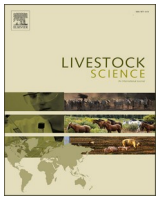
Livestock Science 260 (2022) 104944

Contents lists available at ScienceDirect

Livestock Science

journal homepage: www.elsevier.com/locate/livsci



Short communication

Activity and rumination changes as predictors of calving in primiparous and multiparous Holstein cows

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HIGHLIGHTS

- Dairy cows were fitted with a collar-mounted automated activity monitor.
- Rumination decreased starting at 10 h before calving.
- Activity increased starting at 8 h before calving.
- Activity was greater in primiparous compared to multiparous cows.
- Behaviour change before calving was delayed in multiparous cows.

ARTICLE INFO

Keywords:
Automated activity monitor
Primiparous
Multiparous
Dairy cows

ABSTRACT

The objective of this study was to investigate if rumination and activity changes determined by an automated activity monitoring system (AAM) could be use as predictors of calving in Holstein cattle. A total of 94 Holstein cows (67 primiparous and 27 multiparous) were enroled in the study. Approximately 21 d before their expected calving date cows were moved into the pre-partum pen and fitted with a collar-mounted AAM (Heatime®, SCR Engineers). Rumination and activity behaviour were monitored continuously by the AAM and recorded every 2 h. Cameras were used to record calving time. Rumination and activity data from 100 h prior to calving to 6 h after calving were analysed using the PROC MIXED procedure in SAS. Mean rumination did not differ between parities, but primiparous cows had higher activity than multiparous cows during the entire study ($P = 0.0002$, 37.3 ± 0.5 vs. 33.4 ± 0.8 arbitrary units). Rumination began to decline steadily from -10 h in both parity groups and nadir was reached at 0 h and -2 h in primiparous and multiparous cows, respectively. The rumination arbitrary units and % changes between -10 h and nadir were 26.7 and 64.2% ($P < 0.001$) and 30.6 and 80.5% ($P < 0.0001$) for primiparous and multiparous cows, respectively. Activity started to increase steadily from -8 h in both parity groups, the highest activity change was reached at 0 h and -2 h in primiparous and multiparous cows, respectively. The activity arbitrary units and % changes between -8 h and the highest measure were 10.0 and 26.4% ($P < 0.0001$) and 6.6 and 20.0% ($P = 0.0002$) for primiparous and multiparous cows, respectively. In summary, both rumination and activity changes as measured by a collar-mounted AAM could be used as indicators for calving, with considerations made for the association of parity with both the degree and timing of behaviour change relative to calving.

1. Introduction

The time of calving is critical for the dairy cow, and calf, in order to transition into a successful lactation. Dystocia, or a difficult calving, is associated with a number of negative impacts on health and performance including an increased risk of retained foetal membranes (LeBlanc, 2008), metritis (Huzzey et al., 2007) and displaced abomasum (LeBlanc et al., 2005), in addition to increased risk of culling (Roberts et al., 2012) and reduced milk yield in early lactation (Chapinal et al., 2012). While producers often must rely on visual observation of

Abbreviations: AAM, automated activity monitoring.

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https://doi.org/10.1016/j.livsci.2022.104944
Received 20 December 2021; Received in revised form 8 April 2022; Accepted 12 April 2022
Available online 14 April 2022

