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Short communication: Cow- and herd-level prevalence of hypoglycemia in hyperketonemic postpartum dairy cows

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ABSTRACT

The objective of this study was to quantify the prevalence of hypoglycemia in hyperketonemic dairy cows during the early postpartum period. A prospective observational study was conducted in 100 dairy herds selected by convenience. Within all participating herds, 40 cows (or the entire herd if smaller than 40 cows) were enrolled in the study (total of 3,776 enrolled cows). Herds were visited every 2 wk by an animal health technician. Cows were bled from their coccygeal vessels once between 1 and 14 d in milk, and cow-side testing was performed for ketonemia and glycemia using a device validated in cattle (Precision Xtra, Abbott, Mississauga, ON, Canada). Hyperketonemia was defined as β-hydroxybutyrate ≥1.4 mmol/L, and hypoglycemia was defined as glucose ≤2.2 mmol/L. Descriptive statistics were computed at the cow and herd levels. The cow-level prevalence of hyperketonemia, hypoglycemia, and simultaneous hypoglycemia and hyperketonemia was 20.0% (757/3,776), 13.8% (642/3,776), and 6.2% (235/3,776), respectively. Within the subset of hyperketonemic cows only, the prevalence of hypoglycemia was 31.0% (235/757). At the herd level, the median prevalence was 17.5% (minimum: 5.0%, first quartile: 10.0%, third quartile: 22.5%, maximum: 77.5%) for hyperketonemia, 15.0% (minimum: 5.0%, first quartile: 12.5%, third quartile: 20.0%, maximum: 47.5%) for hypoglycemia, and 7.5% (minimum: 2.5%, first quartile: 5.0%, third quartile: 12.5%, maximum: 17.5%) for simultaneous hypoglycemia and hyperketonemia. The herd-level median prevalence of hypoglycemia within the subset of hyperketonemic cows only was 30.6% (minimum: 2.5%, first quartile: 20.0%, third quartile: 39.1%, maximum: 63.0%). The results from this study show that the prevalence of simultaneous hyperketonemia and hypoglycemia is relatively low in the overall early postpartum cow population but also that approximately one third of hyperketonemic cows are hypoglycemic, which might represent an opportunity to improve their management on the farm.
Key words: hyperketonemia, hypoglycemia, prevalence, dairy cow

Short Communication

Hyperketonemia, defined as an elevated concentration of blood or serum BHB in dairy cows (Duffield et al., 2009), occurs mostly during the first weeks postpartum (McArt et al., 2012). It is a costly disease (McArt et al., 2015) because it increases the risk of additional disease and culling, reduces milk production, and reduces subsequent reproductive performance (Duffield et al., 2009; Ospina et al., 2010b; McArt et al., 2012). At the herd level, hyperketonemia is an important disease to monitor because its prevalence can vary greatly between herds and have significant negative effects (Ospina et al., 2010a; Suthar et al., 2013; Dubuc and Denis-Robichaud, 2017). For example, in a study of 126 commercial dairy herds conducted in Québec (Canada) in which 20 cows per herd were sampled once for BHB between 1 and 14 DIM, the herd-level prevalence of hyperketonemia varied between 4 and 75%, with a median prevalence of 19% (Dubuc and Denis-Robichaud, 2017).

Various treatment strategies for hyperketonemia have been tested in multiple studies with variable success (Gordon et al., 2013). The use of propylene glycol and cyanocobalamin has repeatedly been shown to improve the performance of hyperketonemic cows by increasing the cure rate or by improving the subsequent performance of the cows in milk production, reproduction, or disease (Rollin et al., 2010; McArt et al., 2011; Gordon et al., 2017). Interestingly, a recent study showed that hyperketonemic cows react to treatment differently depending on their glycemic status (Gordon et al., 2017). More specifically, the cure rate and subsequent performance of hyperketonemic cows was different between hypoglycemic (glycemia ≤2.2 mmol/L) and normoglycemic (>2.2 mmol/L) cows (Gordon et al., 2017).

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These data suggest that monitoring both ketonemia and glycemia in early-postpartum cows could improve their management and treatment. Although testing simultaneously for ketonemia and glycemia is relatively easy to perform on farms when using validated cow-side tests (Iwersen et al., 2009; Wittrock et al., 2013; Mair et al., 2016), the prevalence of hypoglycemia and hyperketonemia in early-lactation cows remains unclear. Such information would clarify whether it would be of benefit to test both blood parameters. Therefore, the objective of the present study was to quantify the prevalence of hypoglycemia within the subset of hyperketonemic dairy cows during the early-postpartum period.

