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Behavioural changes in dairy cows with lameness in an automatic milking system

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ABSTRACT

There is a tendency worldwide for the automation of farms; this has included the introduction of automatic milking systems (AMS) in the dairy industry. Lameness in dairy cows is highly prevalent and painful. These impacts potentially affect not only animal welfare, but also farm economies. Three independent observational studies were carried out to assess the impact of lameness on the behaviour of zero grazed high yielding Holstein cows managed in an AMS. The aim of the first study was to examine the impact of lameness on rumination time, the second study investigated differences between lame and sound dairy cows in total eating time and the third study assessed the impact of lameness on milking behaviour (frequency and time of visits to the AMS). In the first study data from 150 cows were used to analyse rumination (collected using rumination collars) for the 48 h following locomotion scoring. A multilevel linear regression demonstrated that lameness had a small but significant negative association (coefficient: −7.88 (SE: 3.93)) with rumination. In the second study the behaviour of eleven matched lame and sound pairs of cows at the feed face was analysed for 24 h after locomotion scoring. Each feeding behaviour variable (total duration time, frequency of feeding bouts and length of bouts) was analysed using individual single level regression models. There was a significant negative association between total feeding time and lameness (coefficient: −73.65 (SE: 25.47)) and the frequency of feeding bouts and lameness (−9.93 (2.49)). Finally, the third observational study used 38 matched pairs of lame and sound cows. Data on the number and timings of visits to the AMS were collected for 24 h after each locomotion score and analysed using a binomial logistic regression model. There was a significant difference in AMS visits between groups; lame animals visiting the robot less frequently than sound cows (median difference 0.50 milking visits; $T = 256.0$; $N = 25$; $p = 0.01$) and lame cows were 0.33 times less likely to visit the AMS between 24:01 and 06:00. Results from these studies reveal that lameness in an AMS affected feeding behaviour, rumination and AMS visits. All of these impacts are likely to have negative consequences for farm profitability, but also implications for the health and welfare of the animals.

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1. Introduction

Automatic milking systems (AMS) were introduced to the dairy industry approximately 20 years ago. The number of installations is increasing rapidly, currently there are approximately 8000 farms with AMS around the world (Jacobs and Siegford, 2012). The most attractive farm benefits for the use of AMS are the freedom they provide farmers compared to conventional parlours and the opportunity to increase milking frequency resulting in an increase in milk production (Uetake et al., 1997; Meskens et al., 2001). Of equal importance, the cows may benefit from the freedom to control their activity, with the possibility of longer periods of lying and reduced stress at the time of milking because they are not gathered and crowded as they are in conventional parlours. Additionally, more frequent milking reduces udder pressure whilst at the same time reducing stress on the udder ligaments (Meskens et al., 2001; Osterman and Redbo, 2001).

As the dairy industry has developed over the last 50 years, there has been an increase in the prevalence of lameness worldwide, for example in the UK the prevalence was 36.8% (Barker et al., 2010), 28.5% in Canada (Ito et al., 2010) and between 28 and 33% in Chile (Tadich et al., 2010). Lameness is a sign of pain and discomfort at the level of the leg but more commonly at the level of the claw (Archer et al., 2010a). Affected animals show behavioural signs of being in pain such as reduction in mobility and alterations in behaviour. Due to discomfort and changes in behaviour it is not surprising that lameness has been associated with a reduction in milk production (Green et al., 2002; Archer et al., 2010b) and in reproduction success (Huxley, 2013).

In conventional parlours it has been observed that lame cows reduced their feeding time (Gonzalez et al., 2008; Gomez and Cook, 2010), increased their lying time (Ito et al., 2010) and modified their gait in order to access their needs (e.g. feed or social contact: Galindo and Broom, 2002). In previous studies investigating the association between rumination and lameness, no definitive differences between lame and sound animals have been identified, possibly because rumination measurement was carried out using visual observations of behaviour over relatively short periods of time and/or across relatively small numbers of animals (Hassall et al., 1993; Singh et al., 1993; Almeida et al., 2008; Pavlenko et al., 2011). An AMS relies on the willingness of the cow to attend the robot by receiving a feed reward when milking (Prescott et al., 1998). Overall studies on lame cows in AMSs in other parts of the world have demonstrated that they visited the milking units less frequently compared to sound animals (Klaas et al., 2003; Bach et al., 2007; Borderas et al., 2008).

Technologies on AMS and other modern dairy farms are monitoring and recording increasing amounts of data on the behaviour of animals. These data have the potential to be used as early indicators for diseases such as lameness and allow us to better understand the secondary health and welfare consequences lameness may have on animals suffering from this painful condition. Three independent observational studies were carried out to assess the impact of lameness on the behaviour of zero grazed high yielding cows housed in an AMS. The aim of the first study was to examine the impact of lameness on rumination time, monitored continuously by rumination collars. The second study investigated differences between lame and sound dairy cows in total eating time over a 24 h period. Finally, the third study assessed the impact of lameness on milking behaviour (frequency and time of visits to the AMS). In each study the null hypothesis stated that there was no difference in behaviour between lame and sound animals.

2. Materials and methods

2.1. Animals and housing

The studies were conducted on a 200 Holstein cows AMS unit, located in the midlands region of the UK, with an average milk yield per cow of approximately 11,500 L per 305 days. All study protocols were reviewed and approved by the University of Nottingham's School of Veterinary Medicine and Science Ethical Review Committee before data collection began.

The unit consisted of four pens, each housing approximately 45 cows. Each pen consisted of three rows of free-stalls bedded with a thin layer of sawdust on a mattress base and one AMS (Lely Astronaut A3, Lely UK Ltd., St Neots, UK). Three of the four pens (Pen 2, 3 and 4) had 59 stalls and the remaining pen (Pen 1) contained 76 stalls. All walking and standing areas were covered with rubber matting (Kraiburg, Kitt Ltd., UK); passageways were cleaned once per hour by automatic scrappers. Cows had free access to the AMS at any time; a maximum of 5 milking visits per cow per day was permitted. The maximum interval allowed between milking visits was set at 12 h. Milking attendance was monitored twice a day (at approximately 07:00 and 15:00 h) and cows were selected if their visit frequency was inadequate (based on their days in milk, parity and yield). Selected individuals were identified and moved to the robot for milking.

Fresh feed was provided as a mixed ration once per day at approximately 08:30; ration was pushed up at 10:00, 12:00, 14:00, 17:00, 20:00 and 06:00. Feed was provided along one side of each pen (approximately 37 m) and each pen contained two large water troughs. In addition, cows were provided with an individual concentrate ration (1.5 kg/day) adjusted to the frequency of milking visits, in the AMS. If the cow produced more than 23 L/day, an additional 0.16 kg per each extra litre of milk was provided.

The farm had a lameness prevention and control plan in operation; all feet of all animals were trimmed every five months by a fully qualified foot trimmer. Additionally any animals that became lame were identified and treated as soon as possible by farm staff. Lactation cows walked through a foot bath containing 5% copper sulphate placed at the AMS exit for at least one day per week. Finally, the diet was fortified with 20 mg of Biotin per cow per day to aid in the prevention of claw horn lesions.

2.2. General experimental procedures

2.2.1. Locomotion score

For all the experiments, locomotion scoring was carried out following the UK industry standard four point system