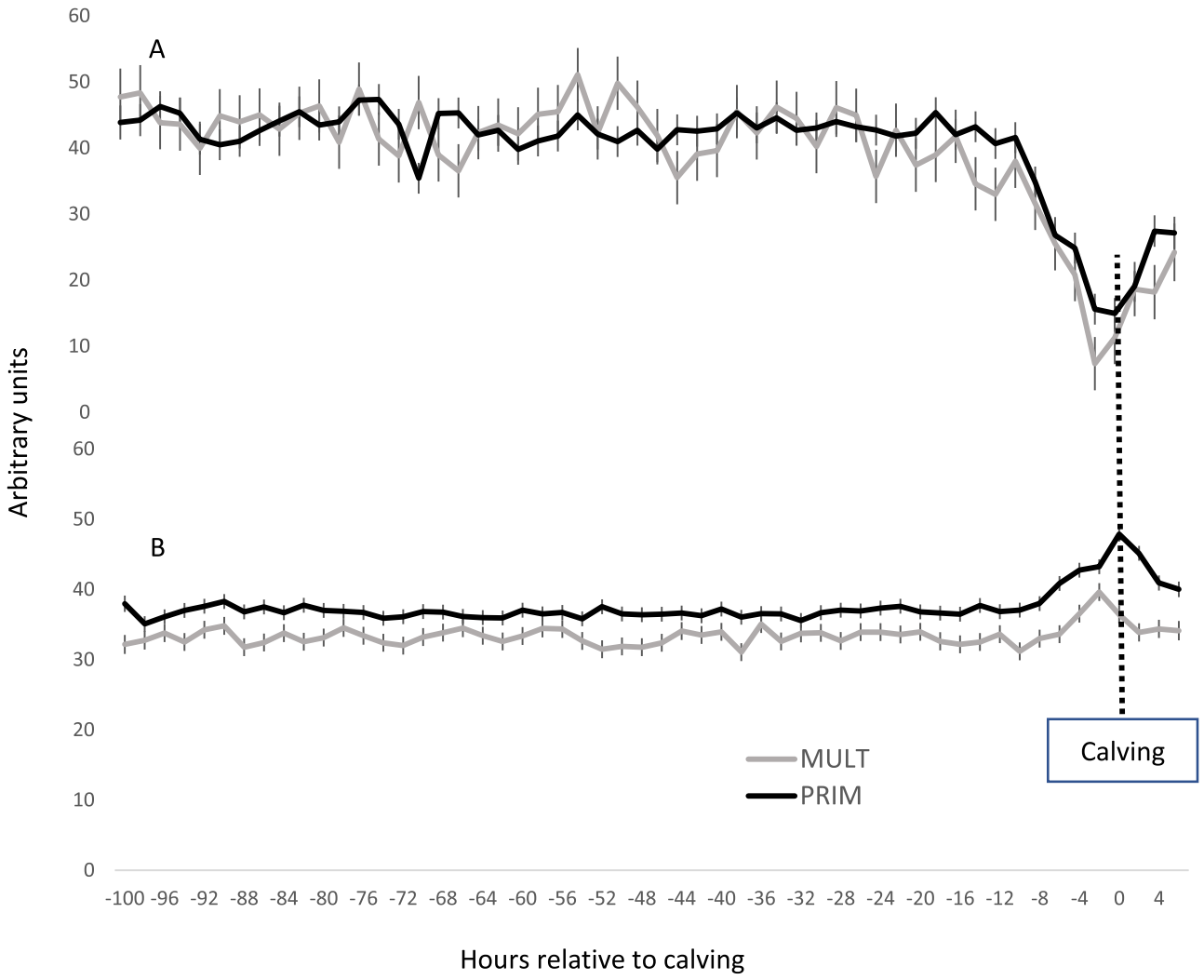

Fig. 1. Least squared means (± SEM) of rumination (A) and activity (B) measured as arbitrary units in 2 h time blocks via a collar-mounted automated activity monitor in 67 primiparous (PRIM) and 27 multiparous (MULT) Holstein cows from 100 h prior to calving to 6 h after calving.

prepartum cattle to identify signs of calving, there has been a recent movement to automated monitoring systems to monitor behaviour, including possible indicators of calving. Crociati et al. (2020) compared dairy cattle either monitored or unmonitored by an intravaginal calving alarm system over a 7-year period. These authors reported an increased incidence of calf death in unmonitored cows that was associated with increased risk for culling, reduced milk yield and increased days open. This indicates that the accurate monitoring of cows for calving and resulting timely assistance is important for cow health and performance in the subsequent lactation.

