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# Performance of automated activity monitoring systems used in combination with timed artificial insemination compared to timed artificial insemination only in early lactation in dairy cows

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## ABSTRACT

Identifying cows in estrus remains a challenge on dairy cattle farms, and tools and technologies have been developed and used to complement or replace visual detection of estrus. Automated activity monitoring (AAM) systems and timed artificial insemination (TAI) are technologies available to dairy farmers, but many factors can influence their relative performance. The objective of the present study was to compare reproductive performance of cows managed with an AAM system combined with TAI, or with a TAI program (Double Ovsynch) for insemination before 88 DIM. From April 2014 to April 2015, 998 cows from 2 herds were randomly assigned either to be inseminated at 85 ± 3 DIM exclusively using the Double Ovsynch protocol for TAI, or to be inseminated based on estrus detection by AAM without hormonal intervention between 50 and 75 DIM; if no alarm was detected by 75 DIM, cows were inseminated following the single Ovsynch protocol (AAM + Ovsynch). The herds used different AAM systems. Parity, hyperketonemia at wk 1 and 2 postpartum (PP), purulent vaginal discharge at wk 5 PP, body condition score at wk 7 PP, and anovulation to wk 9 PP were recorded. These health indicators did not significantly differ between treatments, but did between herds. The effect of treatment on pregnancy at first insemination and by 88 DIM were assessed using logistic regression models. Time to pregnancy was assessed using survival analysis. Results are reported from intention-to-treat analyses. Treatment did not affect pregnancy at first insemination or pregnancy by 88 DIM, but we found significant interactions between treatment and herd for both outcomes. In herd 2, marginal mean pregnancy at first AI was greater with Double Ovsynch (38%) than AAM + Ovsynch (31%), but no difference was observed in herd 1 (Double Ovsynch = 31%; AAM + Ovsynch = 34%). By 88 DIM, a smaller proportion of cows in herd 1 were pregnant in Double Ovsynch (31%) than AAM + Ovsynch (49%), but there was no difference in herd 2 (Double Ovsynch = 38%; AAM + Ovsynch = 38%). We observed a treatment by herd interaction for median (95% confidence interval) time to pregnancy, which were, in herd 1, 110 (106 to 129) and 98 (88 to 113) d, and, in herd 2, 126 (113 to 139) and 116 (105 to 131) d for the Double Ovsynch and AAM + Ovsynch treatments, respectively. The relative performance of AAM-based reproductive management compared with TAI only is likely influenced by herd-specific variables, in particular related to insemination rate when estrus detection is employed.
**Key words:** automated activity monitors, Double Ovsynch, estrus, reproductive management

## INTRODUCTION

Reproductive performance in dairy cows has a large effect on herd profitability and efficiency of production. Prolonged postpartum anovulation is a challenge, as it is associated with extended time to first insemination and decreased conception risk (Gümen et al., 2003; Walsh et al., 2007), and typically affects 20% of cows in dairy herds (Walsh et al., 2007; Dubuc and Denis-Robichaud, 2017). For estrous cycling cows, the challenge resides in the ability to detect cows in estrus because of low frequency and duration of primary signs of estrus (Lopez et al., 2004; Madureira et al., 2015), or due to lack of time and visual detection skills on part of the herd personnel (Denis-Robichaud, 2016). In the last 20 yr, tools and technologies have been developed and implemented to overcome these hurdles. For example, the use of reproductive hormones to increase insemination rate is now common on dairy farms in North America (Caraviello et al., 2006; Ferguson and Skidmore, 2013), and timed artificial insemination (**TAI**) programs have been refined to increase the probability

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of pregnancy per AI (**P/AI**). Many such synchronization programs are available, and recent studies suggest the Double Ovsynch protocol offers good performance for first TAI, especially in primiparous cows (Souza et al., 2008; Herlihy et al., 2012).

