Feedstuffs Reprint

Monitor blood calcium status for better transition cow performance

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DAIRY cattle have a large demand for calcium around the time of calving. The older and more productive a cow is, the more likely she will experience low blood calcium (hypocalcemia) at calving (Lean et al., 2006; Reinhardt et al., 2011; Armstrong et al., 2018).

The timing and magnitude of blood calcium drop and the recovery rate to normal blood calcium concentration have an effect on productivity, reproductive performance and postpartum health conditions during the subsequent lactation.

Following parturition and based on total blood calcium concentrations (Horst and Jorgensen, 1982), cows can be categorized into one of three groups: paretic (clinical hypocalcemia; milk fever), borderline (subclinical hypocalcemia) and non-paretic (normocalcemia).

Why test for blood calcium?

Milk fever is easily recognized as down or weak cows around the time of calving, typically with blood total calcium concentration less than or equal to 5.5 mg/dL. Subclinical hypocalcemia (SCH) occurs with greater frequency within the herd than milk fever and, thus, is more costly.

Reinhardt et al. (2011) showed that 25% of first-calf heifers and more than 40% of all multiparous cows were afflicted with SCH.

SCH is difficult to determine unless blood samples are taken because cows with SCH do not exhibit clinical signs. Neves et al. (2018) defines SCH as "low blood calcium concentrations that are associated with postpartum health disorders, poorer production and reproduction outcomes or both, without associated signs of postpartum paresis."

Normocalcemia has been defined as cows with blood total calcium concentrations greater than 8.5 mg/dL and normal health and performance (Leno et al., 2017). A blood total calcium concentration exceeding 8.5 mg/dL is a good goal, but the effects of parity and sampling time need to be considered.

The Table, adapted from Caixeta et al. (2017), shows the proportion of cows that have SCH by days in milk (DIM). Contrary to popular belief, a large proportion of primiparous animals have SCH shortly following calving.

The study by Caixeta et al. (2017) observed 30 primiparous and 67 multiparous animals, respectively. Low blood total calcium concentration was defined as calcium less than 8.6 mg/dL. Persistent (chronic) subclinical hypocalcemia (pSCH) was defined as low blood total calcium concentrations for the first

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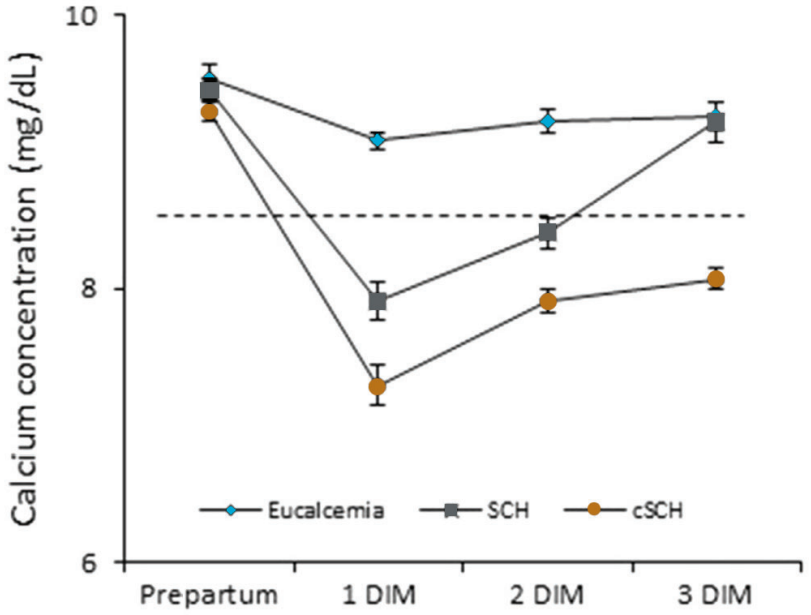
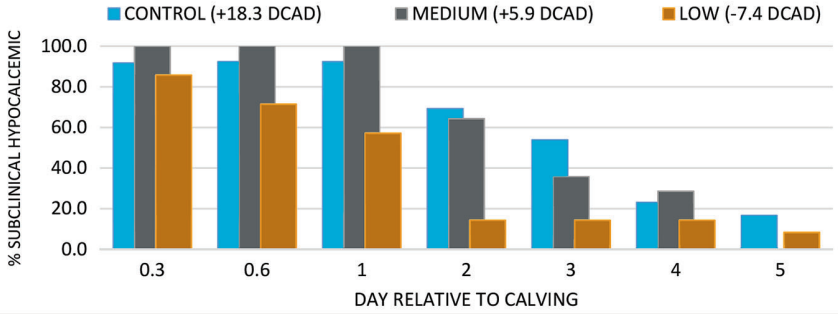
1. Illustration of blood total calcium status (pattern) for three subsets of multiparous cows



Note: Data points indicate least square means, and error bars represent standard error margin.

