TechNote 13

Monitor and mitigate milk fever

IN THIS TECHNOTE

13.1 Understand what causes milk fever

Milk fever, or hypocalcaemia, arises when the dairy cow has lowered levels of blood calcium. Milk fever generally occurs within the first 24 hours post-calving but can still occur 2 to 3 days post-calving. It can be clinical or sub-clinical:

- clinical milk fever (includes both 'downer' and 'non downer' cows): cows with less than 1.4 mM blood calcium
- sub-clinical milk fever: cows with less than 2.0 mM but more than 1.4 mM blood calcium.

Q: What are the signs of milk fever?

A: Cows will be restless and disorientated. They may be staggering or be weak in the hind legs. In severe cases, the cows will be unable to stand (downer cow), have a low body temperature and be unresponsive.

Milk fever increases the risk of other metabolic diseases and infections such as ketosis and metritis, and approximately 5% of downer cows do not recover. In 2000, a study indicated 33% of cows in NZ had sub-clinical milk fever (e.g. blood calcium levels below 2 mM) with an additional 7% showing signs of clinical milk fever (e.g. downer cows and/or blood calcium levels below 1.4 mM). Cows suffering from clinical milk fever produced 14%, less milk, while cows with sub-clinical milk fever produced 7% less milk. The impact of this disorder on the average NZ farm was estimated to be $8,000 per 100 cows.

The dairy cow obtains calcium from her diet or from stores in her bones. Although there are substantial amounts of calcium available from these sources, the absorption from the intestines or resorption from bone is under tight hormonal control and is affected by other minerals (e.g. phosphorus and magnesium) and vitamins (e.g. vitamin D).

With the onset of lactation, and production of colostrum, the cow's requirement for calcium increases substantially (400% increase in a day). To meet these calcium requirements, the cow must increase both the absorption and resorption processes. Any factors that interfere with these processes mean the cow cannot meet the increased demand for calcium and this results in lowered blood calcium concentration and milk fever.

13.2 Identify the factors that influence milk fever

Milk fever is a multifactorial disorder. Thus there are several factors that influence milk fever (Table 1). Some of these factors are controlled by strategic management decisions (e.g. breed, age and BCS of the cow), while others are under tactical control (e.g. mineral/feed management decisions and milking frequency). Other factors that influence milk fever, such as the weather, are not within farmer control.

Table 1. *Factors which influence milk fever (adapted from Roche, 2012)*

Influence	
Nutrition	Several nutritional factors affect the risk of milk fever, including pre-calving feeding level (see TechNote 12: Feed the transition cow appropriately) and minerals (pre-and post-calving). Important minerals are listed below and explained in more detail in the check list and following sections: More important 1. magnesium 2. calcium 3. potassium 4. phosphorus 5. dietary cation anion difference (DCAD) Less important
Genetic strain	Holstein-Friesians with North American genetics are more at risk of milk fever than those of New Zealand origin.
Age	Older cows (6 years and more) have a greater occurrence of milk fever.
Breed	Jersey cows are 2.5 – 5 times more likely to get milk fever than Holstein-Friesian cows.
Milking frequency	Milking cows once a day during the colostrum period reduces the demand for calcium and can potentially reduce the risk of milk fever.
BCS	Cows that are above BCS targets at calving (BCS > 5.5) or well below (BCS < 4.0) are at increased risk of milk fever.
Weather	Wet or frosty weather can increase the risk of milk fever, most probably due to lower dry matter intakes (less energy and dietary magnesium and calcium), increased stress, and less efficient magnesium supplementation (less water drunk and magnesium oxide washed off pasture).

Much research has focused on the effects of feed and mineral management during the transition period on the risk of milk fever and a check list is provided below to quickly step through key recommendations. Each recommendation is expanded on in TechNotes 12 and 13.

