Utilization of Automated Monitors of Daily Rumination Time and Activity for Diagnosis of Periparturient Diseases

Daniela N. Liboreiro[1] and Ricardo C. Chebel[2,3]
[1]Department of Animal Science, University of Minnesota, St Paul, 55108
[2]Department of Large Animal Clinical Sciences & [3]Department of Animal Sciences, University of Florida, Gainesville, 32608

INTRODUCTION

The peripartum period is very challenging to the dairy cow because of hormonal, metabolic and managerial changes. Dry matter intake, amount and daily variability, during the transition period is probably the most important factor affecting the health and performance of dairy cows (Grummer et al., 2004). Metritic cows have reduced prepartum feed intake, which is likely a predisposing factor for immunosuppression and greater susceptibility to uterine infections (Hammon et al., 2006; Huzzey et al., 2007). Furthermore, sub-clinical hypocalcemia is associated with fewer daily visits to the water trough and feed bins (Jawor et al., 2012) and reduced DMI (Martinez et al., 2014). Similarly, sub-clinical ketosis is associated with reduced DMI, reduced number of daily visits to the feeder and reduced time spent at the feeder (Goldhawk et al., 2009). Automated technologies for monitoring behavior of dairy cows have recently become more popular in the USA. Although rumination monitors (ex. HRLD tags, SCR Engineers Ltd., Netanya, Israel) are accurate in measuring rumination time (Schirmann et al., 2009), rumination time within a 2-h period is negatively correlated with DMI (Schirmann et al., 2012). These monitors, however, could potentially be used as tools for early diagnosis of periparturient events (e.g. calving) and peripartum health disorders. Schirmann et al. (2013) demonstrated that daily rumination time (**DRT**) decreased by approximately 63 and 133 min during the 24 h before and 24 h after calving, respectively. Therefore, it seems clear that the ability to monitor peripartum DMI and feeding behavior of individual cows and groups of cows could aid in the precocious identification of unhealthy cows and managerial deficiencies that predispose cows to such diseases.

Daily Rumination Time of Cows diagnosed with Periparturient Diseases

In a recent experiment, Holstein animals (nulliparous = 77, parous = 219) were fitted with individual rumination and activity loggers (HRLD, SCR Engineers Ltd., Netanya, Israel) from -21 to 21 ± 3 d relative to calving. Such systems record jaw movement using a microphone and record minutes of cud chewing in 2 h periods. Furthermore, the HRLD system determines level of activity of the animal based on a recorder of head movement. Rumination and activity data were summarized and analyzed on a daily basis.

Cows were scored for body condition and locomotion and blood samples were collected for determination of NEFA, BHBA and calcium concentrations. All cows were examined at 1, 7 ± 3 and 14 ± 3 DIM for diagnosis of retained fetal membrane and metritis. Cows were milked thrice daily and individual milk yield and milk conductivity data were recorded at each milking (AfiMilk, Kibbutz Afikim, Israel). Milk yield and conductivity data were collected daily in the first 21 DIM and weekly thereafter. To evaluate the correlation between DRT and milk yield, average milk yield in the first 90 DIM was compared with average DRT prepartum and postpartum.

Average prepartum DRT was correlated with average milk yield in the first 90 DIM (correlation: r = 0.27 (95% CI = 0.15, 0.37), $P < 0.01$). Similarly, average postpartum DRT was associated with average milk yield in the first 90 DIM (correlation: r = 0.42 (95% CI = 0.32, 0.52), $P < 0.01$).

