Lameness Monitoring, Use of Locomotion Scoring

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Summary:

Lameness, due to its detrimental effect on cow welfare, health and production, in dairy cows has received quite a lot of attention in the last few decades, not only in terms of prevention and treatment but also in terms of detection, as early treatment might decrease the number of severely lame cows in the herds as well as decrease the direct and indirect costs associated with lameness cases. Assessment of lameness prevalence and severity requires visual evaluation of the locomotion of a cow. Scoring cows for lameness based on changes in locomotion or behavior is essential for farmers to find and treat their lame animals. Human observation of locomotion, by looking at different traits in one go, is used in practice to assess locomotion. Welfare schemes including locomotion assessments are increasingly being adopted, and more farmers and their veterinarians might implement a locomotion-scoring routine together. Generally, lame cows are detected by the herdsman, hoof trimmer or veterinarian based on abnormal locomotion, abnormal behavior or the presence of hoof lesions during routine trimming. In the scientific literature, several guidelines are proposed to detect lame cows based on visual interpretation of the locomotion of individual cows (i.e., locomotion scoring systems, LSS). Monitoring herd lameness prevalence has utility for dairy producers and veterinarians in their efforts to reduce lameness, for animal welfare assessment programs, and for researchers. Locomotion scoring is a method used to quantify lameness and calculate prevalence.

Introduction:

Dairy farming has improved in past 30 years in Iran. By the time high producer farms (Over 40 lit/day, average of 12000 lit/ 305 days) have improved. As a result, dairy farming systems have intensified, with more cattle on fewer farms and per caretaker and higher productivity per animal as is the case in other parts of the world. This trend reduces the farmer's available time to observe and monitor the cows and jeopardizes the health of the cows, in particular the high-yielding ones. Lameness is considered to be the third most costly health problem of dairy cows, after reduced fertility and mastitis. In Iran in some situations infectious diseases are more prevalent than lameness. Nevertheless, lameness has not only been under-recorded on farms but its importance with regard to cow welfare, cow health and farm profitability has also been hugely underestimated. Although in some dairy farms an intensive hoof care program have been started, still many dairy farmers are unaware of the number of lame cows in their herd, and, if noticed, they often do not have enough time to treat them. Generally, lame cows are detected by the herdsman, hoof trimmer or veterinarian based on changes in cow gait, posture

or behavior or the presence of hoof lesions during routine trimming.

Lameness detection:

Lameness can be defined as the clinical manifestation of painful disorders, mainly related to the locomotor system, resulting in impaired movement or deviation from normal gait or posture. It should be noted that abnormal gait may develop not only as a result of disorders in the locomotor system but also disorders in other organs. Although changes in the general behavior of cows, like lying, standing or feeding behavior, have been associated with lameness, changes in locomotion are the most commonly used and most direct ways to monitor lameness.

As a short history of locomotion scoring systems (LSS) as a visual tool and accompanying lameness indicators Manson and Leaver were the first to describe locomotion scoring in cattle in detail. Cows were scored using a 9-point scale based on the absence or presence of tenderness, abduction and difficulty in turning/rising/walking. Wells et al. proposed another system mainly focusing on gait asymmetry and restriction of movement. In this system, only 5 different locomotion classes were used. Sprecher et al. introduced a 5-point lameness scoring system that assessed gait with special emphasis on back posture, both while standing and walking. In addition, short striding and weight bearing between different limbs were used during scoring. Winckler and Willen modified the Sprecher method and introduced their 5-point scoring systems using the following criteria: irregular gait, short striding and reluctance to bear weight. Breuer et al. introduced head bobs in a 4-point scoring system. Flower and Weary proposed head bobs, tracking up and joint flexion as gait indicators to look for lameness. Arc of the foot flight, foot placement relative to body position, limb axis and foot rotation during weight bearing of every limb were looked at by Dyer et al. in their aim to identify lame and sound limbs. The Welfare quality assessment protocol for lameness in cattle focuses on irregular footfall, uneven temporal rhythm between hoof beats and weight not borne for equal time on each of the four feet.

How, When and Where can we do LSS?