Check list to mitigate milk fever	**TechNote and section**
☐ Ensure cows are at target BCS 2-3 weeks prior to calving	12
☐ Separate at-risk cows prior to calving and feed appropriately	12
☐ Supplement all cows with magnesium pre-and post-calving	13.3
☐ Keep dietary calcium levels low pre-calving	13.4
☐ Supplement all colostrum cows with calcium	13.5
☐ Avoid feeds high in phosphorus (e.g. PKE) and supplement with phosphorus if diets are low in phosphorus (e.g. fodder beet)	13.6
☐ Avoid grazing effluent paddocks	13.7
☐ Understand the impact of DCAD in your system	13.8

Research on the effect of milking once a day during the colostrum period on milk fever is limited. What is known is that milking cows once a day for the first 4 - 8 days of lactation reduces milk production by approximately 20% (while the cows are being milked once a day), has only a small impact on dry matter intake (DMI), and thus improves energy status during this period. The reduced milk production has a potential benefit as there is reduced demand for calcium in these cows and this may help maintain blood calcium levels and reduce risk of milk fever. However, this requires confirmation.

Prevention is better than treatment. If milk fever occurs, downer cows need to be treated immediately. Every farm needs to have a treatment protocol. A vet should be involved in setting up an appropriate treatment plan, and all the farm team need to be equipped with the necessary skills and resources to ensure cows are treated correctly.

13.3 Supplement all cows with magnesium (Mg) pre and post-calving

As a rule of thumb, dry cows require 0.4% magnesium in the diet for two - three weeks pre-calving while lactating cows require 0.3% magnesium for four months post-calving.

Magnesium plays a vital role in the prevention of milk fever. It is essential for the efficient absorption and resorption of calcium. Supplementation with magnesium has the largest effect on decreasing the incidence of milk fever and cows should receive supplemental magnesium for 2 – 3 weeks pre-calving until 4 months post-calving. As a rule of thumb, magnesium should be 0.4% DM for a dry cow and 0.3% for a cow in early lactation. This is equivalent to adding approximately 20 g supplementary magnesium to the diet; however, this amount varies depending on current diet, and cow intake (Table 2).

Requirement for Mg in dry cow diet = **0.4% DM**

500 kg cow eating 10 kg DM requires = **40 g Mg**

Winter grass supplies ~ 0.2% DM Mg = **20 g Mg**

Additional dietary requirement from supplement = **20 g Mg**

Three main sources of supplementary magnesium are used and these contain different amounts of magnesium. The amount of magnesium in each source and the amount of each product required to supply 20 g magnesium is detailed in Table 3.

Table 2. Different magnesium sources and amounts required to provide 20 g magnesium.

Source	% Mg	Example of product	Product required (g/cow/d)
Magnesium oxide (MgO)	55%	CausMag	36
Magnesium chloride ($MgCl_2$)	12%	Mag chloride	170
Magnesium sulphate ($MgSO_4$)	10%	Epsom salts	200

These amounts are down the throat and the amount of magnesium supplement that needs to be offered will depend on the administration method.

If you are:

- dusting with MgO the amount offered should be doubled and in wet weather, tripled,
- adding minerals to feed, typical wastage for the feeding method needs to be accounted for (e.g. 5 - 10% wastage for automated in-shed feeding, 10% for feed pads, 15% for trailers and 40 – 60% for silage fed in the paddock).
- adding to water, follow the supplier's instructions. It must be noted that it is difficult to supply enough magnesium using magnesium chloride or sulphate through drinking water, and high doses can reduce the palatability of water causing cows to stop drinking.

A combination of magnesium supplements can be used. For example: Adding 60 g magnesium chloride or magnesium sulphate to the water trough AND dusting pastures with 50 - 70 g magnesium oxide daily will provide a grazing cow with the recommended level of magnesium.

The pros and cons of different magnesium supplementation methods are outlined in Table 4.

Be sure to:

- Check the magnesium content of a product before administration.
- If mixing magnesium supplements with feed, take into account wastage in the feeding method.
- If dusting on pasture, use two to three times the required amount to allow for losses, especially if it is wet.

Q: How much magnesium do my cows need?

A: Cows generally need an extra 20 g supplementary magnesium daily (down the throat) for 2 – 3 weeks pre-calving until 4 months after calving.

Table 3. Pros and cons of magnesium supplementation methods.