Significant associations between DRT and peripartum disorders were observed. Importantly, animals that delivered stillborn calves had reduced DRT during the prepartum and postpartum periods (Figure 1). Cows diagnosed with sub-clinical hypocalcemia in the first 72 h postpartum had reduced DRT on the day of calving (Figure 2). Similarly, metritic cows had reduced DRT from 2 to 11 d postpartum compared with healthy cows (Figure 3). Furthermore, cows diagnosed with sub-clinical ketosis had reduced DRT from d 8 to 11 postpartum compared to healthy cows (Figure 4). During the prepartum period, activity of cows that delivered twins was reduced (430.8 ± 14.9 vs. 465.8 ± 4.1 arbitrary units) and cows that had stillborn calves (499.3 ± 16.2 vs 461.3 ± 4.1 arbitrary unit) was increased. This may suggest that the discomfort associated with twins, dystocia, and stillbirth results in increased activity of prepartum cows. Importantly, cows diagnosed with sub-clinical ketosis had reduced postpartum activity (502.2 ± 16.5 vs. 536.58 ± 6.2).

The recent experiment demonstrates that automated DRT and activity monitors may be a very useful tool for early identification of animals or groups of animals at higher risk for periparturient diseases (e.g. stillbirth, metabolic diseases, etc.). Actually, according to preliminary data from our group, it was possible to identify animals that would have stillborn calves based on prepartum DRT (sensitivity = 50, specificity = 79.7%). Based on DRT on the day of calving it was possible to identify cows at higher risk for sub-clinical hypocalcemia (sensitivity = 66.7, specificity = 61.3%). Among cows that were diagnosed with RP within 24 h after calving, DRT on d 3 after calving could be used to help identify cows at higher risk for metritis (sensitivity = 70.8, specificity = 75%). Although these are promising results, most epidemiologists would agree that tests with sensitivity and specificity < 90% are not suitable as the sole method for diagnosis of diseases. Therefore, herds that use automated DRT and activity monitors should use the data generated as an aid in the diagnosis of periparturient diseases.

Voluntary prepartum DMI is heavily influenced by genetics (Grummer et al., 2004) and some animal and diet characteristics (Hayrli et al., 2002). The low sensitivity and specificity of DRT to diagnose specific diseases may be due to the fact that DRT also may be affected by genetics and animal, environment and dietary factors. Hayrli et al. (2002) demonstrated that obese cows had reduced DMI during the prepartum period. In our experiment, cows with elevated body condition score -21 d relative to calving had reduced prepartum average DRT. Therefore, more studies are necessary to determine how genetics and animal, diet and environment characteristics affect DRT and activity.

CONCLUSIONS

Automated monitors of daily rumination and activity may help in the identification of cows at higher risk of periparturient diseases. Importantly, however, these systems may not be used as the sole diagnostic tool for diseases because sensitivity and specificity are often < 75% (ideal > 90%). It is very important to note that the raw DRT (min/d) may not be as good a tool to identify problems as the change in DRT because several animal, environmental, and dietary factors may affect DRT. Herds that adopt such systems should use the system to identify cows that have a significant decrease in DRT compared with the previous day, but all cows at risk for diseases (postpartum cows) should be observed visually by well-trained herdsmen. Another important use for such systems is the identification of groups of animals that have too much daily variability on DRT. A large experiment on 7 dairies in southern WI is being carried out by our group to determine how daily variability in DRT and activity of groups of cows may be used to determine when there is a risk for a greater proportion of such cows to develop periparturient problems.

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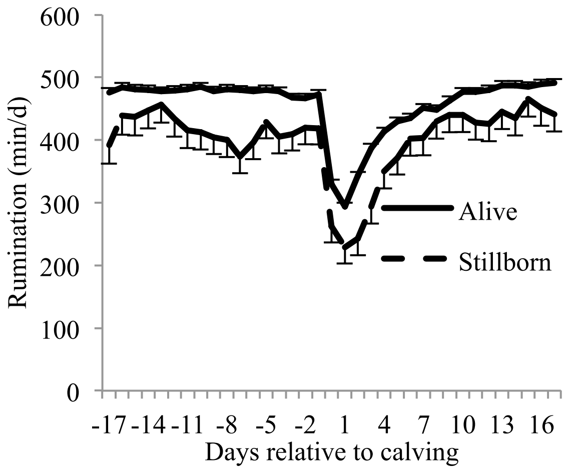

Figure 1. Association between occurrence of stillbirth and daily rumination time.