Because of the time necessary to locomotion score each cow in large dairy herds, a sampling strategy to determine herd lameness prevalence that allows scoring of fewer cows would be useful. Such a sampling strategy must be validated for accuracy compared with the lameness prevalence when all cows in a herd are locomotion scored. Three previously suggested methods of estimating lameness prevalence by strategic sampling of dairy herds were assessed. Sampling strategies tested included (1) sampling a calculated number of cows in the middle third of the milking parlor exit order for each pen, (2) sampling a calculated number of cows weighted across pens and distributed evenly within each pen, and (3) sampling all cows in the high production, low production, and hospital pens. Sampling strategies using the middle of milking parlor exit order and a calculated sample distributed across the herd may be used to obtain an estimate of herd lameness prevalence.

Environmental or cow factors can contribute to locomotion changes not related to lameness and hence, might cause false alerts. Effects of wet surfaces, dark environment, age, production level, lactation and gestation stage on cow locomotion were investigated. In dark environments and on wet walking surfaces cows took shorter, more asymmetrical strides with less step overlap. In general, older cows had a more asymmetrical gait and they walked slower with more abduction. Lactation stage or gestation stage also showed significant association with asymmetrical and shorter gait and less step overlap. When comparing the sensitivity for the detection of non-lame cows, sensitivity increased by 10% when the age and lactation was added in the algorithm (sensitivity was 70% and 80% for the first and second algorithm, respectively). Results of the study shows that using knowledge on influencing factors on cow locomotion will help in reducing the number of false alerts for lameness detection systems under development. However, further research is necessary in order to better understand these and many other possible influencing factors (e.g. trimming, conformation) of non-lame and hence 'normal' locomotion in cows.

Tied cows were considered lame when two of the following indicators were visually present: repeated weight-shifting between feet, rotation of feet from the line parallel to the midline of the body, standing on the edge of a step, resting a foot, and uneven weight bearing when moving from side to side. In contrast to the visual locomotion scoring systems described above, some systems are based on scoring different gait characteristics separately from 1 (normal) to 5 (severely abnormal), such as tracking, spine curvature, speed, head bobbing, general symmetry and abduction/adduction. Most of the visual locomotion scoring systems described in the literature use a specific number of classes ranging from non-lame to severely lame, often referred to as a numerical rating system (NRS). The number of classes range from 2 (lame/none lame) to 9 and allocation to a class depends on the absence or presence of gait characteristics, which differ in degrees of severity between each of these classes. Another approach uses an overall visual analogue scale (VAS). This is generally a continuous 100-unit line with at both ends of the scale the most extreme conditions of the characteristic. If VAS is used for general lameness scoring, those extremes would be ‘perfect gait’ and ‘cow unable to move’. Flower and Weary suggested that such a scoring system might be more sensitive than NRS as it allows observers to record more subtle changes in gait characteristics.

Individual locomotion traits that were most related to locomotion scores in dairy cows, and consistent capabilities of experienced raters in scoring these traits were studied. Locomotion and 5 individual locomotion traits (arched back, asymmetric gait, head bobbing, reluctance to bear weight, and tracking up) were scored independently on a 5-level scale for 58 videos of different cows by 10 experienced raters in 2 different scoring sessions. All traits were significantly related to the locomotion score when scored with a 5-level scale and when classified as

(severely) lame or non-lame. Odds ratios for altered and severely altered traits were 10.8 and 14.5 for reluctance to bear weight, 6.5 and 7.2 for asymmetric gait, and 4.8 and 3.2 for arched back, respectively. In conclusion, raters had difficulties in scoring locomotion traits consistently, especially slight alterations were difficult to detect by experienced raters. Yet, the locomotion traits reluctance to bear weight, asymmetric gait, and arched back had the strongest relation with the locomotion score. These traits should have priority in locomotion-scoring-system guidelines and are the best to be used for the development of automated LSS.

If clinical signs predictive of lameness could be observed more conveniently, as cows are undergoing regularly scheduled examinations while standing, detection levels could increase. The association between postures observed while cows are standing in stanchions and clinical lameness evaluated by locomotion scoring, and the observation of these postures as a test for lameness were evaluated. In a study, cows were observed while standing in stanchions for regularly scheduled management procedures and the presence of arched back and cow-hocked, wide-stance, and favored-limb postures were recorded. The same cows were locomotion-scored as they exited the milking parlor. Back-arched, cow-hocked, and favored limb postures were associated with lameness but were not highly sensitive or specific as diagnostic tests. However, observation of back arch may be useful to identify cows needing further examination.

