

Nutritional Management of Sick and Hospitalized Horses

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Hepatic Disease

Hepatoencephalopathy

Hepatoencephalopathy occurs with decreased functional hepatic mass and reduced ability of the liver to clear gut-derived toxins or byproducts and microbially produced metabolites from the portal blood before they reach the general circulation. Some of these metabolites act as false neurotransmitters (aromatic amino acids) and others are directly toxic to the brain (ammonia, mercaptans, fatty acids, phenols). Hepatoencephalopathy may occur with Theiler's disease, pyrrolizidine alkaloid toxicity, leukoencephalomalacia, or any severe hepatic insult.

Diagnosis of hepatoencephalopathy is made with clinicopathologic findings of hepatic disease and consistent clinical signs of altered behavior or mentation, head pressing, seizures, and neurologic impairment. Affected animals usually have elevated bile acids and hyperammonemia.

Treatment is largely supportive (Barton, 2010). Affected animals may have altered glucose metabolism or decreased feed intake and benefit from intravenous glucose supplementation. Neomycin (10-30 mg/kg, PO, q6h) and metronidazole (10-15 mg/kg, PO, q6h) may be used to decrease the population of ammonia-producing microorganisms in the gut. Lactulose (0.2-0.5 mg/kg, PO, q8h) promotes conversion of ammonia to unabsorbable ammonium, which also reduces blood ammonia. The ability of vinegar (2 cups, PO, q12h) to acidify the gut is debatable but has been suggested as an inexpensive method to reduce ammonia absorption.

Nutritional management of liver disease is aimed at reducing dietary protein and the amount of ammonia and other gut-derived toxins that affect the nervous system. Dietary protein should be restricted as much as possible if the horse has signs of hepatoencephalopathy. Mature adult horses in light work require only about 8% protein in their diet. This amount of protein can easily be met with good-quality grass hay or pasture. Feeding legumes (alfalfa and clover), which are high in protein, should be avoided. Lower dietary protein will result in less intestinal ammonia production. Forage fed should be grass hay or pasture; some clinicians recommend oat hay. Horses with photosensitization can still graze or be turned out at night to avoid sunlight. Dividing up the ration into several small meals will prevent large amounts of ammonia from leaving the gut and reduce the load of ammonia that the liver must detoxify. Feeding protein with an increased ratio of branched chain to aromatic amino acids should improve clinical signs of hepatoencephalopathy.

Branched chain amino acids can be used for energy and protein production. Aromatic amino acids (tyrosine, tryptophan, phenylalanine) are more likely to act as false neurotransmitters and produce neurologic signs. There are commercially available branched chain amino acid supplement pastes for horses that can be used to increase their proportion in the diet. Feeding a concentrate made of a 2:1 ratio of beet pulp to cracked corn with molasses (5.5 pounds [2.5 kg] per 220 pounds [100 kg] per day) provides an improved branched chain to aromatic amino acid ratio. If needed, sorghum, bran, or milo can be substituted for beet pulp. Folic acid, B vitamins, and especially fat-soluble vitamins (A, D, E, and K) should be supplemented to meet requirements. Fat-soluble vitamins should not be supplemented in excess because they can accumulate and have adverse effects. Fat-soluble vitamins should be supplemented as some of these horses may have impaired

bile production and decreased clearance of bile acids from circulation. Vitamin K is important for blood clotting and will help reduce bleeding risks. It is more important to keep horses eating to maintain body condition, rather than make dietary adjustments that cause them to stop eating. If the horse will only eat legumes such as alfalfa, then it can be fed in moderation and divided into several small meals. Affected horses should be fed several small meals throughout the day rather than meal-fed to maintain lower gut and blood ammonia concentrations.

Hepatic Lipidosis

Hepatic lipidosis is a serious and life-threatening condition in any sick or inappetent Miniature Horse, donkey, or pony. Serum triglyceride (TG) concentration should be included with routine laboratory work when examining these animals to determine if they are hyperlipemic (TG > 500 mg/dl) or hyperlipidemic (TG 100-499 mg/dl) and assess their risk for hyperlipemia. Serum triglyceride concentration greater than 1,200 mg/dl has been associated with a poor prognosis in Miniature Horses (Mogg and Palmer, 1995). Serum turbidity is not a useful indicator of hyperlipemia in equines, as hyperlipidemic animals often have normal-appearing serum (Dunkel and McKenzie, 2003). The most important goal of therapy is to get the animal to begin eating and/or supplement calories. If total parenteral nutrition is administered, the lipid portion should not be included. Niacin inhibits lipolysis in cattle and may be added to the partial parenteral nutrition solution by itself or as vitamin-B complex. Whatever primary condition that predisposed the animal to hyperlipemia should also be aggressively treated.

