The impact of nutrition on the health of the horse

Karin Rosenlew

2.3.2009

"*There is something about the outside of a horse that is good for the inside of a man*."
Sir Winston Churchill

The impact of nutrition on the health of the horse

Table of contents page

1. Health, disease and nutrition

1.1. Definition of health

The[i] definition of health, according to Merriam Webster's dictionary is **1 a:** the condition of being sound in body, mind, or spirit; *especially*: freedom from physical disease or pain **b:** the general condition of the body.

Health has commonly been described as "freedom from dis-ease," which is a state of being in comfort and naturalness.

Because health seems to be a singular state of well being, it is often easier to describe and give names to the symptoms of discomfort, types of dysfunction, and degrees of pain rather than trying to give titles to degrees of wellness, feelings of well-being, and freedom of movement. I consider health as the optimum state of well-being allowing the horse freedom from mental stress and physical discomfort and further enabling it to happily perform to its greatest ability, providing a wholesome relationship with its human partner. Health is a state of wholeness in which all aspects and systems of the body function correctly and in harmony with the internal and external environments. In other words, a healthy horse has all systems, including respiratory, digestive, nervous, lymphatic, musculature, and skeletal systems, operating optimally, free from chronic stress and pain in everyday surroundings, whether it is stabled or living outside, resting or exercising, or spending time with humans or its animal partners.

1.2. Signs of health in the horse

A healthy horse will have a good appetite, a glossy coat and it will be very alert to its surroundings.

It is important to recognise the signs of a healthy horse to:

- Avoid buying a sick horse.
- To catch the signs early enough to treat and to prevent the horse from becoming any sicker.
- To be able to give the veterinarian an accurate description of any abnormalities.
- To separate the horse from others to minimize the risk of spreading a contagious disease.

Picture 1. A beautiful, healthy horse. [ii]

1.3. How is nutrition linked to health?

Nutrition is an input to and foundation for health and development. Better nutrition means stronger immune systems, less illness and better health. Healthy horses are stronger, more productive and have a better quality of life. In order to maintain healthy physiological systems, and perform to the best of their abilities, horses must consume a diet containing the correct nutrients in correct quantities. Knowledge of nutrition is important.

Equine nutrition science has traditionally focused on the many forms of nutritional deficiencies. However, there is a dramatic increase in other forms of malnutrition characterized by obesity and the long-term implications of unbalanced dietary and management practices. These may result in diseases such as Laminitis, Colic or Gastric Ulcer Syndrome. In addition to this, many people claim that the type of food they are fed affects their horses' temperaments, and horses may be more or less difficult to manage depending on their diet.

Equine nutrition can be a complicated subject of amounts, percentages, ratios, guesses, and unknowns. However, the results of good nutrition are easily seen: a healthy,

energetic animal in good condition with a glossy coat. The horse owner is able to achieve this result, not by memorizing long nutrition tables or feeding expensive supplements, but by developing a few skills and understanding basic principles of horse nutrition.

2. The structure and function of the equine digestive system

The equine digestive system is a complicated factory designed to process small amounts of food frequently and converts them into nutrients that can be absorbed. The same, concerning the result, could be said of the cow, pig, dog, cat, or even man. However, the horse's digestive system is unique, and perhaps more prone to problems than most others. This is not because of poor design, but is the result of humans changing what nature intended for the horse.

Picture 2. The digestive system of the horse

The horse's digestive system is a complex grouping of organs that is designed for the free-grazing animal. Because of man's constraints on the movement and feed choices of domestic horses, problems can arise. Horse owners who understand how the digestive system works can better manage their horse's feeding to get the best nutrition, with the least complications.

The horse has evolved as a "trickle feeder" designed to spend the majority of his time grazing. An understanding of the anatomy and function of the digestive system sheds light on how best to ensure it functions efficiently even when the horse is no longer predominantly kept in his most natural state.

In their natural state, horses were used to survive on grazing a fibre rich diet and consequently their energy metabolism was dependent on fibre degrading microorganisms inhabiting their gastrointestinal tract. However, modern performance horses are exposed to high intensity training, therefore energy-dense feedstuffs had to be introduced to feed rations to meet their high-energy requirements. These changes in the diet resulted also in changes in the microbial ecosystem inhabiting the gastrointestinal tract, which may also have consequences for the health of the horse.

There are diet related changes in horses' gastrointestinal microbiota, indicating that their ecosystem is affected by the diet. However, our knowledge is still limited on horses' gastrointestinal microbiology. Therefore, further investigations are needed to gain a better understanding of the interactions between gut microbiota and different feeding practices, which would help to develop feeding strategies that can better support equine health and welfare.

3. The particular nutritional requirements of the horse

The implementation of a successful feeding program depends on an accurate assessment of the nutritional value of the feed, as well as an understanding of the nutrient requirements of the specific horse. A presentation of the recommended daily allowances for different classes of horses and the nutritional values of different feeds is beyond the scope of this paper. Therefore, reference is made to the 2007 edition of the National Research Council’s (NRC) book, *Nutrient Requirements of Horses.*

Designed primarily as a reference, both practical and technical, *Nutrient Requirements of Horses* is intended to ensure that the diets of horses and other equids contain adequate amounts of nutrients and that the intakes of certain nutrients are not so excessive that they inhibit performance or impair health. This book is primarily intended

for animal nutritionists, veterinarians, and other scientists; however, individual horse owners and managers will also find some of this material useful.

4. Diagnosis of nutritional problems in horses

Nutrition is frequently implicated as a cause of disease or poor performance of horses. Sudden changes in feed or feeding schedules, toxins present in feeds or forage plants, and excesses or deficiencies of nutrients can all result in clinical problems. Diagnosis of the nutritional cause is necessary to effect a cure. Finding the source of the problem may be as simple as a getting a thorough history (i.e., the horse got into the grain bin). However, in many cases a more thorough investigation may be necessary.

When a problem arises that is suspected to be linked with the nutritional management of the horse, a complete history, evaluation of the horse(s) involved, feed samples, and tissue samples may be necessary to pinpoint the cause. Each case will be different, but the following discussion details a general sequence of inquiry, including which tests would be appropriate in certain situations.

4.1. History

A complete history of the horse(s) should be recorded. This will direct subsequent actions. Important information includes:

A. How long have the horse(s) been on the feeding/management program?

If no changes occurred—either in feeds used or management—for over one month or more, and signs had a slow onset or are vague, consider long term problems such as energy, protein, trace mineral, or fat soluble vitamin deficits/excesses.

If no obvious changes were made but signs were of sudden onset, consider the possibilities of spoiled or contaminated feed, or exposure to toxins. If any changes were made before the onset of clinical signs, they should be highly suspect.

Problematic changes can be as obvious as a sudden change in feed type/amount or as apparently innocuous as receiving a new batch of feed, hay, or bedding.

B. Is the horse turned out in a paddock or pasture?

If yes, look for toxic plants. Always check for signs that the plants were actually consumed by the horses since many toxic species (i.e., buttercups) are unpalatable and normally do not pose a threat unless the pasture is severely overgrazed and/or the horses are underfed. Also check the water source and trees/shrubs around or in the pasture (leaves and bark of some species are potentially toxic), and for evidence that clippings from lawn mowing or trimming were put in the area.

C. How many horses are affected?

If only one horse in a herd or stable is affected and the other animals are on the same feeding regimen, the possibility of a feed-induced problem is reduced. However, it may be an idiosyncratic reaction, or the animal may have ingested something the others avoided. If more than one horse is affected, try to find the common denominator (i.e., feed, age, type of supplements, type of activity, etc.). Also, establish how long the horses have been on the regimens. Verify the reported rations by actually examining the feed room and weighing out the amounts reported to be fed. Ask the people feeding the horses if the animals are actually consuming the amounts to be fed. For example, one horse may have consumed all of a new feed while the rest refused it.

D. Complete feed history: how much of what and when?

Hay: Check for mould and assess overall quality. Is it green and soft, or yellow and fibrous? Does it contain noxious weeds or other contaminants? If alfalfa, check for blister beetles, though they are often hard to find. If a chronic nutritional imbalance is suspected and the same hay has been fed for over a month, nutrient analysis of the hay should be done.

Concentrates: Check for any evidence of mould, abnormal odour, or contaminants. A representative sample should be taken (see below) for nutrient analysis, especially if the feed was custom mixed. If a commercial feed is being used and erroneous formulation is suspected, get the lot number and manufacturer information from the bag. If feed

samples are sent to the manufacturer for analysis, it is important to save some of the feed for independent analysis in case a dispute ensues.

Supplements: Record all supplements' label information and the amount and frequency at which they were fed. Potentially toxic levels of nutrients such as vitamins A and D, selenium, and iron can result from feeding multiple supplements.

It is important to calculate the total intake (from all supplements and concentrates) if signs of toxicity are present.

Water source(s): Inadequate water will result in an increased incidence of impaction colic. Water may also contain high amounts of various trace minerals that would interfere with the absorption/utilization of nutrients. If galvanized steel tanks and copper pipes are in contact with each other, high levels of zinc can leach into the water.

Salt: Regardless of other supplements, salt (NaCl) should be available free choice at all times.

E. Other signs of disease

Check vaccination and internal parasite (deworming) schedule. If weight loss is one of the complaints, the affected animal's teeth should be carefully checked. Liver and kidney problems should also be on the list of things to rule out.

4.2. Samples to Take

A. Feed samples:

When taking feed samples, especially for trace mineral analysis, it is important to avoid contaminating the sample. Wear gloves when handling forages and use the scoop normally used to deliver concentrates to place the samples in a clean sealable plastic bag.

When sampling pastures, take forage samples from a least ten sites, preferably from areas that are obviously being grazed by the animals. Clip the grass and legumes; do not pull them up by the roots. Do not use rusty implements to cut the samples!

For hay samples, ideally a hay corer should be used to obtain core samples from at least 10 bales. If grab samples are obtained, take them from the centre of at least 15 bales.

B. Clinical samples:

Blood: Blood samples are useful mainly to rule out non-nutritional disease problems and to test for toxic heavy metals. Calcium and sodium concentrations in the blood are tightly controlled by hormonal mechanisms and do not reflect dietary intake. Plasma concentrations of micro minerals such as copper, zinc, and selenium may reflect problems with intake but are so variable that only severe imbalances will be detected. Iron status is best determined by measuring serum ferritin, not blood iron. Anemia is NOT diagnostic for an iron deficiency because there are many other, more likely causes of anemia in horses. The only vitamin for which assays are routinely available is vitamin A, and this is not likely to be deficient.

Urine: Creatinine clearance ratios or fractional excretion can be determined for phosphorus, potassium, and sodium, which are reflective of actual intake. Urine calcium content varies radically over a 24-hour period and is not a reliable measure. Blood and urine for these analyses must be collected at the same time.

