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Hypocalcemia—Cow-level prevalence and preventive strategies in German dairy herds

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ABSTRACT

Hypocalcemia around calving is considered a gateway disease that can lead to health disorders and decreased milk production. The objective of this cross-sectional study was to evaluate the prevalence of clinical and subclinical hypocalcemia 0 to 48 h after calving. Blood samples were drawn from 12 animals of each dairy farm (n = 115) and analyzed for serum calcium, magnesium, and phosphorus concentration. Cows not affected clinically but with a serum calcium concentration below 2.0 mmol/L were characterized as subclinical hypocalcemic animals. Recumbent cows with a serum calcium concentration below 2.0 mmol/L were defined as cows suffering from clinical milk fever. Herds were classified into negative (0 to 2/12), borderline (3 to 5/12), and positive (≥6/12) according to the number of animals with hypocalcemia. Strategies to control hypocalcemia were documented. Prevalence of clinical milk fever was 1.4, 5.7, and 16.1% for second, third, and ≥fourth parity cows, respectively. None of the cows in first lactation were suffering from clinical milk fever. Based on the threshold of 2.0 mmol/L, 5.7, 29.0, 49.4, and 60.4% of cows in first, second, third, and ≥fourth lactation were suffering from subclinical hypocalcemia, respectively. Fourteen, 51, and 50 herds were classified as negative, borderline, and positive, respectively. A positive association was observed between serum calcium and serum phosphorus concentration. Serum calcium and magnesium concentration were negatively associated. Only 50 of 115 farms had a control strategy implemented to avoid hypocalcemia. Most common was the use of oral calcium products (40/115 herds), followed by feeding of anionic salts in the close-up diet (10/115 herds). These results indicate that the prevalence of clinical and subclinical hypocalcemia in German dairy herds was high and that an active control strategy was not implemented on all farms. The negative association between calcium and magnesium warrants further research regarding the physiological regulation of these 2 minerals around parturition.

Key words: subclinical hypocalcemia, milk fever, parturition, magnesium

INTRODUCTION

Periparturient hypocalcemia is a common metabolic disorder in dairy cows that leads to an increased risk of detrimental health and production outcomes and in severe cases can be life threatening. Physiologically, serum calcium concentration in the adult cow is maintained above 2.0 mmol/L (Martin-Tereso and Martens, 2014). Due to the start of colostrum production and consequently increasing calcium demand, the nadir of serum calcium concentration occurs 12 to 24 h after parturition (Kimura et al., 2006; Goff, 2008).

Hypocalcemia is considered as a gateway disease and predisposes the cow to various metabolic and infectious disorders in early lactation (Goff, 2008) such as metritis (Martinez et al., 2012) and mastitis (Curtis et al., 1983). In a study by Martinez et al. (2012), numbers of neutrophils were reduced and their ability to undergo phagocytosis and oxidative burst was impaired in cows affected by hypocalcemia which might in part explain the increased risk for infectious diseases. On a cellular level, suppressed function of immune cells was mediated by reduced cytosolic calcium concentration (Martinez et al., 2014).

Cows with naturally occurring hypocalcemia at parturition had elevated concentrations of NEFA and BHBA as indicators of increased lipomobilization (Martinez et al., 2012). The same group of authors were able to repeat these finding in cows with induced hypocalcemia (Martinez et al., 2014). Induction of hypocalcemia with EDTA infusion caused reduced DMI and decreased plasma concentrations of insulin. These negative effects are supported by other studies showing an increased risk for displaced abomasum (Chapinal et al., 2011; Seifi et al., 2011), increased weight loss in

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early lactation (Caixeta et al., 2015), and ultimately an increased culling risk (Seifi et al., 2011; Roberts et al., 2012) for cows with hypocalcemia. Furthermore, subclinical hypocalcemia affected reproductive performance such as estrous cyclicity (Ribeiro et al., 2013; Caixeta et al., 2017) and pregnancy rate to first AI (Chapinal et al., 2012).

