**Managing the waistline: Prevention and Management of EMS**

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*Management of equine obesity and insulin dysregulation including diet, exercise and nutraceuticals, common areas of confusion and practical monitoring.*

**Introduction**

Management of equine metabolic syndrome (EMS) consists of nutritional, exercise and possibly pharmacological interventions. It often involves major changes to feeding, exercise, turn out etc., and so ensuring that the horse’s owner is fully aware of the diagnosis, what EMS is and the importance of management is essential to ensure compliance. Setting targets, and regular monitoring and communication between vet and owner are essential.

The aims of this presentation are to:

1. Discuss dietary management of EMS including immediate, medium term and long term aims.
2. Interpret obesity research and discuss common areas of confusion including rates and targets for weight loss and alterations in the response to dietary restriction associated with time or sensitivity to dietary restriction. The (poor) relationship between BCS and total body fat will also be discussed.
3. Discuss the use of different forage sources and nutraceuticals, including soaked hay in restricted diets and glycaemic responses to different forages.
4. Discuss the use of exercise in the management of EMS including understanding of the appropriate intensities of exercise for horses and ponies.
5. Discuss the return of EMS horses onto pasture.

**Dietary management**

Dietary management is the mainstay of prevention and management of equine metabolic syndrome and will remain so until appropriate pharmaceuticals are developed to better manage the disease. However, it has also been an area of confusion, with many veterinarians feeling uncomfortable with giving nutritional advice.

In the American College of Veterinary Medicine 2010 consensus statement on EMS1 it was acknowledged that dietary management was central to the management of EMS, yet up until that point few dietary studies had been performed, none specifically on EMS affected animals and there was some confusion about some of the fundamental principles. The contention of ideal body weight and the measurement and change in body condition score (BCS) to monitor weight loss were unestablished. How much to feed as a percentage of body weight (BWT), the composition (e.g. non-structural carbohydrate (NSC) concentration), insulinaemic potential and dry matter (DM) content of different forages were not well established. Furthermore, whether to soak hay or not, how long for and the effect of soaking on dry matter and other nutrients had not been established.

**Body condition scoring**

Ideal BWT (or bodymass) is a concept that lacks either biological or published supporting evidence for horses. 2 Indeed, trying to restrict caloric intake based on ideal BWT could be dangerous. This is particularly the case where the DM content of forages being fed have been overlooked, and preserved forages are erroneously calculated as being 100% DM (see below). Dugdale and colleagues 3 showed that current BCS scoring systems have a non-linear relationship to whole body fat content, especially at BCS ≥ 7/9 using a modified Henneke scoring system. At the low end of the BCS scale, only a small change in body fat is required for a 1 point change in BCS and the result is close to linear; whereas as the high end of the scale, a much larger change in body fat is required for a 1 point change in BCS and the relationship is lost.3 This also has implications when monitoring weight loss in horses, where BCS will lag behind losses in BWT in animals where BCS was ≥ 7/9.4

**Dietary aims**

We now know a lot more about the dietary management of EMS, and crucially, how to decide on the specifics of dietary management depending on the actual endocrine status of the animal. As mentioned in my other presentations, insulin dysregulation is the central feature of EMS, not obesity, so decisions about dietary management of EMS should be dictated by endocrine results.

Endocrine testing allows us to understand the spectrum of disease in EMS, with mild cases of seasonal laminitis maybe only requiring removal of supplementary feeding and allowing natural seasonal pasture restriction to drive natural cycles of seasonal weight loss with less attention to the carbohydrate content (or NSC) of the diet. Severe cases of EMS may require a strict weight loss programme and long term maintenance on a diet that has minimal NSC content and therefore minimal glycaemic and insulinaemic responses.

Dietary aims can be divided into:

1. Immediate: reduction in the glycaemic and insulinaemic responses to feed, especially in the face of laminitis;
2. Medium term: induction of weight loss by dietary restriction in overweight and obese animals and;
3. Long term: maintenance on a low glycaemic/insulinaemic diet to reduce the risk of further laminitis episodes.

The immediate objective of EMS management is a reduction in circulating insulin concentration, especially following feeding. Goals in the medium term are normalisation of body condition score (BCS) and reduction in insulin dysregulation (ID), and in the long term a return to normal function while maintaining a low glycaemic/insulinaemic response to the diet.