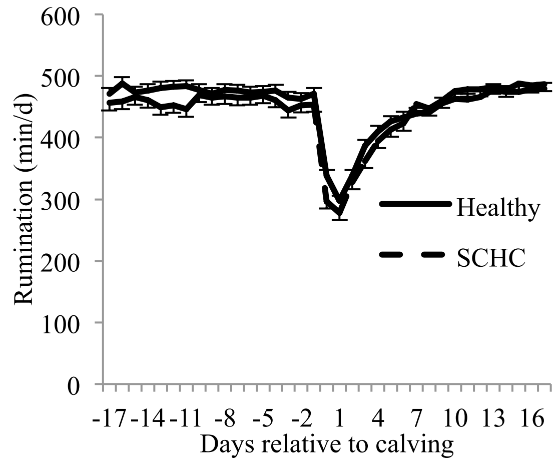

Figure 2. Association between occurrence of sub-clinical hypocalcemia (**SCHC**) and daily rumination time.

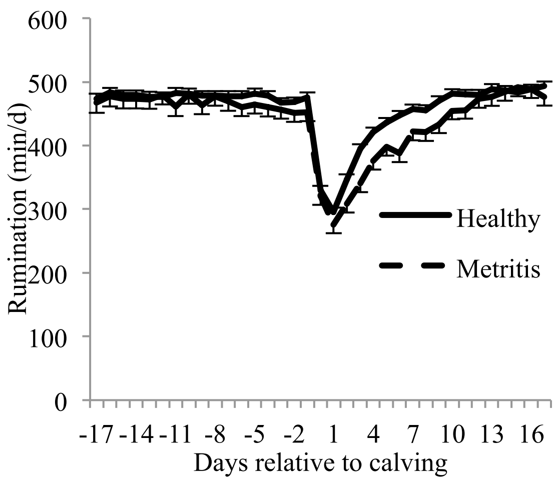

Figure 3. Association between occurrence of metritis and daily rumination time.

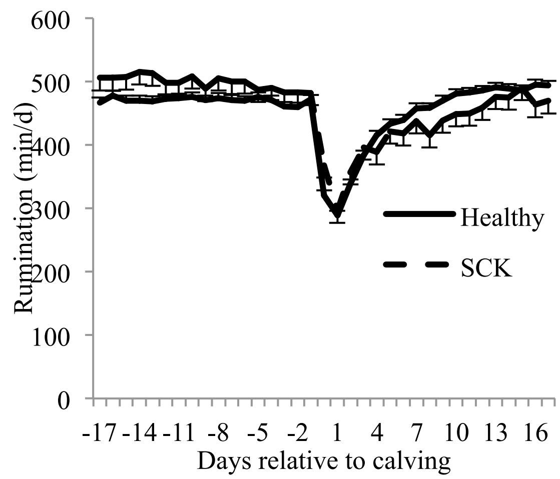

Figure 4. Association between occurrence of sub-clinical ketosis (**SCK**) and daily rumination time.

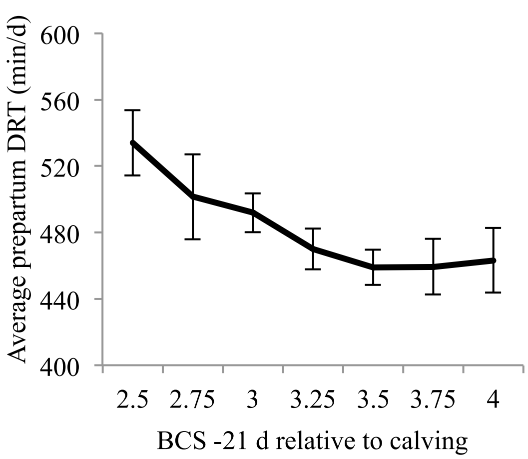

Figure 5. Association between body condition score (BCS) -21 d relative to calving and average prepartum daily rumination time (DRT)