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# Analysis of behavioral changes in dairy cows associated with claw horn lesions

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## ABSTRACT

Detecting lame cows is important in improving animal welfare. Automated tools are potentially useful to enable identification and monitoring of lame cows. The goals of this study were to evaluate the suitability of various physiological and behavioral parameters to automatically detect lameness in dairy cows housed in a cubicle barn. Lame cows suffering from a claw horn lesion (sole ulcer or white line disease) of one claw of the same hind limb (n = 32; group L) and 10 nonlame healthy cows (group C) were included in this study. Lying and standing behavior at night by tridimensional accelerometers, weight distribution between hind limbs by the 4-scale weighing platform, feeding behavior at night by the nose band sensor, and heart activity by the Polar device (Polar Electro Oy, Kempele, Finland) were assessed. Either the entire data set or parts of the data collected over a 48-h period were used for statistical analysis, depending upon the parameter in question. The standing time at night over 12 h and the limb weight ratio (LWR) were significantly higher in group C as compared with group L, whereas the lying time at night over 12 h, the mean limb difference (Δweight), and the standard deviation (SD) of the weight applied on the limb taking less weight were significantly lower in group C as compared with group L. No significant difference was noted between the groups for the parameters of heart activity and feeding behavior at night. The locomotion score of cows in group L was positively correlated with the lying time and Δweight, whereas it was negatively correlated with LWR and SD. The highest sensitivity (0.97) for lameness detection was found for the parameter SD [specificity of 0.80 and an area under the curve (AUC) of 0.84]. The highest specificity (0.90) for lameness detection was present for Δweight (sensitivity = 0.78; AUC = 0.88) and LWR (sensitivity = 0.81; AUC = 0.87). The model considering the data of SD together with lying time at night was the best predictor of cows being lame, accounting for 40% of the variation in the likelihood of a cow being lame (sensitivity = 0.94; specificity = 0.80; AUC = 0.86). In conclusion, the data derived from the 4-scale-weighing platform, either alone or combined with the lying time at night over 12 h, represent the most valuable parameters for automated identification of lame cows suffering from a claw horn lesion of one individual hind limb.
**Key words:** dairy cow, lameness, weighing platform, claw horn lesion

## INTRODUCTION

Orthopedic disorders causing lameness belong to the most common and economically most relevant production diseases of dairy cattle worldwide (Bennett et al., 1999). The prevalence of lameness of dairy cattle in European countries and the United States ranges between 5 and 48% (Manske et al., 2002; Espejo et al., 2006; Amory et al., 2008; Bicalho et al., 2009; Dippel et al., 2009a,b, Barker et al., 2010; Becker et al., 2014b). Reduced milk yield and fertility, increased risk of culling, treatment costs, and additional expenditure for extra labor cause considerable economic loss (Kossaibati and Esslemont, 1997; Warnick et al., 2001; Green et al., 2002; Garbarino et al., 2004; Amory et al., 2008; Bruijnis et al., 2010).

Many farmers were unaware of the financial consequences caused by lame animals and did not realize how the lameness problem affected the productivity and profitability of their dairy enterprises (Leach et al., 2010a,b). In an investigation of 222 English dairy farms, 90% of the farmers did not judge lameness as being a big issue, although the average prevalence of lameness was 36% (Leach et al., 2010a). However, farmers' interest in good claw health is a decisive factor for low within-herd lameness prevalence (Becker et al., 2014a).

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Lesions causing lameness were located in the area of the feet in 88.3% of the cases, 84% of the foot lesions occurred in the hind feet, and 85% of these lesions affected the outer claw (Russell et al., 1982). Digital dermatitis, heel horn erosion, sole ulcers, and white line disease were shown to be the predominant claw lesions of dairy cows (Manske et al., 2002; Barker et al., 2010; Becker et al., 2014a,b).

Cows are a prey species and rather stoic: they seldom show signs of pain until the stimulus is severe (Anil et al., 2005; Hudson et al., 2008). However, it has been shown that slight behavioral changes are present in lame cows. Cows suffering from pain associated with lameness changed their behavior to reduce discomfort (Hudson et al., 2008). These behavioral changes encompass, for example, decreased movement or locomotion, decreased feed intake, reduced mental responsiveness, decreased interaction with other animals, tooth grinding, and changes in posture and gait. In practice, lame cows are often insufficiently identified and treated (Bruijnis et al., 2010). The mean time from the onset of lameness to clinical recognition by the farm personnel was 27 d (Tranter and Morris, 1991).

