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Characterization of peripartum rumination and activity of cows diagnosed with metabolic and uterine diseases

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ABSTRACT

The objectives of the current experiment were to characterize the correlation among total serum Ca, nonesterified fatty acids (NEFA), β -hydroxybutyrate (BHBA), and haptoglobin concentrations and daily rumination time (DRT) and activity of periparturient cows and to determine the association between periparturient events and peripartum DRT and activity. Holstein animals (nulliparous = 77, parous = 219) were enrolled in the experiment approximately 21 d before expected calving date. Cows were fitted with individual Heat Rumination Long Distance collars (HRLD, SCR Engineers Ltd., Netanya, Israel) from enrollment until approximately 21 \pm 3 d postpartum. Blood samples collected weekly from enrollment to 21 d postpartum were used to determine concentrations of NEFA, BHBA, and haptoglobin. Blood samples collected within 72 h after calving were used to determine total serum Ca concentration. Subclinical ketosis was characterized by BHBA >1,000 μ mol/L in any sample, and subclinical hypocalcemia was characterized by Ca <8.55 ng/dL within 72 h after calving. Cows were examined 1, 7 \pm 3, and 14 \pm 3 d postpartum for diagnosis of retained fetal membrane and metritis. Total Ca ($r = 0.15$), NEFA ($r = -0.27$), and haptoglobin ($r = -0.18$) concentrations were weakly correlated with DRT. Concentration of BHBA ($r = -0.14$) was weakly correlated with activity. Postpartum DRT was reduced among cows that delivered twins compared with cows that delivered singletons (437.9 \pm 4.8 vs. 385.9 \pm 17.1 min/d). Prepartum (465.8 \pm 4.1 vs 430.8 \pm 14.9 arbitrary units) and postpartum (536.5 \pm 5.5 vs. 480.3 \pm 19.4 arbitrary units) activity were reduced among cows that delivered twins compared with cows that delivered singletons. Delivery of stillborn calves was associated with reduced

DRT prepartum (478.0 \pm 5.9 vs. 417.0 \pm 23.4 min/d) and postpartum (437.2 \pm 4.8 vs. 386.5 \pm 19.3 min/d). On the other hand, cows delivering stillborn calves had increased activity prepartum compared with cows delivering live calves (499.3 \pm 16.2 vs. 461.3 \pm 4.1 arbitrary unit). Occurrence of retained fetal membrane tended to and was associated with reduced prepartum (444.3 \pm 11.0 vs. 466.5 \pm 4.3 arbitrary unit) and postpartum (488.2 \pm 14.5 vs. 538.8 \pm 5.7 arbitrary unit) activity, respectively. Cows diagnosed with metritis had reduced postpartum DRT (415.9 \pm 10.1 vs. 441.0 \pm 5.2 min/d) and activity (512.5 \pm 11.5 vs. 539.2 \pm 6.0 arbitrary unit). Postpartum activity was reduced among cows that were diagnosed with subclinical ketosis (502.20 \pm 16.5 vs. 536.6 \pm 6.2 arbitrary unit). Although differences in DRT and activity between populations of cows that developed periparturient diseases and healthy cows were observed, further experiments are necessary to determine how DRT and activity data may be used to precociously diagnose individuals that will develop such periparturient diseases.

Key words: periparturient cow, rumination, activity

INTRODUCTION

The peripartum period is very challenging to the dairy cow because of hormonal, metabolic, and managerial changes. The amount and daily variability in DMI during the transition period is probably the most important factor affecting the health and performance of dairy cows (Grummer et al., 2004). Previous research has shown that cows that develop metritis postpartum 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). Dry matter intake and feeding and lying behaviors are also associated with metabolic diseases and lameness. Cows that developed subclinical hypocalcemia within 24 h after calving tended to have fewer daily visits to the water trough and feed bins but

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few changes in standing time and DMI were observed (Jawor et al., 2012). When hypocalcemia was induced in nonpregnant nonlactating cows, DMI was reduced by approximately 45% within the period of induced hypocalcemia (Martinez et al., 2014). Goldhawk et al. (2009), using a BHBA threshold $>1,000 \mu\text{mol/L}$ for diagnosis of subclinical ketosis (**SCK**), demonstrated that cows diagnosed with SCK had reduced DMI, reduced number of daily visits to the feeder, and reduced time spent at the feeder. Edwards and Tozer (2004) demonstrated that the pattern of activity, measured by pedometry (Kibbutz Afikim, Israel), of cows that were diagnosed with displacement of abomasum and ketosis was different from the activity pattern of healthy cows. Therefore, it seems clear that the ability to monitor peripartum DMI, feeding behavior, and activity of individual cows and groups of cows could aid in the early identification of unhealthy cows and management deficiencies that predispose to such diseases.

