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Technical Bulletin

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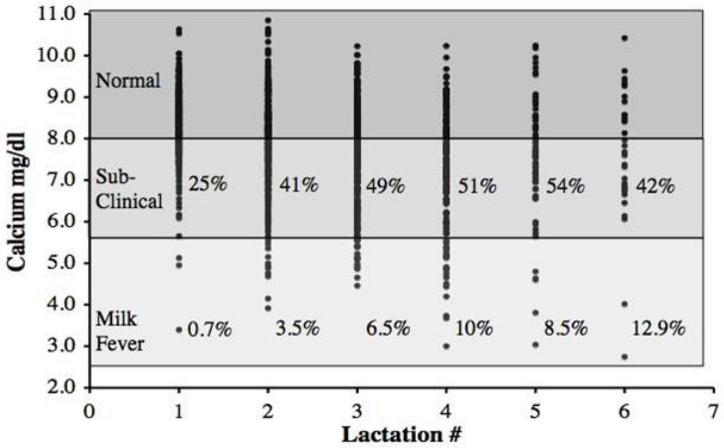
Subclinical Hypocalcemia, A Hidden Health Risk

Introduction

Subclinical hypocalcemia reduces dairy cow productivity and profitablility. The transition from gestation to lactation results in a sudden, dramatic physiological demand for calcium by dairy cows due to the production and secretion of colostrum and milk. Inadequate blood calcium concentrations at this time can result in the metabolic condition hypocalcemia, or milk fever. Clinical hypocalcemia (blood calcium concentrations below 5.5 mg/dL) affects approximately 5 percent of dairy cows in the United States and is often associated with recumbancy, depression and partial paralysis.

Figure 1: Hypocalcemia Chart - Incidence of Hypocalcemia in USA Confinement Herds



Reinhardt et al. 2011. Veterinary Journal. 188:122 NAHMS 2006

As shown in Figure 1, subclinical hypocalcemia is characterized by depressed blood calcium concentrations (between 8.0 and 5.5 mg/dL) without clinical signs. According to a 2011 study by Reinhardt, et. al., subclinical hypocalcemia affects 25 percent of all first-lactation and approximately 50 percent of all second-and-greater-lactation dairy cattle.

Although most cows will experience some degree of hypocalcemia around the time of parturition, the severity and extent of the deficiency depends on the effectiveness of the cow's calcium homeostatic capabilities. When large amounts of calcium leave the blood to be secreted in colostrum and milk, the body responds to this loss by producing parathyroid hormone (PTH).

PTH increases blood calcium in three major ways. First, PTH enhances reabsorption of calcium from the proximal renal tubules. This approach conserves only a minor amount of calcium. Secondly, it stimulates osteoclasts to resorb bone, thereby releasing calcium into the bloodstream. Finally, PTH increases dietary calcium absorption by assisting in the production of 1,25 dihydroxyvitamin D.

This hormone is necessary for the active transport of calcium across the gut wall. Dairy cows with efficient calcium homeostatic mechanisms will experience only a minor drop in serum calcium concentrations before they are able to compensate for the losses. Metabolic alkalosis, resulting from the consumption of diets that are alkalotic (high amounts of sodium and/or potassium), leads to decreased responsiveness of target tissues to PTH and, thus, low blood calcium.

Low Blood Calcium Has Significant Negative Impact

The negative effects of low blood calcium on periparturient dairy cow health are far-reaching, as afflicted animals are predisposed to several other metabolic and infectious disorders and are oftentimes less productive. This is because blood calcium is essential for proper muscle, nerve and immune system function. Specifically, cows with hypocalcemia are more likely to develop dystocia, uterine prolapse and displaced abomasums due to decreased muscle contractions. Hypocalcemia also suppresses contraction of the teat sphincter muscle responsible for the closure of the teat orifice after milking, thereby increasing the likelihood of mastitis. Cows with hypocalcemia may also have higher blood non-esterified fatty acid and ß-hydroxybutyrate concentrations.

