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Integrating an automated activity monitor into an artificial insemination program and the associated risk factors affecting reproductive performance of dairy cows

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ABSTRACT

The aim of this study was to compare 2 reproductive programs for the management of first postpartum artificial insemination (AI) based on activity monitors and timed AI, as well as to determine the effect of health-related factors on detection and expression of estrus. Lactating Holstein cows (n = 918) from 2 commercial farms were enrolled. Estrous cycles of all cows were presynchronized with 2 injections of $PGF_{2\alpha}$ administered 2 wk apart. Treatments were (1) first insemination performed by timed AI (TAI) and (2) first insemination based upon the detection of estrus by activity monitors (ACT; Heatime, SCR Engineering, Netanya, Israel) after the presynchronization, whereas cows not inseminated by the detection of estrus were enrolled in the Ovsynch protocol. Body condition score (BCS; scale 1 to 5), hock score (scale: 1 to 4), gait score (scale: 1 to 4), and corpus luteum presence detected by ovarian ultrasonography were recorded twice during the presynchronization. On the ACT treatment, 50.5% of cows were inseminated based on detected estrus, whereas 83.2% of the cows on the TAI treatment were inseminated appropriately after the timed AI protocol. Pregnancy per AI did not differ by treatment (30.8 vs. 33.5% for ACT and TAI, respectively). Success of pregnancy was affected by parity, cyclicity, BCS, milk production, and a tendency for leg health. In addition, treatment × cyclicity and treatment × parity interactions were found to affect pregnancy success, where anovulatory cows and older cows had compromised pregnancy outcomes on the ACT treatment but not on the TAI treatment. Factors affecting pregnancy outcomes varied among farms. Hazard of pregnancy by 300 DIM was affected by farm, parity, BCS, a treatment × cyclicity interaction, and a tendency for an interaction between leg health and farm. Detection of estrus was affected by farm, parity, cyclicity, and leg health, but not BCS or milk production. Expression of estrus was compromised in anovular and older cows, and by the timing of the estrus event, but not by gait score, BCS, or milk production. Increased duration of estrus, but not intensity of estrus, improved pregnancy per AI. In conclusion, using an automated activity monitor for the detection of estrus within a Presynch-Ovsynch program resulted in similar pregnancy per AI and days open compared with a reproduction program that was strictly based on timed AI for first postpartum AI. In contrast, notable variations in reproductive outcomes were detected between farms, suggesting that the use of automated activity monitors is prone to individual farm management.
Key words: dairy cow, automated activity monitor, timed artificial insemination, health

INTRODUCTION

The dairy industry significantly relies on timed AI protocols to synchronize ovulation or estrus for postpartum AI. Surveys have indicated that approximately 75 and 21% of herds implement an estrus or ovulation synchronization program for the first postpartum AI in the United States and Canada, respectively (Caraviello et al., 2006; Denis-Robichaud et al., 2016). Because of increasing evidence of poor detection of estrus resulting from poor or unidentified expression of estrus (Stevenson, 2001), use of synchronization programs has significantly improved AI submission rates (Chebel et al., 2010) and reduced the duration and variability of the interval from calving to first service (Stevenson, 2001). Although evidence that breeding cows at the time of estrus may result in greater (Tenhagen et al., 2004a; Stevenson and Phatak, 2005; DeJarnette et al., 2001) or similar (DeJarnette et al., 2001) conception rates compared with Ovsynch-like timed AI protocols, overall pregnancy rates are often greater (Cartmill et al., 2001; Cerri et al., 2004) for timed AI protocols be-

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cause all cows are submitted to AI. Synchronization of ovulation allows for management practices to reduce time needed for visual observation of estrus and creates a fixed schedule of AI allowing better planning and use of labor resources. Compliance to injection schedules has been identified as a problem in carrying out protocols successfully (Stevenson and Phatak, 2005).

In spite of the success observed in timed AI programs, concern has increased about the extensive use of hormone therapies in animal production. The dairy industry is not an exception to this trend (Pieper et al., 2016), and more interest from commercial farms and research institutions have aimed to better rationalize the use of pharmacological interventions in reproductive programs (Saint-Dizier and Chastant-Maillard, 2012). The challenge, nonetheless, is to achieve overall herd fertility similar to currently adopted reproductive programs.