Source: Caixeta et al. (2017).

2. Percentage of multiparous (third lactation and greater) Holstein cows with subclinical hypocalcemia (blood total calcium under 8.5 mg/dL) by pre-fresh dietary treatment relative to DIM



Note: There was a significant reduction ($P < 0.05$) in the percentage with SCH at 24 and 48 hours post-calving for cows fed the LOW (fully acidified; urine pH of 5.96), high-calcium prepartum diet.

Source: Adapted from Leno et al. (2017).

three DIM.

As shown in Figure 1, approximately 10% of multiparous cows maintained blood total calcium concentrations in the normal range postpartum. A second group, comprised of about 40% of mature cows, experienced a dip in total blood calcium concentrations shortly following calving that rebounded quickly. A third group, comprising roughly 40% of multiparous cows, remained sluggish in recovering, taking more than three DIM to rise above the hypocalcemic threshold. These were considered pSCH cows.

Cows that experience blood total calcium at or below 8.59 mg/dL at 24-48 hours after calving are 3.7, 5.5, 3.4 and 4.3 times more likely to develop displaced abomasum, ketosis, metritis and retained placenta, respectively, and are less likely to exhibit estrus before 60 DIM (Rodriguez et al., 2017).

Cows with pSCH — blood total calcium at or below 8.6 mg/dL for each of the first three DIM (Figure 2) — are 3.7 times less likely to be pregnant at first service, while cows with blood total calcium greater than 8.6 mg/dL are 1.8 times more likely to cycle by the end of the voluntary waiting period (Caixeta et al., 2017).

Cows with SCH are 1.7 times more likely to be culled within the first 60 DIM (Roberts et al., 2012).

When to test?

Measuring blood calcium concentration in cows after calving can be a tool to identify the prevalence of SCH and the opportunities that may exist to improve calcium status through feeding and management in any dairy herd.

Determining sampling time (DIM) and cut point (threshold blood calcium level) is paramount to defining and determining which cows have SCH.

A field survey of 1,724 fresh primiparous and multiparous dairy cows demonstrated that the time of sample collection affects the prevalence of SCH (Armstrong et al., 2018). Blood calcium concentrations are lowest between 12 and 24 hours after calving (Goff, 2008).

Researchers at Cornell University reported that measuring blood calcium concentration within 12 hours of calving is a poor predictor of postpartum health disorders and pregnancy to first service and has no association with the first nine Dairy Herd Improvement Assn. tests in primiparous cows. However, measuring low blood calcium concentrations within 12 hours of calving is associated with higher milk production in multiparous cows (Neves et al., 2018a).

Neves et al. (2018b) found that blood total calcium concentration obtained at one DIM was also poorly correlated with blood total calcium concentrations at two, three and four DIM, nor did they find a correlation between blood calcium concentration measured at one DIM and the prevalence of metritis. Their findings suggest that calcium status at less than one DIM has little relationship to calcium status at two, three and four DIM for postpartum health disorders or milk production.

In contrast, blood total calcium concentrations at two DIM for the second lactation and four DIM for cows in the third lactation and higher are associated with greater risk of developing metritis or displaced abomasum (Neves et al., 2018b). These researchers also found that low blood total calcium concentrations at four DIM were associated with lower milk production in multiparous cows.

Martinez et al. (2012) found that the greatest association of hypocalcemia with metritis occurs when blood samples are obtained within the first three DIM.

These studies suggest that SCH, defined using a serum or plasma total calcium concentration cut point of less than 8.6 mg/dL, should be measured in first- and second-lactation animals at two DIM, while third-parity and higher cows should be measured at four DIM.

However, taking blood samples at different times based on lactation number may not be practical on many dairy farms. In such cases, we recommend sampling all cows between two and four DIM.

Reducing hypocalcemia

A successful prepartum feeding program can reduce the prevalence of SCH to less than 25% at two DIM (Figure 2), according to Leno et al. (2017). Feeding prepartum diets to achieve a negative dietary cation anion difference (DCAD) can help cows maintain higher blood total calcium after calving, improve start-up milk and reduce postpartum disorders.

