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Evaluation of two methodologies for lameness detection in dairy cows based on postural and gait abnormalities observed during milking and while restrained at headlock stanchions

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ABSTRACT

Lameness is a critical issue on dairies with an impact on production and animal welfare. Early lameness detection followed by effective treatments could improve prognosis and cure rate of lame cows. Current methods for lameness detection are based on locomotion score (LS) that requires observation of cows walking, preferably at the exit of the milking parlor. This is a time-consuming task that is difficult to implement on large dairies. Therefore, a common methodology for lameness detection is based on milkers' and cow pushers' observations of cows walking to the milking parlor or standing at the milking stall (MPP). Observation of postural abnormalities predictive of lameness while cows are locked at stanchions (S) can be used as an alternative detection method. The objective of this research was to study the association between postural and gait abnormalities observed with S and MPP methodologies and lameness using LS ≥ 3 as the reference method, as well as to evaluate the epidemiological characteristics of those methods as a diagnostic test for lameness. A secondary objective was to describe the type of hoof lesions observed with postural and gait abnormalities detected with LS, MPP, and S methodologies. A cross-sectional study design was performed on 2274 cows from one farm in California (US). Arched back, cow-hocked, wide-stance, and favored-limb postures as well as uneven gait were observed. Both lameness detection methodologies, S and MPP, indicated that arched back and favored-limb were postural abnormalities associated with lameness. However, the epidemiological test characteristics for each of the postures evaluated as a diagnostic test for lameness indicated that both detection methods, S and MPP, had good specificity (> 0.91) but poor sensitivity (0.04–0.39). A convenience sample of 104 cows, selected based on LS > 3, favored-limb, presence of two or more abnormal postures, and gait anomalies with either S or MPP methods, received a hoof examination. Lesions were observed on cows selected by LS (17/24), MPP (21/30), and S (33/60) criteria, suggesting a lack of concordance between lameness detection methodologies and visible hoof lesions. Nevertheless, due to the lack of acceptance of LS as the lameness detection method on large commercial dairies in California, it is imperative that future research evaluates modifications of S and MPP lameness detection techniques, considering hoof lesion as reference method.

Abbreviations: LS, locomotion score; MPP, lameness detected by milkers while cows stand at the milking parlor and by pushers when cows walk towards the parlor; S, observation of postural abnormalities predictive of lameness while cows are locked at stanchions; ArchS, arched back posture observed at stanchions; HockS, cow-hocked posture observed at stanchions; Stance S, wide-stance posture detected at stanchions; ArchMPP, arched back posture observed entering the parlor or walking to the milking parlor; HockMPP, cow-hocked posture observed at milking parlor; FavMPP, favored-limb posture observed at or walking to the milking parlor; GaitMPP, uneven gait observed walking to the milking parlor; LACT, lactation number; DIM, days in milk; AVMK, average milk from day 1–7.

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1. Introduction

Lameness on dairies is a world-wide problem that negatively impacts animal welfare (Juarez et al., 2003; O'Callaghan et al., 2003; Dyer et al., 2007), herd production level (Sprecher et al., 1997; Juarez et al., 2003; Archer et al., 2010; Huxley, 2013; Norring et al., 2014) and social perception of livestock farming (Leach et al., 2012a). Previous research shows a wide variation of lameness prevalence across countries, herds, seasons, and housing types, ranging from 3% to 60% (Espejo et al., 2006; Cramer, 2007; Tadich et al., 2010; Hoffman et al., 2014). Current lameness prevalence in cattle is considered unacceptably high (Potterton et al., 2012).

Lameness prevalence on dairy herds could be reduced by adopting mitigation strategies that decrease lameness incidence, or by early lameness detection and treatment that improves prognosis and cure rate (Leach et al., 2012b). However, dairy producers seem to have difficulties with lameness identification resulting in an underestimation of its prevalence (Whay et al., 2003; Espejo et al., 2006). Thus, accurate lameness detection methods that could be easily implemented on dairies will be valuable tools to decrease lameness prevalence.

