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Milk Fever (Parturient Paresis) and Its Impact on Dairy Cattle Production

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Abstract

Milk fever (Parturient paresis) is a metabolic disturbance or production disease of dairy cattle that occurs just before or soon after calving due to low ionized calcium (Ca^{++}) levels in the blood. It is associated with calcium drain within the fetus and milk during pregnancy and calving, respectively. It can be clinical or sub-clinical based on clinical signs. High yielding dairy cows are the most susceptible to milk fever during the peri-parturient period. Milk yield, parity, age, breed, body condition score (BCS), and diet composition of the animal are the most common factors that contribute to the occurrence, incidence and severity of milk fever. Economically, it reduces milk yield and fertility which leads to the culling of high producing dairy animals from a herd. Diagnosis of milk fever is based on history taking, clinical examination and laboratory diagnosis. It is commonly treated with oral calcium solutions and intravenous calcium borogluconate. Prevention of milk fever is economically important to dairy producers to minimize production losses, death losses and veterinary costs associated with the disease. Multiple strategies have been utilized to prevent hypocalcaemia including feeding anionic salts, low calcium ion diets, vitamin D supplementation, dietary magnesium supplementation, and managing the body condition score of animals during the peri-partum period. Hence, prevention of milk fever is the key to reduce the economic impacts of the disease in the dairy industry.

Introduction

Milk fever is one of the most common mineral-related metabolic diseases of dairy cows that occur just before or soon after calving as a result of low ionized calcium levels (Ca^{++}) in the blood. It is one of the metabolic diseases occurring most commonly in adult cows within 48 hours after parturition, but it may occur several weeks before or after parturition. On the day of parturition, dairy cows commonly produce 10 liters or more of colostrums containing 23g or more of calcium, approximately 6 fold as much calcium as the extracellular calcium pool contains (Khan *et al*., 2012). During the dry period, calcium demand is relatively low. Hence, intestinal absorption and bone resorption of calcium are relatively inactive during this time. The onset of lactation results in a sudden loss of calcium through milk. When the calcium homeostatic mechanism is unable to meet the demand of calcium for milk production, hypocalcemia occurs. About 50% of dairy cows in their second lactation and above have blood calcium concentrations that fall below the threshold for subclinical hypocalcemia after calving (Reinhardt *et al.*, 2011). Milk fever can be clinical or sub-clinical based on whether an animal may or may not show clinical signs. The clinical signs include ataxia, poor appetite, reduced rumen motility, low body temperature, slow respiration, quick and weak heartbeats, paresis due to reduced muscle function that may develop into complete paralysis and coma. It can be diagnosed based on the history of the animal at calving, clinical signs, age of dam and response to intravenous calcium borogluconate solution (Radostits *et al*., 2007).

Treatment of milk fever should be done as early as possible for good recovery and to avoid complications. Most commonly calcium borogluconate is used for treating milk fever. The key to the prevention of milk fever is management of a close up dry cow or management during late pregnancy. Multiple strategies must be designed for the management of hypocalcemia and to enhance calcium mobilization in dairy cows, particularly in peri-parturient period (Amaral-Phillips, 2017). The most important economic loss of milk fever is due to a reduction in milk production, loss of animals due to culling and mortality and the cost of treatment of the animals.

Risk factors

Milk fever is a common non-infectious disease of dairy cows throughout the world. It is common outcome of modern dairy industry that is pushing for maximization of profit. The risk factors for hypocalcaemia could be grouped into intrinsic risk factors, which are associated within the animal itself and extrinsic risk factors, which are outside of the animal's body which are commonly known as environmental factors (Aberaw, 2017).

I. Intrinsic risk factors for hypocalcaemia

A. Number of parity and milk yield

The increased prevalence rate of milk fever is associated with the increased number of calving (parity) and milk yield. Bernard *et al.* (2017) showed that the incidence of milk fever in Jersey and Holstein Friesian cows with more than four parities was significantly higher than those in their second, third and fourth parities. Neves *et al.* (2017) also reported animals in their third or greater parities were 70% more likely to be affected by subclinical hypocalcaemia than second-lactation animals. Second-lactation animals, as compared with older parities, can better maintain Ca^{++} turnover rates in the immediate postpartum period. The prevalence of clinical milk fever was 1.4%, 5.7%, and 16.1% for 2nd, 3rd, and ≥ 4th parity cows, respectively. Different researchers suggested that this is because of the reduced ability to mobilize calcium from bones, a decline in intestinal transport of calcium and the reduced ability to produce calcitriol in older cows (Venjakob *et al.*, 2017).