Analysis of scores, however, is done after transformation of the original 5-level scale into a 4, 3, or 2 level scale to improve reliability and agreement. Different ways of merging levels to optimize resolution, reliability, and agreement of locomotion scores were evaluated. Overall intra- and interrater reliability and agreement and specific intra- and interrater agreement were determined for the 5-level scale and after transformation into 4, 3, and 2 level scales by merging different combinations of adjacent levels. The specific intra rater agreement was 76.4% for locomotion level 1, 68.5% for level 2, 65% for level 3, 77.2% for level 4, and 80% for level 5. Specific interrater agreement was 64.7% for locomotion level 1, 57.5% for level 2, 50.8% for level 3, 60% for level 4, and 45.2% for level 5. Specific intra- and interrater agreement suggested that levels 2 and 3 were more difficult to score consistently compared with other levels in the 5-level scale. The acceptance threshold for overall intra- and interrater reliability and agreement and specific intra- and interrater agreement was exceeded only for the 2-level scale when the 5 levels were merged as (12)(345) or (123)(45). In conclusion, when locomotion scoring is performed by experienced raters without further training together, the lowest specific intra- and interrater agreement was obtained in levels 2 and 3 of the 5-level scale. Acceptance thresholds for overall intra- and interrater reliability and agreement and specific intra- and interrater agreement were exceeded only in the 2-level scale.

Agreement, reliability, and validity of manual and automatic locomotion scoring systems (MLSSs and ALSSs, respectively) used in dairy cattle lameness research were compared and

evaluated. There are many different types of MLSSs and ALSSs. Twenty-five MLSSs were found in 244 articles. MLSSs use different types of scale (ordinal or continuous) and different gait and posture traits need to be observed. The most used MLSS (used in 28% of the references) is based on asymmetric gait, reluctance to bear weight, and arched back, and is scored on a five-level scale. Fifteen ALSSs were found that could be categorized according to three approaches: (a) the kinetic approach measures forces involved in locomotion, (b) the kinematic approach measures time and distance of variables associated to limb movement and some specific posture variables, and (c) the indirect approach uses behavioral variables or production variables as indicators for impaired locomotion. The utilization of MLSSs and ALSSs should aim to the prevention and efficient management of conditions that induce impaired locomotion. Long-term studies comparing MLSSs and ALSSs while applying various strategies to detect and control unfavorable conditions leading to impaired locomotion are required to determine the usefulness of MLSSs and ALSSs for securing optimal production and animal welfare in practice.

Consistency of LSS, change between observers, cows, field conditions…….

Locomotion scoring requires the observer to distinguish normal from abnormal walking behavior. Since scoring is based on observer judgment it is open to some degree of interpretation. Hence, observers should be trained and retrained by observers familiar with the scoring system in order to obtain a high degree of agreement between and within observers. As with every new observation, observers gradually build up more experience with the scoring system and with the range in which indicators can be shown, they will also drift in interpretation of the borders of each specific class. Periodical re-training is therefore advised to reach an acceptable level of inter-observer reliability. Using fewer locomotion classes is sometimes suggested to improve intra- and inter-observer reliability. The intra- and inter-observer variation of locomotion scoring systems for cattle have been assessed in several studies. Engel et al. pointed out that when using discrete scores, cows that were in between categories might be scored in different classes by less trained and trained observers even if they had more or less the same opinion. In the study of O'Callaghan et al. the intra- and inter-observer reliability using a 5-point scale were 56 % and 37%. These scores increased to 93% and 81%, respectively, when a one-point difference was allowed.

High within-observer agreement is a prerequisite for obtaining valid mobility scorings, and within-observer agreement cannot be estimated in a barn, because the gait of cows is dynamic and may change between 2 occasions. The within-observer agreement according to the observers' educational background and experience with cattle, based on video recordings with very diverse types of gait were studied. Groups of farmers, bovine veterinarians, first- and fourth-year veterinary students, researchers, and cattle-inexperienced sensory assessors evaluated mobility using a 5-point mobility score system developed

specifically for walking cows (n=102 observers). The evaluation sessions were similar for all groups, lasted 75 min, and were organized as follows: introduction, test A, short training session, break, and test B. In total, video recordings of 22 cows were displayed twice in a random order (11 cows in each test × 2 replicates). When adjusting for the fixed effects of video sample and gait scoring preferences, the probability of assigning the same mobility score twice to the same cow varied from 55% (sensory assessors) to 72% (fourth-year veterinary students). In general observers could categorize the mobility characteristics of cows quite well. Observers who preferred to assess the attributes back arch or the overall mobility score (based on uneven gait) had the highest agreement, respectively, 69 or 68%. The mobility score achieves sufficiently high within-observer repeatability to allow between-observer agreement estimates, which are reliable compared with other more-complex scoring systems. Consequently, the new scoring scale seems feasible for on-farm applications as a tool to monitor mobility within and between cows, for communication between farmers and veterinarians with diverse educational background, and for lameness benchmarking of herds.