Post-mortem: GI contents, liver, and kidney biopsy: Most beneficial for chronic trace mineral imbalances (especially copper and zinc) or toxin exposure.

Common Nutritional Problems: Differentials to Consider

Table 3.

Problem	Nutritional Cause(s)	Rule outs
Weight Loss	Inadequate feed, poor dentition, parasite infestation, heavy metal toxicity, malabsorption, sand ingestion	Chronic illness
Anemia	Excess iron, copper deficit, Iron deficit (rare)	Chronic illness
Developmental Orthopaedic Disease	Excess energy intake, inadequate or imbalanced intake of Ca, P, Cu, Zn, I, Se; sudden increase in plane of nutrition	Hereditary predisposition
Rhabdomyolysis	Excess carbohydrate intake, electrolyte deficit, vitamin E deficit (?)	Overexertion
Colics • Spasmodic • Impaction • Enteroliths	 Sudden change in feed, grain overload, toxic plants or substances Inadequate water intake, excessively fibrous feed, sudden change in feed Alfalfa hay or other alkalinizing feed, Ingestion of foreign objects	 Stress Impaired GI motility
Laminitis	Grain or carbohydrate overload, toxin exposure	Metabolic disease, obesity

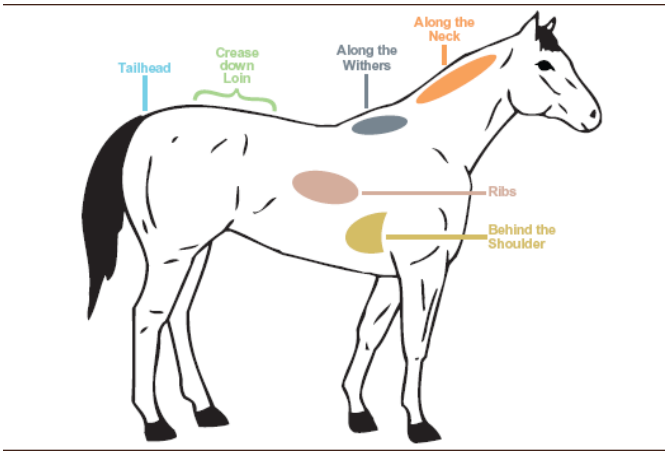
5. Balancing and monitoring the diet

Art and science are combined to determine the best feeding program for your horse. The foundation of the ration should be based on science. Once the foundation ration is established, art and experience come into play to provide your horse with a well formulated, practical diet.

For a thorough job of ration balancing, multiple nutrients and their interactions with one another should be considered. Most professionals use computer programs to evaluate all factors. To make the best use of your feed analysis results, consult with your nutrition

professional (feed dealer, extension agent, consultant, veterinarian). Their knowledge of daily nutrient requirements and feed composition will help you to develop a fundamentally sound, fact-based diet for your horses.

Although rations can be calculated mathematically, feeding is not an exact science and the diet must be monitored to make sure it is appropriate for the individual. No two horses are identical, horses must be monitored to assess their condition, and then the diet should be adjusted accordingly. Condition scoring is a way of assessing body fat. Horses are assigned a score of between 1. and 9. The areas that are assessed are shown in the picture below.



Picture 4. Areas of Emphasis for Body Condition Scoring

The descriptions of each body score category are shown in Appendix 1.

Each of the areas is scored individually and then the scores are averaged to produce a final overall score. This is done by looking and by feeling each area.

The suggested condition scores are different according to the type of work the horse does. A racehorse should have a condition score of 5-7, and an endurance horse 4-5. A pregnant mare's condition score of 7-8 would be acceptable, as it is difficult for mares to put weight on while lactating. While calculating the amount of feed for horses, the condition score should be taken into account and the feed adjusted as necessary to avoid a horse becoming too fat or too thin. As well as quantities, the type of feed should be considered.

6. Quality of feed

6.1. Water

Water is essential for body and fluid balance, digestive function, and gastrointestinal health. Specific physiologic and husbandry conditions of the horse, such as lactation and cold weather, elicit different water needs.

Lack of water can cause dehydration or impactions. Water consumption can be a problem when horses are stressed or traveling to shows. They may be reluctant to drink strange water that tastes different or is in a different bucket. Adding a few teaspoons of a tempting flavor (fenugreek, banana, cherry, rosemary, cumin, peppermint, oregano, molasses, apple juice) to the water at home for a few weeks before shows and then adding it to the water at shows may help disguise the taste of unfamiliar water if you have a horse that is fussy about drinking.

Horses should ideally always have free access to good quality, palatable water except after strenuous exercise, when the horse is still hot. These horses should be cooled down before being allowed as much water as they want to avoid colic or laminitis. However, before and during prolonged physical activity, the horse should be allowed to drink as often as practical and as much as it wants.

Preventing dehydration

Dehydration occurs when your horse's body loses excessive amounts of water. In the exercising horse, fluid loss occurs in the form of sweat. Early in dehydration, the horse can cope well with the fluid loss. As dehydration progresses, the heart rate will rise, because there will be less fluid in the blood vessels, so the heart has to pump the blood around faster to achieve the same effect. Your horse will urinate less frequently, or not at all. Your horse's performance will deteriorate, as the dehydration contributes to exhaustion. Eventually, with severe dehydration, your horse will not longer be able to perform, and may even collapse.

The key strategy for preventing a drop in performance either during or after periods of heat stress is one that prevents dehydration. This can only be accomplished by timely

and adequate provision of water and balanced electrolyte solutions to replace both the water and electrolytes lost through sweating. This will help a horse to control its body temperature by ensuring adequate body fluids to sustain sweating and heart function. Further strategies include finding shade, exposing the horse to wind or fans, or repeated application of water. Provision of water alone results in a dilution of already-depleted electrolyte solutions within the body fluid. Kidneys read this ingested water as an overload, resulting in renal excretion of more water - taking with it even more electrolytes.

6.2. Forages and pastures

Forages are pasture grasses, legumes and forbs. Forages may be either grazed directly or conserved. Forages represent a significant portion of the diet for all classes of post-weaned horses and may constitute the entire diet for equids in the wild and large numbers of domesticated horses.

Plant species, maturity, and environmental effects affect overall forage quality. In general, factors that reduce plant growth and maintain swards at an immature growth stage will enhance forage digestibility through elevated cell content:cell wall ratios. Conversely, those factors (e.g., warm temperatures, strong light) that increase rates of growth and development will result in decline in quality through decreased leaf:stem ratios and associated declines in cell contents and increased cell wall content and lignifications.

Conservation of forages is achieved by drying (hay), ensilaging (silage), or applying preservatives. The ultimate aim of haymaking is to produce a palatable, hygienic product that retains much of the nutrient quality of the original sward. This is achieved by minimizing nutrient losses in the field and curing the herbage to a stage that prevents moulding and reduces nutrient losses and deterioration during storage. Forages may be conserved as silage when weather conditions are not sufficiently reliable for hay production. During ensilaging, forage is preserved by anaerobic fermentation of the NSC (non-structural carbohydrate) fraction to organic acids, resulting in a decline in pH usually from about pH 6 to 4.5. The acidity prevents the growth of spoilage microorganisms. There are few reports on feeding ensiled forages to horses, as they

have historically been regarded as unsuitable for horses due to their acidity and perceived laxative effects and questionable hygienic quality, as silage can occasionally contain *Listeria* spp. or *Clostridium botulinum*, to which horses are highly susceptible. However, with the advent of high-Dry Matter-baled silage (haylage), there is often insufficient moisture for proliferation of *Clostridia* spp. and feeding haylage to horses is becoming increasingly popular.

Picture 5. A mouthful of haylage.

Variations in the nutrient content of forages arise from differences in soil fertility and growing conditions. Therefore, only laboratory analysis will give sufficient information of the nutritive value of a certain batch of hay or haylage. Forage analysis should routinely serve as a base when planning balanced rations for individual horses.

Some studies have reported forage type, form, or change in dietary forage to influence colic risk. Bearing in mind such findings, it may be prudent to introduce new feeding regimens, forage types, or batches gradually over time. Other problems associated with feeding hay include the elicitation of respiratory compromise. Even well made and stored hay, which to the naked eye appears “clean”, contain considerable numbers of respirable particles, which can lead to the onset of allergic respiratory disease in horses. In an effort to prevent such problems, it is common practice to soak hay in water to

reduce the number of respirable particles; however if soaked for more than 10 minutes, this operation results in the loss of considerable amounts of minerals. Hay contaminated with non-forage plant species can also present a hazard to equine health. The hygienic quality of ensiled products for horses is paramount, as horses do not possess the ability of ruminants to metabolize certain toxins. Ensiled products that have been subject to aerobic spoilage (moulding) should not be fed.

Fibrous forages clearly form the basis of the diet of wild equids, and there is a large body of circumstantial evidence that suggests that insufficient dietary fibre in equid diet can lead to hindgut acidosis, colic, gastric ulcers, increased risk of crib-biting and wood-chewing and behavioural problems.

Pastures that are being used as a major source of nutrition will require different management protocols than pastures that are being used primarily as a source of exercise and social interaction. Regardless of the intended use of the pastures on the farm, pastures need to be managed in order to provide ground cover and optimum forage quality for horses. The feed value of pastures for horses is a function of pasture intake and forage nutrient composition, digestibility, and bioavailability.

6.3. Concentrates

Grains and grain by-products

A wide variety of grains and grain by-products may be used as feeds for horses, usually to increase the energy density of horse diets.

Traditionally cereal is the main source of energy in many concentrate feeds. Unprocessed straights such as oats, barley and maize, as well as some coarse mixes, all contain a relatively high proportion of cereal starch. This energy source is rapidly broken down in the horse’s digestive system to release a rush of fuel into the bloodstream, which tends to encourage excitability. Starch may also contribute to fractious or bad-tempered behaviour if it is fed in excessive quantities: if the amount of starch in a feed overwhelms the horse’s digestive system, it will end up causing acidity in the hindgut and general discomfort for the horse. It is known that oversupply of starch

or other rapidly fermentable carbohydrates can result in lactate acidosis, hindgut dysfunction, colic, and laminitis in horses.

Picture 6. Oats, *Avena Sativa*

High starch products are therefore best avoided when choosing feeds for naturally exuberant or difficult characters. Fibre and oil on the other hand release fuel to the horse gradually and tend not to encourage excitable behaviour, despite being valuable sources of energy. It is therefore possible to feed hard working or poor doing horses plenty of calories whilst keeping over-exuberance at bay. Fibre and oil are also safely digested and will not cause irritating abdominal pain.

The starch content of grains can be radically reduced by different grain processing methods. Micronising is an example of a cooking method, which involves soaking the grain to swell the starch granules and then passing it under an infrared heat source to swell and fracture the starch granules – a process known as “gelatinisation”. To achieve maximum gelatinisation of the starch, and thus maximum digestibility, the temperature

and length of time for which the grain is exposed to the heat are crucial. Micronising (and other processing methods) maximises the chances of the starch content being digested in the foregut, where it should be and minimises the risk of undigested starch passing to the hindgut and causing problems like fractious behaviour and digestive upsets.

