J. Dairy Sci. 98:128–134
http://dx.doi.org/10.3168/jds.2014-7932

Clinical ketosis and standing behavior in transition cows

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ABSTRACT

Ketosis is a common disease in dairy cattle, especially in the days after calving, and it is often undiagnosed. The objective of this study was to compare the standing behavior of dairy cows with and without ketosis during the days around calving to determine if changes in this behavior could be useful in the early identification of sick cows. Serum β-hydroxybutyrate (BHBA) was measured in 184 cows on a commercial dairy farm twice weekly from 2 to 21 d after calving. Standing behavior was measured from 7 d before calving to 21 d after calving using data loggers. Retrospectively, 15 cows with clinical ketosis (3 consecutive BHBA samples >1.2 mmol/L and at least one sample of BHBA >2.9mmol/L) were matched with 15 nonketotic cows (BHBA <1.2 mmol/L). Five periods were defined for the statistical analyses: wk −1 (d −7 to −1), d 0 (day of calving), wk +1 (d 1 to 7), wk +2 (d 8 to 14), and wk +3 (d 15 to 21). The first signs of clinical ketosis occurred 4.5 ± 2.1 d after calving. Total daily standing time was longer for clinically ketotic cows compared with nonketotic cows during wk −1 (14.3 ± 0.6 vs. 12.0 ± 0.7 h/d) and on d 0 (17.2 ± 0.9 vs. 12.7 ± 0.9 h/d) but did not differ during the other periods. Clinically ketotic cows exhibited fewer standing bouts compared with nonketotic cows on d 0 only (14.6 ± 1.9 vs. 20.9 ± 1.8 bouts/d). Average standing bout duration was also longer for clinically ketotic cows on d 0 compared with nonketotic cows [71.3 min/bout (CI: 59.3 to 85.5) vs. 35.8 min/bout (CI: 29.8 to 42.9)] but was not different during the other periods. Differences in standing behavior in the week before and on the day of calving may be useful for the early detection of clinical ketosis in dairy cows.

Key words: β-hydroxybutyrate, disease, welfare, dairy cattle, health

INTRODUCTION

The transition from late gestation to early lactation has been associated with a high incidence of production diseases (Mulligan and Doherty, 2008), often related to the cow's inability to overcome negative energy balance. Cows compensate for rapid fetal growth in the final weeks of gestation and the onset of lactogenesis by mobilizing fat stores. All cows at this stage of lactation must rely, to some degree, on body reserves to meet the demands of lactation, but prolonged negative energy balance is often associated with ketosis (Ingvartsen, 2006). A poor adaptive response to negative energy balance and rapid lipolysis results in hyperketonemia, defined by overproduction of NEFA, and inadequate hepatic metabolism, resulting in accumulation of prominent ketone bodies: BHBA, acetoacetate, and acetone (Andersson, 1988; Grummer, 1993; Drackley, 1999).

Cows with high plasma concentrations of ketones around calving are at increased risk of disease (Duffield et al., 2009; Ospina et al., 2010a; Seifi et al., 2011), are more likely to be removed from the herd (McArt et al., 2012), are less likely to conceive at first service, and have lower milk production (Ospina et al., 2010b; McArt et al., 2012). The incidence of ketosis is estimated to range from 26 to 60% for subclinical ketosis (Simensen et al., 1990; Duffield et al., 1998; McArt et al., 2012) and from 2 to 15% for clinical ketosis (Duffield, 2000).

Despite the benefits of NEFA analysis for identifying prepartum cows at risk for ketosis (e.g., Ospina et al., 2010a; Seifi et al., 2011), no cowside test is available for this metabolite, limiting the practical use of this measure. Inexpensive cowside tests are available to detect acetoacetate and acetone in the urine (e.g., Ketostix Strip, Bayer, Leverkusen Germany) and BHBA in the milk (e.g., Keto-Test, Elanco Animal Health, SKK, Japan) and in the blood (e.g., Precision Xtra Meter, Abbott Diabetes Care, Abingdon, UK) (Carrier et al., 2004; Iwersen et al., 2009). These tests are useful for the diagnosis of ketosis in individual animals (Carrier et al., 2004) but are not validated for use before calving to assess energy balance (Oetzel, 2004; Ospina et al., 2010a), limiting their use for identifying cows at risk for this disease.

Recent work has demonstrated that changes in feeding and social behavior can be used in the early identification of cows at risk for ketosis. Goldhawk et al. (2009) reported that ketotic cows spent less time at the feed bunk and visited the feeder less often during the week before calving; for every 1-kg decrease in

Received January 11, 2014.
Accepted September 15, 2014.
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DMI, cows were 2.2 times more likely to develop ketosis. Those authors also found that cows that developed subclinical ketosis after calving had fewer competitive interactions at the feed bunk during peak feeding periods (Goldhawk et al., 2009). Although these behaviors show promise in identifying cows at risk for disease, no technologies are currently available that allow for practical monitoring of individual feeding and social behavior on commercial farms.

