

UNDERSTANDING GRASS STAGGERS (HYPOMAGNESAEMIA)

Introduction

Grass staggers occurs when the level of magnesium (Mg) in the cerebrospinal fluid (CSF) falls below a critical level. As the level of Mg in the blood declines prior to the Mg level in the CSF, measuring blood Mg level provides a guide about the Mg status of an animal. However, note CSF Mg concentrations are generally maintained in relative constancy despite wide variations in plasma Mg concentrations.

Clinically grass staggers is characterised by hyper-excitability, muscular spasms (tetany) and convulsions. Hypomagnesaemia can be rapidly fatal. Outbreaks have been reported where up to 20% - 30% of a cow herd was found dead.

Aetiology

Magnesium has many physiological and biochemical functions, so it is essential for animal health and production. Magnesium serves as a co-factor for many enzymes and is required for the activity of some hormones, such as parathyroid hormone.

Extracellular Mg is vital to normal nerve conduction, muscle function, and bone mineral formation. Magnesium deficiency potentiates an accumulation of acetylcholine at the motor neuron end-plates, causing neuromuscular excitability.

Magnesium Requirements

Maintenance of normal serum Mg is virtually wholly dependent on dietary magnesium absorption. There are no hormonal systems directly controlling plasma Mg concentrations. Magnesium homeostasis depends on a continual absorption of Mg from the rumen to provide for the amounts lost in milk and endogenous secretions. When dietary intake exceeds daily requirement, Mg is excreted in the urine.

A lactating cow requires 2g available Mg per day, plus 0.15g of Mg per litre of milk. This means a dairy cow producing 20L of milk per day requires 5g of available Mg daily. Beef cattle have broadly similar requirements but produce less milk. A beef cow producing 8L milk per day requires 3.2g of available Mg per day (refer Fig 1).

Magnesium absorption occurs in the reticulorumen via both active and passive transport mechanisms. To be available for absorption, Mg must be in its soluble form (Mg⁺⁺) in the rumen liquor. In general, ingested Mg is poorly available (average 17%). This means 20g Mg from pasture equates to 3.4g available Mg.

In addition, increased rumen pH, high dietary potassium (K), formation of insoluble Mg soaps in the rumen, and rapid rumen transport rates all reduce Mg absorption from feed or oral supplements.

Predisposing Factors

Many factors can play a role in hypomagnesaemia.

Diet

1. Low magnesium intake

- Low Mg content in forage / feed (e.g rapidly growing pasture with low dry matter (DM) content).
- Reduced feed intake by the animal (e.g. inclement weather, yarding, transport).

2. Rapid transit of feed through the rumen

Lush pasture increases the rate of passage of ingesta through the rumen, meaning insufficient time is available for Mg solubilisation and absorption.

3. Formation of insoluble complexes

Mg can become bound in chelates or other insoluble complexes so the Mg cannot be extracted from food. This means Mg is unavailable for absorption, so passes through the rumen and is excreted in faeces.

4. Interference by other minerals

- Potassium (K)
High levels of dietary potassium (often via use of K fertiliser or effluent to increase spring pasture growth and yield) reduces absorption of Mg.
- Sodium (Na)
Low Na levels trigger aldosterone secretion. This hormone causes a decrease in Na in the saliva with a reciprocal increase in K. This increased K in saliva results in increased K in ruminal fluid. Consequently low Na has the same effect on Mg absorption as high dietary K.
- Calcium (Ca)
If the calcium concentration in blood decreases, the concentration of Mg in the CSF falls more rapidly when blood Mg decreases.
Low Mg concentrations can inhibit the release of parathyroid hormone (an important hormone in calcium homeostasis). This can result in an impaired capacity to mobilise Ca stores and result in hypocalcaemia (milk fever).
- Nitrogen (N)
High intraruminal ammonium ion concentrations reduce Mg absorption (this effect is additive and independent of the effect of K). This can be caused by ingestion of herbage with high nitrogen (N) and low soluble carbohydrate concentrations.

