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Randomized clinical trial of a calcium supplement for improvement of health in dairy cows in early lactation

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ABSTRACT

Prophylactic Ca supplementation immediately after calving is a common strategy to prevent clinical and subclinical hypocalcemia in parturient dairy cows. The objective of this study was to evaluate the effect of prophylactic administration of an injected Ca supplement on blood Ca concentration at 24 and 48 h after treatment, incidence risk of clinical disease and culling, milk production in early lactation, and probability of pregnancy at first insemination. Cows without signs of visible milk fever (n = 984) from 7 farms were blocked by parity and randomly assigned to receive either Ca gluconate (35% wt/vol) in combination with Ca glucoheptonate (10% wt/vol; TheraCalcium, Vétoquinol Canada Inc., Lavaltrie, Quebec) or a placebo (medication vehicle solution with no Ca) at first contact with each cow after calving and again 12 to 24 h later. Each dose was 120 mL injected subcutaneously over 2 sites. Total serum Ca concentration (tCa) was measured from coccygeal blood samples before (time 0) and 24 and 48 h after first treatment in a subsample of cows (n = 129). Blood β-hydroxybutyrate concentrations were measured from all cows twice between 3 and 16 d in milk at weekly visits and cows were evaluated for vaginal discharge once between 28 and 42 d in milk. Disease events, production data from the first 3 Dairy Herd Improvement milk tests, reproduction, and culling data were collected from each herd. For cows that had received 1 injection of Ca before the blood sample at 24 h (n = 95), tCa was significantly higher in the treated cows: mean ± standard error, 2.03 ± 0.03 versus 1.90 ± 0.03 mmol/L, accounting for tCa at time of enrollment and a treatment by tCa at enrollment interaction. At 48 h, no significant difference was found in tCa between treatment and control (mean ± SE, 2.12 ± 0.02 and 2.10 ± 0.03 mmol/L, respectively). Cows treated with the Ca product were significantly less likely to have received intravenous, subcutaneous, or oral supplemental Ca for exhibiting clinical signs of hypocalcemia than control cows (5.0 vs. 8.4%). No effect was found of treatment on retained placenta, metritis, hyperketonemia, prevalence of purulent vaginal discharge, culling from the herd, early lactation production, probability of pregnancy to first artificial insemination, or time to pregnancy. With this subcutaneous prophylactic Ca treatment regimen, blood Ca levels were temporarily increased at 24 h after treatment, but no effect was observed of supplemental Ca on the risk of disease or culling, milk production, or reproductive performance.
Key words: hypocalcemia, calcium supplement, periparturient, transition, disease

INTRODUCTION

Milk fever (**MF**) or clinical hypocalcemia is a metabolic disorder that results when homeostatic mechanisms fail to maintain blood Ca levels around calving to the point that visible signs of muscle weakness occur. The lactational incidence risk (**LIR**) has been reported to range from 3 to 6% of cows of all parities depending on geographical location (DeGaris and Lean, 2008). McLaren et al. (2006) reported a mean MF incidence of 4.2% in a sample of 48 dairy herds in Ontario, Canada. Calcium is critical for muscle and nerve function and reduced blood Ca compromises skeletal muscle strength and gastrointestinal motility, which can predispose cows to reduced DMI, increased incidence of metabolic diseases, and decreased milk yield (Oetzel, 2013). Milk fever has also been associated with immune suppression by impairing the activity of mononuclear blood cells (Kimura et al., 2006).

Subclinical hypocalcemia (**SCH**) as a distinct but related disease entity to MF has been recognized more recently and been the focus of much research. The principle of SCH is that below certain thresholds of blood Ca concentration undesirable consequences occur despite an absence of visible signs. The prevalence of plasma Ca between 1.5 and 2.0 mmol/L within 48 h postpartum, which is assumed to correspond to SCH,

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has been reported to vary from 25 to 54% depending on parity (Reinhardt et al., 2011). Subclinical hypocalcemia around calving has been associated with increased odds of a displaced abomasum (**DA**), greater odds of culling, reduced milk yield in early lactation, and a difference in early lactation fatty acid metabolism (Chapinal et al., 2011; Roberts et al., 2012; Chamberlin et al., 2013). Martinez et al. (2012) found that cows with a blood Ca concentration less than 2.15 mmol/L at any point during the first 3 DIM had lower concentrations of neutrophils, impaired neutrophil function, and increased incidence of metritis compared with cows that maintained blood Ca above 2.15 mmol/L.