A horse's behaviour can be strongly influenced by the type of energy in their diet, as well as the amount. Whilst diet cannot fundamentally change a horse's temperament, it can be a useful tool in encouraging the right behaviour.

Fats and oils

Fats and oils are generally used in equine diets to increase energy density and/or substitute for hydrolysable and rapidly fermentable carbohydrates in the form of cereal grains. However, fat supplementation has other potential benefits, including improved energetic efficiency, enhanced body condition, diminished excitability, and metabolic adaptations that increase fat oxidation during exercise. Dietary fats also serve as carriers for fat-soluble vitamins and supply the essential fatty acids (EFAs) linoleic acid and α-linoleic acid that are not synthesized by the body, although an EFA requirement for horses has not been determined.

Fats and oils are added to horse rations to decrease dust, lubricate mixing equipment, serve as binders for pelleting, prevent sifting of ingredients in the mix, carry fat-soluble vitamins, and improve hair coat. However, the most important functions of fat in horse diets are to increase energy density of the diet and lessen the risk of colic, founder, gastric ulcers, and exertional myopathies (tying-up) induced by high-starch rations.

Horses can utilize up to 20% added fat in the total ration without adverse effects. In a number of studies, fat digestibility has run between 76 to 94% with up to 20% added fat in the ration. However, fat digestibility was less from animal than vegetable sources. Fat sources differ primarily in degree of saturation (number of double bonds). Animal fats tend to be less pure and may not be as palatable. Corn and soybean oil were the most palatable fat sources for horses in several studies.

Fats should contain less than 1.5% moisture, less than 0.5% insoluble impurities, and less than 0.1% unsaponifiables for animal fats and less than 2% for hydrolyzed fats. Most importantly, fats should be free of oxidative rancidity as indicated by a peroxide value of less than 20 mEq/kg.

Picture 7. Canola Oil, *Brassica rapa ssp oleifera*

Fats and oils generally cost two to fives times more per unit of weight compared to cereal grains, but provide about three times more energy that is available. Therefore, on a DE basis, they are usually comparable in cost.

Choosing a fat source for horses involves knowledge of the available products, a comparison of attributes, benefits, shelf life, cost, and a personal decision.

Oil is a concentrated source of slow release energy however; the more oil is included in the diet, the more antioxidants the body requires to deal with the free radicals produced during its metabolism. Feed companies have formulated oil dense feeds that contain additional anti-oxidants in the form of vitamins E and C, as well as selenium and zinc, to support the safe and efficient utilisation of the oil by the body.

Protein

Protein is a major component of most tissues in the body, second only to water. All tissues in the body are made of protein along with enzymes, hormones, and antibodies.

Protein is made of chains of amino acids. Twenty so-called “primary” amino acids make up most proteins. The types of amino acids incorporated into a protein chain as well as the length of the protein chain differentiate one protein from an other. Therefore, the horse’s requirement is actually for amino acids. Individual amino acid requirements (with the exception of lysine) have not been established for the horse. There are 10 presumed essential amino acids for the horse. These amino acids cannot be synthesized by the body in sufficient quantities to meet the demand for them. All the necessary amino acids required for a protein to be made must be present at the same time. One that is present in less than adequate amounts is referred to as a limiting amino acid because it will limit protein synthesis. The challenge in feeding horses is to provide adequate quantities of protein that will allow for sufficient concentrations of circulating amino acids in the blood that the body can draw on to synthesize tissues, enzymes, and hormones, as well as repair tissues.

Picture 8. Soya plant leaves and seedpods.

The quality of protein supplements fed to horses is a function of both the amino acid profile and digestibility of the protein source. Protein supplements are either from plant or animal sources. Those of animal origin are superior in terms of their amino acid profile to those of plant origin. However, animal protein sources are more expensive and often unpalatable compared to protein supplements of plant origin. It is of note that in some

countries, such as the UK, feeding animal protein products to horses is banned (DEFRA, 2006).

Protein sources such as milk byproducts and soybean meal, as well as canola meal, have proved superior to other protein sources for growing horses based on greater average daily gain. This is probably due to a better amino acid profile in these protein sources, as well as a potentially superior digestibility in the foregut of the horse. Soybeans and some varieties of peas contain a trypsin inhibitor that can interfere with protein digestion, and cottonseed meal contains gossypol, which has been suggested to bind iron and interfere with protein digestion. During processing, heating can destroy the trypsin inhibitors in soybeans and peas and inactivate the toxins from gossypol in cottonseed meal, making them acceptable for inclusion in horse feeds. Other protein supplements used in horse feeds include sunflower meal, peanut meal, lupin seed meal, beans, linseed meal, brewers' dried grains, and distillers' grains.

Particular attention should be paid to the lysine level in the protein source especially for growing horses and lactating mares. Deficient lysine levels will limit growth in young horses and may affect milk protein quality thereby, ultimately affecting the growth and development of the nursing foal.

6.4. Supplements

A feed supplement is anything fed to a horse in addition to a natural diet of forage. Technically grain is a supplement. However, the term has come to mean any additional nutrients (such as certain vitamins and minerals, extra protein, energy, etc.) that might be lacking in the diet and are added to a horse's ration. In recent years, a growing number of horse owners have also been feeding herbal supplements and various compounds to enhance certain aspects of health and performance.

In most cases, horses need a general vitamin-mineral supplement to balance their ration. Supplemental vitamins differ in chemical form, vitamin activity, and stability. Supplemental minerals differ in chemical form, concentration, and bioavailability. More research needs to be done to get a better understanding on the digestibility and

availability of minerals and vitamins. There is already evidence that e.g. organic Vitamin E is much better absorbed than synthetic Vitamin E.

The problem with simply adding inorganic trace minerals to your horse's feed is that they are not effectively utilized. Inorganic minerals have a low availability, ranging from 4-22%. Many of the inorganic products have molecular weights, which are too large to be absorbed and used by the intestinal tract. Therefore, the body must expend energy to break down and restructure these minerals so that they can be transported across the intestinal wall, into the bloodstream where they are used by the horse. Unfortunately, up to 80% of these inorganic minerals, when broken apart, will combine with other substances that will render them unavailable to the animal. They then are excreted out of the body and never make a nutritional contribution to the animal. Adding more inorganic trace minerals is not the answer because toxicity can occur.

Chelates are minerals that are attached to other molecules such as proteins or carbohydrates and used to improve the bioavailability of minerals.

Many of the vitamins when added to a feed that is not for immediate consumption must be protected to maintain their activity and efficacy. Some commercial vitamin suppliers will accomplish this by coating vitamins with things like gelatine, wax, or sugar or alternatively they will place short expiry dates on products. Many vitamins in an unprotected form are incompatible with other vitamins and minerals. Vitamin B_1 for example is incompatible with B_2, both are incompatible with B_{12} in the presence of light, and most vitamins are prone to oxidative destruction by iron, copper, sulphates, sulphides, phosphates and carbonates. It is particularly difficult to prevent these destructive interactions in *liquid vitamin preparations* such as “body builders or tonics”. Seeking evidence on the biological activity of the vitamins in these types of products from the manufacturers is advised, if the information is not available one could question their effectiveness.

Some other substances that might contribute to the well-being of the horse:

- Digestive Enhancers - These work to help improve and maintain a good bacterial population in the horse's gut for efficient digestion and utilisation of the overall

diet. They are not a food source for the horse but are particularly useful for those with compromised gut function such as horses under stress e.g. training, travelling, competing, suffering long-term worm damage, after a course of antibiotics etc. The term is generally used to refer to probiotics, prebiotics and yeast, which may be included in a compound feed or available as supplements. Prebiotics - Do not contain live organisms. Help to promote healthy gut function either by providing a food source that only beneficial bacteria can utilise or by mopping up pathogenic species of bacteria. Probiotics - Contain live bacterial populations designed to help restore a healthy population of microorganisms in the digestive tract. Yeast - Enhances fibre digestion by stimulating cellulose-digesting bacteria. Particularly beneficial for older horses who are known to be less efficient at digesting fibre. Yea Sacc^{1026} is the type of yeast culture registered for use in horse feeds in Europe.

- Omega-3 Fatty Acids - Because of promising results in other species concerning inflammation and immune function, researchers are looking for similar effects of omega-3 fatty acids in the equine.
- Anti-oxidants - Free radicals can be harmful to cells and are produced during normal metabolic function. The body has defence mechanisms against them, which are termed anti-oxidants. Certain vitamins and minerals, particularly Vitamin E and Selenium, are antioxidants.

Horses involved in strenuous activities might benefit from some types of supplements, since high-stress performance depletes some of the body's nutrients and mineral stores more rapidly than a natural diet of forages can replace them. A wise use of certain supplements could also benefit horses with various health problems. In addition, many dietary deficiencies in horses are sub clinical (not obvious), so horse owners tend to err on the side of trying to supply additional nutrients in case the horse might have a deficiency.

Some horses are hard keepers, slow healers, have poor stamina, poor reproductive performance, poor hoof growth, or weak hoof horn. These problems and other conditions have stimulated interest in supplements and creation of countless new

products. There are many vitamin/mineral supplements - some containing several nutrients, while others contain only a few specific vitamins, such as biotin or thiamine. These supplements are often available in liquid, block, pellet, or powder form - and they are easy to add to any feeding program.

Most horse owners want their horses to receive the best possible care, even if this dictates that diets be augmented with nutritional supplements. First, you should realize that there is nothing inherently wrong with many of the nutritional supplements on the market today. Several fill critical voids in the nutritional profile. For instance, a well-formulated vitamin and mineral supplement might be perfect for an easy keeper that maintains his weight on only mid-quality forage. Other products target specific problems and these too might be quite useful in a particular situation.

Problems occur, when individuals not well versed in nutrition make decisions about a horse's diet. While owners and caretakers may think they are doing what is most beneficial for the horse, feeding too many supplements can backfire.

One of the most widespread problems with supplementation is the provision of excessive amounts of nutrients. This problem can snowball quickly, especially when multiple supplements are given over an extended period. Consider minerals, for example. When nutritionists formulate feeds, they know well the ins and outs of mineral digestibility, including the various interactions that occur among minerals in the body. With this knowledge, they are able to determine how much of each mineral should be supplied in the daily ration to meet the horse's needs without setting up a potentially harmful overload. If a concentrate is fed according to the directions on the feedbag, the horse receives appropriate mineral nutrition for its stage of life and workload. As supplements are added, however, the nutritional profile of that ration changes, sometimes considerably. If sufficient products are heaped into a ration, problems may ensue.

Aside from the health of the horse, over supplementation is expensive. Most equine athletes can benefit from supplementation at one time or another. Electrolyte preparations, for instance, are appropriate for horses that sweat on a near-daily basis.