Automated technologies for monitoring behavior of dairy cows have recently become more widely adopted in the United States. Recent experiments have demonstrated that the Heat Rumination Long Distance collars (**HRLD**, SCR Engineers Ltd., Netanya, Israel) is accurate in measuring rumination of different types of cows (prepartum and postpartum) compared with visual observation (Schirmann et al., 2009). Although the HRLD system was not able to correctly predict individual cows' DMI within a day and was actually negatively correlated with DMI within 2-h periods and with daily feeding time (Schirmann et al., 2012), changes in rumination over time are expected to reflect changes in DMI. Furthermore, these monitors could 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. Similarly, feeding time was decreased by approximately 66 and 82 min during the 24 h before and 24 h after calving, respectively (Schirmann et al., 2013).

The hypotheses of the current experiment were that peripartum DRT and activity are correlated with concentrations of metabolites (e.g., Ca, NEFA, and BHBA) and haptoglobin. Furthermore, we hypothesized that periparturient metabolic and infectious disorders are associated with DRT and activity. The objectives of the current experiment were to determine the correlation among concentrations of metabolites and haptoglobin and DRT and activity of periparturient cows and to characterize the periparturient DRT and activity patterns of cows diagnosed with metabolic and uterine disorders.

MATERIALS AND METHODS

Cows, Facilities, Management, and Nutrition

The experiment was conducted on one dairy farm in northwestern Wisconsin from July 2013 to April 2014, with Holstein animals enrolled from July 2013 to October 2013 and calving occurring from August 2013 to November 2013. Holstein animals (nulliparous = 77, parous = 219) were enrolled in the experiment at 258.3 ± 0.2 d of gestation (mean \pm SEM). During the prepartum period, animals were separated by parity (nulliparous vs. parous) and housed in 1 of 3 freestall pens with 3 rows of stalls. The barns were naturally ventilated and had artificial lighting. The stocking density ranged from 85 to 110% of headlocks in the pen of nulliparous animals and from 60 to 90% in the pens of parous animals. As animals demonstrated signs of calving (discomfort, restlessness, tail twitching, and visualization of the allantonic sac through the vulva), they were moved to a loose housing pen with straw bedding.

During the immediate postpartum period (1 to 21 ± 3 DIM), primiparous and multiparous animals were commingled in 1 freestall pen with 3 rows of stalls. The barns were naturally ventilated and had artificial lighting. From 1 to 21 ± 3 DIM, pens were stocked at 80 and 95% of headlocks and stalls, respectively. From 21 ± 3 DIM until the end of lactation, cows were housed in a cross-ventilated freestall barn with stocking density varying between 110 and 120% of headlocks and between 119 and 130% of stalls.

From enrollment to calving, nulliparous and parous animals were fed the same TMR except that the TMR of parous animals contained anionic salts. From 1 DIM to the end of lactation, primiparous and multiparous cows were fed the same TMR. During the prepartum period, the TMR was offered once a day; during the postpartum period, the TMR was offered once a day during the winter and twice a day during the summer (70% in the a.m. and 30% in the p.m.).

Rumination and Activity

Cows were fitted with HRLD collars (SCR Engineers Ltd.) from -21 to 21 ± 3 d relative to calving. Rumination was recorded in minutes per 2-h intervals, and total rumination minutes per day was used for statistical analysis unless otherwise stated. Activity was recorded every 2 h and total activity per day was used for statistical analysis unless otherwise stated.

BCS and Locomotion Score

At enrollment, 3 ± 3 , and 24 ± 3 DIM, all cows were scored for body condition (1 = emaciated and 5

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