A number of recent studies have also been conducted using automated activity monitoring (AAM) systems to determine if behaviours such as activity and rumination can be used as indicators of calving. In this regard, Miller et al. (2020) and Borchers et al. (2017) reported an increase in activity and a decrease in rumination time within the 24 h before calving. The objective of this study was to investigate the changes in rumination and activity in the days and hours before calving using a collar-mounted AAM, to determine the timeframe for which prediction of calving may be possible in primiparous and multiparous Holstein cows. Based on past literature, we anticipated the greatest change in the measured behaviours to occur between 8 and 5 h prior to calving.

2. Materials and methods

This was a retrospective study conducted on a commercial dairy farm located near Wetaskiwin, Alberta, Canada (53°02′54.0″N, 113°19′28.0″W) from October 2019 to February 2020. All experimental procedures used in this study were conducted according to the guidelines of the Canadian Council of Animal Care (CCAC, 2009).

2.1. Animals and procedures

A total of 94 Holstein cows (67 primiparous and 27 multiparous) were enrolled. Approximately 21 d before their expected calving date cows were moved into the pre-partum pen (1200 square feet) in groups of 10 cows. Cows were fitted with a collar-mounted AAM (Heatime®, SCR Engineers by Allflex, Netanya, Israel) 21 d before expected calving until 21 d after calving. Cameras were used to record calving time.

2.2. Statistical analyses

Changes in rumination and activity data from 100 h prior to calving (0 h) to 6 h after calving were analysed in a mixed model using the PROC MIXED (SAS version 9.4; SAS Institute Inc., Cary, NC, USA) procedure with hour relative to calving as a repeated measure and cow as a random effect. The model included hour relative to calving (–100 to 6 h), parity

Table 1
Least squared means and standard error of the mean (SEM) of rumination and activity measured as arbitrary units in 2 h time blocks via a collar-mounted automated activity monitor in 67 primiparous (PRIM) and 27 multiparous (MULT) Holstein cows from −10 h to 2 h relative to calving (0 h).

Parity	Measure	Hours relative to calving							SEM
		−10	−8	−6	−4	−2	0	2	
PRIM	Rumination	41.6[a]	34.9[b]	26.8[c]	24.9[c,e]	15.6[d]	14.9[d]	19.1[d,e]	2.3
MULT	Rumination	38.0[a]	31.6[a]	25.5[b]	20.9[b,d]	7.4[c]	11.3[c,d]	18.7[b,d]	4.0
PRIM	Activity	37.7[a]	37.9[a]	40.8[b]	42.7[b]	43.2[b]	47.9[c]	45.1[b,c]	1.1
MULT	Activity	31.2[a]	33.0[a]	33.7[a,b]	36.6[b]	39.6[c]	36.4[b]	33.9[b]	1.3

a–eWithin a row, values without a common superscript differ significantly ($P < 0.05$).

(primiparous vs. multiparous), and their interaction. Data are presented as least squared means ± standard error of the mean (SEM).

3. Results

Mean rumination was not associated with parity ($P = 0.56$, 41.0 ± 0.8 vs. 40.3 ± 1.1 arbitrary units for primiparous and multiparous, respectively). However, mean activity was associated with parity, with primiparous cows having higher activity than multiparous cows during the entire study ($P = 0.0002$, 37.3 ± 0.5 vs. 33.4 ± 0.8 arbitrary units). Rumination changes were more variable in multiparous cows compared to primiparous cows (Fig. 1). Rumination began to decline steadily from −10 h in both parity groups and nadir was reached at 0 h and −2 h in primiparous and multiparous cows, respectively (Fig. 1). The first significant decrease in rumination was observed between −10 and −8 h in primiparous cows ($P = 0.03$, 6.7 arbitrary units and 16.1% change, Table 1) and between −8 and −6 h in multiparous cows ($P = 0.05$, 6.1 arbitrary units and 19.3% change, Table 1). The rumination arbitrary units and% changes between −10 h and nadir were 26.7 and 64.2% ($P < 0.001$) and 30.6 and 80.5% ($P < 0.0001$) for primiparous and multiparous cows, respectively (Table 1). Rumination started increasing at 2 h in primiparous cows and at 0 h in multiparous cows. Activity started to increase steadily from - 8 h in both parity groups and the highest activity change was reached at 0 h and −2 h in primiparous and multiparous cows, respectively (Fig. 1). The first significant increase in activity was observed between −8 and −6 h in primiparous cows ($P = 0.05$, 2.9 arbitrary units and 7.7% change, Table 1) and between −4 and −2 h in multiparous cows ($P = 0.07$, 3.0 arbitrary units and 8.2% change). The activity arbitrary units and% changes between −8 h and the highest measure were 10.0 and 26.4% ($P < 0.0001$) and 6.6 and 20.0% ($P = 0.0002$) for primiparous and multiparous cows (Table 1).

