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Definition of prepartum hyperketonemia in dairy goats

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ABSTRACT

A prospective cohort study was conducted on 1,081 dairy goats from 10 commercial herds in Québec (Canada) to define prepartum hyperketonemia based on optimal blood β-hydroxybutyrate acid threshold values for the early prediction of pregnancy toxemia (PT) and mortality in late-gestation dairy goats. All pregnant goats had blood sampled weekly during the last 5 wk of pregnancy. The blood was analyzed directly on the farm for β-hydroxybutyrate acid quantification using a Precision Xtra meter (Abbott Diabetes Care, Saint-Laurent, QC, Canada). Body condition scores on the lumbar region and sternum were noted. Each goat was classified as being at low (n = 973) or high risk (n = 108) of having PT by producers based on a standardized definition. The optimal threshold for predicting a PT diagnosis or mortality for each week before kidding was determined based on the highest sum of sensitivity and specificity. The association between hyperketonemia and subsequent PT was tested using a multivariable logistic regression model considering hyperketonemia at wk 4 prepartum, litter size, and body condition score at wk 4 prepartum as covariates, and herd and parturition cohort as random effects. The association between mortality and hyperketonemia was also tested using a logistic regression model accounting for the presence or absence of treatment during the last month of pregnancy. The hyperketonemia definition based on PT varied between ≥0.4 and ≥0.9 mmol/L during the last 5 wk prepartum. Goats affected by hyperketonemia at wk 4 prepartum and with a large litter size (≥3 fetuses) had 2.1 and 40.5 times the odds, respectively, of subsequent PT than other goats. Hyperketonemia definitions based on mortality varied between ≥0.6 and ≥1.4 mmol/L during the last 4 wk prepartum, and was ≥1.7 mmol/L during the first week postpartum. Goats affected by hyperketonemia and treated by producers had 3.4 and 11.8 times the odds, respectively, of subsequent mortality than did other goats. These results showed that prepartum hyperketonemia could be defined in dairy goats using subsequent risks of PT or mortality during the last month of pregnancy.

Key words: dairy goat, β-hydroxybutyric acid, hyperketonemia, pregnancy toxemia

INTRODUCTION

Hyperketonemia is defined as an elevated concentration of ketone bodies in blood, serum, or plasma (Duffield et al., 2009). In ruminants, concentration of BHBA is commonly used to quantify energy balance during the last weeks of pregnancy and during the first weeks of lactation (Herdt, 2000). In dairy goats, the last month of pregnancy is a critical period for the management of energy balance because 60 to 80% of the fetus' growth occurs during this period (Twardock et al., 1973; Rook, 2000) and because DMI is reduced simultaneously (Morand-Fehr, 1989). Therefore, a state of negative energy balance can occur during this period (Herdt, 2000). An excessive negative energy balance prepartum can be identified by the presence of hyperketonemia (Sadjadian et al., 2013).

Prepartum hyperketonemia can be clinical (pregnancy toxemia; **PT**) or subclinical (Herdt, 2000; Radostits et al., 2007; Brozos et al., 2011), although specific data in goats are not well described. Pregnancy toxemia, which is commonly seen during the last month of pregnancy in goats or sheep, generally has a low morbidity rate (2–5%) but a high mortality rate (80%; Brounts et al., 2004; Zamir et al., 2009; Brozos et al., 2011). Risk factors for PT include carriage of multiple fetuses, greater age, and extreme (fat or thin) BCS (Rook, 2000; Brozos et al., 2011). Clinical signs of PT are usually nonspecific at the beginning of the disease and may include anorexia, isolation from herdmates, distal limb edema, depression, prolonged recumbency, and weakness. If disease lasts more than 3 to 6 d, the symptoms generally progress to lateral recumbency, blindness, nystagmus, star-gazing, tremors, ataxia, coma, and death (Andrew, 1997; Rook, 2000; Brozos et al., 2011).

