Relationship of Nutrition to Abomasal Displacement and Parturient Paresis

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Abomasal Displacement

Abomasal displacement is primarily a disease of dairy cows. The majority of papers on abomasal displacement discuss the treatment and there are relatively few papers which discuss the etiology and prevention of abomasal displacement. However, it seems that there are certain factors which predispose dairy cattle to abomasal displacement. The primary predisposing factors seem to be 1) advanced pregnancy or recent parturition, 2) abomasal hypomotility or atony, and 3) gas production and accumulation in the abomasum.

The factors which contribute to abomasal hypomotility or atony include feeding large quantities of grain, feeding diets high in corn silage, concurrent disease, lead feeding, hypocalcemia, and metabolic alkalosis. Factors which have been suggested as contributing to increased gas production are feeding diets high in concentrate and limited in roughage.

Much of our insight into the pathogenesis of abomasal displacement is the result of a series of experiments by Svendson (1969). Svendson examined abomasal motility as one of the factors predisposing to abomasal displacement. Abomasal motility was markedly depressed as an experimental feeding of a meal was changed from five pounds of hay to three pounds of concentrate and motility was further depressed when the amount of concentrate was increased to 15 pounds. These same effects on abomasal motility could be recreated by collecting 300 ml of rumenal fluid from cows which had recently eaten the various diets and infusing the rumenal fluid into the abomasum of experimental cows. The depression of abomasal motility could also be created by infusion of 300 ml into the abomasum of a mixture of Volatile Fatty Acid's (VFA) at a concentration of 120 mM but not at a concentration of 70 mM. The second factor related to abomasal displacement was abomasal gas production. Abomasal gas production was also related to diet. Abomasal gas changed slightly from 580 ml per hour prefeeding to 775 ml per hour following feeding of 5 pounds of hay. Following feeding of 3 pounds of concentrate, gas production increased to a maximum of 1040 ml per hour and to 2150 ml per hour after feeding 15 pounds of concentrate. The increase in gas production must presumably be caused by either a change in the composition of digesta entering the abomasum which results in greater gas release or an increase in the volume of rumen effluent flowing to the abomasum. When rumen fluid collected after the feeding of either 5 pounds of hay or 15 pounds of concentrate was titrated to a pH of 2, there was only about a 20% increase in the amount of gas released by unit of rumen fluid. The most probable explanation for the increased production of abomasal gas must be that the flow from the rumen to the abomasum is increased after feeding concentrate.

From the results of this experiment, it seems appropriate to draw some conclusions. First, it doesn't seem likely that the amount of gas produced per unit of rumen effluent can be altered to any significant extent through feeding practices. As dairy cows are fed more concentrate, more rumen effluent will be transfered to the abomasum and more abomasal gas will be produced. Second, that as the concentration of VFA's in the rumen effluent increases, there is an associated decrease in abomasal motility. It has also been demonstrated that the feeding of concentrates stimulates the development of rumen papilla. As ruminal papilla develop, the capacity to absorb VFA's produced in the rumen increases. Therefore, it seems that of the two factors which predispose to abomasal displacement, the only one which can be altered through nutritional management is the concentration of VFA's in the rumen effluent. This can be done through stimulating rumen papilla development through gradually increasing the amount of concentrate rather than through abrupt changes in amount. Second, the site of VFA production and absorption can be controlled by feeding rations which form a functional fiber mat. A functional fiber mat effectively traps particles of concentrate and will result in fermentation of concentrate and absorption of VFA's more dorsally in the rumen. Thus, the concentration of VFA's in the rumen effluent entering the abomasum will be reduced.

In contrast to the experimental observations, it seems that some dairymen can feed high concentrate diets without having problems with abomasal displacements and

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some can have relatively high incidence on a ration of very similar composition. I propose that the structure of the fiber mat in the rumen is an important factor affecting the incidence of abomasal displacement. The fiber mat has two important functions. First, it is composed primarily of coarse roughage material which floats on the upper layer of rumen fluid and is the material upon which the cow ruminates. The second function of the fiber mat is to act as a particle trap. Thus, maintaining a functional fiber mat becomes an important objective for the prevention of abomasal displacement.