B. Age of the cow

The risk of a cow developing milk fever will increase with age. From the third lactation onwards, dairy cows produce more milk, resulting in a higher calcium demand. Moreover, increased age is known to impair Ca metabolism; for instance, bone and intestine vitamin D receptors decline with aging. Thus hypocalcaemia is age related and most marked in cows from third to seventh parturition**.**

C. Breed of the cow

Certain breeds of dairy cows are more susceptibility to milk fever than other breeds. Specifically the incidence increases in high producing dairy cows such as Jerseys and Guernseys than Holstein Friesian and Brown Swiss breed. This might be due to higher milk production per unit of body weight in the most susceptible breeds. In general cross breed or temperate breeds are more susceptible to milk fever than tropical zebu breeds. This could be attributed to their high milk yield and low ability to maintain their calcium homeostasis of cross breed and temperate breed. In addition, the other important reason of higher susceptibility to milk fever is lower number of intestinal receptors for 1, 25-Dihydroxy vitamin D3 (1, 25(OH) D3), which is responsible for intestinal calcium absorption and bone calcium resorption (Weiss *et al*., 2015).

D. Body condition score (BCS)

Excessive BCS prior to calving has been recognized as a risk factor for the development of metabolic problems. The occurrence of milk fever also increases in cows with higher BCS, possibly due to decreased calcium intake (Ostergaard *et al*., 2003)**.** The development of milk fever in over-conditioned cows may be due to the decrease in DMI, at the same time decreasing calcium intake consequently results hypocalcaemia at calving.

II. Extrinsic risk factors

Dietary factors

The diets providing dry cows a high daily intake of calcium are associated with an increased incidence of parturient paresis. At this level, the maintenance requirement of calcium can be met predominantly by passive absorption since active absorption of dietary calcium and bone resorption are suppressed. Cows in this condition are not able to quickly replace plasma calcium lost in milk and become severely hypocalcaemic. Higher calcium intake impairs the uptake of calcium. Prepartum diets high in cations like sodium and potassium are

associated with an increased incidence of milk fever.

Clinical Signs

- Hypocalcaemia can be clinical or subclinical based on whether an animal may or may not show clinical signs. Clinical milk fever is the most severe hypocalcaemia results in cow's inability to stand after calving and is the most easily recognized form of hypocalcaemia with blood calcium concentration less than 5 mg/dL. Subclinical hypocalcaemia results in less severe disturbances in blood Ca and does not have any outward sign. During subclinical hypocalcaemia, blood calcium concentration ranges between 5.5 and 8.0 mg/dL (Wubishet *et al.*, 2016).
- Based on the degree of hypocalcaemia and time of occurrence, the clinical signs of milk fever are divided into three stages.

Stage I (Stage of Excitement)

- Stage I is characterized by mild excitement and tetany without recumbency. This phase often goes unobserved because its signs are subtle and of short duration (often less than 1 hour). Affected cattle may appear excitable, nervous, anorexia, weakness, weight shifting and shuffling of hind leg (Fig.1).

Stage II (Stage of Sternal recumbency)

- Cows in stage II milk fever are in sternal recumbency. They exhibit moderate to severe depression, cold extremities, mild bloat, and partial paralysis and typically lie with their head turned into their flank (Fig.2). Body temperature is subnormal, muzzle dry and the heart rate is rapid.

Stage III (Stage of Lateral recumbency)

- Stage III hypocalcemic cows are completely paralyzed, typically bloated, in lateral recumbency (Fig.2) and progressively loss consciousness thus leading to coma. There is a marked fall in temperature and increased heart rate. Cows will not survive more if not treated.

Diagnosis

- Diagnosis of milk fever is based on history taking, clinical examination and laboratory diagnosis. While taking history, all the detailed information of the cow including age, breed, stage of lactation, milk yield and calving day should be collected.
- Laboratory determination of blood calcium level and good response to intravenous calcium solutions are the most accurate methods to diagnose a case of milk fever. The normal serum Ca concentration is 8-10 mg/dL. Cows with serum calcium lower than 7.5 mg/dL are considered hypocalcaemic. Animals with serum calcium level of 5.5 to 7.5 mg/dL show signs of stage I hypocalcaemia. Stage II hypocalcaemia seen with calcium levels of 3.5 to 6.5 mg/dL and stage III seen when calcium concentration falls below 3.0 mg/dL (Hunt and Blackwelder, 2002).

Treatment

- Treatment of milk fever should be done as early as possible. Commonly milk fever is treated with oral calcium solutions, intravenous calcium borogluconate and Dextrose Salines. Supplementation of calcium borogluconate by oral route is the best approach to hypocalcemic cows that are still standing, such as cows in stage I hypocalcemia or which have undetected subclinical hypocalcemia.
- For cows in stage II and III of milk fever should be treated immediately with a slow IV administration of 500 ml of 23% calcium borogluconate. Extremely high dose of calcium may cause fatal cardiac complications. Subcutaneous calcium administration can also be used to support blood calcium concentrations around calving (Fig. 3 & 4).

Prevention and Control strategies of milk fever

The occurrence of milk fever or subclinical hypocalcaemia is related to increased incidence of several other transition cow disorders. As a result, strategic prevention of milk fever is economically important to the dairy farmer to minimize the production loss, death loss and veterinary costs associated with milk fever. Multiple strategies have been utilized to prevent hypocalcaemia and mobilize calcium in dairy cows through nutritional management including feeding anionic salts, low calcium ion diets and vitamin D supplementation.