In contrast, there has been a growing interest in monitoring standing behavior for the early detection of illness in cattle. For example, Proudfoot et al. (2010) showed that standing behavior during transition differs for cows diagnosed with claw horn lesions in mid lactation. The use of electronic data loggers facilitates on-farm monitoring of this behavior (e.g., O'Driscoll et al., 2008; Ledgerwood et al., 2010). If changes in standing time could be used to identify cows at increased risk for ketosis, these cows could then be subjected to targeted testing of BHBA, which could expand the practicality of test application and improve ketosis detection. However, to our knowledge, no work to date has attempted to determine whether standing behavior could be used to predict ketosis in dairy cows. The objective of this study was to describe standing behavior of dairy cows with and without ketosis during the period around calving to determine whether changes in standing behavior precede clinical signs of disease.

MATERIALS AND METHODS

Animals, Housing, and Management

This study was conducted on a commercial dairy farm located in Whatcom County in Washington State between July and September 2012. Temperature averaged from 10.5 to 21°C with an average total rainfall of 2.1 mm/d during the test period. All animal use was approved by the University of British Columbia's Animal Care Committee, according to the guidelines outlined by the Canadian Council of Animal Care (CCAC 2009).

In total, 184 Holstein dairy cows (62 primiparous and 122 multiparous cows) were monitored from approximately 7 d before calving until 21 d after calving. Cows were housed in 3 separate identical prepartum pens, each equipped with 118 headlocks (76 cm, center to center), 75 m of feed bunk space, 9 m of linear water space, and 100 stalls (1.3 × 2.4 m) bedded with an average of 4.6 ± 2.5 cm (mean ± SD) layer of sawdust over a tire and concrete base once per week. Stocking ranged from 50 to 70 cows per pen (61 ± 10; mean ± SD), which equated to an average stocking rate of 42 to 59% at the feed bunk and 50 to 70% in the freestalls. Animals were moved to a maternity pen bedded with deep straw when signs of imminent calving were visible and remained there for the first 24 h postpartum. After calving, all cows were moved to a single postpartum pen that contained 180 headlocks (76 cm center to center), 6.8 m of post-and-rail with hay access, 5 m of linear water space, and 173 stalls (1.2 × 2.2 m) bedded with an average of 8.9 ± 2.5 cm (mean ± SD) of sawdust over a tire and concrete base twice per week. The stocking rate ranged from 136 to 163 cows per group (146 ± 8 cows; mean ± SD), which equated to an average stocking rate of 75 to 90% at the feed bunk and 78 to 94% in the freestalls. Cows remained in the postpartum pen until they were approximately 21 to 25 DIM. Cows were removed from the pen for approximately 2 h for milking 3 times per day at approximately 0700, 1400, and 2100 h and fed a TMR once daily at approximately 0700 h. Three weeks before calving, cows were fed a TMR consisting of 70% forage (corn silage, alfalfa hay, oat hay, straw) and 30% concentrate mix (canola, distillers grains, ground corn) with a standard vitamin and mineral pack. Lactating cows were fed a TMR consisting of approximately 50% forage (corn silage, alfalfa hay, and oat hay) and 50% concentrate (canola, cottonseed, distillers grains, and ground corn) with a standard vitamin and mineral pack and additional niacin, choline, yeast, and sodium bicarbonate.

Standing Behavior

Each cow was fitted with a data logger (Hobo Pendant G Acceleration Data Logger, Onset Computer Corp., Pocasset, MA) within a week of her expected calving date (d −7 to −3). Standing behavior was recorded using this Hobo data logger as described by Ito et al. (2009) and validated by Ledgerwood et al. (2010). The logger was wrapped in foam padding and attached to the lateral aspect of the distal hind cannon, proximal to the fetlock, with elastic wrap (Co-Flex, Andover Coated Products Inc., Salisbury, MA). It was oriented so that the x-axis was parallel, the y-axis was perpendicular, and the z-axis pointed away from the sagittal plane but parallel to the ground. At 1-min intervals, the logger recorded position relative to the orientation of the axes; this information was used to determine standing and lying times, number of bouts, and the duration of each bout. The loggers were removed and replaced between d 0 and 3 after calving and then every 10 d thereafter until 21 DIM.

Determination of Ketosis Status and Participation in Study

After calving, blood samples were obtained from cows twice a week (Monday and Thursday) following