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Popular Article

Calcium, Electrolytes and Markers in Downer Cow Predictions and Monitoring

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Abstract

Blood tests play a crucial role in diagnosing and managing downer cows in dairy farming. This abstract summarizes key diagnostic markers and their significance in assessing the health and prognosis of downer cows. Creatine Phosphokinase (CPK) and Aspartate Transferase (AST) serve as specific indicators of muscle damage, while Non-Esterified Fatty Acid (NEFA) levels detect fatty liver. Serum electrolyte imbalances, particularly hypocalcemia and hypokalemia, are associated with prolonged recumbency. Serum magnesium and phosphorus levels are also considered. Ornithine Carbamoyltranferase (OCT) and Glutamate Dehydrogenase (GDH) values provide insights into the severity of fatty liver and hepatocellular damage. These blood tests aid in diagnosing underlying issues, guiding treatment, and improving the prognosis of downer cows in dairy herds.

Introduction

Blood tests from individual animals are routinely used to diagnose disease problems in dairy cattle. Veterinarians, producers and nutrition consultants alike seem to be interested in extracting pertinent information relative to herd nutrition and health status from blood tests. The term “downer cow” is generally used to describe a cow which is in sternal recumbency and unable to rise. There are a number of causes, including metabolic disease, toxic mastitis or metritis, exhaustion from calving, calving paralysis, hip joint luxation, and pelvic fracture. While in sternal recumbency, cows generally lie on one pelvic limb. Pressure damage resulting from this position is considered to cause local damage to muscle and nerve tissue. This tissue damage is generally held to be the cause of the pelvic limb dysfunction in downer cows. The treatment of downer cows can be expensive in terms of the time taken and the drugs used. Therefore, it would be helpful to have a prognostic test to determine which animals are unlikely to recover because of severe muscle damage.

Downer cows usually have reduced appetite which aggravates fatty liver, initiating a vicious cycle of worsening appetite. This may explain why moderate or severe fatty liver often leads to liver failure and death in downer cow. A panel of tests - which included creatine phosphokinase (CK), aspartate transferase (AST), glutamate dehydrogenase (GDH), calcium, magnesium, phosphorus and potassium is performed on the

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majority of the routine cases to predict and monitoring of "downer cow".

Utility of CK testing

CPK normally ranges between 105 to 409 IU/L. A value greater than 1000 IU/L indicates severe muscle damage from being down. Maximum CPK activity occurs first 48hrs of recumbency and > 48hrs its activity declines rapidly. Downer cows had significantly higher CK, AST and urea level and significantly lower cholesterol than healthy cows. For downer cow problems, consider CPK and AST in the blood test. Prolonged recumbency causes ischemic necrosis of muscles resulting in increased permeability of cell membrane allowing seepage of AST, ALT and CPK enzymes into circulation.

Creatine phosphokinase is considered as a specific marker of muscle damage and increase in CPK testified ischemic damage to the muscle causing its seepage into the circulation. The CPK levels need to be interpreted in relation to the days of recumbency when the sample is taken. Critical levels may be highest initially up to 50 times and may reduce to 10 times normal range at 7 days of recumbency.

Aspartate Transferase (AST)

Normal AST range for cow is 60-125 IU/L. In downer cows with increased AST activity, concurrent analysis of serum CK activity helps to identify the origin of AST (muscle or liver). Increases in AST were likely due to muscle damage, because the correlation between serum CK and AST activity was high. Consequently, as the liver-derived portion of serum AST activity cannot be distinguished, the diagnostic value of AST in downer cows suspected for liver dysfunction is diminished. AST levels over 200 IU/L flag a guarded prognosis and levels over 500 IU/L can indicate severe muscle damage. Serum AST activity may also have value in diagnosing fatty liver.

Non-Esterified Fatty Acid (NEFA)

Non-esterified fatty acids are considered useful for detection of fatty liver in downer cows, as a high NEFA concentration is indicative of extended lipid mobilization and is highly correlated with liver lipid content. Serum NEFA gradually increases during the last week before parturition and then acutely increases at calving, which triggers even more fatty liver infiltration. In downer cows this phenomenon is more intense because the appetite loss and the difficulties in accessing food lead to a higher negative energy balance, which in turn increases NEFA mobilization and blood concentration. The NEFA serum concentration is also stress-sensitive which increases NEFA release, resulting in more rapid lipid accumulation in the liver.

Serum cholesterol concentration was significantly decreased in cattle with moderate and severe fatty liver compared to the healthy cows and cows with mild fatty liver, and was inversely related to NEFA concentrations. These resulted in fatty liver infiltration was associated with decreased serum cholesterol, higher NEFA, and higher NEFA/cholesterol ratio. The NEFA/cholesterol ratios herein were about 3 times higher in cows with moderate fatty liver and more than 4 times higher in cows with severe fatty liver compared with the reference cows.

Normal values for cows in positive energy balance are than 200micromolar. During the close-up period, values increases slowly as the cow approaches calving and usually range from 200 to 300 micromolar. Values greater than about 700 µM beyond 7 days indicate severe negative energy balance.