System	Pros	Cons
In-line Water Dispenser	In diet all the time Easy to monitor Centralised	Decreased intake in wet conditions Eliminate alternative water sources
Trough Dispensers	Works with non-centralised water supply	Need to pre-charge trough Variable accuracy Decreased intake in wet conditions
Dusting – Paddock or Hay	Easily calculated Simple task	Weather affected Time consuming High wastage Variable accuracy
Application to Silage	Mixed through feed Easily measured Simple task	Variable mixing Wastage (when paddock feeding) Variable intake of individuals
Automated/in-shed Feeding System	Relatively easy Measurable Can be formulated into feed	Variable individual intake As a sole method may be difficult to supply adequate mineral Period of Mg demand may result in unprofitable use of supplements
Drenching	Accurate and efficient Low capital	Labour intensive Skill required Not suitable in all sheds
Mineral Blocks / Licks	Easy to use	Unlikely to provide sufficient minerals Expensive

13.4 Keep dietary calcium (Ca) levels low pre-calving

Recommendations are to keep dietary calcium levels low (< 0.5% DM) prior to calving.

Cows maintain blood calcium levels at 2.2 to 2.5 mmol/L by regulating their dietary calcium absorption (from their intestines), and if necessary resorption (from bones). The ability of the cow to alter the proportion of calcium absorbed from the diet or resorbed from bone takes time. This is an important consideration for the calving cow as her demand for calcium increases rapidly after calving by approximately 400%.

The recommendation to keep dietary calcium levels very low (< 0.5% DM) prior to calving is to stimulate an increase in the proportion of calcium that is absorbed from the diet at this time.

For example, if a transition cow requires 15 g of calcium pre-calving but is being fed 100 g, (approximately 1% DM) she will only be absorbing 15% of the dietary calcium. If instead she was only being fed 20 g calcium (0.2% DM) pre-calving, she would be absorbing 75% of the dietary calcium. In this later scenario, when lactation commences and the calcium requirements for colostrum and milk production markedly increase, the cow will be able to absorb a greater proportion of the extra dietary calcium supplied.

This management strategy is commonly used and is effective on many pasture-based farms. However, when the level of calcium in pastures is over 0.5% DM, it is sometimes difficult to keep calcium levels low enough to stimulate adequate calcium absorption post-calving.

Q: Should I supplement with calcium pre-calving?

A: No, general recommendations are to keep dietary calcium levels low pre-calving (<0.5% DM) to stimulate absorption of a higher proportion of dietary calcium. Then, after calving, when a high-calcium diet is fed, calcium absorption can increase quickly and reduce the risk of milk fever.

In addition to recommending low levels of dietary calcium pre-calving, the risk of milk fever can also be reduced by feeding very high levels of calcium (> 2% DM) prior to calving. In pasture-based systems, these high calcium levels are difficult to achieve; however, if feeding a high level of supplement through this period, it may be possible to increase calcium intake to these levels pre-calving.

Calcium binders can be used to reduce calcium absorption pre-calving

An alternative strategy that has been tested is the use of calcium binders pre-calving to mimic the effect of a low-calcium diet. Administration of short-term calcium binders, such as zeolite, reduces calcium availability pre-calving, and increases blood calcium post-calving. However, limited has been research conducted in pasture-based systems, and the impact on absorption of other important minerals, such as phosphorus and magnesium, needs to be considered. Research indicates grazing cows treated with zeolite had higher blood calcium levels for a week post-calving; however they had lower than recommended phosphorus levels prior to calving, and lower magnesium levels pre-and post-calving. These results indicate using zeolite would not be a good strategy in diets already low in phosphorus or magnesium (e.g. fodder beet) and more research is required to determine the cost/benefit of using zeolite in pasture-based systems.

13.5 Supplement all colostrum cows with calcium

All cows should receive at least 100 g lime flour each day during the colostrum period, with this increasing to 300 g lime flour for cows with an increased risk of milk fever.

Post-calving, cows require more dietary calcium, and all cows should receive supplementary calcium (lime flour; calcium carbonate) daily during the colostrum period. For some cows, supplementation with 100 g lime flour is enough to prevent milk fever; however, for cows at risk of milk fever (e.g. older cows, Jerseys, those greater than BCS 5.5 at calving or with previous history of milk fever) a higher daily dose of 300 g lime flour is required.

