, the severity of foot lesions had a more pronounced effect on the daily activity levels of cattle than did the type of lesion present.

Animal welfare implications

The results of this work provide insight into how this highly stoical species deals with pain. The methodology can be applied to future pain or welfare studies of cattle, or even other species.

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