Early identification of goats at risk of developing PT could increase the chances of recovery (Rook, 2000; Brozos et al., 2011). The use of BHBA concentrations

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in blood was shown to be an interesting parameter for diagnosing PT (Henze et al., 1998), and prepartum hyperketonemia could be used to identify, earlier, animals at high risk of subsequent PT. Unfortunately, no prepartum BHBA threshold values have been validated to define hyperketonemia to predict PT. A blood threshold of ≥0.8 mmol/L was proposed for dairy sheep as an acceptable value (Panousis et al., 2012). Many veterinarians currently use this value in dairy goats because of the absence of specific goat information (Bani Ismail et al., 2008; Sadjadian et al., 2013). However, it remains unknown whether or not this value is relevant in dairy goats of North America.

Recently, the use of a handheld device for on-farm blood BHBA quantification in dairy goats has been validated (Doré et al., 2013; Pichler et al., 2014). In the aforementioned studies, the Precision Xtra (Abbott Diabetes Care, Saint-Laurent, QC, Canada) handheld meter showed a near-perfect correlation between its results and those of the gold standard test, the colorimetric enzymatic reaction with an automated serum analyzer (Doré et al., 2013). Therefore, this device could be used for blood BHBA quantification for on-farm surveillance of hyperketonemia.

The main objective of the present study was to define prepartum hyperketonemia in dairy goats based on finding the optimal BHBA thresholds for predicting subsequent risk of developing PT using the Precision Xtra handheld meter. Another objective was to define prepartum hyperketonemia based on finding the optimal threshold for predicting subsequent risk of mortality.

MATERIALS AND METHODS

A prospective cohort study was conducted from January 2012 to December 2013. Herd selection was based on convenience, with herds located within a radius of 200 km from the bovine ambulatory clinic of the Université de Montréal (Saint-Hyacinthe, QC, Canada), herds having regular DHIA testing (every month), and herds having a history of multiple PT cases over the last 2 yr. Sample size calculation was based on finding a significant difference between prevalence of PT in groups with normal and abnormal ketonemia values in blood. An a priori estimated difference of 14% in the prevalence of PT between goats with normal ketonemia (PT: 1%) and hyperketonemic goats (PT: 15%) when considering α and β errors of 5 and 20%, respectively, and an estimated prevalence of hyperketonemia of 5% in the study population were used for sample size calculation. The Animal Care Committee of the Université de Montréal approved this project.

Farm Sampling

A veterinarian and a research technician visited the participating herds weekly, starting 5 wk before the anticipated kidding date until at least 95% of the group had kidded. At each farm visit, a blood sample was collected from the jugular vein from each goat and blood BHBA was quantified while on the farm (Precision Xtra, Abbott Diabetes Care). The analytical sensitivity of the BHBA assay was 0.1 mmol/L. The inter- and intraassay coefficients of variation were 5.3 and 3.7%, respectively (Doré et al., 2013). The blood results were blinded to the producers. A lumbar and sternal BCS estimation using a 0.5-point scale (0 to 5; Hervieu and Morand-Fehr, 1999; Morand-Fehr and Hervieu, 1999) was performed at each farm visit by the same person.

Data Recording

For each goat, producers had to record information on kidding period (number of newborn kids, kids alive after 48 h, presence or absence of dystocia) and health during the last month of pregnancy and the first week of lactation. Targeted information included goat identity, breed, farm name, litter size, number of stillbirths (fetus died in uterus), number of goats kids still alive 48 h after birth, and all treatments given before kidding.

Definition of the Outcomes of Interest

Because no gold standard exists for defining PT, producers were provided a standardized chart summarizing the clinical signs of PT: prolonged recumbency, weakness, partial to complete anorexia, teeth grinding, depression, ataxia, limb swelling, lateral recumbency, blindness, tremors, convulsion, coma, and death (Rook, 2000; Brozos et al., 2011). Definition of PT was based on the presence or absence of those different clinical signs. To reduce variation on definition of PT from farm to farm, only one person presented this chart to the producers and the definition of PT was repeated to each producer at the beginning of every month of data collection to standardize the outcome definition. At the end of the data collection or at time of death for the goat, the producers scored each goat for presence of PT, based on a 4-point scale (absence, low, moderate, or strong suspicion of PT) using the previously defined chart.

The second outcome of interest studied was mortality during the last month of pregnancy and the first week of lactation. Goats that died were classified as dead before parturition or during the first week following parturition, depending on the time of death.

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