In general, veterinary treatments and management decisions are more effective the earlier they are taken once the disease is established (González et al., 2008). A decrease in milk yield lasted from 4 mo before individual cows were diagnosed clinically lame until 5 mo after this point in time (Green et al., 2002). Interest is increasing in automated methods to detect lameness, as early detection is difficult and the economic effect is significant (Espejo et al., 2006; Chapinal et al., 2010). Therefore, various automated tools were developed and tested with the aim to improving the assessment and early detection of lameness on dairy farms. Using the 4-scale weighing platform, it was found that lame cows reduced the weight-bearing of the affected limb (Rushen et al., 2007; Pastell et al., 2010). Furthermore, lame cows, as compared with nonlame cows, showed a higher asymmetry of weight within each pair of limbs and had a greater standard deviation of the weight applied on each limb over time (Neveux et al., 2006; Rushen et al., 2007; Chapinal et al., 2010). The latter parameter proved to be the most accurate predictor of whether a cow was lame or not. The use of tridimensional accelerometers revealed that grazing lame dairy cows, as compared with nonlame cows, spent more time lying and had fewer lying bouts per day (Sepúlveda-Varas et al., 2014). Generally, lying bouts of lame cows lasted longer than those of nonlame cows (Chapinal et al., 2010; Yunta et al., 2012; Sepúlveda-Varas et al., 2014). Acute locomotion disorders lead to a decrease in (1) feed intake, (2) number of meals, (3) visits to the feeders, and (4) a considerable decrease in eating time (González et al., 2008). By using the noseband pressure sensor technology, it is currently possible to detect, differentiate, and record eating and rumination behavior automatically (Braun et al., 2014). The analysis of heart rate variability (**HRV**) as a parameter of heart activity represents another suitable automated method to assess stress and welfare status in farm animals (von Borell et al., 2007). Heart rate variability reflects the balance between the sympathetic and parasympathetic tone and delivers information on the stress response of the autonomic nervous system (Mohr et al., 2002; von Borell et al., 2007). In general, sympathetic activity tends to increase heart rate (**HR**) and decrease HRV, whereas parasympathetic activity tends to decrease HR and increase HRV. Lower values in HRV and higher values in HR were found to be associated with higher levels of stress in goats (Nordmann et al., 2011), and this can also be expected in cows.

It was the aim of the current study to evaluate the suitability of various automated methods (measures of weight distribution, lying and standing behavior at night, feeding behavior at night, and heart activity) to assess altered behavior in cows associated with lameness caused by a claw horn lesion of one individual hind claw.

## MATERIALS AND METHODS

### *Cows and Housing*

The study was carried out between April 2013 and March 2014 on a commercial dairy farm with around 900 lactating German Holstein cows located close to Chemnitz, Germany. Cows were housed in a group of 30 to 40 moderately lame cows (not used for this study) in a freestall pen with concrete slatted floor and rubber floor cubicles. Multiparous German Holstein dairy cows [n = 44; parity = 3.09 ± 1.22 (mean ± SD); DIM = 104.95 ± 47.03; BW = 625.63 ± 69.91 kg; daily milk yield at d 1 = 34.40 ± 7.18 kg] were included in the study. Cows were milked twice daily, in a carrousel milking parlor, at approximately 1400 and 0200 h and fed a TMR diet once daily that was formulated to meet the requirements for lactating dairy cows. Water was available ad libitum from self-filling troughs. Preventive foot trimming was routinely performed 3 times per year by a certified foot trimmer and therapeutic foot trimming whenever the farm personnel identified a cow as being lame. The experimental protocol was approved by the Animal Care Committee of the University of Leipzig (Landesdirektion Sachsen, Referat 24 - Veterinärwesen und Lebensmittelüberwachung, Pharmazie, GMP Inspektorat, Anzeigennummer: A 30/12, Registriernummer: 24–9168.21/4/30).

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