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Reproductive performance of lactating dairy cows managed for first service using timed artificial insemination with or without detection of estrus using an activity-monitoring system

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ABSTRACT

Lactating dairy cows (n = 1,025) on a commercial dairy farm were randomly assigned at 10 ± 3 d in milk (DIM) to 1 of 3 treatments for submitting cows to first artificial insemination (AI) and were fitted with activity-monitoring tags (Heatime; SCR Engineers Ltd., Netanya, Israel) at 24 ± 3 DIM. Cows (n = 339) in treatment 1 were inseminated based on increased activity from the end of the voluntary waiting period (50 DIM) until submission to an Ovsynch protocol; cows without increased activity from 21 to 65 DIM began an Ovsynch protocol at 65 ± 3 DIM, whereas cows without increased activity from 21 to 50 DIM but not from 51 to 79 DIM began an Ovsynch protocol at 79 ± 3 DIM. Cows (n = 340) in treatment 2 were inseminated based on activity after the second $PGF_{2\alpha}$ injection of a Presynch-Ovsynch protocol at 50 DIM, and cows without increased activity began an Ovsynch protocol at 65 ± 3 DIM. Cows (n = 346) in treatment 3 were monitored for activity after the second $PGF_{2\alpha}$ injection of a Presynch-Ovsynch protocol, but all cows received timed AI (TAI) at 75 ± 3 DIM after completing the Presynch-Ovsynch protocol. The activity-monitoring system detected increased activity in 56, 69, and 70% of cows in treatments 1, 2, and 3, respectively. Treatment-2 cows had the fewest average days to first AI (62.5), treatment-3 cows had the most average days to first AI (74.9), and treatment-1 cows had intermediate average days to first AI (67.4). Treatment-1 and -2 cows in which inseminations occurred as a combination between increased activity and TAI had fewer overall pregnancies per AI (P/AI) 35 d after AI (32% for both treatments) compared with treatment-3 cows, all of which received TAI after completing the Presynch-Ovsynch protocol (40%). Based on survival analysis, although the rate at which cows were inseminated differed among treatments, treatment did not affect the proportion of cows pregnant by 300 DIM. Thus, use of an activity-monitoring system to inseminate cows based on activity reduced days to first AI, whereas cows receiving 100% TAI after completing a Presynch-Ovsynch protocol had more P/AI. The trade-off between AI service rate and P/AI in the rate at which cows became pregnant was supported by an economic analysis in which the net present value ($/cow per year) differed by only $4 to $8 among treatments. We conclude that a variety of strategies using a combination of AI based on increased activity using an activity-monitoring system and synchronization of ovulation and TAI can be used to submit cows for first AI.
Key words: estrus detection, activity monitoring system, timed artificial insemination

INTRODUCTION

Although hormonal synchronization protocols that allow for timed AI (**TAI**) in lactating dairy cows have been widely adopted, AI based on detection of estrus plays an important role in the overall reproductive management program on most dairies in the United States (Caraviello et al., 2006; Miller et al., 2007). Increased physical activity is a secondary sign of estrus in cattle, and automated electronic systems that incorporate activity monitoring as a means to associate increased physical activity with estrous behavior and timing of AI in cattle have been developed and marketed to the dairy industry (Holman et al., 2011; Jónsson et al., 2011; Valenza et al., 2012). New technologies for detection of estrus, however, must be practically integrated into a systematic reproductive management strategy and empirically evaluated to determine the usefulness and economics of these technologies for improving reproductive performance. Although some experiments have assessed this new technology under field conditions (Neves et al., 2012; Valenza et al., 2012), within-farm treatment comparisons are needed to determine the efficacy and economic outcomes of the management strategies that combine detection of activity and synchronized breeding programs.