On the other hand, a horse doing light work in a cool climate may not need an electrolyte. The cost of supplementation can skyrocket as more and more products are given, with some horsemen actually spending more money on nutritional supplements than they do on a well formulated concentrate. As mentioned previously, these expenditures may be totally unnecessary.

Equine nutritionists are the go-to individuals anytime a question concerning your horse's diet arises. Those nutritionists at the forefront of research can conduct a thorough nutritional evaluation of your horse's diet and tell you exactly what your horse requires and what, if anything, is missing or being fed in excess. The opinion of the veterinarian that oversees the health of your horse is a critical component of a nutritional evaluation, and that opinion can offer valuable insight into certain medical conditions that might affect nutritional status. Therefore, collaboration among the nutritionist, the veterinarian, the caretaker, and the owner is the best possible scenario in deciding what nutritional supplements your horse actually needs.

7. Feeding practices

Whilst these seem to have been set in stone for centuries they have actually been developed through a combined understanding of horse behaviour and how the horse's digestive system works. Experience has shown that the horse will thrive and perform better if we respect his psychological and physiological needs and follow as natural a course as possible.

1. Feed little and often

Remember the horse is a "trickle feeder" with a proportionally small stomach, which is also fairly rigid. A large feed will simply pass through the stomach more quickly, before the digestive process in the stomach is complete and risks causing problems further down the digestive tract. Dividing the total daily compound feed into as many smaller feeds as possible is much more natural and encourages digestion that is more efficient.

2. Feed plenty of forage

As the horse has evolved to live on fibre from vegetation, his gut needs a constant supply of forage in order to function correctly. Horses have evolved to spend a long time

eating and forage in particular takes a long time to chew. Feeding plenty of forage to a stabled horse helps satisfy his need to chew and to relieve boredom, reducing the risk of behavioural abnormalities, known as "stereotypies", such as weaving or wind-sucking developing.

3. Avoid making sudden changes to diet

The microbial population of the horse's gut comprises a balance of various species, each responsible for digesting different elements of the horse's diet. If a sudden change is made to the diet this microbial population can be disrupted resulting in the production of toxins from bacteria which die. These toxins can cause metabolic disorders (e.g. laminitis) and digestive efficiency can be compromised, leading to colic or diarrhoea. A gradual change allows the bacteria to adapt and minimises the risk of metabolic or digestive upsets.

4. Keep feed buckets and scoops clean

Obvious really - smelly buckets put horses off eating! More seriously though, there is a risk of cross contamination where a number of horses are involved and one or more is receiving medication and especially if competing under Jockey Club or FEI rules.

5. Provide a clean, fresh water supply

Water is the most important nutrient - a lack of it will kill a horse far quicker than any other nutrient. 65-75% of a horse's bodyweight is water and it is needed to maintain body temperature, to lubricate joints and to transport nutrients around the body. It is also a constituent of saliva and other digestive juices. Horses are notoriously fussy and sometimes choose not to drink rather than to drink dirty water. With constant access, they will rarely over drink.

6. Allow time after feeding before working

After a feed of compound feed, it is best to wait at least 1 hour before strenuous exercise/riding; otherwise, the blood supply will be diverted away from the digestive tract to the muscles resulting in impaired digestion. A full stomach may also restrict the area in which the lungs can expand, reducing cardio-vascular efficiency.

7. Feed each horse as an individual

Whilst the basis of each horse's diet should be forage, their requirements will vary according to workload, temperament and how efficiently they utilise their feed. A good

doer in light work will have completely different requirements from a nervous Thoroughbred in hard work. The art is to achieve a balanced diet, which meets the horse's requirements for work whilst maintaining healthy condition.

8. Choose good quality feed and forage

Forage should be mould and dust free to reduce the risk of respiratory disease. Hay may be soaked or haylage may be chosen for higher moisture, lower dust content. Compound feed should be stored in clean, dry conditions out of direct sunlight and protected from contamination by vermin such as rats and mice. Products produced by reputable manufacturers are often more cost effective as their quality ingredients are cooked to ensure maximum digestibility.

9. Look after the system

Sharp edges on teeth make chewing difficult so the horse will swallow larger particles of food, resulting in choke in some cases, and reducing the efficiency of the digestion process. The horse may also waste food by dropping it from his mouth or “quidding". Worm damage results in scar tissue, which can accumulate over a number of years, reducing the area available for the absorption of nutrients and making it difficult for the horse to maintain its weight and condition. Regular worming assists in promoting good condition throughout the horse's life.

10. Feed at regular intervals

The digestive system is not designed to be empty for any length of time. If a horse cannot have "ad lib" access to forage then feeding at regular intervals helps reduce the length of time the system is empty. Horses also thrive on routine and are happier knowing when and where their next meal is coming from!

8. Feed storage

Correctly storing your horse's feed can help prevent the following:

- Growth of mould on the feed
- Breakdown of nutrients
- Insect infestation
- Attracting rats/mice and other pests to your barn
- Transmission of diseases to your horse

One of the most obvious reasons to keep your horse's feed stored properly is to prevent it from going bad. Mould and other organisms that grow on it can potentially make your horse sick. Preventing infestations is also important, as not many horses will touch feed that has bugs crawling all over it. Though mould and insect infestations are good reasons to review your horse feed storage methods, one of the best reasons is to prevent diseases accidentally being spread to your horse.

A number of diseases (such as EPM) can be spread through the urine and/or faecal matter of animals that find your horse's feed just as tasty as he does. Bug infestations and mould growth are usually easy to see, but faecal contamination may not be apparent, making its prevention even more important.

Picture 9. A clean Feed Room

Preventing nutrient breakdown is also a very good reason to properly store horse feed. Most nutrients begin to break down when exposed to oxygen and sunlight. Heat, as well as moisture, also causes accelerated break down of most nutrients.

The most important factor of any storage method is that it is horse proof! Whether the container itself is horse proof, or it is locked in a feed room that the horses cannot possibly get into, it is essential that there is absolutely no equine access to your feed stores.

Storing dried hay correctly is an art and science. Because of the many factors involved (time of storage, light, humidity) it is best to seek advice before storing hay for any length of time. Haylage must be used quickly after the bale has been opened.

9. Parasite and Dental issues

It is a fact that all horses have internal parasites. If left unchecked, bots and worms can rob a horse of necessary blood, nutrients and energy. If left untreated, a horse suffering with parasites can experience permanent damage, chronic digestive problems and weakened athletic potential. The good news is parasite damage is easily preventable. There are many products on the market to provide you with options for a safe and effective deworming program. Consult your veterinarian to choose a program that fits your situation and stick with it.

Picture 10. A horse with jagged teeth hooks that caused painful mouth wounds.

Uneven wear can cause sharp points that interfere with chewing, causing weight loss due to insufficient intake or poor digestion. Old horses may also have cracked or loose teeth. Get your veterinarian to check your horse's teeth at least once a year. Horses younger than five or older than twenty may need teeth checked more frequently.

10. The health problems associated with incorrect feeding

10.1. Illnesses due to deficiencies or excesses of nutrients

Descriptions of uncomplicated nutrient deficiencies in horses are rare. The nutrients most likely to be deficient are caloric sources, protein, calcium, phosphorus, copper, sodium chloride, and selenium, depending on age and type of horse and geographic area. Signs of deficiency are frequently nonspecific, and diagnosis may be complicated by deficiencies of several nutrients simultaneously. The consequences of increased susceptibility to parasitism and bacterial infections may be superimposed over still other clinical signs. Simple excesses are more common. Nutrients most commonly given in excess of needs, leading to toxicity or induced deficits of other nutrients, are energy, phosphorus, iron, copper, selenium, and vitamin A.

Energy Deficiency:

Many nonspecific changes found in horses with nutritional deficiencies are related to caloric deficiency and can result from inadequate intake, maldigestion, or malabsorption. In partial or complete starvation, most internal organs exhibit some atrophy. The brain is least affected, but the size of the gonads may be strikingly decreased, and oestrus may be delayed. The immune system is adversely affected, resulting in increased risk of viral diseases. The young skeleton is extremely sensitive, and growth slows or may completely stop. A decrease in adipose tissue is an early and conspicuous sign and is seen not only in the subcutis but also in the mesentery; around the kidneys, uterus, and testes; and in the retroperitoneum. Low-fat content of the marrow in the long bones is a good indicator of prolonged inanition. The ability to perform work is impaired, and endogenous nitrogen losses increase as muscle proteins are metabolized for energy.

Energy Excess:

Overfeeding of high-calorie feeds results in obesity in horses and may contribute to developmental orthopedic disease in growing horses. Obesity increases the risk of laminitis and colic due to strangulation of the small intestine by pedunculated mesenteric

lipomas. Obese horses and ponies have decreased insulin sensitivity and reduced heat and exercise tolerance.

Protein Deficiency:

A deficiency of dietary protein may represent either an inadequate intake of high-quality protein or the lack of a specific essential amino acid. The effects of deficiency are generally nonspecific, and many of the signs do not differ from the effects of partial or total caloric restriction. In general, the horse will have poor quality hair and hoof growth, weight loss, and inappetence. In addition, there may be decreased formation of Hgb, RBC, and plasma proteins. Milk production is decreased in lactating mares. The following liver enzymes have shown decreased activity: pyruvic oxidase, succinoxidase, succinic acid dehydrogenase, D-amino acid oxidase, DPN-cytochrome C reductase, and uricase. Corneal vascularization and lens degeneration have been noted. Antibody formation is also impaired.

Mineral Deficiencies and Excesses:

Nutritional Secondary Hyperparathyroidism (Bighead, Bran disease): Horses of all ages fed grass hay or pasture and supplemented with large amounts of grain-based concentrates or wheat bran are most likely to develop relative or absolute calcium deficiencies leading to nutritional secondary hyperparathyroidism. Excess phosphorus intake (Ca:P ratio <1.0) causes the same clinical signs. Blood concentrations of calcium do not reflect intake due to homeostatic mechanisms, though blood inorganic phosphorus may be elevated due to mobilization of bone mineral content. Serum alkaline phosphatase activity is usually increased, and clotting time may be prolonged slightly. Young, growing bone is frequently rachitic and brittle. Fractures may be common and heal poorly. Swelling and softening of the facial bones and alternating limb lameness are frequently reported.

Phosphorus Deficiency: This is most likely in horses being fed poor-quality grass hay or pasture without grain. Serum inorganic phosphorus concentrations may be decreased and serum alkaline phosphatase activity increased. Occasionally, serum calcium levels

may be increased. An insidious shifting lameness may be seen. Bone changes resemble those described for calcium deficiency. Affected horses may start to consume large quantities of soil or exhibit other manifestations of pica before other clinical signs are apparent.