In a retrospective study including 1,462 cows from 480 dairy farms in 21 states of the United States, the prevalence of hypocalcemia was 25% in first lactation cows and about 50% in multiparous cows (Reinhardt et al., 2011). Clinical milk fever was prevalent in 1, 4, 6, and 10% of first, second, third, and ≥fourth lactation cows, respectively. These results originate from the 2002 National Animal Health Monitoring System (**NAHMS**) dairy study (USDA, 2002). This study has been used as a reference for the prevalence of hypocalcemia multiple times. But the study was not specifically designed to estimate cow- and herd-level prevalence of hypocalcemia and the currentness of the results are limited.

More recently, different strategies (e.g., oral calcium supplementation, anionic salts) to prevent hypocalcemia have evolved and were implemented in the dairy industry (Martin-Tereso and Martens, 2014). These approaches might affect the prevalence of hypocalcemia. To our knowledge, however, no information is available reporting the actual prevalence of hypocalcemia and associated preventive strategies.

Therefore, the objective of this study was to estimate the prevalence of hypocalcemia on a cow-level and the implemented preventive strategies to control for hypocalcemia in commercial German dairy herds.

MATERIALS AND METHODS

The experimental procedures reported herein were conducted with the approval of the Institutional Animal Care and Use Committee of the Freie Universität Berlin.

Study Population

A cross-sectional study was conducted based on a convenience sample of 115 dairy herds from 8 federal states of Germany between February 2015 and August 2016. Inclusion criteria for herds were (1) participation in a federal DHIA testing system, (2) freestall housing with at least 100 milking cows, (3) feeding of a TMR-based diet, and (4) a computerized herd management software. Average herd size was 513 and ranged from 112 to 2,607 lactating cows. The average milk production (305-d ECM, 4.0% fat, 3.4% protein) was 9,231 kg (range 6,257–10,880 kg). Holstein Friesian cows were the dominant breed on 112 farms. Two farms kept Simmental cattle and 1 farm Jersey as the dominant breed.

A sample size calculation was conducted according to Dohoo et al. (2009). We assumed that the prevalence of milk fever tends to be highly clustered within herds because of the effect of herd management (e.g., breed, dry cow nutrition) on the risk of hypocalcemia. Therefore, we selected an intra-cluster correlation coefficient of 0.3. A sample size of 1,388 animals with 12 animals per herd was deemed adequate to estimate the true prevalence of subclinical hypocalcemia on a cow level with 95% confidence and 10% precision.

If a farm provided less than 12 blood samples the farm was excluded from statistical analysis. If a farm supplied more than 12 blood samples, 12 cows were selected, using a random function in Excel (Office 2010, Microsoft Deutschland Ltd., Munich, Germany). A random list was generated separately for each of the farms.

Experimental Procedures

Veterinary practitioners had been invited to participate in the study by an information leaflet sent out by regular mail. Participating practices were informed about the nature and duration of the study and received a package containing serum blood collection systems (S-Monovette 9mL Z, Sarstedt AG and Co, Nürnbrecht, Germany), cryo-vials (Cryvial, Carl Roth GmbH and Co. KG, Karlsruhe, Germany) to store serum at −20°C until analysis, and a written standard operating procedure. This standard operating procedure described which information to record for each cow enrolled and how to examine the cow before blood collection. A case report form for each cow was provided to document time of sampling, ear tag number, time of calving, calving ease (i.e., unassisted calving or assisted calving with at least one person), clinical symptoms of milk fever (i.e., recumbency), and parity. Administration of calcium products, time relative to calving, and route of administration (i.e., subcutaneous, intravenous, oral) of these products was also documented. Sampling 12 cows per herd, veterinarians were asked to include 4 primiparous cows into the cohort. The farm personnel was asked, if other preventive strategies, such as feeding of anionic salts in the close-up group or injection of vitamin D before calving were implemented.

Animals were enrolled by convenience when a veterinarian visited the farm on a given day and an animal met the inclusion criteria of being within 48 h after parturition.