It is recommended to feed a fully acidified, negative-DCAD diet to maintain urine pH at 5.5-6.0 prepartum for more than 21 days prior to calving with a minimum daily intake of 180 g of calcium.

Cornell University researchers have demonstrated that feeding a negative-DCAD diet prepartum that achieves urine pH values of 5.5-6.0 with high dietary calcium can improve postpartum calcium status, dry matter intake and milk yield (Leno et al., 2017). During the first three weeks of lactation, cows fed the fully acidified, high-calcium prepartum diet produced 3.3 lb. more milk per day than cows on a diet with partial anion supplementation and produced 6.8 lb. more milk per day compared to a control diet with no supplemental anions (Leno et al., 2017).

Summary

Monitoring blood total calcium concentrations in a dairy herd can be beneficial, descriptive and cost effective. We advise checking the blood total calcium concentration at two to four DIM using an SCH cutoff of 8.6 mg/dL. A high-performing peripartum program should achieve a 25% or lower prevalence of SCH at two to four DIM. Feeding a fully acidified prepartum diet with a high calcium concentration will help achieve this prevalence goal.

A sage veterinarian once said, "For every one thing you miss for not knowing, you will miss 10 for not looking." If you don't test, you'll never know how much SCH the herd is experiencing.

Cows (%) with low blood calcium concentration from one to three DIM by parity group

DIM	Parity 1	Parity 2+
1	37	88
2	40	73
3	33	48
pSCH	20	40

Adapted from Caixeta et al. (2017).

References

Armstrong, S.A., S.S. Bascom, G.A. Holub and D.E. Nuzback. 2018. Factors affecting prevalence of subclinical hypocalcemia in a 1,724 cow survey. Am. Dairy Sci. Assn. Abstract M80.

Caixeta, L.S., P.A. Ospina, M.B. Capel and D.V. Nydam. 2017. Association between subclinical hypocalcemia in the first three days of lactation and reproductive performance of dairy cows. Theriogenology 94:1-7.

Goff, J.P. 2008. The monitoring, prevention and treatment of milk fever and subclinical hypocalcemia in dairy cows. Vet. J. 176:50-57.

Horst, R.L., and N.A. Jorgensen. 1982. Elevated plasma cortisol during induced and spontaneous hypocalcemia in ruminants. J. Dairy Sci. 65:2332-2337.

Lean, I.J., P.J. DeGaris, D.M. McNeil and E. Block. 2006. Hypocalcemia in dairy cows: Meta-analysis and dietary cation anion difference theory revisited. J. Dairy Sci. 89:669-684.

Martinez, N., C.A. Risco, F.S. Lima, R.S. Bisinotto, L.F. Greco, E.S. Ribeiro, F. Maunsell, K. Galvao and J.E.P. Santos. 2012. Evaluation of peripartal calcium status, energetic profile and neutrophil function in dairy cows at low or high risk of developing uterine disease. J. Dairy Sci. 95:7158-7172.

Neves, R.C., B.M. Leno, K.D. Bach and J.A.A. McArt. 2018b. Epidemiology of subclinical hypocalcemia in early-lactation Holstein dairy cows: The temporal associations of plasma calcium concentration in the first four days in milk with disease and milk production. J. Dairy Sci. 101:9321-9331.

Neves, R.C., B.M. Leno, M.D. Curler, M.J. Thomas, T.R. Overton and J.A.A. McArt. 2018a. Association of immediate postpartum

plasma calcium concentration with early-lactation clinical diseases, culling, reproduction and milk production in Holstein cows. J. Dairy Sci. 101:547-555.

Reinhardt, T.A., J.D. Lippolis, B.J. McCluskey, J.P. Goff and R.L. Horst. 2011. Prevalence of subclinical hypocalcemia in dairy herds. Vet. J. 188:122-124.

Roberts, T., N. Chapinal, S.J. LeBlanc, D.F. Kelton, J. Dubuc and T.F. Duffield. 2012. Metabolic parameters in transition cows as indicators for early-lactation culling risk. J. Dairy Sci. 95:3057-3063.

Rodriguez, E.M., A. Aris and A. Bach. 2017. Associations between subclinical hypocalcemia and postparturient diseases in dairy cows. J. Dairy Sci. 100:7427-7434. ■