Salt Deficiency: Horses are most likely to develop signs of salt (NaCl) deficiency when worked hard in hot weather. Sweat and urinary losses are appreciable. Horses deprived of salt tire easily, stop sweating, and exhibit muscle spasms if exercised strenuously. Hemoconcentration and acidosis may be expected. Anorexia and pica may be evident in chronic deprivation, although these are not specific signs of salt deficiency. In lactating mares, milk production seriously declines. Polyuria and polydipsia secondary to renal medullary washout may be seen in prolonged deficits.

Potassium: Chronic dietary deficiency of potassium results in a decreased rate of growth, anorexia, and perhaps hypokalemia. However, most forages contain more than sufficient potassium for the average horse. Acute deficits due to sweat losses are more likely and may cause muscle tremors, cardiac arrhythmias, and weakness. Excess potassium intake, especially if given as a bolus PO or IV, also will induce cardiac arrhythmias such as atrial fibrillation.

Magnesium: Foals fed a purified diet containing magnesium at 8 mg/kg (3.6 mg/lb) exhibited hypomagnesemia, nervousness, muscular tremors, and ataxia followed by collapse, with increased respiratory rates, sweating, convulsive paddling, and death after a few weeks. However, most commonly used feeds contain Mg well in excess of the 70-100 mg/kg dry ration currently recommended. Over supplementation of this mineral is more likely. Though the effects of excessive Mg intake in horses have not been determined, based on data from other species it may cause clinical signs of calcium deficiency.

Iron: Iron deficiency may be secondary to parasitism or chronic blood loss and results in microcytic, hypochromic anemia. However, it is highly unlikely that even anemic horses are iron deficient. Iron excess interferes with copper metabolism and also causes

microcytic, hypochromic anemia. Blood transferrin concentrations are the most reliable method to determine the iron status of a horse.

Zinc: Zinc deficiency in foals causes reduced growth rate, anorexia, cutaneous lesions on the lower extremities, alopecia, decreased blood levels of zinc, and decreased serum alkaline phosphatase activity. Excesses (>1,000 ppm) were associated with developmental orthopedic disease in young horses. The effects of excesses or deficits of zinc have not been documented in adult horses.

Copper: An apparent relationship between low blood copper concentrations and uterine artery rupture in aged parturient mares suggests reduced copper absorption with age or reduced ability to mobilize copper stores. Dietary deficiency may cause aortic aneurysm, contracted tendons, and improper cartilage formation in growing foals. Excessive copper intake may interfere with selenium and/or iron metabolism.

Selenium: Selenium deficiency results in reduced serum selenium, increased AST activity, white muscle disease, and perhaps rhabdomyolysis in working horses. Selenium excesses of as little as 5 ppm in the ration cause loss of mane and tail hairs and sloughing of the distal portion of the hoof.

Vitamins:

A Vitamin A deficiency may develop if dried, poor-quality roughage is fed for a prolonged period. If body stores of vitamin A are high, signs may not appear for several months. The deficiency is characterized by nyctalopia, lacrimation, keratinization of the cornea, susceptibility to pneumonia, abscesses of the sublingual gland, incoordination, impaired reproduction, capricious appetite, and progressive weakness. Hooves are frequently deformed, with the horny layer unevenly laid down and unusually brittle. Metaplasia of the intestinal mucosa and achlorhydria have been reported. Genitourinary mucosal metaplasia may be expected. Bone remodelling is defective. The foramina do not enlarge properly during early growth, and skeletal deformities are evident. The latter may be seen in foals of vitamin A-deficient mares.

If sun-cured hay is consumed or the horse is exposed to sunlight, it is doubtful that a vitamin D deficiency will develop. Prolonged confinement of young horses offered only limited amounts of sun-cured hay may result in reduced bone calcification, stiff and swollen joints, stiffness of gait, irritability, and reduced serum calcium and phosphorus.

Signs of experimental thiamine deficiency include anorexia, weight loss, incoordination, decreased blood thiamine, and increased blood pyruvate. At necropsy, the heart is dilated. Similar signs have been seen in bracken fern poisoning. Under normal circumstances, the natural diet plus synthesis by microorganisms in the gut probably meet the need for thiamine. However, needs may be increased by stress.

Although natural feeds plus synthesis within the gut normally provides adequate riboflavin, limited evidence indicates an occasional deficiency when the diet is of poor quality. The first sign of acute deficiency is catarrhal conjunctivitis in one or both eyes, accompanied by photophobia and lacrimation. The retina, lens, and ocular fluids may deteriorate gradually and result in impaired vision or blindness. Equine recurrent uveitis has been linked to riboflavin deficiency but may be a sequela of leptospirosis or onchocerciasis.

The normal feedstuffs of horses generally contain very little vitamin B12 . However, the horse can synthesize this vitamin in the gut, from which it is absorbed.

10.2. Colic

The term "colic" means only "pain in the abdomen" or "pain in the belly". There are many causes for such pain, ranging from the mild and inconsequential to the life threatening or fatal. One of the problems with equine colic is that it can be very difficult in the early stages to distinguish the mild from the potentially fatal. This is why all cases of abdominal pain should be taken seriously right from the onset.

Major types of colic

Impaction colic: This is the term used when the intestine becomes blocked by a firm mass of food. Impactions most commonly occur in the large intestine at one of the

flexures. This is a fairly common type of colic, which usually resolves relatively easily with appropriate treatment. However, an impaction may be just the first obvious sign in a more complicated case.

Picture 11. Resting is normal, but if you see a horse repeatedly lie down and get up, or if he has assumed an odd position, he may be colicking. Photo by Bob Langrish

Gas colic: Sometimes gas builds up in the intestine, most commonly in the large intestine and/or caecum. The gas stretches the intestine, causing pain. Gas colics usually resolve fairly easily with appropriate treatment, although it is essential to ensure that there is no underlying reason for the problem.

Spasmodic colic: Some cases of colic are due to increased intestinal contractions, the abnormal spasms causing the intestines to contract painfully. These cases usually respond fairly well.

Displacement/volvulus/torsion ('twisted gut"): In a "displacement", a portion of the intestine has moved to an abnormal position in the abdomen. A "volvulvus" or "torsion" occurs when a piece of the intestine twists. The suspension of the small intestine from the mesentery (the "net curtain") and the unfixed nature of much of the large intestine predispose horses to intestinal displacements and torsions. Except in rare cases, these types of colic cause a total blockage of the intestine and require immediate surgery if the horse is to survive. In the early stages of a displacement/torsion colic, the signs may be similar to those of a horse with one of the more benign causes of colic. That is why it is important to take all cases of colic seriously, and to seek veterinary advice at an early stage.

Enteritis/colitis: Some cases of abdominal pain are due to inflammation of the small (enteritis) or large (colitis) intestines. These are serious medical cases and require immediate veterinary attention.

Gastric distension/rupture: When a horse gorges itself on grain or, even more seriously, a substance which expands when dampened like dried beet pulp, the contents of the stomach can swell. The horse's small stomach and its inability to vomit mean that in these circumstances the stomach may burst. Once this has happened death is inevitable. If you suspect that your horse may have gorged itself on concentrate feeds, seek veterinary advice immediately.

"Unknown": In many cases of colic, it is impossible to determine the reason for the pain. Symptomatic treatment, close monitoring and attention to any adverse developments usually lead to resolution of the problem.

Prevention of colic

If you happen to be a horse, colic is probably an unfortunate fact of life. Annual colic incidences of approximately 10% are quite common. Listed below are some of the management factors which are thought to reduce colic incidence. Horses, which fall into high-risk categories, such as stabled horses in intense training and fit horses recently injured, should be monitored particularly closely.

- Allow as much turnout as possible.
- Maintain a regular feeding schedule.
- Ensure constant access to clean water.
- Provide at least 60% of digestible energy from forage.
- Do not feed excessive digestible energy.
- Do not feed mouldy hay or grain.
- Feed hay and water before grain.
- Provide access to forage for as much of the day as possible.
- Do not over graze pastures.
- Do not feed or water horses before they have cooled out.
- Maintain a consistent exercise regime.
- Make all changes in diet, exercise level and management slowly.
- Control intestinal parasites and assess efficiency periodically.

10.3. Gastric ulcers

Sport horses tend to be stabled horses, and consequently suffer from one of the most common health problems of the stabled horse - gastric ulceration. We humans have the luxury of a quick trip to the drug store for our favourite heartburn remedy, and we can call our physicians for a more in-depth diagnosis of why we experience such agonizing gastrointestinal pain. Horses can only show us by indirect signs that they are in chronic, debilitating pain. It is not surprising that gastric ulceration can actually be a cause of poor performance in the sport horse.

In any species, ulceration is an erosion, or sloughing of one or multiple areas of the surface layer of the stomach. Gastric ulceration is very common in horses. In various studies, from 70% - 100% of horses examined had endoscopic evidence of gastric ulceration. This, however, does not mean that all of these horses had clinical signs of gastric ulceration. Unlike people, who develop gastric ulcers in response to a bacterial infection, no infectious cause of gastric ulceration has been identified in horses. Few specific causes of gastric ulceration have been clearly identified. However, most practitioners recognize that stress seems to precipitate gastric ulceration in foals; and

infrequent feeds of low-roughage, high carbohydrate foods and a high level of training have been implicated in adult horses.

Unlike humans, horses secrete gastric acid continuously, whether they are eating or not. In the wild, horses spend the majority of their days continually eating small amounts of relatively poor quality, high roughage food. Continual acid secretion accommodates this natural lifestyle perfectly. When horses are fed large quantities of high quality food infrequently, their stomachs rapidly empty, essentially leaving the stomach with nothing to do. The stomach has a variety of protectant factors against the effects of gastric acid, but when the stomach is empty, the horse's ability to withstand the effects of gastric acid can be overwhelmed. The use of certain anti-inflammatory drugs (such as phenylbutazone or flunixin meglumine) can also induce gastric ulcers in horses. If gastric ulceration becomes severe, the erosions may begin to bleed. Horses can eventually become anemic and low in protein due to losses through the gastric ulcers.

How do I prevent gastric ulcers?

- Horses that have constant access to turnout and roughage in the form of hay or pasture rarely develop gastric ulceration.
- Horses that are not in training rarely develop gastric ulceration.
- It is thought that the best prevention for gastric ulceration is to mimic, as best as possible, the life of a horse at free range. This translates into frequent small meals, a preponderance of roughage in the diet, and plenty of turnout.

10.4. Laminitis

Laminitis is a disease associated with ischaemia of digital dermal tissues, it is not primarily an inflammatory disease; hence, lamin-itis is a misnomer. The bond between the dermal and epidermal laminae (the inter-laminar bond) is the only means of support of the distal phalanx within the hoof. If sufficient inter-laminar bonds are destroyed the animal becomes foundered i.e. the pedal bone moves distally within the hoof.

You can prevent laminitis by avoiding high-risk situations. The following is a list of “causes” or circumstances that are commonly known to precede the onset of laminitis.