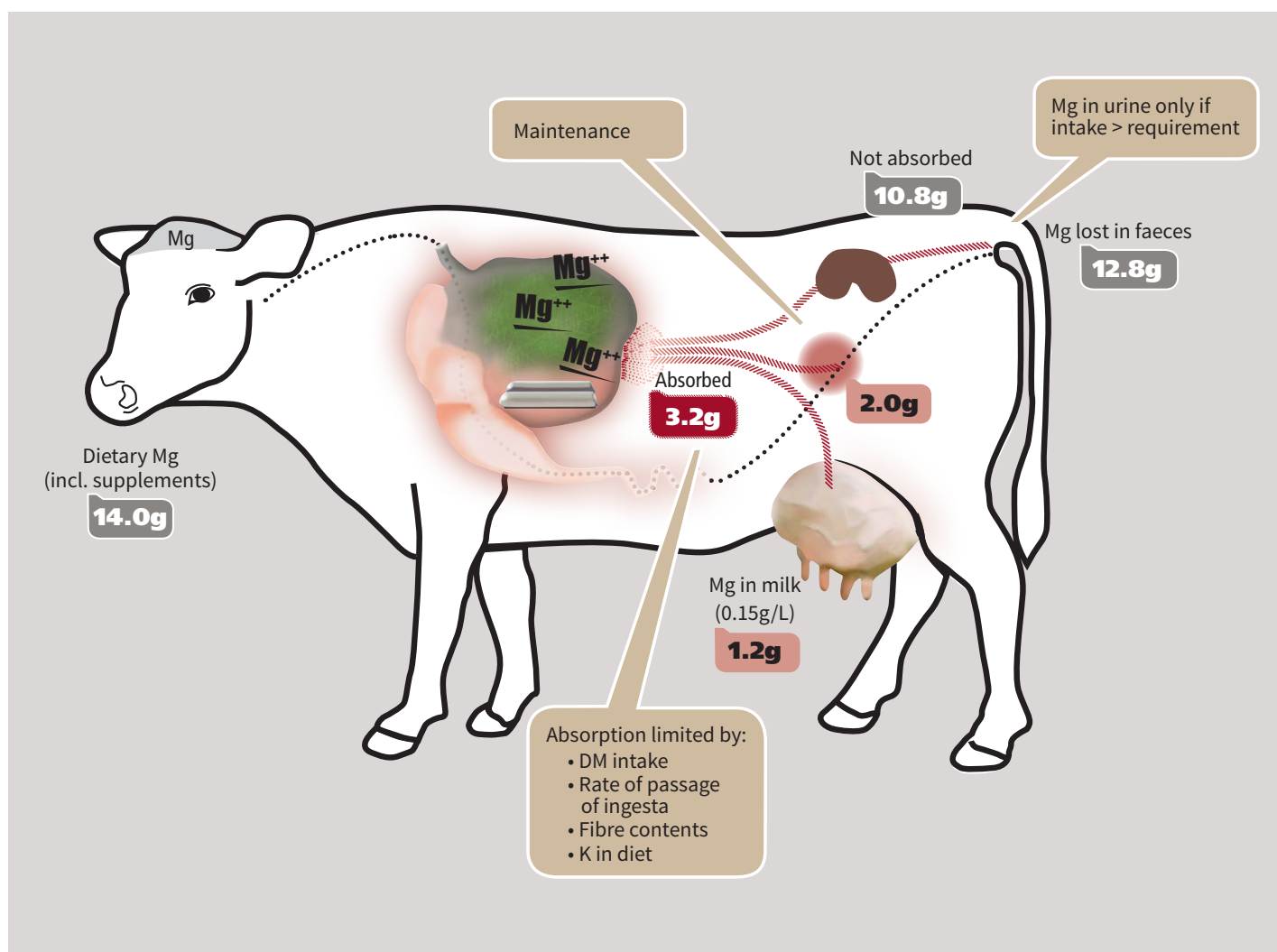


Fig 1. Magnesium flow and excretion in an 'in-balance' 500kg lactating beef cow

THIS TABLE ILLUSTRATES LIKELY MAGNESIUM REQUIREMENTS FOR A SPRING CALVING NEW ZEALAND BEEF COW VERSUS DIETARY INTAKE FROM SEASONAL NZ PASTURE

Stage of Season	Mg in NZ pasture						Cow# Mg Requirements*				Deficit / Surplus (g Mg)
	Milk production (L)	Pasture level Mg (g/kg DM)	Pasture intake (kg DM)	Total Mg in consumed pasture (g)	Mg availability (%)	Mg absorbed (g)	Maintenance (g Mg)	Pregnancy (g Mg)	Milk (g Mg)	Total (g Mg)	
Pre-calving	0	1	12	12	10	1.2	2	0.3	0	2.3	-1.1
Post-calving	8	1	16	16	10	1.6	2	0	1.2	3.2	-1.6
Post-mating	10	2	13	26	15	3.9	2	0	1.5	3.5	+0.4
Post-weaning	0	4	10	40	30	12	2	0.2	0	2.2	+9.8

Table 1. #Cow in this example is a 500kg cow, producing 10L in peak lactation.

