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Field trial of 2 calcium supplements on early lactation health and production in multiparous Holstein cows

Antonia R. Domino, Helen C. Korzec, and Jessica A. A. McArt[1]
Department of Population Medicine and Diagnostic Sciences, College of Veterinary Medicine, Cornell University, Ithaca, NY 14853

ABSTRACT

Our objectives were to measure serum Ca concentrations in the first 48 h postpartum in cows supplemented with oral Ca or subcutaneous Ca and nonsupplemented cows and evaluate the effect of these treatments on the incidence of metritis, displaced abomasum, mastitis, and early lactation disease (any of the diseases milk fever, retained placenta, metritis, or displaced abomasum), removal from the herd, pregnancy to first insemination, and average daily milk yield for the first 10 wk of lactation. We conducted 2 experiments on 1 commercial herd in New York State. In experiment 1, multiparous Holstein cows (n = 30) were blocked by parity (2 and ≥3) and sequentially assigned at calving to nontreated control (CON, n = 10), subcutaneous administration of 500 mL 23% Ca gluconate at calving (SC, n = 10), or administration of an oral Ca bolus containing 43 g of calcium at calving and again 12 h later (OB, n = 10). Blood was collected before treatment and at 1, 2, 4, 8, 12, 24, and 48 h thereafter for measurement of serum total Ca concentration. In experiment 2, 1,478 multiparous Holstein cows were sequentially assigned by calving date to the same 3 treatments (CON, n = 523; SC, n = 480; OB, n = 475). In experiment 1, SC cows had greater Ca concentrations from 1 through 12 h post-treatment and OB cows had greater Ca concentrations at 1 and 24 h post-treatment compared with CON cows. We found no difference in risk of metritis, displaced abomasum, early lactation disease diagnosis, or pregnancy to first insemination among treatments. Treatment with SC or OB had no effect on average daily milk yield compared with CON cows (CON = 46.7 kg; SC = 47.1 kg; OB = 47.0 kg). Cows treated with SC or OB that had a high relative herd milk rank in the previous lactation were almost half as likely to be diagnosed with mastitis in the first 60 DIM compared with CON cows [risk ratio $(RR)_{SC} = 0.57$, $RR_{OB} = 0.54$]; however, we found no difference in risk of mastitis among treatments for cows with low relative herd milk rank. Second-parity cows fed a negative prepartum dietary cation-anion difference ration and treated with SC or OB were more likely to be removed from the herd than CON cows ($RR_{SC} = 3.91$, $RR_{OB} = 4.72$); this difference was not observed in second-parity cows fed a neutral prepartum dietary cation-anion difference ration or in parity ≥3 cows. Although Ca supplementation increased serum Ca, this effect did not greatly improve milk production or health and reproductive outcomes.

Key words: dairy cow, subclinical hypocalcemia, calcium, calcium supplementation

INTRODUCTION

Dairy cows mobilize a large quantity of Ca around the time of calving to meet the demands of colostrum production and lactation, and this increased Ca requirement often results in hypocalcemia in the immediate postpartum period. Whereas clinical hypocalcemia (milk fever; **MF**) affects approximately 5% of periparturient dairy cows (Goff, 2008), subclinical hypocalcemia (**SCH**), a low serum concentration within 48 h of calving, is much more prevalent, affecting up to 50% of postpartum multiparous cows (Reinhardt et al., 2011). Subclinical hypocalcemia has been associated with hyperketonemia, displaced abomasum (**DA**), retained placenta, metritis and mastitis, decreased reproductive performance, and decreased milk production (Chapinal et al., 2011, 2012; Martinez et al., 2012). Thus, prevention of SCH represents a sizable opportunity for avoiding other postpartum diseases in dairy cows, thereby improving animal well-being and farm economics.

Testing for SCH is costly and inconvenient, so current efforts have focused on prevention at the herd level rather than identification and treatment of individual animals. The mainstay of prevention is the reduction of the DCAD in prepartum rations (Horst et al., 1997; Lean et al., 2006; Goff, 2008), which has been shown to reduce the incidence of SCH from 50 to 30% (Joyce et al., 1997). Even at a 30% incidence, SCH is estimated

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[1]Corresponding author: jmcart@cornell.edu

to cost a 2,000-cow dairy nearly $50,000 annually (Oetzel, 2013).