- Obesity.
- Overeating on foods rich in carbohydrate or rapidly fermentable fibre i.e. cereals, coarse mixes, rapidly growing or fertilised grass.
- Any illness which involves a toxaemia. This may be a bacterial infection or following the ingestion of plant or chemical toxins.
- Cushing's Disease. This is a condition which follows an abnormality affecting the pituitary gland in the horse's head. It results in the horse failing to shed its winter coat. The coat becomes long, matted, and eventually curly. The horse drinks and eats increased amounts of food while sweating excessively and losing weight. All Cushing's cases suffer laminitis.
- Weight-bearing laminitis. When the horse is severely lame on one leg and has to put all his weight on the contra-lateral limb, they often suffer from founder in the weight-bearing limb. This is particularly common in hind feet.
- Concussive laminitis (road founder). When horses are subjected to fast or prolonged work on hard surfaces, they may develop laminitis because of trauma to the laminae, particularly if their horn quality is poor.
- Hormonal problems. Animals, which are “good doers”, may be hypothyroid or have an abnormal peripheral cortisol enzyme system. The latter condition, recently described has been called obesity related laminitis or peripheral Cushing's disease. Others develop laminitis when they are in season.
- Cold weather. A few horses show laminitis during cold weather, fitting warm leg wraps during cold snaps prevents the problem in most cases.
- Stress. Worming, vaccination, travelling or separation from a "friend" can trigger an attack of laminitis.
- Drug induced laminitis. Although some wormers can precipitate laminitis, the most common group of drugs, which cause laminitis, are the corticosteroids. Even injecting short acting corticosteroids into joints can cause severe laminitis.

Overeating / Obesity are the most common high-risk situations, which lead to laminitis. The secret to avoiding laminitis in this situation is not to turn the horse out whilst he is fatter than condition score 5. This means he should not have a fat depot

along his crest or at the tail head, around the sheath or udder or over the loins. You should be able to feel his ribs easily by running your hand along his side yet you should not be able to see his ribs.

Limiting the grass intake can be accomplished by using a grazing mask or muzzle or by restricting the area available for grazing.

Picture 12. Horse with severe laminitis in both front feet showing typical laminitis gait. The hind feet are placed as far forward as possible before the horse attempts painful shuffling steps in front.

10.5. Developmental Orthopedic Disease

Both genetic and nutritional factors are recognized as potential contributors to developmental orthopedic disease (DOD) in growing horses. New information points to a possible link between the two factors. The genetic factor could involve glucose intolerance or insulin insensitivity, which is, expressed when young horses are fed large amounts of carbohydrates to promote rapid growth.

It is reported that some horses less than one year of age, which develop DOD, such as osteochondritis dissecans (OCD), also exhibit glucose intolerance. When these horses are fed large amounts of grain, their glucose concentrations can be maintained near

normal only by producing excessive amounts of insulin. Increased insulin can affect bone metabolism by preventing the proper formation of bone from cartilage, possibly resulting in OCD lesions. This condition should be suspected whenever familial groups of horses have developed DOD. Management of these horses would involve greatly decreasing their starch intake by substituting fat and high-quality forages for grains as nutrient sources.

Fat in horse rations does not produce the typical glycemic response (150% increase in plasma glucose and corresponding plasma insulin increase for two to three hours following meals) seen in horses fed high-grain rations. By using fat, growth can be maintained without excessive carbohydrates from grains and the resulting excessive insulin production.

Picture13A: This colt has physitis of the right distal radius. Normally the thickened growth plate is painful when palpated.

Picture 13B: Radiographs of the colt in Picture 13A. The left carpus (L) is normal and the right carpus (R) is affected by physitis. The widened, irregular growth plate is identified by the arrow.

As always, total rations for young horses must be balanced for energy, protein, calcium, phosphorus, copper, and zinc to minimize the occurrences of DOD. Since several forms of DOD are associated with mineral deficiencies or imbalances in broodmares, dietary prevention of DOD should begin with proper broodmare nutrition.

10.6. Heaves

COPD, Chronic Obstructive Pulmonary Disease, Heaves, Equine Asthma or Emphysema, Broken Wind can be caused by dusty or mouldy hay, dust and moulds in bedding, or pollens, dust and other irritants in the environment. Any horse exposed to respiratory irritants may develop COPD. The longer they are exposed the more severe the condition may become. Horses kept stabled may be at higher risk.

Coughing, increased respiration, laboured breathing or yellow nasal discharge may be signs of COPD. Symptoms range in severity from mild, to so severe that the horse appears listless, has difficulty breathing and develops a muscular 'heave line' along the horse's barrel from taking a double exhalation. An elevation in body temperature is not a symptom of COPD. The horse's appetite should remain normal unless the condition has developed so the horse has extreme difficulty breathing.

Picture 14. You will start to notice a "heave line" as your horse gets worse

This chronic lung condition builds gradually. If recognized early, good feed and stable management may slow or prevent its progression and the horse may be able to take on an almost normal workload. If the horse is continually exposed to the irritants, the disease may progress to the point where the horse is unable to thrive.

Good stable and feeding practices can help avoid and control COPD. Make sure that any fodder and bedding is mould and dust free. Provide plenty of fresh air in a clean environment. A veterinarian will be able to suggest drug therapy to help alleviate symptoms and some owners find various herbal or natural remedies effective. There is no sure cure; once a horse has COPD it will always be at risk of further lung damage.

10.7. Equine Rhabdomyolysis Syndrome

Equine Rhabdomyolysis Syndrome (ERS) is also known as Monday morning disease, setfast, azoturia, tying-up and exertional rhabdomyolysis. The condition is characterised by damage ("lysis") of striated muscle fibres (especially type II muscle fibres).

The signs vary in degree from a mild abnormality of gait to recumbency. ERS may cause behavioural problems during backing.

Measurement of “muscle enzymes” in the blood can give a guide to the severity of the muscle damage. The most specific indicator of muscle damage is creatine kinase (CK). Levels in the blood increase rapidly after the onset of ERS.

Mild cases of ERS can be detected by using an exercise test in which blood levels of the muscle enzyme CK are checked before, and four hours after, 20 minutes of trotting exercise. An increase of more than twice pre-exercise values, confirms that the horse has ERS.

Equine rhabdomyolysis syndrome appears in two forms: sporadic and recurrent. It is important to differentiate the sporadic cases from the acute recurrent episodes because the management of each differs. Various causes of the sporadic form have been described - such as carbohydrate overload, viral myositis, vitamin E / Selenium deficiency and exertional myopathy. These factors may also act as triggers for the recurrent form.

Two specific causes of recurrent ERS have been identified so far. Equine polysaccharide storage myopathy, and a calcium channel disorder.

Equine polysaccharide storage myopathy (EPSM) was first seen in Quarter horses in the USA, but has since been recorded in other breeds - including draft horses and draft horse crosses, and warmbloods. The diagnosis is confirmed using a muscle biopsy, which shows characteristic accumulation of abnormal levels of polysaccharides (glycogen) in the muscle.

The cause of EPSM is unknown. Affected horses have high resting glycogen levels in the muscle. However, this is not because they are unable to break the glycogen down - rather it appears that they manufacture more of it.

The calcium channel disorder is a defect in calcium metabolism within the muscle cell that interferes with normal control of muscle contractions. This form is found in Thoroughbreds and appears to be inherited.

Trigger factors depend on the horse and the type of work it does. The major trigger factor in polo horses is lack of fitness. ERS tends to be seen early in the season; after a rest period prior to exercise and if the horse has had more strenuous exercise than normal. Horses with an excitable temperament are more likely to be affected. Typically, the signs of ERS in polo horses are severe.

Management of horses affected with ERS plays an important role in reducing the risk of recurrence. The carbohydrate content of the diet should be reduced as much as possible and replaced by oil. To replace 20% of the caloric intake with oil would require about 500ml for a 500kg horse. Oil should be added to the diet even if the horse is turned out and only eating roughage. This lowers the muscle glycogen and is unlikely to adversely affect performance. Horses should receive a daily minimum roughage intake of 1% of body weight.

Attention should be given to vitamin and mineral levels. This is especially so if large amounts of oil are added to the diet (in which case the requirements for vitamin E and selenium may be increased).

It is important to resume exercise early. According to Dr Cathy McGowan, formerly of the Royal Veterinary College, it is not necessary to wait until the muscle enzymes return

to normal before starting work again."If your horse is walking freely I’m happy for you to exercise it." She advises that warm-up work should be relaxed rather than too collected. It is also best to have regular exercise with no days off. Horses should be turned out as much as possible without exposing them to too much rich pasture.

Dantrolene, a drug that decreases the release of calcium within the muscle, is sometimes helpful, especially in Thoroughbreds, to allow the horse to get back to regular work.

10.8. Grass sickness

Grass Sickness is a disease of equines in which there is damage to parts of the nervous system, which control involuntary functions, producing the main symptom of gut paralysis. The cause is unknown but the nature of the damage to the nervous system suggests that a type of toxin is involved. The disease occurs almost exclusively in horses with access to grass.

Picture 15. Horse suffering from Grass sickness.

The main line of investigation at present is the role of soil borne Clostridium botulinum type C as the cause of grass sickness. It has been discovered that the concentration of C.botulinum type C toxin is high in the intestine of acute cases and that horses with low levels of antibody to the bacteria and its toxin are at increased risk from the disease. Recent epidemiological studies carried out by the University of Liverpool, the Animal

Health Trust and the R(D)SVS also provide supportive evidence for the involvement of Clostridium botulinum. This includes the increased risk when grass is contaminated by soil or birds present on the pasture.

10.9. Diarrhoea

Diarrhoea is a relatively common but potentially serious condition that can affect horses of any age. It may or may not be accompanied with signs of colic. It is advisable in all but the mildest of cases to call the vet to ensure necessary treatment is initiated and conditions that are more serious are identified before they progress. As with human illnesses, there are many different causes of diarrhoea in horses and therefore many different ways your vet may choose to treat the diarrhoea. In all cases, it is essential that adequate quantities of clean water are available as a considerable amount of fluid and electrolytes can be lost in horses with diarrhoea. Electrolyte supplementation should be considered at this stage. Always consult your vet for advice.

Diarrhoea in the horse can be due to minor digestive upsets caused by a change in feed or lush pasture, excess water intake or stress caused by travelling or competition. Internal parasites can be involved, for example, small red worms. More serious forms of diarrhoea include ‘Colitis X’ (which is often of a multifactor origin), bacterial infections and antibiotic induced diarrhoea. Often, the exact cause of diarrhoea is elusive and a more general treatment regime is applied while further diagnostics are carried out in order to come closer to a diagnosis.

Your vet will examine the horse and decide what tests and treatments are necessary. Tests they may want to perform to identify the cause of the diarrhoea and allow more effective treatment of the horse include taking blood samples and a faecal sample. Occasionally, if the horse is colicky then your vet may take a sample of fluid from your horse’s abdomen: a “peritoneal tap” or they may want to perform a rectal examination.