**Immediate goals: reduction of insulinaemic responses to feed**

Insulin dysregulation is central to the definition of EMS and also central to the risk for laminitis, so in order to fully understand the role of different feeds in management of EMS, their effect on postprandial hyperinsulinemia needs to be measured. Reduction in postprandial hyperinsulinemia is the immediate and ultimate goal of EMS dietary management. This will typically involve removal of any supplementary feeds such as grains, pellets or mixes and all treats and feeding of a low NSC, forage-only diet, supplemented with a balancer. In the short term, before any forage analysis can be performed, feeding soaked grass hay (cold water for 7-16 hours) or alfalfa hay (cold water for 15-30 minutes) will be useful to decrease insulinaemic responses. For more detail see “Back on their feet again: Management of endocrine laminitis”.

**Weight loss by dietary restriction and how much to feed**

Dietary restriction for weight loss will also involve removal of any supplementary feeds and treats and feeding of a low NSC, forage-only diet, supplemented with a balancer. This type of restriction is recommended during periods of weight loss and laminitis

Current recommendations for safe weight loss in horses have been extrapolated from studies in humans and companion animals where a target loss in BWT of approximately 0.5% - 1% per week is aimed for after week one. 2 Initial weight loss in the first week is usually removed from the calculations due to a considerable reduction in gut fill at the onset of caloric restriction.4 There have now been several research studies from the University of Liverpool looking at caloric restriction using a commercial chaffed preparation 4, hay 5 and soaked hay 6 where animals were fed at between 1% and 1.25% of their current BWT daily as forage only on a DM basis in a controlled environment with only 1 hour a day muzzled pasture access. All studies resulted in safe weight loss within the target weight loss rates, without side effects, and the latter two studies where insulin dysregulation was measured showed a significant improvement of their insulin response to IV challenge. 5,6 There was some variability between animals in each study, which has been termed “weight loss resistance”.5 The rate of weight loss clearly varies between horses by over 50% and is important to factor in to any caloric restriction protocol. In studies using owner-managed clinical cases of EMS, we have developed tailored protocols which allow for variation and adjustment of weight loss in horses. 7

As mentioned above, it is important to factor in the DM% of the forage fed. For example, most hays will be only around 85% DM and wrapped hay (haylages) around 60% DM. This clearly makes a large difference to the daily amount fed as fresh weight. With the abovementioned studies, the amount of weight loss on average per week after week one when ponies were fed 1% of their BWT daily as DM of chaff was 0.7%, 4 when fed 1.25% of their BWT daily as DM of hay was 0.44% 5 and when fed 1.25% of their BWT daily as DM of soaked hay was 1.0% 6 of their week 1 BWT.

The much greater weekly reduction in BWT in the soaked hay study was further investigated by correcting the DM in the hay soaked for 7 or 16 hours in accordance with the ‘insoluble’ ADF content of fresh and soaked hays (and validated using a test-soaking protocol). 2 This showed that there was a loss of 14% DM in soaked hay (with little difference between 7 or 16 hours soaking) and this accounted for a 23.5% greater energy restriction implying that soaked hay was more equivalent to feeding 1% BWT as DM than 1.25%. This could have dangerous consequences if target guidelines for weight loss are not well understood e.g. an underestimation of BWT (or an erroneous application of “ideal” BWT) or a poorer than usual batch of hay or indeed the misguided restriction to 1% BWT forage fed daily as fresh weight without consideration of the DM proportion of the original forage, or indeed, the soaked forage.