Lower levels of lime flour can be mixed in with feeds, while the higher levels (200 – 300 g) need to be dusted on pasture or mixed in with molasses as a lick. After the colostrum period there is no known benefit of supplementing cows with calcium (lime flour) unless milk fever is occurring in the milking herd or cows are consuming large amounts of low calcium feeds e.g. maize silage or cereal grains.

Q: How much calcium do my cows need after calving?

A: All cows should receive at least 100 g lime flour daily during the colostrum period, while those at increased risk of milk fever (older cows, Jerseys or those greater than BCS 5.5 at calving) should receive 300 g lime flour.

13.6 Maintain dietary phosphorus (P) within recommended ranges.

The recommended range for phosphorus pre-calving is between 0.25 and 0.45% DM.

Generally, due to the use of phosphorus fertilisers in pasture-based systems, phosphorus levels in pasture fall within this range. If levels are greater than this the excess phosphorus can interfere with production of vitamin D. As vitamin D is required for calcium absorption from the diet this increases the risk of milk fever. Therefore, feeds that are high in phosphorus e.g. palm kernel extract (PKE), distillers grains, or maize gluten, should be limited to less than 30% of the diet in the two to three weeks pre-calving, and removed completely from the diet in cows prone to milk fever.

A phosphorus deficiency close to calving can also contribute to milk fever. Some feeds contain very low levels of phosphorus. For example, whole fodder beet contains on average 0.2% DM as P, with bulbs in some regions containing less than 0.05% DM. Therefore, if cows are fed fodder beet pre-calving, a phosphorus deficiency can occur. Recommendations are to supply supplementary phosphorus to these cows. Examples of the different types of phosphorus supplements, amount of phosphorus contained in these and administration methods are outlined in Table 5.

Current recommendations for cows grazing fodder beet are to supplement daily with di-calcium phosphate (DCP) as a slurry on the supplement (e.g. straw/silage). An alternative is to add soluble phosphorus (e.g. soluphos) to drinking water. However, there can be substantial wastage when mixing and applying a slurry and individual animals will eat varying amounts of the supplement. Additionally, water intake from troughs during late winter/early spring can be very low due to the high water content of the crop and alternative water sources (e.g. puddles). Other options for phosphorus supplementation to cows grazing fodder beet include mineral licks; however, the effectiveness of mineral uptake from these licks is low.

Q: Is PKE a good feed for cows pre-calving?

A: No, if there is a risk of milk fever, do not feed PKE to springing cows. PKE is relatively high in phosphorus and this can increase the occurrence of milk fever.

Q: Does fodder beet require phosphorus supplementation?

A: Yes, fodder beet is low in phosphorus and it is recommended that cows grazing fodder beet are supplemented with phosphorus.

Table 4. Different phoshorus sources and recommended dose rates.

Supplement	Phosphorus (% DM)	Other minerals (% DM)	Dose* (g/cow/d)	Administration method
Di-calcium Phosphate (DCP)	18% P	21% Ca	50 g	Mixed into a slurry and applied to supplement (e.g. silage or hay) Dusted on pasture
Mono-calcium Phosphate (MCP)	21.5% P	16% Ca	30 g	Mixed into a slurry and applied to supplement (e.g. silage or hay) Dusted on pasture
Magnesium phosphate (MagPhos)	14% P	26% Mg	42 g	Mixed into a slurry and applied to supplement (e.g. silage or hay) Dusted on pasture
Mono-sodium phosphate (e.g. soluphos)	26% P	31% Na	20 g	Water soluble so can be dosed through in-line dispenser Mixed in with water or feed

13.7 Avoid grazing effluent paddocks and supplementing with feeds high in potassium (K) pre-calving

The recommended range for potassium pre-calving is between 1.0 and 4.5% DM.

Potassium interferes with the absorption of magnesium in the rumen, and as magnesium is important for calcium absorption, high levels of dietary potassium can contribute to milk fever. Therefore, it is recommended to avoid feeding a diet high in potassium pre-calving.

Potassium levels in pasture range from approximately 1.0 – 4.5% DM and sometimes pasture contains too much potassium for the transition cow. However, research trials determined that feeding pastures with potassium levels ranging from 3.3 to 4.2% DM did not alter blood calcium levels or increase the risk of milk fever.