The gait attributes commonly used in subjective locomotion scoring systems and use new technology to evaluate these gait attributes objectively on 60 Holstein lactating dairy cattle were explored. Kinematic gait analysis more commonly used in sports and equine science was adapted for use on dairy cattle to assess stride characteristics, joint flexion, and spine posture in dairy cows with different lameness status. Cows that were lame had shorter stride length and had negative tracking distance compared with non-lame cattle. Lame cattle did not show any difference in spine posture when walking. Gait alterations were more evident in cows with sole ulcers, which showed considerable shortening of stride and had more negative tracking compared with cows with no hoof lesions. Cows with sole ulcers also showed significant shortening of the spine when walking than cows with no hoof lesions.

Locomotion scoring changes during time, procedures and lesion occurrence:

The association between locomotion scores and lesions were investigated and it was concluded that the presence of a lesion does not imply that it is necessarily associated with increasing locomotion score. The lack of association between certain lesions and poor locomotion scores indicates either that these lesions are causing different severities of lameness, or that the case definitions used were not sufficiently precise. Locomotion score may not be sensitive enough to detect all lesions (and possibly discomfort).

The same idea happen in our field, It was shown that sole ulcer and interdigital necrobacilosis increase locomotion score but digital dermatitis does not necessarily increase locomotion score. In other findings just 52% of the scored cows show a lesion in their feet that varies between different scoring times and persons who scored (28-72%). Rezaei et al. reported a potency of high LSS in detecting lesions in zone 4 of the claws (sole ulcers)

In practice it was claimed that cows with high locomotion scores stay in high scores for a long time as Keyvanirad et al. showed that two month after a high LSS (4 and 5) in a five point locomotion scoring, 57.01 cows still remain in the same scores, three month later it reduce to 36.84, four month later it reduced to 21.92% and five month after scoring still 7.01% of the cows were in high locomotion scores. Shafigh et al. reported a variation between 43.55-56.99 % stability of high LSS in a month after the first treatment. However Khalilifard et al. reported an elevation of the LSS two month before till two month after occurrence of the lesions. Hashemifard et al. reported an elevation of LSS three month before to three month after claw horn lesions.

Although some researchers believe that parity, days in milk and body condition score may affect locomotion scores, Mohamadnia et al. reported an insignificant elevation in scores 1 and 2 in a five point scale LSS after hoof trimming and the overall increase was not significant. Khaghani et al. didn't record any changes in LSS after parturition.

Estimates of point prevalence suggest that locomotion scoring identifies three times as many lame cows than when estimated by farmers. The impact of under-recognition on the interval between identification of lameness (using locomotion score) and treatment were evaluated. Survival analyses were used to quantify the number of days between identification of a specific locomotion score and presentation, by farm staff, of a cow for lameness treatment. All cows which had a locomotion score of >3 were presented for lameness treatment subsequently, although >40% were treated more than 3 weeks after being identified. Only 75% of events where cows had a locomotion score of 3 were followed by treatment with >65% of those treatments occurring >3 weeks after the first score of 3. Improving the recognition of lameness by farm staff is thus likely to appreciably reduce the interval between reduced mobility and lameness treatment. However Khaghani et al., 2012 reported an almost equal occurrence of the lesions in cows that were referred to hoof trimming chutes by dairy labor and the cows with high LSS.

Locomotion scoring, lying behavior and lesion recording during hoof trimming are all ways of evaluating hoof health in dairy cows. The relationship between these measures in a random sample of 1340 cows from 42 Danish dairy herds were evaluated. The hypothesis was that locomotion scoring and/or the monitoring of lying behavior could be used as tools to identify cows with hoof lesions, either of the horn or of the skin. Cows were locomotion scored, lying behavior recorded and data on hoof lesions seen during hoof trimming collected. The results were analyzed using logistic regression with hoof lesion as the outcome and locomotion score (1-5), mean duration of lying bouts, parity and lactation stage as explanatory variables. This analysis was undertaken for all types of lesions, for hoof horn lesions only and for skin lesions only. It was concluded that locomotion scoring and duration of lying bouts may be used as tools in the management of hoof health in dairy herds.

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