As such we currently recommend feeding a minimum of soaked hay at 1.5% weighbridge measured actual BWT daily (equivalent to 1% BWT DM) and then, only if the horse is being monitored regularly under veterinary supervision. 7 Weight loss at 0.5%-1.0% BWT weekly should only be for a limited period of time (usually 3 – 4 months), with clear outcome targets of improved insulin regulation used as a clear guide as to when to relax to the caloric restriction and increase the DM intake. 7

**Balancing calorie restricted diets**

When horses have their intakes restricted in order to elicit weight loss, careful attention to balancing the diet needs to be employed. Ideally the forage should be analysed, but in reality many feed companies offer vitamin and mineral premix “balancers” that can be fed to ensure adequate vitamin and mineral intakes. Some chaff based forages are marketed as already containing a vitamin and mineral premix that will provide sufficient nutrient balancing, provided the full manufacturer recommended weight of the chaff is fed each day. When choosing a balancer attention needs to be paid to the ingredients. Many balancers marketed for laminitic horses or as “low calorie” actually also have quite low protein. This is also somewhat misguided as due to the low volume required to be fed for most balancers (around 125 g/pony/day) the caloric difference typically has negligible effect on energy provision, yet can contain insufficient protein to balance a restricted grass hay based forage diet with borderline protein provision. We would typically recommend a balancer with a protein of around 25% on UK grass hay diets, 7 although this is usually not a problem if feeding high protein alfalfa based forage diets.

When balancing soaked hay, attention needs to be paid to loss of mineral salts in the soaking process. 8 Unlike earlier studies with limited analysis and varied soak times, our studies have shown a consistent reduction in NSC with soaking of grass hays for either 7 or 16 hours (between feeds) in cold water. This included both hays sampled and soaked as part of experimental studies, but also of hays soaked by their owners. 8 The average reduction in NSC was 50%, accompanied by 21% loss in calcium, 49% loss of phosphorus, 39% loss of magnesium, 66% loss of potassium, 65% loss of sodium, 72% loss of chloride and 24% loss of suphur. There were no significant losses of crude protein, nor any of the elements (Fe,Zn,Cu,Mn,Mo,Co). 8 For mixed grass hays we have analysed from the Northwest of the UK this is important, as average pre-soaking NSC% were 18% and grass species available do not allow for selection of low NSC (≤10%) varieties. However, importantly, the minerals lost are not found in typical vitamin and mineral balancers and additional mineral supplementation needs to be fed to horses on soaked hay diets.

**Role of Nutraceuticals**

Nutraceuticals play an important role in the dietary management of people with metabolic syndrome, but less work to date has been performed in horses. A combination of chromium and magnesium failed to improve morphometric measurements or insulin regulation in obese laminitic horses. 9 Although 30 mg/kg magnesium fed to a small group of ponies did help 3/5 insulin dysregulated ponies. 10 Supplementation with 4 g per day of L-carnitine resulted in a mild reduction in postprandial insulin and glucose concentrations 11 which is promising, but further work needs to be done. Similarly, 3 months supplementation of a complementary feed enriched with Spirulina platensis in horses with EMS on an energy restricted diet improved BW losses and fasting serum insulin levels compared to control horses. 12 One nutraceuticals shown to have clear effects on improving insulin sensitivity in obese horses are short-chain fructo-oligosaccharides (FOS). 13 Although in another study, the improvement insulin sensitivity from feeding FOS was not able to be differentiated as additional to the improvements seen following 6 weeks of caloric restriction and marked weight loss in ponies fed soaked hay. 6

It is interesting to note that FOS are fructans which have been fed in large doses to cause laminitis. 14 However, when fed at such large doses FOS are acting like any carbohydrate overload model, indeed the doses required to induce laminitis from FOS are higher than those required to induce laminitis from glucose. 15 Further, the insulinaemic response to FOS is much lower than to glucose. 16 Despite speculations of extremely high fructans concentrations possibly ingested by grazing horses being presented in a conference abstract, 17 most grazing horses could only ingest very small quantities of fructansper hour. The contribution of fructans to laminitis are simply via inducing an insulinaemic response to carbohydrate ingestion (in combination with other components of the pasture’s total NSC content) and not as a carbohydrate overload effect. Indeed FOS has not only been shown to be insulin sensitizing 13 but also protective against a grain overload challenge at typical grazing doses. 18

**Pasture and grazing muzzles**

Turning horses out to pasture is a source of cheap forage, possibly also natural FOS supplementation and provides exercise and socialisation, so is popular with owners and horses alike. Unfortunately pasture forage intake is very hard to measure and the NSC content of grass can be very high in improved pastures, but successful long term management of EMS can include grazing provided the insulin dysregulation, especially the hyperinsulinaemic response to carbohydrates, is monitored and controlled and grazing is also carefully controlled. 7

Consider zero turn out when an immediate reduction in the insulinaemic response to feed is required (e.g. during a laminitic episode). In markedly insulin dysregulated horses this may also include the initial or entire period of dietary restriction. However, following weight loss, most horses improve their insulin dysregulation and grazing can be resumed. 7

Then practical steps to facilitate return to grazing can be implemented.