Serum electrolyte imbalances

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Serum electrolyte imbalances or deficits may be associated with prolonged recumbency following treatment for parturient paresis

1. Calcium homeostasis

The regulation of serum Ca is controlled by three potent calcitropic hormones: associated parathyroid hormone (PTH) secreted from the parathyroid gland, 1,25-(OH) D_3 , a metabolite of vitamin D produced in the kidney and calcitonin, while calcitonin plays a valuable feedback relationship with hypercalcemia, or managing blood Ca concentrations after an intravenous calcium treatment, it has a lesser impact on fever calcium homeostasis. Normal blood Ca^{++} in the adult cows is maintained between 8.5 and 10mg/dl (2.0 -2.8mmol/L). Ionozed calcium level is most important than total calcium measurements. Maintenance of blood Ca^{++} within the acceptable range is a balancing act between the Ca^{++} demand of milk production and the cow's homeostatic mechanisms to maintanin blood calcium. During the dry period, the supply of calcium through the diet is usually not activated until parturition. Therefore, dry period is the phase most important in the development of milk fever and consequences of downer cow. During subclinical hypocalcemia, blood Ca concentration ranges between 5.5 and 8 mg/dl.

The downer cows had significantly lower ionized serum Ca concentration compared with the reference and healthy fresh cows. This was expected, because hypocalcemia is the most frequent cause of recumbency in fresh cows. Some of the downer cows suffered severe hypocalcemia (ionized Ca concentrations as low as 0.7 mmol/L).

2. Serum Potassium

All downer cows had significantly lower median serum K concentrations compared with reference and healthy fresh cows. K concentration was significantly lower in downer animals that died compared to animals that were cured. It is generally accepted that cows being off-feed for more than 3 d will finally result in hypokalemia. However, the cows were hypokalemic without being off-feed, as the sampling was performed within 6 h after their recumbency. The degree of hypokalemia may be partly attributed to the various degrees of inappetance that these cows had. Nevertheless, we cannot draw conclusions about the reason the downer cows were hypokalemic. Given that hypokalemia can lead to muscle weakness and degeneration and recumbency, K concentration should always be evaluated in downer cows and considered in the prognosis.

Hypokalaemia in recumbent cows occurs due to the fact that muscle ischaemia as a result of prolonged recumbency increases the cell membrane permeability of muscle fibres and allow loss of potassium from the cell causing myotonia which appears to be the basis of downer cow syndrome. Hypokalemia could also occurs due to rapid urinary excretion and diminished alimentary absorption of potassium associated with reduced feed intake. Diminished excitability of nerve and muscle cells, weakness and flaccid paralysis are the consequences of hypokalaemia Hypomagnesemia as well as normal magnesium level have been recorded in downer cows. The sodium concentration in downer cows was within normal range.

Normal ranges for bovine serum calcium, magnesium, phosphorus, and potassium

	Calcium	Magnesium	Potassium	Phosphorus
Normal range (mmol/L)	2.0-2.6	0.63-1.15	1.3-2.5	3.9-5.8

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3. Serum magnesium

Serum magnesium levels below 0.8mg/dL (0.33 mmollL) indicate severe hypomagnesemia and clinical signs occur with levels of 0.3-0.7 mg/dL (0. 12-0 .29 mmoIlL). Normal values are 2.2-2. 7mg/dL (0.9-1 .11 mmoI/L). Erythrocyte magnesium concentrations are also low, indicating a chronic deficiency. Serum calcium levels tend to fall when serum magnesium levels become very low and are below normal in most clinical cases. A long-term lowlevel hypomagnesemia has been associated with the downer cow especially when it accompanies hypocalcemia.

4. Serum phosphorous

Persistent hypophosphatemia has been regarded as a cause of downer cow syndrome associated with milk fever. Many veterinarians claim that these cows respond to treatment with phosphorus. However, persistent recumbency is associated with subnormal levels of serum phosphorus which increase to normal in the cow stands regardless of treatment with or without phosphorus. Mature dairy cows may become recumbent in early lactation and subnormal levels of serum phosphorus may be present.

Other indicators

Ornithine carbamoyltranferase (OCT

OCT is a reliable index of fatty liver severity, which, in turn, is an indicator of poor prognosis of downer cows. Although the relatively small number of downer cases did not enable sensitivity evaluation to verify a cut-off point, the data indicate that OCT values above 40 U/L suggest severe fatty liver and guarded prognosis for downer cows.

Glutamate dehydrogenase (GDH)

Detection of high activity in recently calved cows may be an important indicator of fatty liver and of the poor prognosis of downer cows. Increased GDH activity also indicates acute hepatocellular damage. GDH values > 16 U/L might indicate guarded prognosis for downer cows due to severe liver damage

We believe that the panel of tests applied to downer cows, especially in the first week of recumbency, helps to determine whether severe muscle damage is limiting recovery. It also provides information on other causes of recumbency and aids awareness of herd problems such as low concentration of calcium, phosphorus and potassium. However, significantly higher activities of serum enzymes of creatinine phosphokinase, aspartate and alanine amino transferase were observed in downer cows. Concluded that the downer cows should be treated with potassium in addition to calcium, phosphorus and magnesium.

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