At this stage, your vet may decide to initiate electrolyte therapy as well as medication. They may decide to use drugs to control toxins, antibiosis or administer a charcoal drench.

If the horse's condition becomes more serious, hospitalisation for fluid therapy and more intensive electrolyte therapy may be necessary as well as medication more specific to the horse's condition.

Diarrhoea associated with Diet

Mild cases of diarrhoea can be caused by dietary changes. If the amount or type of feed is changed suddenly, a mild digestive upset can result. These will usually resolve with time, as the horses digestive system adapts to the new feed. Thus, it is always advisable to make changes to any horses feed over a period of time. In the same way, lush pasture can cause mild diarrhoea as it results in a more rapid passage through the gut. Lush pasture also lacks long fibre, needed to produce normal faeces.

Certain grains and lush pastures contain high levels of soluble carbohydrates. These carbohydrates ferment in the horse's large intestine, upsetting the microbial balance. This increases the acidity in the gut and therefore, causes diarrhoea. This type of diarrhoea can be associated with laminitis, thus care should be taken to restrict further intake of lush grass or grain, while increasing the horses roughage intake. Adding chaff and decreasing the grain content of feed, as well as feeding smaller, more frequent feeds can help to improve the diarrhoea. Supplements can sometimes help in these cases: it is best to discuss this with your veterinarian.

Stress induced diarrhoea

Some horses can get mild diarrhoea when travelling and competing. This is due to nervous stimulation of the intestinal system and will usually resolve once the horse has been removed from the stressful environment. Provision of fresh water and occasionally electrolyte replacement is recommended for these horses.

Parasite induced diarrhoea

Intestinal parasites are commonly associated with diarrhoea, therefore it is highly advisable to perform a faecal egg count and strategically worm any horse with persistent diarrhoea. Faecal egg counts are a good routine adjunct to your worming routine; all you

need to do is place a sample of fresh faeces in a clean pot or plastic bag and drop it down to your vet. Your vet will then contact you to let you know the results and what wormer would be the most suitable to use. Horses can have relatively large numbers of small red worms ‘resting’ in their bowel wall. Under certain environmental conditions these ‘resting’ larvae’ can be stimulated to be released into the intestine, causing gut damage, irritation and persistent low-grade diarrhoea. If untreated this type of diarrhoea can turn into a more serious condition with mild colicky signs, loss of appetite, loss of condition and can even be fatal. A strict worming schedule to include all horses grazing together, and pasture management will prevent this type of diarrhoea.

Infection induced diarrhoea

Bacteria, such as Salmonella and Clostridium can cause severe diarrhoea. They will often cause the horse to appear depressed, lose its appetite, be colicky and they may have a fever. The diarrhoea is often profuse and has a distinctive odour. If you are at all concerned that your horse may have this type of diarrhoea, contact your vet immediately. The ‘usual suspects’ in foals include Rotavirus and Cryptosporidium in and in all age groups Salmonella sp., Clostridium spp. and Aeromonas sp. should be suspected as described above.

Some horses on an intensive level of work have been known to develop acute, profuse diarrhoea with a high temperature. This is often associated with rapid dehydration and weight loss over 24 – 36 hours. This condition is known as ‘Colitis X’. Its cause is not fully identified but it is thought that stress has a role. Intensive treatment and diagnostics are needed to rule out other common causes of diarrhoea but it must be advised that it is a serious and sometimes fatal condition. Please seek veterinary advice.

Most cases of diarrhoea will resolve with treatment, with the milder cases often resolving by themselves. It is worth bearing in mind, however, that untreated diarrhoea can cause serious complications such as laminitis and severe dehydration. It is also worth considering that there are several infectious causes of diarrhoea, thus it is a good idea to minimise horse-to-horse contact and wash your hands well after handling an animal with diarrhoea.

10.10. Metabolic syndrome

Horsemen have known for decades that obesity is an unhealthy condition in horses. In olden times, overweight horses were not common because horses were required to toil all day in front of a plough or behind a herd of cattle. In this age, obese horses are more the rule rather than the exception. Despite admonitions by veterinarians and nutritionists to keep horses in moderate body weight, well-meaning horse owners ply their charges with high-calorie concentrates and hay. More times than not, the result is a plump middle-aged horse that is anything but healthy or athletic. He gasps for breath when subjected to mild exercise, and his limbs bear the brunt of unnecessary pounds.

Now, scientists have uncovered yet another reason to keep mature horses slim and conditioned: equine metabolic syndrome. Because it is a relatively novel discovery, scientists are just beginning to learn the intricacies of this disorder. At first, the veterinary sect could not agree on a suitable name. In the past, it has been commonly referred to as peripheral Cushing's syndrome, pseudo-Cushing's syndrome, hypothyroidism, and insulin resistance syndrome. Less common names included omental Cushing's syndrome, or central obesity. A mysterious-sounding moniker evolved as well, syndrome X. Eventually, researchers agreed on the terminology proposed by the World Health Organization to designate this condition: equine metabolic syndrome.

As the accurate diagnosis of equine metabolic syndrome becomes more widespread, researchers are learning more about the causes, signs, and treatments of the disorder.

Insulin Resistance: The Root

Equine metabolic syndrome is characterized foremost by insulin resistance, defined as a peculiar physiological response to the ingestion of foods that are eventually broken down to glucose or other sugar molecules. Abundant in certain feedstuffs commonly fed to horses, glucose causes a normal state of hyperglycaemia or elevated sugar in the blood. Hyperglycaemia prompts the release of insulin from the pancreas, which encourages the removal of glucose from the bloodstream by fat or skeletal muscle cells. Once in the cells, glucose can be put to work immediately to fuel exercise or growth or stored as glycogen or fat for later use. Insulin resistance implies that either the central

tissue (liver) or the peripheral tissues (the skeletal muscle or the fat cells) are relatively insensitive to the action of insulin or that the quantity of insulin released by the pancreas in response to hyperglycaemia is diminished. This leaves glucose circulating in the blood. Because glucose levels do not drop, the pancreas continues to discharge insulin, leading to elevated concentrations of insulin in the bloodstream, a condition known as hyperinsulinemia.

What predisposes a horse to insulin resistance? Little is known on this front but responsibility might rest on genetic, gestational, and environmental factors. In humans, causative factors are well documented: aging, pregnancy, smoking, reduced physical activity, and obesity. In genetically susceptible humans, glucose intolerance can lead to noninsulin-dependent diabetes mellitus.

In the equine model, obesity appears to be related to the onset of metabolic syndrome. One suggested cause is that certain fat cells produce cortisol, among other hormones, which interferes with the ability of insulin to move the glucose into cells. Because obese horses have more fat cells, more cortisol is produced and there is greater interference with insulin. This explains why weight reduction is effective in increasing insulin sensitivity.

Not all fat horses are insulin resistant. Current beliefs hold that horses whose fat cells produce high levels of leptin as well as cortisol are the ones prone to insulin resistance. Leptin is not believed to cause insulin resistance but is found to be higher in horses that are insulin resistant.

Age and diet may be directly related to the development of equine metabolic syndrome. Age is thought to decrease the horse’s sensitivity to insulin. Meals high in starch and sugar cause significant spikes in blood glucose and insulin, and years of consuming such meals might lead to insulin resistance.

Obesity-Associated Laminitis

An overwhelming clinical sign of equine metabolic syndrome is laminitis, but not the disabling, painful disease related to gastrointestinal failure and endotoxemic insults. The

laminitis exhibited by these obese, middle-aged horses tends to be mild. On occasion, so minimal are the laminitic episodes that knowledgeable, conscientious horse owners cannot vouch definitively for any clinical signs of lameness. The hard evidence speaks a different tale, however. Abnormal hoof growth occurs. Dropped soles, unusual growth lines, and separation of the hoof at the white line are frequently observed. More damning, however, is the shifting of the coffin bone within the hoof capsule, which is obvious upon radiography.

But what causes the laminitis? Over the years, the root of laminitis in obese mature horses has been attributed to (1) endocrine disorders, namely hypothyroidism; (2) aggravation of a pre-existing laminitis caused by endotoxemia (overconsumption of grain, for example); and (3) mechanical inadequacy due to the stress of excessive weight on soft tissues of the leg.

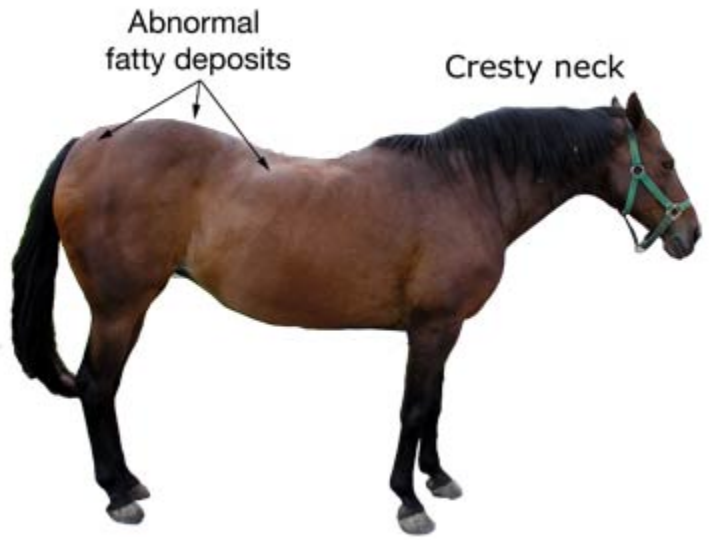
Regardless of the cause, laminitis is the result of changed circulation to the laminae, the interconnected layers of tissue that insure the integrity of the hoof. In obese horses, researchers believe that insulin insensitivity and vascular spasms may incite changes in the endothelial tissue of the laminae. On a physiological level, this concurs with the circulation problems observed in human patients with noninsulin-resistant diabetes mellitus. Despite well-founded theories, a definitive cause for obesity-associated laminitis remains elusive.

Diagnosis

At this time, diagnosis of equine metabolic syndrome is based on description and physical characteristics, results of glucose-tolerance testing, and elimination of similar conditions.

Description and physical characteristics. Affected horses are usually between the ages of eight and 18, though numerous patients have fallen outside this range. Horses and ponies of nearly all breeds have been diagnosed, though Morgans, Peruvian Pasos, Paso Finos, domesticated Spanish Mustangs, and warmbloods appear to be especially predisposed to the syndrome. As a group, ponies tend to become overweight more readily than horses and are often inclined to suffer from laminitis.

What's more telling than either age or breed of the patient is distribution of exterior body fat. Areas of unusual fat accumulation include the top of the neck (commonly called the crest), over the shoulders, and the rump (including deposits over the croup and just above the tail head). Significant fat sometimes settles in the sheaths of geldings, so much so that they may appear swollen.



Picture 16. External signs of insulin resistance may include: abnormal fatty deposits, especially along the crest, rump, and above the eyes.