Although the incidence of milk fever in pasture-based cows is generally low, the potassium levels (up to approximately 4.2% DM) that were tested are within the natural range for pasture. It is recommended to avoid adding fertiliser to, or grazing pastures with higher than usual potassium levels (e.g. effluent paddocks) in the weeks prior to calving.

If pasture use is minimal and supplements make up a large proportion of the diet, recommendations are to reduce feeds that are high in potassium, e.g. high potassium forages and by-products.

Q: Can I graze effluent paddocks with my springers?

A: No, it is wise to limit access to pastures high in potassium, such as effluent paddocks, in the weeks prior to calving.

13.8 Understand the impact of DCAD in your system.

The dietary cation anion difference (DCAD) is the difference between the cations (positively charged minerals) and the anions (negatively changed minerals) in the diet.

The main cations in the diet of the dairy cow are potassium (K) and sodium (Na), and the primary anions are chlorine (Cl) and sulphur (S). The proportion of these minerals in the diet influences blood pH (blood acidity), which in turn affects calcium absorption and subsequently alters the risk of milk fever.

Collective research indicates that when the DCAD is negative, less than 0 mEq/kg DM, blood pH drops and calcium absorption from the small intestine increases, thereby reducing the risk of milk fever.

Urinary pH levels at different DCAD values are highlighted in Figure 1. Urinary pH is an indicator of blood pH, and blood pH is negatively associated with calcium absorption from the small intestine. Thus a low blood pH increases dietary calcium absorption and reduces the risk of milk fever.

The profile highlighted in Figure 1 indicates that the effect of lowering DCAD on urinary pH is not linear; it is not until DCAD values are negative, (below 0) that there is any significant drop in urinary pH. This means that it is not until DCAD is negative that there is a significant drop in blood pH, increase in calcium absorption and reduced risk of milk fever.

DCAD (mEq/kg DM)

=

((% Na x 434) + (% K x 256))

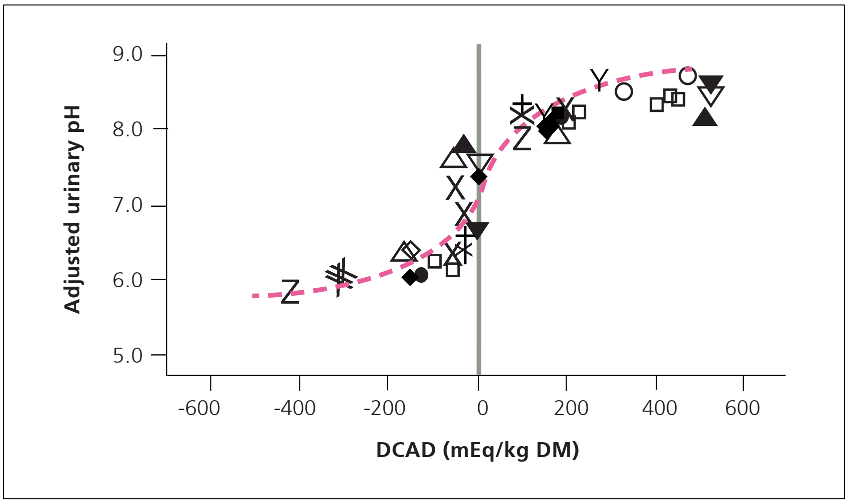
–

((%Cl x 282) + (%S x 624))

Q: Do I need to worry about DCAD?