The first reported use of automated activity monitoring (**AAM**) systems was 4 decades ago (Kiddy, 1977). Their use has since been refined (At-Taras and Spahr, 2001; Firk et al., 2002; Løvendahl and Chagunda, 2010), and their performance, when used in combination with TAI, has been, on average, comparable to TAI in recent clinical trials (Neves et al., 2012; Fricke et al., 2014; Dolecheck et al., 2016). For first AI, AAM systems were used to identify cows in estrus between the voluntary waiting period (**VWP**) and possible enrolment in an Ovsynch protocol, 12 or 46 d later (Neves et al., 2012; Fricke et al., 2014; Dolecheck et al., 2016). When employing AAM, not all cows will be detected in estrus within an economically desirable time, but this interval is not well defined. If a goal is to maximize the use of AAM, it is likely necessary to wait for the length of an estrous cycle so all cows have a chance to be detected in estrus by the system once. The estrous cycle of dairy cows was traditionally reported to be approximately 21 d in length (Hartigan, 2004), but recent studies suggest the interovulatory interval varies from 18 to 28 d (mode = 22 d; Sartori et al., 2004; Remnant et al., 2015). To identify most cyclic cows using an AAM system in the period following the VWP, the system should be used for long enough to include the interovulatory interval of most cows. In previous studies, 22 to 31% of cows were not detected in estrus in that period (Fricke et al., 2014; Dolecheck et al., 2016), so AAM likely needs to be complemented with use of some TAI. To quantify the performance of AAM systems on commercial dairy farms, it is useful to compare reproductive performance with an AAM system combined with TAI to the exclusive use of the Double Ovsynch protocol, which has a high P/AI relative to other TAI protocols (Souza et al., 2008; Herlihy et al., 2012). Although previous studies showed that the use of AAM system in combination with TAI resulted in similar overall performance to the use of TAI alone (Neves et al., 2012; Fricke et al., 2014; Dolecheck et al., 2016), for the present study we hypothesized that the AAM system combined with TAI would have less P/AI than Double Ovsynch,. The objective of our study was to compare reproductive performance of cows managed with 1 of 2 reproduction management programs in the early breeding period: exclusive use of Double Ovsynch for first AI, or an AAM system combined with TAI for cows not inseminated based on AAM after 25 d following the VWP.

## MATERIALS AND METHODS

### Cows and Housing

This study was evaluated and approved by the University of Guelph Animal Care Committee (Animal Utilization Protocol #2676). From April 2014 to June 2015, a randomized controlled trial was conducted in a convenience sample of 2 commercial freestall herds with Holstein cows in Ontario, Canada. The average (and maximal) temperature in spring, summer, fall, and winter were 12.2 (31.2), 16.7 (30.0), 2.8 (22.4), and −9.3 (9.8)°C, respectively. During this period, herds 1 and 2 had, on average, 655 and 530 milking cows and an average herd 305-d mature-equivalent milk production from DHIA records of 12,880 and 11,430 kg, respectively. For cows inseminated after an AAM alarm, both herds inseminated cows following an a.m.-p.m. schedule (i.e., the insemination was performed the morning following an afternoon or evening alarm or in the afternoon following a morning or mid-day alarm). According to our hypothesis, we aimed to enroll 1,050 cows to identify a difference in pregnancy at first AI of 32 versus 41%, with 95% confidence, 80% power, and a 15% loss to follow-up, so as to have 448 cows in each treatment for analysis of first service P/AI (Abramson, 2011). Both herds milked 3 times per day. All cows, regardless of their treatment, were equipped with an AAM device within 1 wk postpartum (**PP**): AfiAct (AfiMilk, Kibbutz Afikim, Israel) in herd 1, and HeatSeeker (BouMatic, Madison, WI) in herd 2. Both systems were in use on the farms for over 1 yr before the study, and system settings that were being used before the study were retained. Both farms were also using TAI protocols to complement AAM before the experiment, but not the Double Ovsynch protocol. To ensure that the TAI protocols were correctly implemented, we provided injection and insemination lists weekly and verbally confirmed that these were followed with the person responsible for reproduction management in each herd.

### Treatments

Cows were assigned to treatments weekly according to their identification number that was assigned sequentially at birth or at first calving in herd 1 and 2, respectively. The Double Ovsynch treatment consisted of insemination at 85 ± 3 DIM using the Double Ovsynch protocol (GnRH – 7 d – $PGF_{2\alpha}$ – 3 d – GnRH – 7 d – GnRH – 7 d – $PGF_{2\alpha}$ – 56 h – GnRH – 12 to 16 h – AI). Treatment based on AAM (AAM + Ovsynch) consisted of cows inseminated only based on AAM alarm between 50 and 75 DIM; if no alarm was