A total of 100 commercial dairy herds located within a 1-h drive of the bovine ambulatory clinic of the Université de Montréal (Faculté de Médecine Vétérinaire, St-Hyacinthe, QC, Canada) were recruited for this prospective observational study. Herd selection was based on convenience among the clients enrolled in a regular preventive medicine program at the bovine ambulatory clinic (n = 135). Data collection was performed over a 1-yr period from November 2014 to October 2015. The sample size of 100 herds was targeted based on the following assumptions: an expected herd-level prevalence of hypoglycemia in hyperketonemic cows of 15%, precision around the estimate of 5%, and an α-value of 5%. Within every participating herd, 40 cows (or the entire herd if smaller than 40 cows) were systematically enrolled in the study during the data collection period. The sample size of 40 cows per herd was based on the following assumptions: expected cow-level prevalence of hypoglycemia in hyperketonemic cows of 15%, α-value of 5%, and precision of estimate of 8%.

Participating farms were visited every 2 wk by a veterinarian and an animal health technician. During farm visits, all cows between 1 and 14 DIM were bled from their coccygeal vessels to quantify ketonemia and glycemia using a cow-side device (Precision Xtra, Abbott, Mississauga, ON, Canada). For logistical reasons, cows were bled between 3 and 4 h after their first feeding of the day. The blood sample was collected in a 1-mL syringe and was immediately tested with the device that had been validated for use in cattle (Iwersen et al., 2009; Wittrock et al., 2013). The analytical sensitivity of the device for BHB was 0.1 mmol/L, and its maximum value was 7.2 mmol/L (Iwersen et al., 2009). Hyperketonemia was defined as a blood BHB concentration of $\geq$1.4 mmol/L (Duffield et al., 2009). The analytical sensitivity and the maximum value of the device for glucose were 0.1 and 5.2 mmol/L, respectively (Wittrock et al., 2013). Hypoglycemia was defined as a blood glucose value of $\leq$2.2 mmol/L based on response to insulin treatment (Gordon et al., 2017). Data collection procedures were approved by the animal care committee (14-Rech-1747) of the Université de Montréal (St-Hyacinthe, QC, Canada).

Statistical analyses were performed using SAS (version 9.4; SAS Institute Inc., Cary, NC). The experimental units of the study were the cow and the herd. Descriptive statistics were computed (PROC FREQ and PROC MEANS in SAS). The coefficient of correlation between ketonemia and glycemia values was also computed (PROC CORR in SAS). The cow-level prevalence of hyperketonemia (no. hyperketonemic/no. tested), hypoglycemia (no. hypoglycemic/no. tested), and simultaneous hypoglycemia and hyperketonemia (no. hyperketonemic and hypoglycemic/no. tested) was computed (PROC FREQ in SAS). The prevalence of hypoglycemia within the subset of hyperketonemic cows was also calculated (no. hyperketonemic and hypoglycemic/no. hyperketonemic). These calculations were performed for each individual herd as well as for the entire cow population (all cows pooled together). These data were also stratified by parity group (1, 2, 3 and more) and by DIM (1 to 14). In a second step, using the prevalence measures computed for each individual, herd-level descriptive statistics of the prevalence (minimum, maximum, quartiles, median) were computed (PROC MEANS and PROC FREQ in SAS). In other words, the within-herd prevalence of each herd was computed and ranked to determine the minimum and maximum values as well as quartiles and median values. Specifically, for the herd-level median prevalence of hypoglycemia among hyperketonemic cows only, it was calculated within each herd (no. hyperketonemic and hypoglycemic/no. hyperketonemic) and then ranked to determine the minimum and maximum values as well as quartiles and median values.

Data from 3,776 cows (100 herds) were collected in this study. The participating herds had a median size of 87 lactating cows (range: 31–371). The number of cows per herd enrolled in the study ranged from 31 to 40. The median DIM at sampling was 8 (range: 1–14). At the cow level, the median values of ketonemia and glycemia were 0.8 mmol/L (range: 0.1–6.5) and 3.0 mmol/L (range: 0.5–5.2), respectively. The coefficient of correlation between ketonemia and glycemia values was -0.21 ($P < 0.01$). The prevalence of hypoglycemia among the subset of hyperketonemic cows only was 31.0% (235/757). Prevalence data stratified by parity group and by DIM are presented in Table 1 and Figure 1, respectively. Herd-level prevalence data are also presented in Table 1. Glycemia frequency distributions for the overall study population as well as for the subset of hyperketonemic cows only are presented in Figure 2A.