Prevention of abomasal displacement

Maintaining a functional fiber mat in the rumen is important for the prevention of abomasal displacement. The particles of roughage material should be long enough to stimulate rumination and act as a functional particle trap. Since there is not an easy method for determining the quantity of roughage particles above a predetermined length, especially when the forage is in the form of a silage or has been ground, an alternative method for evaluating the adequacy of roughage function can be the amount of time the cows spend ruminating. A minimum of 50% of the cows should be chewing their cuds when the cows are not being fed, moved to the milking parlor or being milked. One means of attempting to maintain an adequate fiber mat is to feed a minimum of 5 pounds of long stem hay. The hay should be fed an hour before concentrate is fed. It is even better if the long stem hay can be fed twice daily. However, a functional fiber mat can be maintained without feeding long stem hay if the quantity and length particles in ground hay or silage are adequate. The problem is in determining adequacy of quantity and length of forage particles. Observing the proportion of cows ruminating may be the most effective means of determining adequacy of the fiber mat. Another factor to consider is that the fiber mat is in a continual dynamic state of new material being added and degradation of existing material. If the cow goes "off-feed" for any reason, degradation of the fiber mat will continue to occur. When the primary condition which caused the cow to go "off-feed" is corrected and the cow resumes eating, there may not initially be a functional fiber mat and the concentration of VFA's in the rumen effluent will be elevated until the fiber mat is re-established. During this period of time the cow is at increased risk of abomasal displacement.

Parturient Paresis

Milk fever or parturient paresis is a common metabolic disease of dairy cattle. The importance of parturient paresis to the dairy industry may not be fully appreciated because the incidence is relatively low and an effective treatment is available. However, cows which have milk fever are at increased risk for several other periparturient diseases including dystocia, retained fetal membranes, mastitis, ketosis, and abomasal displacement. In additon, cows which have had milk fever are at greater risk to be removed from the herd earlier and in at least one trial, cows which had parturient paresis produced 14% less milk in the subsequent lactation compared to non-paretic cows. Although milk fever tends to be a disease of high producing dairy cows, epidemiologists often times have made inappropriate comparisons of the effect of milk fever on subsequent milk production by using herdmates of average production rather than high producing cows or using the preceding or subsequent lactation of the same cow.

Risk Factors for Milk Fever

Although there is not a clear correlation between **milk yield** and milk fever, it seems reasonable to assume that as milk yield increases, the metabolic stress to maintain calcium homeostasis must increase.

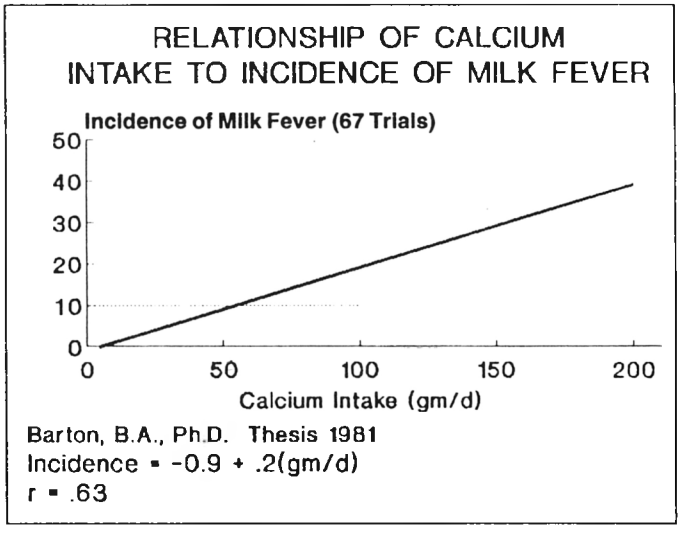
The incidence of milk fever increases with **age.** This relationship can be explained by the fact that milk production increases while calcium availability from the bone decreases and calcium absorption from the gut decreases with advancing age. In addition to the decreased age-related absorption of calcium from the gut, inappetence and rumino-intestinal stasis are well established features of the parturient cow which further reduce availabilty of dietary calcium.