Kidney Disease

Most horses with acute renal failure recover with appropriate treatment. For these horses, it is important to keep them eating and drinking normally; specific dietary management is less essential. Dietary management of chronic renal failure is aimed at reducing calcium intake and avoiding excessive dietary protein (Schott, 2010). Mature adult horses in light work require only about 8% protein in their diet. This amount of protein can easily be met with good-quality grass hay or pasture. The low blood protein in horses with chronic kidney disease is due to losses into the urine secondary to renal damage. Unfortunately, undue protein supplementation in these cases provides no real benefit to the horse. Excessive dietary protein will make the horse urinate more and may overwork already badly damaged kidneys. Legumes (alfalfa and clover) are high in both protein and calcium. Therefore, legumes should be avoided in most cases. The only effective way to reduce blood calcium levels is to reduce dietary calcium and the amount of calcium that the kidneys have to excrete into urine. Salt supplementation (1-2 ounces, 1-2 times per day) may encourage horses to drink and urinate more. However, studies in several other species have shown that salt supplementation can worsen kidney disease. Regardless, horses with renal disease should have free-choice access to trace-mineralized salt. Some clinicians have recommended supplementing omega-3 fatty acids to horses with kidney disease. Omega-3 fatty acids have good anti-inflammatory activity and may reduce renal inflammation without the possible adverse effects of nonsteroidal anti-inflammatory drugs. Feeding horses with chronic kidney disease to maintain body condition and quality of life is vital. It is more important to keep horses eating, rather than make dietary adjustments that cause them to stop eating. If the horse will only eat legumes such as alfalfa, then it can be fed in moderation.

Respiratory Disease

Stabled horses are constantly exposed to large amounts of airborne irritants. This is especially

true when horses are kept in stalls, fed hay, and bedded on straw. Horses with infectious respiratory tract infections also likely benefit from reduced inhaled dust levels because they have damaged respiratory epithelium and impaired mucociliary clearance.

Equine respiratory tract infections may be exacerbated and prolonged by concomitant airborne dust exposure (Raymond et al., 1994; Art et al., 2002). Horses with infectious respiratory tract infections that are kept in dusty environments have prolonged recovery due to increased coughing, hypersecretion of mucus, and bronchoconstriction. Some authors speculate that infectious respiratory tract infection coupled with stabling in a dusty environment may cause horses to become sensitized to inhaled environmental aeroallergens and contribute to the development of heaves later in life. It is important to minimize dust exposure for horses recovering from respiratory tract infections.

Heaves (recurrent airway obstruction) is a reactive airway disease of horses characterized by bronchoconstriction, excessive mucus production, and pathologic changes of the bronchioles (Lavoie, 2003). Affected horses are hypersensitive to inhaled environmental dust. Environmental change to reduce inhaled dust exposure is essential for the successful treatment of heaves.

Respirable Dust Deposition in the Airways

The respirable dust concentration (RDC) is defined as the small particles (< 5 μ m in diameter) that are able to enter the peripheral, smaller diameter airways and potentially cause pulmonary inflammation (Clements and Pirie, 2007a; 2007b). The breathing zone is defined as the region surrounding the horse's nostrils (Woods et al., 1993). Dust exposure in the horse's breathing zone more accurately reflects its respiratory challenge because horses spend much of their time with their muzzles in close contact with hay and bedding (Art et al., 2002). The primary sources of airborne dust that horses are exposed to are feed and bedding (Raymond et al., 1994; Art et al., 2002). The highest exposure of airborne irritants comes from mold-contaminated forages and bedding sources.

Even in well-ventilated stables, airborne dust concentrations (ADC) in the horse's breathing zone are still high when the horse eats and nuzzles its forage (Blackman et al., 1998). Stable ventilation alone does not remove particles from the horse's breathing zone (Art et al., 2002). The amount of respirable dust in the horse's breathing zone can be much higher than the overall stall or stable environment (Woods et al., 1993; Art et al., 2002). The only effective way to reduce inhaled particles in the horse's breathing zone is to feed a reduced-dust forage (Woods et al., 1993; Blackman et al., 1998).

Good-quality hay that passes visual inspection still contains large numbers of particles that can reach the terminal airways and irritate the respiratory tract (Clarke and Madelin, 1987; Warr and Petch, 1992; Raymond et al., 1994; Art et al., 2002; James and Moore-Colyer, 2010). Hay is the primary source of inhaled respiratory irritants in the horse's environment, especially if it was baled in less than favorable conditions (Moore-Colyer, 1996). Clements and Pirie (2007a) reported that feed had a greater influence on mean and maximum RDC in the horse's breathing zone than stall bedding. Inhaled particles found in hay that can act as respiratory irritants include mold spores, bacteria, endotoxin, and plant and insect fragments (Clarke and Madelin, 1987; Moore-Colyer, 1996; Art et al., 2002).

If hay is baled with a high moisture content, then it produces heat and promotes growth of thermotolerant fungi (*Aspergillus fumigatus*) and bacteria such as the actinomycetes (*Saccharopolyspora rectivirgula* and *Thermoactinomyces vulgaris*) (Clarke and Madelin, 1987; Art et al., 2002). Ideally, hay is baled at 15-20% moisture because it will heat very little and contain small amounts of dust and mold spores (Clarke and Madelin, 1987). The heaviest growth of thermotolerant fungi

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and actinomycetes occurs when hay is baled at 35-50% moisture. High-moisture hay can contain large amounts of fungal and actinomycete spores.