The consequences of MF and the inability to rapidly and practically identify SCH have emphasized the importance of prevention. Prior to calving, prevention strategies are principally focused on the DCAD of the precalving ration. A large number of Ca supplementation products that can be given orally or subcutaneously have been promoted to producers as additional insurance against hypocalcemia. Administration to all cows or all multiparous cows after calving has been instituted in many herds. Some oral supplements such as $CaCl_2$ are acidifying in addition to providing rapidly absorbed Ca. Given as a drench, gel or paste, or as a component of a Ca bolus, several studies have shown that $CaCl_2$ raises blood Ca for 12 h after administration (Goff and Horst, 2003; Sampson et al., 2009; Blanc et al., 2014). Subcutaneous administration of 500 mL of Ca borogluconate (23%; 10.5 g of Ca) has been shown to increase blood Ca concentrations to about 120% of baseline for approximately 6 h after calving (Goff, 1999). Cows given 200 mL of Ca borogluconate (40%; 6 g of Ca) were more likely to have blood Ca concentrations above 2.0 mmol/L 12 h after treatment (Moheffi-Fani and Azadnia, 2012).

Several studies have examined the effects of Ca supplements on disease, production, and reproduction of parturient dairy cows. A controlled trial administering $CaCl_2$ gel prophylactically to 204 Holstein cows in one herd found treated cows had higher serum Ca concentrations at d 1 and 2 after calving and reduced incidence of MF and DA (Oetzel, 1996). Conversely, Hernandez et al. (1999), using 60 cows from a single large dairy [including one-third purposively selected with retained placenta (**RP**)], did not find a significant effect of $CaCl_2$ gel on serum Ca or the incidence of metritis or DA; time to first insemination, pregnancy status after first insemination and milk production were similarly unaffected. However, differences in these outcomes would be extremely difficult to establish with such a limited sample size. Melendez et al. (2003) examined $CaCl_2$ gel and a second Ca propionate supplement on 479 cows in a single herd feeding anionic salts and found no treatment effect on MF, RP, metritis, ketosis, DA, pregnancy at first service, overall pregnancy rate, and services per pregnancy. More recently, a controlled trial involving 927 multiparous cows from 2 herds evaluated the effect of supplementation with oral Ca boluses after calving and found that among cows with a previous lactation mature-equivalent milk production greater than 105% of herd average, supplementation was associated with 2.9 kg more milk at first DHIA test after calving (Oetzel and Miller, 2012). Cows that were lame in the dry period that received the Ca boluses had fewer total health events in the first 30 d after calving; however, there was no treatment effect on the other disease, production, or reproduction outcomes examined.

The objective of this study was to evaluate the effect of prophylactic administration of a commercially available injected combination of Ca gluconate and Ca glucoheptonate on the incidence of clinical disease and culling, milk production in early lactation, and probability of pregnancy at first insemination. In addition, the effect of administration of the product on blood Ca concentrations was evaluated at 24 and 48 h after treatment, in cows without clinical hypocalcemia.

MATERIALS AND METHODS

Study Population

The study was conducted on 7 commercial dairy farms in Ontario, Canada, from June 2013 to March 2014. Herd size ranged from 40 to 500 lactating cows. Herds were purposively selected on proximity to the University of Guelph and willingness to comply with the Ca supplementation protocols. To be eligible for enrollment, study herds had to be subscribed to a milk recording service (Canwest DHI), administer Ca supplementation according to protocol directions to all cows calving in the herd during the study period, and refrain from use of other forms of prophylactic Ca supplementation for the duration of the study. All herds fed a TMR and prepartum cows did not receive supplemental anionic salts such that the calculated DCAD of all diets was positive. All herds consented to a study protocol that had been reviewed and approved by the University of Guelph Animal Care Committee.

Study Design and Data Collection

Cows were enrolled in the study by farm personnel as soon as observed after calving. Because personnel were not typically in the barn through the late night, the greatest time from calving to enrollment was 8 h. Cows that had calved were categorized within each herd as being in first or second parity, or third and greater