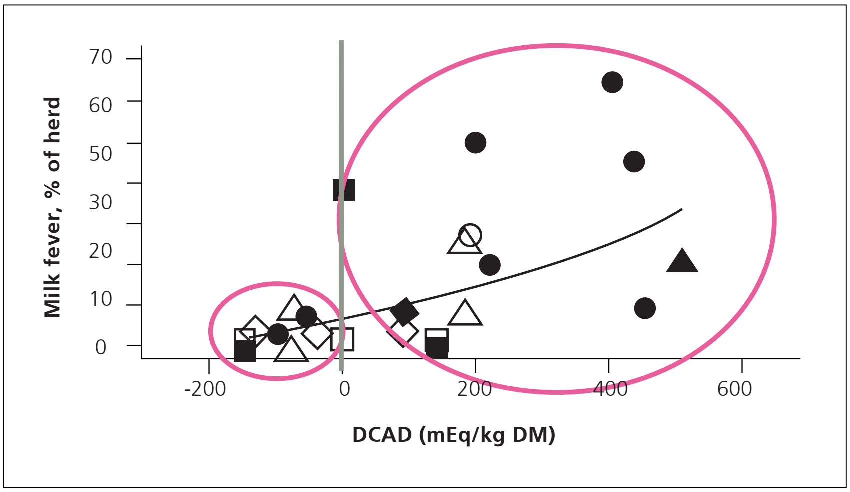
A: No, not in pasture-based systems as it is virtually impossible to achieve a negative DCAD; however, if feeding low DCAD supplements, then DCAD can be lowered sufficiently to reduce the risk of milk fever.

Figure 1. Relationship between urinary pH and DCAD (adapted from Charbonneau et al., 2006).



When DCAD levels are negative (below 0) there is a noticeable drop in the incidence of milk fever (Figure 2); however when DCAD levels are above 0, there is very little correlation between DCAD and incidence of milk fever.

Figure 2. Relationship between incidences of milk fever in the herd and DCAD levels (adapted from Charbonneau et al., 2006).



In pasture-based systems, or where a high proportion of other green forages are fed, achieving a negative DCAD is generally not possible. Therefore, strategies to reduce DCAD in a pasture-based system are not likely to be of benefit. A negative DCAD can only be achieved by replacing pasture with low DCAD feeds (e.g. maize silage, brewers grains, PKE), and adding ionic salts to the diet (e.g. magnesium sulphate and magnesium chloride).

If milk fever is an issue in a pasture based system, and factors such as cow BCS, feeding levels and mineral management (e.g. magnesium, calcium, phosphorus, and potassium) do not reduce the occurrence, lowering the DCAD to a negative value (ideally -100 mEq/kg DM)) is an option. However, this will require increased use of supplementary feeds, alter feed management decisions and potentially increase costs. An example of a simple low DCAD diet is provided in Table 6.

In systems where there are a high proportion of supplementary feeds, in particular low DCAD feeds such as maize silage, molasses, PKE or brewers grain, a negative DCAD is more easily achievable. Therefore, adding ionic salts e.g. magnesium sulphate or magnesium chloride, or removing high potassium forages from the diet will lower the DCAD further (ideally - 100 mEq/kg DM), improve calcium absorption, and reduce the risk of milk fever.

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13.9 Maintain recommended feeding levels pre-calving

Cows that are at, or above, target BCS should be fed at 90% of metabolisable energy requirements.

Increasing pasture intake prior to calving to more than 90% of requirements in cows that are at, or above, BCS targets lowers calcium concentration post-calving and increases the risk of milk fever. Although the exact reason for this is not clear, it is probably due to one or more of the following:

- increased dietary calcium intake pre-calving and consequently reduced calcium absorption post-calving,
- increased dietary potassium pre-calving,
- reduced dry matter and calcium intake post-calving.

Table 5. *Example of a low DCAD diet.*

Variable	DMI	Na	K	Cl	S	Mg	Ca	P	DCAD	DCAD
	kg	%DM							mEq/kg DM	eaten/day,mEq
Pasture	2	0.3	3.6	1.3	0.3	0.25	0.5	0.4	500	1000
Maize silage	6	0.01	1.1	0.4	0.1	0.1	0.2	0.1	110	660
PKE	1	0.01	0.8	0.25	0.24	0.34	0.6	0.7	-10	-10
$MgSO_4$	0.15	0	0	0	13	10	0	0	-8112	-1217
$MgCl_2$	0.10	0	0	35	0	12	0	0	-9870	-987
TOTAL	**9.25**	**0.07**	**1.50**	**0.88**	**0.35**	**0.44**	**0.33**	**0.27**		**-554**

DCAD eaten, mEq	-554
Diet DCAD, mEq/kg DM*	-60

* this figure should be less than zero and ideally closer to -100/mEq/kg DM

13.10 Further reading

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