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Based on an analysis using 5,818 records from 13 studies in 8 dairy herds in the United States, the rate of anovulation in lactating Holstein cows averaged 23% at 50 to 65 DIM (Bamber et al., 2009), a time coinciding with the end of the voluntary waiting period (**VWP**) and onset of AI breeding to detected estrus or TAI, or both, in most herds. Furthermore, only 71% of lactating Holstein cows in which estrus was synchronized were detected with increased activity by an activity-monitoring system and ovulated (Valenza et al., 2012). Although anovular cows submitted to a protocol for synchronization of ovulation and TAI have reduced fertility and more pregnancy losses than their cycling herd mates (Santos et al., 2004a,b; Sterry et al., 2006), many anovular cows submitted to synchronization of ovulation and TAI conceive and maintain pregnancy. Thus, a combined approach in which insemination is based both on activity detected by an automated monitoring system followed by submission of cows not detected with activity to TAI after synchronization of ovulation may be an effective and economical strategy to submit lactating dairy cows for first AI.

Our objective was to compare reproductive performance of lactating dairy cows managed for first AI using TAI with or without detection of estrus using an activity-monitoring system on a commercial dairy farm. Three reproductive management strategies were compared to assess the percentage of cows detected with increased activity based on the activity-monitoring system and to assess the fertility of cows inseminated based on activity versus TAI after synchronization of ovulation. Our overall hypothesis was that reproductive performance would be similar among the 3 treatments. From a physiological perspective, our hypothesis was that cows inseminated based on detected activity after the second $PGF_{2\alpha}$ injection of a Presynch-Ovsynch protocol would have lower fertility compared with cows detected in estrus after the second $PGF_{2\alpha}$ injection of a Presynch-Ovsynch protocol but submitted to receive TAI after completing the protocol. Finally, we compared the economics of the 3 programs based on a simulation study using a decision-support system that accounts for the cost and revenue associated with different reproductive management programs for dairy herds (Giordano et al., 2012).

MATERIALS AND METHODS

Cows, Housing, and Feeding

This study was conducted from June 2011 to October 2012 on a commercial dairy farm milking approximately 1,000 cows located near Lancaster, Wisconsin. Lactating Holstein cows (n = 1,025; 387 primiparous and 638 multiparous) were enrolled into the study on a weekly basis. Cows were milked 3 times daily and were fed a TMR once daily that was formulated to meet or exceed minimum nutritional requirements for high-producing dairy cows (NRC, 2001). The rolling herd average of the farm during the experiment was approximately 44 kg of milk per cow per day, with 3.8% fat and 3.1% protein. Cows were housed in sand-bedded freestall barns and were handled to receive hormonal injections for synchronization of estrus and ovulation and for inseminations using an automatic sort gate and palpation rail system after exiting the milking parlor. All cows received injections of bovine somatotropin (Posilac, 500 mg; Elanco Animal Health, Indianapolis, IN) at 14-d intervals beginning at approximately 60 DIM until dry-off. All procedures were approved by the Animal Care and Use Committee of the College of Agricultural and Life Sciences of the University of Wisconsin-Madison.

Detection of Activity and AI

Lactating dairy cows (n = 1,025) were fitted with activity-monitoring tags (Heatime; SCR Engineers Ltd., Netanya, Israel) at 24 ± 3 DIM upon exiting the post-fresh pen. Before each milking, data collected by the activity-monitoring system was read by a transceiver unit placed on an archway at the milking parlor entrance and recorded by the activity-monitoring system software (Data Flow 1 version 4.7; SCR Engineers Ltd.) installed on an on-farm computer. All settings of the herd-management software were based on those being used by the farm at initiation of the experiment as described in detail elsewhere (Valenza et al., 2012). The software threshold to alert that cows were possibly in estrus was set at 4.7, and software settings were not changed during the course of the experiment.

Inseminations were performed based on increased activity detected by the activity-monitoring system or TAI, according to the respective treatments (described below) by 2 herd inseminators. Twice daily (after the first (0700 to 0900 h) and second (1400 to 1700 h) milkings, a list of cows with activity levels that exceeded the system threshold to consider a cow in estrus was generated by the activity-monitoring system software. Individual cows were inseminated once based on activity or at a fixed time after a synchronization-of-ovulation protocol (i.e., TAI). Cows inseminated to increased activity were not reinseminated if they appeared on a subsequent list of cows to be inseminated. Inseminations based on synchronization of ovulation and TAI were conducted once per week. Ovulation was synchronized using GnRH (100 μg of gonadorelin diacetate tetrahydrate; Fertagyl; Intervet Animal Health, Millsboro,