Effects of Soaking Hay

Soaking hay in water has been the traditional method to reduce RDC. However, soaking hay is difficult and not always a practical management recommendation for horse owners. The nutritional impact of soaking hay can be significant and is often overlooked, especially if the hay is of marginal quality.

Clements and Pirie (2007b) found that only immersing 5 kg of hay in a haynet in a bucket of water and feeding immediately afterwards significantly reduced both mean breathing zone and RDC compared to dry hay. There was no significant difference in mean breathing zone RDC between hay that was only immersed (dunked in a bucket of water until completely submerged) or soaked for 16 hours. Blackman and Moore-Colyer (1998) reported no significant difference in the decrease of respiratory dust particles when 2.5 kg of hay in a haynet was soaked for either 10 or 30 minutes. Both treatments reduced respiratory dust by at least 93%, compared to unsoaked hay.

Soaking hay affects its nutritional value in a time-dependent manner (Warr and Petch, 1992; Moore-Colyer, 1996; Blackman et al., 1998). Even soaking hay for as short as 30 minutes or less can reduce sodium, potassium, phosphorus, magnesium, and copper concentrations (Moore-Colyer, 1996; Blackman and Moore-Colyer, 1998). Prolonged soaking reduces the nutritional value of hay and soaking hay for longer than 30 minutes has a considerable negative impact on nutrient composition (Warr and Petch, 1992; Moore-Colyer, 1996; Blackman et al., 1998). Two studies (Moore-Colyer, 1996; Blackman and Moore-Colyer, 1998) reported that there was little to gain regarding reduced respiratory challenge and much nutritional value to lose if hay was soaked for longer than 30 minutes. Soaking hay for 30 minutes effectively minimized its respirable challenge and maintained maximal nutritional value (Moore-Colyer, 1996).

Effects of Steam-Treating Hay

Steaming hay reduces airborne dust and preserves the nutritional content of hay. Both steam-treating and soaking hay have been shown to reduce respiratory particles by at least 93% (Blackman and Moore-Colyer, 1998). There was no significant difference in respirable particles between hay that was soaked for 10 or 30 minutes and hay that was steamed for 80 minutes. When compared with dry hay, steam-treating resulted in no loss of nutrients. Soaking hay for 10 or 30 minutes significantly reduced phosphorus, potassium, magnesium, sodium, and copper. Using a commercially available hay steamer (Haygain hay steamer, Jiffy Steamer Co, Union City, TN, USA), James and Moore-Colyer (2010) reduced fungal elements by 100% and bacterial growth by 98.84%, compared to dry hay.

Feeding Forage Alternatives

Haylage

Haylage is fermented forage that has higher moisture content than hay and is lower in dust and mold spores, if properly processed. Clements and Pirie (2007b) investigated the effects on RDC when feeding hay or haylage and bedding horses on straw or wood shavings. The results of this study indicated that feed has a greater impact on RDC than bedding and haylage is preferable to hay to improve equine respiratory health. Feeding haylage instead of hay reduced mean RDC by 60-70%

and maximum RDC by 76-93%. Changing bedding from straw to wood shavings also reduced RDC, especially maximum RDC, but the results showed that RDC in the horse's breathing zone is more influenced by close contact with feed rather than bedding.

Hay Cubes

Feeding hay cubes instead of hay significantly lowers a horse's respirable dust exposure. Raymond et al. (1994) investigated the respirable dust levels that horses were exposed to when fed alfalfa cubes and good- or poor-quality hay. Feeding hay cubes significantly reduced the amount of dust in the horses' breathing zone as compared to when the horses were fed hay. Compared to alfalfa cubes, good- and poor-quality hay contained increasingly more potential aeroallergens, such as plant material, fungal spores, pollen grains, dust mites, and their feces. In contrast to hay, alfalfa cubes contained negligible fungal spores and no pollen grains.

Hay Pellets

Woods et al. (1993) reduced dust in the breathing zone of ponies to only 3% of previous levels when feed was changed from dusty hay to pellets and bedding was changed from straw to wood shavings. Airborne dust concentration in the stall was significantly affected by environmental change as well; ADC was approximately doubled when ponies were fed dusty hay and bedded on straw, compared to feeding pellets and bedded on wood shavings. Key aeroallergens such as *S. rectivirgula*, *A. fumigatus*, and dust mite allergens, were significantly higher when hay and straw were in the ponies' environment.

Exercise-Induced Pulmonary Hemorrhage

Erythrocyte numbers in bronchoalveolar fluid were reduced when horses were supplemented with docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA) for 83 and 145 days and exercised on a high-speed treadmill (Erickson et al., 2007). There was no effect when horses were supplemented with only DHA. Fish oils are an excellent source of omega-3 fatty acids such as DHA and EPA. Supplementation of DHA and EPA may improve erythrocyte membrane fluidity and their movement through capillaries, which could reduce the likelihood for pulmonary capillary bleeding. Omega-3 fatty acids have anti-inflammatory effects, which may also reduce airway inflammation and consequently the predisposition for capillary rupture.

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