Session 11: Behavioral signs of impaired animal health and welfare

Analysis of behavioral changes for early detection of lameness in dairy cows

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Introduction Lameness is one of the most prevalent diseases affecting the welfare of cows in modern dairy production. Diagnosis at an early stage results in a reduction of medications, faster recovery, and a shortened period of suffering for the cow. Previous research has reported clear differences in the behavior, i.e. locomotor activity and lying behavior, of severely lame cows in comparison to non-lame cows. However, effects of moderate lameness on cow behavior have rarely been investigated so far. The aim of this study was to identify behavioral changes in moderately lame cows that have the potential to be used for an automatic on-farm system for early lameness detection in the future.

Materials and Methods Ethical approval was obtained from the Veterinary Office of the Canton Zurich in Switzerland (Approval ZH061/15). The study was conducted on 17 Swiss dairy farms with cubicle housing systems that provided an indoor area (≥ 1 cubicle per cow) and a permanently accessible outdoor area. Herd size ranged from 31 to 91 (mean $\pm$ SD: 55.9 $\pm$ 17.4) lactating cows. On each farm, cow behavior was recorded continuously during two periods (A, B) of 48 h each with an interval of 6 - 10 weeks in between. A sample of 5-11 non-lame (locomotion score 1 of 5) and 2-7 moderately lame (locomotion score 3 of 5) cows was selected based on visual lameness scoring (based on Sprecher et al., 1997). Overall, 219 cows were included in the study of which 142 cows non-lame and 66 were moderately lame in period A, and 128 cows were non-lame and 53 moderately lame in period B. In between the two periods, the cows underwent corrective claw trimming. Locomotor activity and lying behaviors (recorded by MSR145 accelerometers attached to left hind leg), feeding and rumination behaviors (by RumiWatch halter with noseband sensor), visits to the brush and the concentrate feeder, and the milking order position were compared between moderately lame and non-lame cows. Data was statistically analyzed in R (version 3.3.2) using linear-mixed effects models (lmer; package lme4). P-values were calculated using parametric bootstrap (PBmodcomp; package pbkrtest) by comparing the statistical models with and without the fixed effect locomotion score, whereby days in milk and parity were included in the models as nuisance factors.

Results In comparison with non-lame cows, moderately lame cows had a lower average locomotor activity per 24 h, a longer lying duration per 24 h and a longer average lying bout duration, but a similar number of lying bouts per 24 h. Eating time per 24 h and the number of eating chews per 24 h were reduced in moderately lame compared with non-lame cows, whereas no effect of moderate lameness was evident for ruminating time per 24 h and number of ruminating chews per 24 h. Moderately lame cows visited the concentrate feeder and the brush less frequently, and they were further back in the milking order compared with non-lame cows. The observed changes in activity, lying, and feeding behaviors are known to cause disadvantages with respect to the bodily constitution and energy supply, which may predispose moderately lame cows to other health problems and a shorter life. Moreover, the restriction in mobility is likely to further affect the cows' low resilience and social behaviors.

Table 1 Recorded behaviors with mean values (minimum - maximum) of non-lame and moderately lame cows and the p-value.

Behavior	Non-lame cows	Moderately lame cows	p-value
Average locomotor activity [g/h]	315.2 (116.9 - 607.2)	288.5 (133.4 - 534.2)	p = 0.007
Lying duration [min/24 h]	655.8 (324.9 - 976.8)	696 (320.3 - 1089.6)	p = 0.027
Average lying bout duration [min]	85.6 (29.9 - 245.9)	101.4 (25.8 - 335.5)	p = 0.008
Lying bouts [n/24 h]	8.5 (2 - 20)	7.8 (3 - 27)	p = 0.11
Eating time [min/24 h]	460.4 (243.2 - 909.6)	414 (255.3 - 605.7)	p = 0.033
Eating chews [n/24 h]	31920 (11850 - 55030)	28200 (14650 - 43820)	p = 0.05
Ruminating time [min/24 h]	494.6 (84.62 - 677.4)	492.6 (285.5 - 663.5)	p = 0.53
Ruminating chews [n/24 h]	31520 (5889 - 50440)	29870 (12940 - 48080)	p = 0.86
Visits to concentrate feeder [n/24 h]	9 (0 - 26)	6.1 (0 - 17)	p = 0.014
Visits to brush [n/24 h]	2.3 (0 - 11)	1.8 (0 - 10)	p = 0.046
Milking order [relative position]	0.47 (0.01 - 0.99)	0.63 (0.02 - 0.99)	p $\leq$ 0.001

Conclusions The behavior of moderately lame cows differed in many of the investigated behaviors in a biologically relevant way from non-lame cows. The effects on the everyday life of moderately lame dairy cows in loose housing systems indicate that even an early stage of lameness already has a great potential effect on animal welfare.
The use of behavioral changes seems to be promising to elaborate an automatic on-farm system for early lameness detection. However, further analyses are necessary to assess their reliability for lameness detection and to create algorithms considering several parameters in combination or track changes within cows over time to achieve sufficient sensitivity and specificity.

References
Sprecher, D. J., D. E. Hostetler, and J. B. Kaneene. 1997. A lameness scoring system that uses posture and gait to predict dairy cattle reproductive performance. Theriogenology 47, 1179–1187. https://doi.org/10.1016/S0093-691X(97)00098-8