While it is a well established fact that **high prepartum dietary calcium** intakes increase the risk of milk fever, more recent research has also incriminated prepartum **dietary electrolyte balance** as an important risk factor for milk fever.

Genetics and breed are recognized as risk factors for milk fever. Among breeds of dairy cattle, Jersey cattle seem particularly predisposed to milk fever.

Prevention of Milk Fever

Limiting Calcium



Limiting calcium intake has been a commonly recommended practice to prevent milk fever. However, when the results of 67 trials were evaluated by Barton, calcium intake would have to be limited to 60 g/day to reduce the incidence of milk fever to 10% and daily intake would have to be reduced to 20 g to approach 0% incidence. It becomes obvious that reducing the calcium intake to these relatively low levels is difficult especially if legume forages are included as part of the diet.

Feeding Anionic Salts

Because it may be difficult or impossible to provide dry cow rations which are low enough in calcium to maintain an acceptable incidence of milk fever, feeding anionic salts may be an effective alternative for the prevention of milk fever.

Several formulas have been used in calculating the anion-cationic balance of a ration. The following are the commonly used formulas:

A. Cation-anion balance = mEq (Na + K + Ca + Mg) − mEq (Cl + SO_4 + H_2PO_4 + HOP_4)

B. Cation-anion balance = mEq (Na + K) − mEq (Cl)

C. Cation-anion balance = mEq (Na + K) − mEq (Cl + S)

D. Cation-anion balance = mEq (Na + K + Mg) − mEq (Cl + S + P)

Of these formulas, B and C are the most commonly used. Formula C is applicable under most conditions and provides a standardized formula that allows comparison of cation-anion balance between various trials and diets. Formula B is a commonly used formula to evaluate the cation-anion balance of a diet and is workable as long as sulfur containing compounds are not used to alter the cation-anion balance of the ration.

The cation-anion balance of a ration is calculated on the basis of the amount of positive or negative charge per unit weight of diet. The amount of charge is usually expressed in terms of millequivalents (mEq) of charge per gm of the element. The following table contains the cations and anions of concern in calculating cation-anion balance and their respective mEq per gram.

Mineral	Molecular Weight	Valence	Equivalent Weight	Millequivalents per Gram
	(g)		(g)	(mEq/g)
Sodium	23	1	23	43.5
Potassium	39	1	39	25.6
Calcium	40	2	20	50
Magnesium	24	2	12	83
Phosphorus	31	1.8	17.2	58
Chloride	35.5	1	35.5	28.2
Sulfur	32	2	16	62.5

The cation-anion balance of the ration is determined by converting the percentage of element in the ration to g/kg of ration and multiplying the g/kg of ration by mEq/g of element to derive the mEq/kg of ration. The following example should demonstrate the calculation of the mEq/kg of cations or anions from the ration analysis.

Mineral	% of Ration DM	g/kg of Ration DM	mEq/kg
Sodium	.24	2.4	104.4
Potassium	1.50	15.0	384.0
Chloride	.30	3.0	84.6
Sulfur	.26	2.6	162.2