* Strategies to reduce pasture intake include strip grazing, grazing after other horses/livestock, mowing pastures (with removal of clippings) and turn out onto dirt yards/schools, monitoring for sand ingestion.
* A pony can ingest up to 2/3 of its daily DM requirements in 3 hours of unmuzzled grazing on good pasture so restriction of amount versus time is the general rule of thumb.
* Muzzles significantly reduce pasture intake and are useful for allowing turnout. Owners should ensure that the horse can still drink through the muzzle and potential complications such as changes in herd hierarchy, skin rubs and abnormal incisor wear are monitored.
* In Australia, native pastures can have markedly lower NSC, and scrubby/wooded paddocks can be a natural way of restricting pasture intake as long as toxic weeds are not present.
* If in doubt, monitor insulin concentration 3-4 hours after turnout on to pasture to determine its effect.

**Exercise**

Assuming laminitis allows, exercise is beneficial not only as it induces weight loss, but also because it improves insulin sensitivity, independent of weight loss. There is no doubt that dietary management will improve insulin sensitivity and reduce hyperinsulinaemia in an obese animal, but exercise can be equally important or more important in horses that may not be obese at the time of diagnosis. Exercise improves glucose dispersal independently of insulin through vascular mediated effects as well as improves sensitivity to insulin of muscle and adipose tissues via improvement of the expression and content of GLUT-4. This effect has been shown in both normal horses 19 and insulin resistant ponies. 20 Exercise combined with dieting also improves weight reduction directly through energy consumption.

Moderate intensity exercise for 20-30 minutes/day is recommended as a minimum. Ideally exercise should be at a low to moderate intensity for maximum effect, which in horses and ponies < 20 years of age is conservatively around 55% VO2max or 75% heart rate max or 160 beats per minute. This translates to canter exercise on the flat (ridden or unridden) 21 which may not be possible for many horses, especially those recovering from laminitis.

Turn out increases activity, but shouldn’t be at the expense of increased pasture intake. In horses where laminitis limits activity, track grazing systems and horse walkers are examples of ways in which unridden exercise can be increased. Tracker systems have been shown to treble daily walking distances and improve body fat indices. 22

**Medical therapy**

Metformin: This is a commonly prescribed drug for management of type II diabetes in people, where its mechanisms of action are not fully understood, but it results in a reduction in hyperglycaemia and improves insulin sensitivity. In horses, the efficacy of metformin is likely to be limited by its very low oral bioavailability (4-7%). There is mixed evidence regarding its effect on insulin sensitivity in EMS horses. More recent work has demonstrated a reduction in enteric glucose absorption in metformin treated horses, suggesting that the enterocyte is the most likely site of action. 23 For horses that are being fed low NSC diets, metformin in unlikely to have any significant beneficial effects. It might have some benefit when optimal management is not possible; for example when pasture turn out cannot be avoided. It might also be useful in cases that have been managed successfully and are being reintroduced to pasture, or in cases that, despite weight loss and exercise, still have an exaggerated glycaemic and insulinaemic response to oral sugar tests. Dose is 15-30mg/kg PO and it should be given approximately 30 mins before consumption of feed.

Levothyroxine: Supplementation of levothyroxine in weight-loss resistant EMS cases has been used for many years in the USA to increase metabolic rate and enhance weight loss. Studies have demonstrated enhanced weight loss and insulin sensitivity with levothyroxine use, and following 1 year’s administration side effects that were not considered significant. 24 It should probably be reserved for refractory/severe cases, and is not a substitute for dietary restriction, as when given unlimited access to feed horses just eat more to compensate. An initial dose of 0.1mg/kg PO SID is given for 3-6 months, which should then be tapered down over 4 weeks to allow restoration of normal thyroid function. Careful monitoring of weight loss is essential.

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