Additional products marketed for SCH prevention include oral calcium boluses that contain multiple forms of calcium salts as well as injectable Ca supplements. Oetzel and Miller (2012) demonstrated that use of oral Ca boluses decreased adverse health events for lame cows and increased milk yield in multiparous cows with above-average production in the previous lactation. Miltenburg and colleagues (2016) found that subcutaneous administration of 35% Ca gluconate and 10% Ca glucoheptonate resulted in greater serum Ca concentrations 24 h post-treatment compared with no treatment, and Amanlou et al. (2016) reported that subcutaneous administration of 40% Ca borogluconate resulted in an increased DMI at 1 DIM, a decreased SCC, and a decreased risk for metritis and endometritis compared with nontreated cows. However, to our knowledge, oral and injectable calcium supplements have not been compared in a field trial on a commercial dairy.

We hypothesized that postpartum supplementation with oral Ca boluses or subcutaneous Ca would be superior to no Ca supplementation in the reduction of early lactation disease incidence and herd removal and would increase early lactation milk yield and risk of pregnancy to first AI. Our objectives were to measure serum Ca concentrations during the first 48 h postpartum in nontreated control cows, cows receiving subcutaneous Ca supplementation immediately postpartum, and cows administered an oral Ca bolus immediately and 12 h postpartum, and to compare the efficacy of oral or subcutaneous postpartum calcium supplementation with a nontreated control group on early lactation disease incidence, herd removal, early lactation milk yield, and risk of pregnancy to first AI.

MATERIALS AND METHODS

All procedures were reviewed and approved by the Cornell University Institutional Animal Care and Use Committee (Protocol 2015–0119).

Study Population

The study was conducted on a Holstein dairy in New York State milking approximately 3,800 cows producing an average of 40 kg of milk per cow per day during the study period. During the last 3 wk of gestation, cows were housed in 2 close-up freestall pens (pen A and pen B) with a maximum stocking density of 100%. Pen A and pen B were delivered a TMR twice daily with a targeted DCAD level of −10 to −15 mEq/100 g of DM and 0 mEq/100 g of DM, respectively. Cows were monitored for signs of parturition by trained farm employees and moved to straw-bedded maternity pens when entering stage 2 labor. Within 6 h of parturition, cows were milked with bucket milkers and moved to a freestall fresh pen with a maximum stocking density of 80%, where they were fed a fresh cow TMR delivered twice daily. Cows were milked 3 times per day in a 100-stall rotary parlor (Delaval AB, Tumba, Sweden).

Study Design and Data Collection

Experiment 1. Between December 7 and 20, 2015, 30 cows in their second-or-greater lactation were enrolled to determine the effect of treatment on serum total Ca concentrations over time. All enrolled cows were fed a targeted prepartum ration DCAD of −10 to −15 mEq/100 g of DM. Cows were blocked by parity (parity 2 and ≥3) and sequentially assigned at calving to 1 of 3 groups: nontreated control (**CON**, n = 10), subcutaneous administration of 500 mL of 23% Ca gluconate (10.7 g of Ca; Radix Labs, Eau Claire, WI; **SC**, n = 10), or oral administration of 2 Ca boluses containing 43 g of Ca (Bovikalc, Boehringer Ingelheim, St. Joseph, MO; **OB**, n = 10). Subcutaneous Ca treatments were administered in a single location behind either shoulder via a simplex set and a 14-gauge needle over a period of approximately 5 min. The first oral Ca bolus was given immediately after calving and the second administered 12 h after calving. All treatments were administered by the research team. Initial treatment-sequence order was determined using the random number function in Excel (Microsoft, Redmond, WA) and repeated in that order for the remainder of the enrollment period. For all cows, blood was collected from the coccygeal vessels into an evacuated tube without anticoagulant (Becton Dickinson, Franklin Lakes, NJ) immediately before treatment and at 1, 2, 4, 8, 12, 24, and 48 h thereafter; for cows in the OB group, the 12-h blood sample was collected before the second bolus was administered. Samples were allowed to clot at room temperature, transported to Cornell University, and centrifuged within 12 h of collection for 5 min at 800 × *g* and 21°C. Serum was harvested and frozen at −80°C. All serum samples were submitted en masse at the end of the experiment to the New York State Animal Health Diagnostic Center (Ithaca, NY) for quantitative measurement of total Ca concentrations (Hitachi Modular P800, Roche Diagnostics, Indianapolis, IN).

Experiment 2. Between February 7 and August 15, 2016, 1,548 multiparous cows were enrolled in a field trial to determine the effects of oral or subcutaneous Ca supplementation on the incidence of health events in the first 60 DIM, average daily milk yield for the first 10 wk of lactation, and risk of pregnancy to first AI compared with an untreated control group. Cows