A. Feeding of low-calcium diets

- Feeding with low calcium diets during dry period is one of milk fever prevention strategy. This was achieved through feeding the cows with less than 50 g per day. Therefore, to do so,

high calcium forages such as alfalfa, have to be eliminated from animal's diet. Forages such as corn silage and grass hay have to be routinely used in dry form to reduce calcium composition within it. Bhanugopan and Lievaart (2014) reported feeding hay, straw and grain during the dry period was a general nutrition strategy used by all the farmers. Feeding grain reduces the risk of milk fever because it helps the rumen to adapt to the high-energy feeds given post-calving and grain is also low in calcium.

B. Dietary cation-anion balancing (DCAB)

- Dietary cation-anion balancing is a nutritional tool for reducing milk fever in early lactation as well as improving the health and production of the cow. It is a common prevention strategy by supplementing anionic salts to reduce diet cation-anion difference and was implemented in the dairy industry. The goal of this type of supplementation is to reduce absorbable cations such as sodium and potassium while increasing available anions like chlorine and sulfur monoxide in the diet (Goff, 2008).
- It is very difficult to control hypocalcaemia if total ratio of K is >1.8%. Since high potassium diets usually induce milk fever, pre-calving potassium levels should be kept as low as possible. As dry fodder contains more potassium, feeding of dairy animals with higher amounts of dry fodder should be discouraged to prevent milk fever. Inclusion of silage and succulent/green fodder as a major portion of the dry cow's diet is essential, as it has lower potassium content (Thirunavukkarasu *et al*., 2010).

C. Oral calcium drenching during calving

- Oral calcium supplementation is one of the preventive strategies of milk fever around calving. According to Amanlou *et al.* (2016) results, cows given 2 infusions of subcutaneous Ca within the first 18 hrs postpartum were less likely to develop metritis and clinical and subclinical endometritis and hypocalcaemia than non-treated control cows.

D. Peripartum dietary magnesium supplementation

- Ensuring adequate magnesium supplementation is vital for the prevention of milk fever. Magnesium plays a very important role in calcium metabolism, as it is a key intermediate in the resorption of calcium from bone by parathyroid hormone. High levels of magnesium could induce a lower renal calcium excretion. Milk fever is usually accompanied by an increased concentration of plasma magnesium level to stimulate calcium homeostatic mechanisms, which is essential for restoring the normal blood calcium level.

E. Vitamin D supplementation

- A practice by some farms is supplementing high amounts of vitamin D to prepartum dry cows in the feed. Supplementation requires that up to 10 million IU of vitamin D must be injected or fed daily for 10-14 days before calving. These vitamin D doses pharmacologically increased intestinal Ca^{++} absorption.

F. Body condition score management

- Achieving the correct BCS at calving and dry period is critical for the prevention of milk fever. Over conditioned cows at calving are up to four times more likely to develop milk fever. The main reasons could be, firstly, dairy cows with higher BCS at calving have a higher calcium output in milk, making them more prone to milk fever. Secondly, over-conditioned dairy cattle have a reduced feed intake relative to thinner cows, in the last week of pre-calving. This reduces the intake of calcium and magnesium to the levels of hypocalcaemia. It is important to prevent the dry cows from being too fat. Cows with marked body condition loss in the dry period are also at greater risk of milk fever (Charbonneau *et al.*, 2006).

Fig.1 Typical posture of a cow in milk fever (Stage II)

Fig.2 Cow in Advanced stage of milk fever (Stage III)

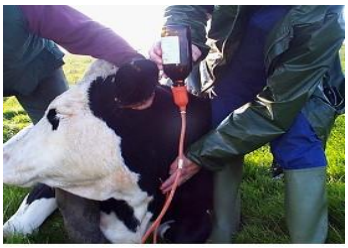

Fig.3 Intravenous Calcium administration through jugular vein

Fig.4 Intravenous Dextrose saline administration through jugular vein

Conclusion

- Milk fever is a common metabolic disturbance of dairy cows resulting from hypocalcaemia that occurs in adult high producing dairy cows during calving. Milk fever has both direct and indirect economic impacts in dairy industry. The most important direct economic losses due to milk fever are losses due to a reduction in milk production of affected cows, loss of animals through death and culling, and the cost of treatment of the animals. On the other hand, increased incidence of infertility, dystocia, retained placenta, metritis, mastitis and displacement of abomasum are the indirect impacts. Therefore, the prevention of milk fever is the key to reduce the economic impacts of the disease. Management practices like nutritional strategies and body condition management are critical for the prevention of the disease. Based on the above conclusion, the following recommendations are forwarded: training dairy farmers is very important to be aware of milk fever and proper ration formulations for their dairy cows. The owners of dairy farms should reduce the energy source of feed especially concentrate to avoid over-conditioning of the cow around calving. Awareness should be created for farmers to observe their dairy cattle from 48-72 hrs before and after parturition for evidence of milk fever. Further study should be conducted on the epidemiology and economic impacts of milk fever in the dairy industry.

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