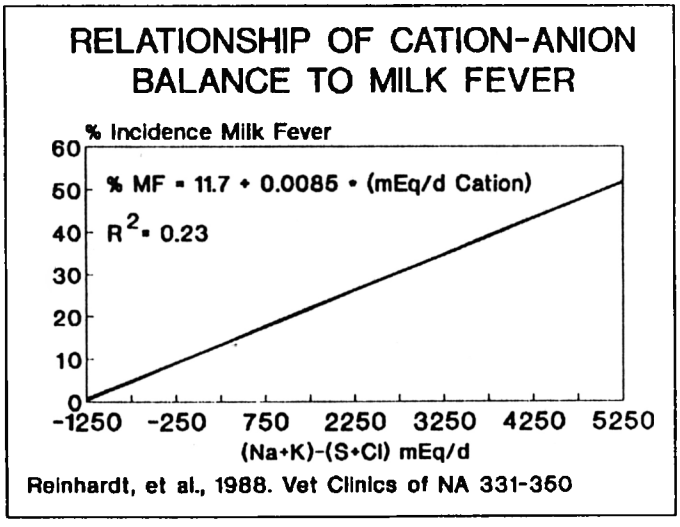
The cation-anion balance for this ration would be as follows:

$$\begin{aligned} \text{mEq/kg} &= \text{mEq/kg (Na + K)} - \text{mEq/kg (Cl + S)} \\ &= (104.4 + 384) - (84.6 + 162.2) \\ &= (488.4) - (246.8) \\ &= 241.6 \end{aligned}$$

Adding Anionic Salts

The following tables contains a list of salts that have been added to rations to make them more anionic.

Salt	Molecular Weight	Equivalent Weight	Cost per CWT	Cost per Equivalent
	(g)	(g)		
$Al_2(SO_4)_3 \cdot 16H_2O$	630	105	36	0.08325
$MgSO_4 \cdot 7H_2O$	246	123	21.05	0.05703
$MgCl_2 \cdot 6H_2O$	204	102	93	0.20894
$CaCl_2 \cdot 2H_2$				
Granular	129	64.5	30.50	0.04333
Pelleted	129	64.5	48	0.06819
$CaSo_4 \cdot 2H_2O$	172	86		
NH_4Cl	53.5	53.5	38.45	0.04531
$(NH_4)_2SO_4$	132	66	10	0.01454



Combinations of salts are recommended because they decrease the potential for toxicity due to excessive NPN, SO_4, AL, or Mg. The levels of feeding the various salts relate to the recommended maxium levels of intake of various minerals they contain as suggested by NRC. The maximun safe total dietary intake levels recommended by NRC for Al is 1,000 ppm, for S is 0.40%, and for Mg is 0.40%. The amount of anionic salts that have supplemented in various trials range from 1.9 to 3.4 equivalents per cow per day. If we assume that the cows were consuming 11.4 kg of dry matter per day in these trials, the cation-anionic balance of the rations would have been decreased by 167 to 300 mEq/kg of dry matter. From the work summary of feeding trials by Reindhart in Figure 2, the regression suggests that the incidence of milk fever should approach 0 when the daily dietary cation-anion balance is -1250 mEq per day. Again, assuming a daily dry matter intake of 11.4 kg per day, the goal would be to attain dry cow ration with a cation-anion balance of -110 mEq/kg.

Summary

Recent research seems to indicate that anion-cation balance is more important than calcium intake relative to susceptibility to milk fever. The importance of feeding alfalfa to prepartum cows as a risk factor to milk fever may relate more to its content of potassium than calcium. Feeding anionic salts for a short period prepartum can reduce the risk of milk fever. When anionic salts were fed for 21 days prepartum, the incidence of parturient paresis and hypocalcemia was reduced. Recent research has demonstrated that feeding anionic salts for 7 days can alter calcium metabolism. The feeding of 125 g each of ammonium chloride and sulfate for 21 days costs approximately $2.50 per cow. If milk fever is associated with a 14% decrease in subsequent milk production, a one percent reduction in the incidence of milk would be cost effective.

There may be some problems associated with the feeding of anionic salts. First, anionic salts are not palatable and it may be difficult to mask the taste of anionic salts unless they are fed imcorporated with silages. Also they tend to concentrate in the bottom of the bunk rations which are composed of dry materials. Second, there is one report in the literature which suggests the ammonium salts can be toxic if they are dosed over a short period of time. Third, it may be difficult to add enough anionic salts to correct extremely cationic diets. However, even adding some anionic salt to the diet will improve the cation-anion balance.

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