Affected broodmares show unusual oestrous cycling, which makes them incredibly difficult to get pregnant. Anecdotal evidence by owners is also instrumental in diagnosing equine metabolic disease. Owners frequently describe their horses as easy keepers, finding it virtually impossible to reduce the weight of these horses by calorie restriction alone. Many report that high-calorie feeds such as grain are not being fed.

Results of glucose-intolerance testing. Veterinarians often perform an oral or intravenous glucose tolerance test on horses they suspect to be insulin resistant. Following the administration of glucose, insulin and glucose responses are measured and compared against the responses of normal horses. This test should be performed on a fasted animal so glucose from a recent meal does not shade the results of the assessment.

According to some equine veterinarians, the only truly effective method of diagnosing insulin resistance is the “euglycemic hyperinsulinemic clamp.” The procedure is complicated, time-consuming, and can be expensive. Because of these limitations, veterinarians typically diagnose on clinical signs alone.

Elimination of similar conditions. In the past, veterinarians often misdiagnosed equine metabolic syndrome, suggesting hypothyroidism or Cushing’s syndrome instead.

In humans, hypothyroidism occurs when the thyroid gland fails to produce sufficient thyroid hormone, leading to clinical manifestations of thyroid insufficiency such as low metabolic rate and tendency to gain weight. In horses, neither obesity nor laminitis develops in mature horses from which the thyroid gland has been removed. Thyroid stimulation tests, designed to gauge thyroid function, fail to identify hypothyroidism. Additionally, the thyroid glands from horses affected with equine metabolic syndrome appear normal. Hence, it is clear that the combination of obesity and laminitis are not always ramifications of inadequate thyroid hormone production.

Also mistaken for equine metabolic disease is Cushing’s syndrome. This endocrine disorder involves dysfunction of the pituitary pars intermedia. Using tests most commonly administered to verify Cushing’s syndrome (including the dexamethasone suppression test), veterinarians yielded negative results on these obese, laminitic horses. The pituitary glands of these horses also revealed no pathology, leading researchers to believe that Cushing’s syndrome was not to be blamed for the signs. Misdiagnosis of Cushing’s syndrome is understandable as a few of the clinical symptoms are shared by individuals with equine metabolic syndrome: abnormal distribution of fat, elevated circulating insulin, glucose intolerance, predisposition to laminitis, and infertility. Other clinical features of Cushing’s are not normally documented in horses suffering from metabolic syndrome, notably an excessively shaggy coat that fails to shed and increased drinking and urination.

Prevention and Treatment

Diet. Too many horses eat too many groceries; it’s that simple. The objective of all equine feeding programs should be straightforward: provide sufficient feed to satisfy

nutrient requirements for growth, maintenance, or work while maintaining optimal body condition. Optimal should not be confused with maximal or obese. Optimal body condition can be defined as a nutritional state in which the animal's ribs can be felt with gentle palpation but cannot be seen.

Horses become overweight because they consume too many calories in relation to the work asked of them. Those that perform mild to moderate work may need little more than good-quality grass hay or pasture and a complete vitamin and mineral supplement, particularly if they are good keepers (able to maintain weight easily). This ration, though simple, is considered low in starch, one important step in dodging equine metabolic syndrome.

Mature horses diagnosed with metabolic syndrome should not be given grain, grain mixes with molasses, or unlimited access to pasture. A balancer pellet (concentrated protein, minerals, and vitamins) can be given to provide essential nutrients without unwanted carbohydrates. If a horse requires additional energy, nonstarch alternatives such as corn oil or rice bran can be fed.

In young growing horses, feeding grain in large quantities should be discouraged. Horses that are overfed as youngsters are the very ones that are likely to be obese in midlife and become prone to laminitis. Termed "easy keepers," these horses harbor disproportionate quantities of fat within their abdomens, which in turn makes them more susceptible to metabolic syndrome.

Exercise. In addition to changes in diet, an exercise program should be implemented to slim down overweight horses or prevent them from becoming too heavy. Exercise can be provided in numerous ways: riding, driving, ponying, round pen work, hand walking, longeing, or long-lining. Not only does exercise ward off obesity, research has shown that it improves insulin sensitivity in horses and ponies. A combination of diet changes and increased exercise is the most effective way to increase insulin sensitivity. Exercise programs must be designed with the individual in mind. A realistic assessment of the horse must be made and an appropriate exercise regime chalked out, especially with horses that are old, unfit, or of questionable soundness. If a horse has suffered a mild

bout of laminitis, consultation with a veterinarian and farrier is warranted before any exercise is started.

Medication. No medication is suitable for treating metabolic syndrome. The two most commonly used medications for the management of Cushing's syndrome—pergolide and cyproheptadine—have proven ineffective for treatment of metabolic syndrome. Both medications have a tendency to limit pancreatic insulin secretion, which only adds to the problem.

Equine metabolic syndrome has emerged on the veterinary scene as a health threat to middle-aged, obese horses. Though deep understanding of the disease has not occurred, a diet and near-daily exercise program that emphasizes moderate body condition may be just enough to elude this dangerous disease.

[i] **References:**

Books and publications:

Frape, David, *Equine Nutrition and Feeding,* (Blackwell Science, 1998).

White, N.A. (1994) *Epidemiology of colic*. Equine Research Centre's Farm Management Proceedings. 48

Cohen, N.D., et al (1995). *Case control study of the association between various management factors and development of colic in horses*. J. Am. Vet. Med. Assoc. 206 (5) 667.

Henneke et al. (1983) Equine Vet. J. 15(4):372

McGowan CM, Menzies-Gow NJ, McDiarmid AM, Patterson-Kane.JC.,Veterinary Record (2003) 152, 109 – 112

McGowan CM, Posner RE, Christley RM.,Veterinary Record (2002) 150, 535 - 537

National Research Council (U.S.), *Nutrient Requirements of Horses,* the National Academies Press, 2007.

Ralston Sarah L., VMD, Ph.D., Extension Specialist in Animal Science, *Diagnosis of Nutritional Problems in Horses,* Rutgers Cooperative Extension, FS894

Reeves, M.J. and Salman, M (1993). *Risk factors for equine colic identified by means of a multicentered case-control study*. Proc. Am. Assoc. Eq. Pract. 39 93.

Vörös, Annamaria, (2008) *Diet related changes in the gastrointestinal microbiota of horses*. Dept. of Animal Nutrition and Management, SLU. Examensarbete / Sveriges lantbruksuniversitet, Institutionen för husdjurens utfodring och vård vol. 258.

Internet resources:
http://www.healingchance.com/Healthy_Horse.html
http://pets.solveyourproblem.com/horses/signs-healthy-horse.shtml
http://www.equestrianandhorse.com/care/veterinary/digestive-processes.html
http://www.thehorse.com/pdf/anatomy/anatomy10.pdf
http://www.baileyshorsefeeds.co.uk/feedingexplained/digestion.htm
http://www.baileyshorsefeeds.co.uk/about/bagofbaileys.htm
http://www.baileyshorsefeeds.co.uk/feedingexplained/rules.htm
http://www.baileyshorsefeeds.co.uk/whatproduct/supplements/outshine.htm
http://www.mccauleybros.com/getexpertinfo/conditionchart/
http://www.horseadvice.com/horse/messages/15453/15684.html
http://www.uky.edu/Ag/AnimalSciences/pubs/asc114.pdf
http://www.das.psu.edu/equine-science/news/the-anatomy-and-function-of-the-horse2019s
http://www.spillers-feeds.com/en-gb/united-kingdom/
http://evrp.lsu.edu/healthtips/EquineNutrition.htm
http://www.buckeyenutrition.com/equine/technical.html
http://www.horsetalk.co.nz/nutrition/water-022.shtml
http://horses.about.com/od/commonproblems/p/heaves.htm
http://www.laminitis.org/
http://www.levertonco.co.uk/acatalog/Developmental_Bone_Disorders.html
http://www.admani.com/AllianceEquine/index.htm
http://www.grasssickness.org.uk/main.htm
http://vetmedicine.about.com/library/weekly/aa120701a.htm
http://www.tufts.edu/vet/sports/ulceration.html

http://www.understanding-horse-nutrition.com/horse-feed-storage.html
http://www.ca.uky.edu/agc/pubs/asc/asc143/asc143.htm
http://www.thehorse.com/ViewArticle.aspx?ID=10222
http://www.equiworld.net/uk/horsecare/feeding/articles/o/traceminerals.htm
http://www.equinediets.com/Vitamins.aspx
http://www.equinediets.com/Diarrhoea.aspx
http://njaes.rutgers.edu/horsepastures/index.htm
http://www.equi-analytical.com/PuttingResultsToWork/RationEvaluations.htm
http://www.arundelhorsevets.co.uk/community/fact-sheets/factsheet.php?Title=Diarrhoea&Category=Equine
http://www.horsetalk.co.nz/health/electrolytes-147.shtml
http://www.merckvetmanual.com/mvm/index.jsp?cfile=htm/bc/182606.htm
http://www.ker.com/library/EQUINEWS//v9n2/art5.pdf
http://www.ker.com/library/Equinews/v11n120.pdf
http://www.admani.com/AllianceEquine/TechBulletins/FeedingFatsAndOilsToHorses.htm

[ii] **Pictures and tables:**

1. http://www.robinsons-uk.com/blog/wp-content/uploads/2008/12/good-conf.jpg
2. http://www.baileyshorsefeeds.co.uk/library/rev0/images/main/318.jpg
3. http://esc.rutgers.edu/publications/PDF_Files/fs894.pdf
4. http://www.mccauleybros.com/getexpertinfo/conditionchart/
5. http://www.hippolytshop.com/futterjournal/futterkonzepte/feature-verdauungdespferdes.htm
6. http://caliban.mpiz-koeln.mpg.de/~stueber/thome/band1/tafel_068_small.jpg
7. http://cncgroup.org/Images/canoil1.jpg
8. http://www.dkimages.com/discover/previews/962/65013052.JPG
9. http://rivendellfarm.net/images/feedstoragetn.jpg
10. http://1.bp.blogspot.com/_beLd7MjrO5o/STCVqdIpDmI/AAAAAAAAOLA/i-7LXWnP90Y/s1600-h/teeth+hooks+ridges.jpg
11. http://www.myhorse.com/assets/Health/Emergency/asset_upload_file713_2558_thumb.jpg
12. http://www.horseshoes.com/advice/laminitis/pollitt1/equinelaminitisarevisedpathophysiology.htm
13. http://www.equinesite.com/articles/modules.php?name=News&file=article&sid=1248
14. http://www.miniaturehorsetalk.com/index.php?showtopic=62230
15. http://www.yourhorse.co.uk/Your-Horse-News/Search-Results/General-news/June-08/June-5-Equine-Grass-Sickness2/
16. http://www.balancedequinenutrition.com/IRexample.jpg