In recent years, automated estrus-detection systems, such as pedometers and accelerometers, have become more reliable, with evidence that they are able to correctly identify cattle in estrus (Roelofs et al., 2005; Hockey et al., 2010; Løvendahl and Chagunda, 2010) and properly indicate insemination times by predicting the timing of ovulation (Roelofs et al., 2005; Stevenson et al., 2014). Previous studies have indicated that if detection of estrus can be performed more frequently and during night hours, it reduces the proportion of cattle with unobserved estrus episodes (Hall et al., 1959; Van Vliet and Van Eerdenburg, 1996; Roelofs et al., 2005). Furthermore, Chebel and Santos (2010) demonstrated that visual detection of estrus assisted by tail chalk removal in addition to a timed AI protocol did not result in significantly different pregnancies per AI compared with cows that were subjected to timed AI protocols alone. In fact, a recent survey across Canada demonstrated that dairy producers that adopted automated activity monitors (**AAM**) found an increase in pregnancy risk from 14.9 to 17.0 between the year before and year after adoption of the AAM (Neves and LeBlanc, 2015). In summary, the incorporation of detection for estrus ("cherry-picking") in timed AI-based reproductive programs has been common practice for many years, but the introduction of AAM has the potential to further minimize pharmacological interventions for efficient breeding programs.

Although strong evidence exists that AAM are capable of detecting cows in estrus, factors that may affect their efficiency are still unclear. Lameness has been shown to decrease walking activity during estrus (Walker et al., 2008) and decrease the number of standing mounts in a given estrus episode (Diskin and Sreenan, 2000). In addition, BCS has also been reported to decrease the expression of estrus (Roelofs et al., 2010; Madureira et al., 2015). Although effects of physical health have been reported using visual observation of estrus behaviors, it is still unclear if factors of physical health also affect the expression of estrus as measured by AAM.

The objective of our study was to investigate the effect of integrating the use of AAM in conjunction with a timed AI protocol on submission rates and pregnancy per AI compared with solely using a timed AI protocol for first AI. Furthermore, we investigated the effects of parity, BCS, milk production, and gait and hock lesion scores on the expression of estrus, as measured by AAM, and the previously mentioned reproductive program treatments.

MATERIALS AND METHODS

This experiment was conducted between September 2012 and July 2014 at the University of British Columbia's Dairy Education and Research Centre (farm A; Agassiz, BC, Canada) as well as a local commercial dairy farm (farm B) in Dewdney (BC, Canada). All procedures were approved by the Animal Care Committee of the University of British Columbia. The cattle used in this experiment were cared for as outlined by the guidelines provided by the Canadian Council of Animal Care (2009).

Animals and Housing

A total of 918 high-producing Holstein dairy cows were enrolled in this study from 2 different herds (farm A: n = 466; farm B: n = 452). The rolling herd average size of each farm was 260 and 350 cows for farms A and B, respectively. Cows produced 12,195 ± 2,145 (farm A) and 12,965 ± 2,215 (farm B) kg of milk (mean ± SD 305-d mature-equivalent yield) and had a range of BCS from 2 to 4 on both farms at 40 ± 7 DIM. Cows from farm A were housed in a naturally ventilated wooden-framed barn with a freestall design, equipped with deep sand-bedded stalls. Cows were milked twice daily at 0500 and 1500 h with automatic milking machines. Cows from farm B were housed in a naturally ventilated wooden-framed barn equipped with fans and a freestall design; stalls were equipped with mattresses and bedded with sawdust. Farm B milked 3 times daily at 0400, 1200, and 1600 h with automatic milking machines. Fresh TMR was delivered twice daily on both farms at approximately 0700 and 1600 h. The TMR was formulated following the NRC (2001) guidelines to meet or exceed the requirements of a 620-kg Holstein cow producing 40 kg/d of 3.5% FCM. All cows had ad libitum access to both TMR and water.