Calcium is critical for effective immune cell function, and cows with hypocalcemia are at an increased risk for developing immune-related infectious diseases such as mastitis, retained placenta and metritis. In a University of Florida study, Martinez, et. al. (2012) found that subclinical hypocalcemia impaired neutrophil phagocytosis and oxidative burst, increased the incidence of uterine diseases and reduced pregnancy rates. In recent work published in the Journal of Dairy Science by Chapinal, et. al. (2012), cows with blood calcium concentrations of 8.4 mg/dL or less within the week prior to parturition and for up to three weeks after produced significantly less milk than cows with blood calcium concentrations greater than 8.4 mg/dL.

These data underscore the importance of proper blood calcium concentrations both before and after calving, as hypocalcemia can have significant negative impacts on early lactation milk yield. Additionally, these data challenge the traditional subclinical hypocalcemia total blood calcium threshold of 8.0 mg/dL. A more appropriate concentration of blood calcium for periparturient dairy cows might be 8.5 mg/dL or greater, as this level may more adequately describe the point where negative effects on animal health and performance begin.

Greater Economic Cost Of Subclinical Hypocalcemia

Because subclinical hypocalcemia affects a much higher percentage of cows, lost revenue associated with this condition far exceeds that of clinical hypocalcemia. In 2012, G.R. Oetzel illustrated that the economic loss to a 2,000-cow dairy with a 2 percent annual incidence of clinical hypocalcemia (at $300 per case) is approximately $12,000 per year. If the same herd has a 30 percent annual incidence of subclinical hypocalcemia (at $125 per case) in second-and-greater-lactation cows (65 percent of cows in the herd), the loss is approximately $48,750 per year. Thus, the economic loss from subclinical hypocalcemia can be more than four times greater than the economic loss from clinical hypocalcemia.

There are several different strategies that may be utilized to prevent subclinical hypocalcemia in dairy cows. One of the most thoroughly researched and efficacious is feeding a negative dietary cation-anion difference (DCAD) diet for approximately 21 days prior to parturition. There are a variety of ways to calculate DCAD, but the most widely used equation in the industry is DCAD = $(Na^{+} + K^{+}) - (Cl^{-} + S^{2-})$. By increasing the amount of anions (chloride and sulfur) in the diet compared to cations (sodium and primarily potassium), the cow will be placed in a state of compensated metobolic acidosis.

Research has demonstrated that a dietary DCAD level of -15 mEq/100g might be the level that results in the best response. Most studies have found that the physiological functions stimulated by PTH to increase blood calcium levels are enhanced when negative DCAD diets are fed.

Taking Control

Angela Rowson, DVM, DAVP (Dairy Practice), offers these useful guidelines for lowering the incidence of subclinical hypocalcemia.

1. Feed an acidogenic diet with a DCAD between -10 and -15 mEq/100 g. Selecting an anionic product that is palatable can help achieve a low DCAD while maintaining high dry-matter intakes.

2. Monitor urine pH values, especially after significant changes to the diet. Because the pH of a cow's urine accurately reflects the pH of her blood, this simple test is an inexpensive and quick way to gauge the optimal level of anion supplementation. Be sure to collect midstream urine that is free of feces and vaginal secretions, as both of these may alter pH. Recommended urine pH is between 5.5 and 6.0. If the average urine pH is below 5.5, excessive anions have been used and their intake should be lowered. Conversely, if urine pH is above the 6.0 target level, addition of anions is necessary.

3. Feed the acidogenic diet for three to four weeks prior to calving. Feeding a negative DCAD diet for a minimum of three weeks prepartum is essential, as some cows calve prior to their expected calving date. A properly balanced, negative DCAD diet can be safely fed for extended periods of time without deleterious effects.

4. Feed proper amounts of other macrominerals. Recommended feeding rates include calcium (feed a minimum of 180 g and not less than 1.5% DM), phosphorus (45 g and not less than 0.38% DM), magnesium (54 to 60 g), chloride (96 to 120 g) and sulfur (48 to 56 g).

5. Perform total blood calcium testing. Routinely collect whole blood from a sub-population of fresh cows after calving (ideally 48 hours postcalving). Following these recommendations will lead to more consistent interpretations of results. Values should be greater than 8.0 mg/dL, with 8.5 mg/dL or higher being optimal.

6. Continue regular monitoring. Once target urine pH and total blood calcium values are achieved, continue to monitor these parameters. This will allow early intervention when numbers deviate from target values.