4. Discussion

The objective for this study was to investigate if the changes in activity and rumination as measured by a collar-mounted AAM were useful indicators of calving and to determine the timeline before calving in which the indicators were significant. An important consideration for evaluating calving indicators in an AAM is to determine any differences between multiparous and primiparous cows. In the current study, there was no difference in overall rumination during the study period between parities, but activity was greater in primiparous compared to multiparous cows. Previous studies have also reported no difference in rumination time between parities (Calamari et al., 2014; Borchers et al., 2017). While there was no difference in rumination between multiparous and primiparous cows in the current study, it is important to note that there was a delay in significant decrease in rumination of on average 2 h for multiparous compared with primiparous cows. This could be a key consideration when trying to predict time of calving using rumination. Regarding activity, while Borchers et al. (2017) did not find an overall difference in activity between parties, there was a significant increase in activity of primiparous compared to multiparous cows starting at −6 to 0 h relative to calving. The authors suggested that activity may be a more important indicator of calving for primiparous than multiparous cows, another key consideration for the prediction of calving. Similar to rumination in the current study, there was a delay in significant increase of activity before calving in multiparous compared to primiparous cows, of about 4 h. These results suggest that parity should be a consideration when using AAM to predict calving.

In the current study, rumination decline began around −10 h relative to calving and resulted in a decrease of 64 and 81% in rumination for primiparous and multiparous cows, respectively. There is some variation in the time of rumination decline in previous literature, with a range of about −10 to −5 h relative to calving (Pahl et al., 2014; Borchers et al., 2017; Miller et al., 2020). There is also some variation in the degree to which rumination declines before calving, with a range of 15 to 70% (Schirmann et al., 2013; Calamari et al., 2014; Clark et al., 2015). These differences could be due to the use of different AAM, which include different algorithms for measuring and calculating rumination, as well as differences among cattle. In the current study, activity significantly increased between −6 to −4 h before calving, which is similar to previous literature that reported increased activity at a range of −6 to −5 h before calving (Jensen et al., 2012; Borchers et al., 2017; Miller et al., 2020). The degree of increased activity was greater in previous studies compared to the current study, with an average of 50% in only primiparous cows (Borchers et al., 2017) and 52% in both primiparous and multiparous cows (Miller et al., 2020). These results indicate that while there is variation in rumination and activity measured among studies, both behaviours are useful indicators of calving.

In conclusion, the results indicate that rumination and activity changes as measured by a collar-mounted AAM, showed significant differences in the hours before calving. This indicates that both measures of behaviour could be used as indicators to predict calving. The current study also found that parity had a significant effect on overall activity and was associated with the timing of behaviour changes relative to calving. When using these indicators to predict calving, the method should consider that activity is reduced and that the change in both rumination and activity before calving was delayed in multiparous compared to primiparous cows. Overall, the collar mounted AAM may be a useful tool to predict calving and ensure timely assistance to dairy cows.

CRediT authorship contribution statement

K. Macmillan: Methodology, Investigation, Writing – original draft, Visualization. **M. Gobikrushanth:** Formal analysis, Investigation, Writing – review & editing, Visualization. **M.G. Colazo:** Conceptualization, Methodology, Investigation, Writing – review & editing, Supervision, Funding acquisition.

Declaration of Competing Interest

Authors declare no conflict of interest. Companies mentioned below had no influence on data selection and interpretation of results.

Acknowledgments

The authors would like to thank Alberta Agriculture and Forestry for financial support, and Breevliet Ltd. (Wetaskiwin, AB) and SCR by Allflex (USA) for assistance and technical support during the study.

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