*Mg requirements for liveweight (LW) gain are not included in this example. Liveweight gain typically requires 0.45g Mg / kg LW gain.



Cow Factors

1. Age

Most cases of hypomagnesaemia occur in cows >4 years of age. It is rare for a first calving heifer to be affected, as heifer milk production (and therefore Mg demand) is lower than for a mature cow. Whilst there is considerable individual variation in a cow's ability to absorb Mg, in general as cows get older their Mg absorption rates decrease.

2. Breed

Most susceptible ¹		Least susceptible		
Angus	Hereford	Jersey	Holstein	Brahman

'Least susceptible' cows have a higher ability to digest and absorb Mg.

3. Production

High levels of milk production typically means more demand for Mg, therefore high producing cows are at higher risk.

4. Body condition

Thin and over-fat cows are more at risk than cows in moderate body condition. Cows that lose body condition in early lactation are at particular risk as soft tissue has a much lower Mg content than grass. That is, a cow that maintains production partly by using body reserves is more likely to be in negative balance for Mg, than a cow maintaining production just from eating pasture.

Management Factors

1. Fertiliser use

High levels of K and N fertiliser (or effluent) increases hypomagnesaemia risk as Mg absorption is reduced.

2. Reducing feed (therefore Mg) intake

Management factors such as yarding, mustering, moving, or transport also reduce feed intake. This means Mg intake is reduced and can predispose "at risk" cattle to hypomagnesaemia.

Environmental Factors

Any additional stress on cows at the critical time around calving and early to peak lactation may predispose them to hypomagnesaemia. These stressors include wind, rain, exposure (lack of shelter); sudden change of feed and feed quality; sudden lowering of temperature. Mortality from hypomagnesaemia is frequently associated with inclement weather conditions.

Prevention

It is recommended that all cows are supplemented with additional magnesium, starting at least 3 weeks prior to calving.

Magnesium can be;

1. Top-dressed onto pasture
2. Added to silage and other feeds
3. Added to cattle drinking water system
4. Drenched to cows individually
5. Delivered into rumen via a slow release capsule

Refer to Table 2 for a summary of forms of Mg supplementation.

DAILY SUPPLEMENTATION WITH MAGNESIUM SALTS IS REQUIRED IN COWS FROM ONE MONTH BEFORE CALVING TO MID LACTATION. THIS TABLE PROVIDES AN EXAMPLE OF MAGNESIUM PROVIDED BY VARIOUS COMMONLY USED SUPPLEMENTS

Mg form	Mg content (%)	Recommended dose (g)	Mg dose (g)	Mg availability (%)	Daily Mg absorption (g)
Mg oxide	55	22 g (drenched) 44 g (dusted)	12.1	33	4
Mg chloride	10	122 g	12.2	Not published (est 33%*)	4*
Mg sulphate	12	100 g	12	Not published (est 33%*)	4*
Mg pidolate	8.5	60 g (= 100mL)	5.1	Not published (est 50%*)	2.6*
Rumetrace	90	One capsule for 9 - 12 weeks	189 (slow release technology)	100%	2

Table 2.* Availability of Mg in this salt is unpublished so estimated % has been used to calculate daily Mg absorption on this basis.

Summary

- Grass staggers occurs when dietary intakes of Mg are insufficient to meet metabolic needs
- The condition can be rapidly fatal and affect a significant proportion of cows on an individual property
- Hypomagnesaemia occurs when there is inadequate Mg intake; excess dietary K; lush pasture increasing the rate of passage of ingesta. Outbreaks are often preceded by inclement weather
- Prevention is critical and involves supplementing adult pregnant and lactating cows with additional Mg

THE APPROPRIATE MG SUPPLEMENT(S) FOR LACTATING BEEF COWS		
Stage of Season	Deficit / Surplus (g Mg)	Recommended Supplement
Pre-calving	- 1.1	Any Mg daily, including Rumetrace
Post-calving	- 1.6	Any Mg daily, including Rumetrace
Post- mating	+ 0.4	Generally not required
Post-weaning	+ 9.8	Generally not required

Table 3. Recommended Mg supplementation for various times of the season

References

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¹ Elliott, M. Grass tetany of Cattle in New South Wales. University of Western Sydney, 2002.

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