Automatic systems for lameness detection based on behavior, kinematic, and kinetics approaches have gained attention over the last decade. However, they are still at an early developmental stage and require further development (Bicalho et al., 2007; Viazzi et al., 2013; Schlageter-Tello et al., 2014). Consequently, visual observation of gait and posture abnormalities remains the most common method to identify lame cows. Various scoring methods have been proposed to assess gait. The five-level locomotion score (**LS**) system described by Sprecher et al. (1997) is widely referred to in the literature. Most research studies evaluating the efficacy of preventive strategies and treatment of hoof lameness in cattle use LS or gait score as the reference technique (Potterton et al., 2012). However, LS evaluations require individual observation of walking and standing cows, most often when leaving the milking parlor. This is a time-consuming task, difficult to implement on most large dairies. Some studies have proposed new strategies that could be easily implemented on commercial dairies (Leach et al., 2009; Thomsen, 2009; Hoffman et al., 2014). Based on behavior indicators related to abnormal weight distribution, Leach et al. (2009) proposed a method to detect lameness while cows were restrained on tie-stalls. Lameness indicators included weight shifting between hind legs, resting a foot, uneven weight when moving from side to side, and reluctance to bear weight on a particular foot. Thomsen (2009) evaluated arched back posture of cows standing in pens as a diagnostic method for lameness detection. Most recently, Hoffman et al. (2014) evaluated a simple lameness detection method while cows were restrained at self-locking stanchions. Observed postural abnormalities included arched back, cow-hocked, wide-stance, and favored-limb. Overall, these methodologies showed limited validity as diagnostic tests for lameness.

Farm personnel observations of lame cows while walking to the milking parlor (cow pusher) or standing at the milking stall (milkers) are commonly used as the methodology for lameness detection (**MPP**). Prior research on hoof lesion identification at the milking parlor was limited to digital dermatitis (Rodriguez-Lainz et al., 1998; Relun et al., 2011; Stokes et al., 2012). To the best of our knowledge, the present study is the first one assessing the reliability of detection techniques based on postural and gait observations carried out during milking as a lameness diagnostic test. Furthermore, observation of postural and gait abnormalities predictive of lameness while cows are locked at stanchions (**S**) could be used as an alternative detection method. Thus, the objective of this research was to study the association between postural and gait abnormalities observed with S and MPP methodologies and lameness using LS ≥ 3 as the reference method, as well as evaluate the sensitivity and specificity of these postural and gait observations, with locomotion scoring as the gold standard. A secondary objective was to describe the type of hoof lesions observed with postural and gait abnormalities detected with LS, MPP, and S methodologies.

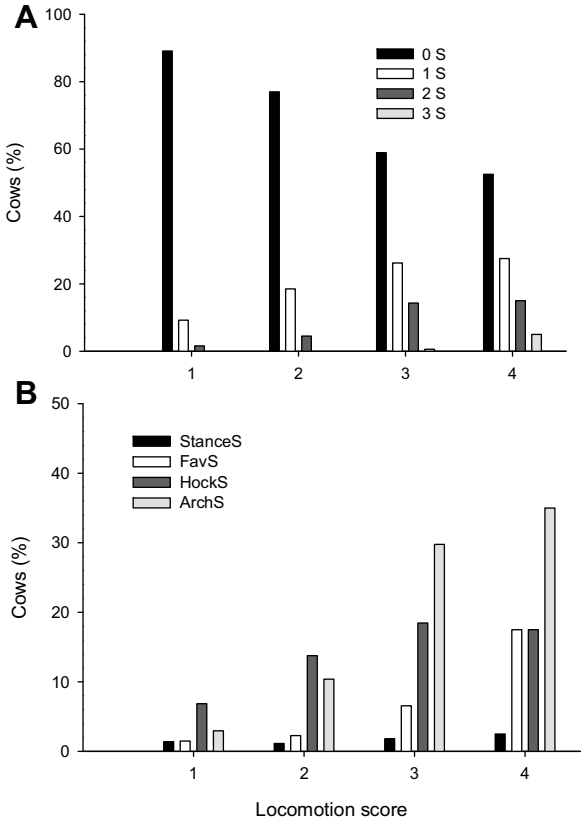

Fig. 1. Proportion of lactating dairy cows (n = 2009) observed while locked at stanchions with none (0 S), one (1 S), two (2 S) and three (3 S) postural abnormalities (Panel A), and with wide-stance (StanceS), favored-limb (FavS), cow-hocked (HockS) and arched back (ArchS) postures (Panel B) by locomotion score. No cows were classified with locomotion score 5.

2. Materials and methods

All procedures were approved by the University of California Davis Institutional Animal Care and Use Committee (# 17440).

2.1. Cows and herd management

The study was conducted in May 2014 over a ten-day period on a 2384 lactating Holstein cow free-stall commercial dairy farm in Tulare County (California). There were 13 lactating cow pens on the study dairy. Cows were milked twice a day in two 20 by 20 herringbone parlors and fed a total mixed ration twice a day. Average milk yield was 37.2 kg per cow and day. Stalls were bedded with dry manure and new bedding was added every two weeks. Feed alleys were made of grooved-concrete floors that were flushed twice a day with lagoon water. Walkways to the milking parlor were made of grooved concrete padded with rubber mats. At the exit of the milking parlor, cows walked through a foot bath of 258 cm length and 190 cm width, with 5% of formalin (35% formaldehyde). At dry-off, cows were scheduled to visit the hoof trimmer. Twice a week, before the hoof trimmer visit, on-farm employees identified lame cows during milking.