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Exertional Rhabdomyolysis in Horses: A Review

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ABSTRACT
Exertional rhabdomyolysis describes a syndrome frequently observed when feeding and exercise are out of balance, particularly when a horse on a high-energy diet abruptly cuts back on exercise. Depending on the cause of the muscle damage, exertional rhabdomyolysis can be classified as sporadic or chronic. The accumulation of muscle glycogen during the rest time and the subsequent production of excessive lactic acid when the horse resumes activity are cause of symptoms including stiffness, cramping and pain observed. Exertional rhabdomyolysis may develop as a result of potassium deficit, thiamine shortage, hypocalcemia, enzyme abnormalities and impaired metabolism. In order to diagnose exertional rhabdomyolysis, blood tests is used to assess moderate to high levels in muscle enzyme levels, such as creatine kinase and aspartate aminotransferase. First line of treatment for an exertional rhabdomyolysis episode is stall rest then maintenance of hydration and electrolyte balance, pain management, sedation and gradual return to exercise. Prevention of exertional rhabdomyolysis entails ensuring horses receive regular turn-out, stress reduction, the bulk of the diet consisting of forage and less grain, provision of plenty fresh water and supplementation of mineral and antioxidant.
KEY WORDS: *Electrolyte; Exertional rhabdomyolysis; Glycogen; Hydration; Lactic acid*

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I. INTRODUCTION

Exertional Rhabdomyolysis (ER), commonly known as an exercise-induced condition in horses is characterized by extreme breakdown of muscle tissue (Valberg, 2022). The syndrome, exertional rhabdomyolysis (ER) is frequently observed when feeding and exercise are out of balance, particularly when a horse on a high-energy diet abruptly cuts back on exercise (Knoepfli, 2002). It is most frequently seen in training horses, the condition develops after a day of rest on full rations and intense exertion (Singh, 2020). ER results in exercise-related muscular soreness and cramps (Rice, 2022).

Exertional rhabdomyolysis can be classified as sporadic or chronic. Sporadic ER include occasional episodes or a single tying up episode while chronic ER is defined as recurrent bouts of tying up and elevated muscle enzyme activity (McNeil, 2024).

Suggested reasons for ER include genetic factors, hormonal and electrolyte imbalances, heavy musculature, stress, vitamin and mineral deficiencies, age, and female sex (Kosa et al., 2021). Accumulated glycogen within the muscle cells of an inactive horse may produce adenosine triphosphate anaerobically due to lack of oxygen causing lactic acid build up, waste products and heat (Arighi et al., 1984). This leads to changes in the cell by preventing the cell's enzymes from functioning and the myofilaments from contracting well. Myoglobin and muscle enzymes leak from the damaged muscles into the bloodstream. The renal tubules which process and filter urine may precipitate and form solid deposits as a result of elevated blood myoglobin levels causing kidney dysfunction and renal failure.

Clinical manifestation include reluctance to walk, stiff hindquarters, pawing, tachycardia, tachypnea, slightly elevated temperature, sweating and reddish-brown urine (Valentine et al., 1999).

Diagnosis include history, clinical signs, marked increased levels of three muscle enzymes, creatine kinase (CK), aspartate aminotransferase (AST) and lactate dehydrogenase (LDH) (Quist et al., 2011, El-Ashker, 2012), and biopsy.

Management and treatment of exertional rhabdomyolysis episode involve stall rest, maintenance of hydration and electrolyte balance by giving balanced polyionic electrolyte solutions intravenously (Singh, 2020), pain management by administering non-steroidal anti-inflammatory drugs such flunixine meglumine, phenylbutazone or ketoprofen (Ulman, 2000), sedation with tranquilizers like acepromazine, xylazine, or detomidine and gradual return to exercise.

Prevention of exertional rhabdomyolysis include ensuring horse receives regular exercise, stress due to overexertion, separation from stablemates or traveling reduced. The bulk of the diet should consist of forage with minimum grain, plenty of fresh water should be provided and mineral and antioxidant supplemented (Young, 2020; Lindinger, 2022).

This paper aims to discuss the various forms, common causes, pathophysiology, clinical presentation, diagnosis, available treatments and management options, as well as the prevention and control of equine rhabdomyolysis.

Synonym

Tying-up, Monday morning disease, azoturia, and Set-Fast are other names for exertional rhabdomyolysis (Valberg, 2016). The term "Monday Morning Disease" was once used to describe ER. This term dates back to the early 1900s, when draft horses, which were frequently utilized for heavy work during the week, frequently suffered from muscle soreness and stiffness when they returned to work following a rest period.

Types of exertional rhabdomyolysis

Equine tying-up episodes can be categorized depending on the cause of the muscle damage (Biles, 2015; Liburt and William, 2017):

1. Sporadic exertional rhabdomyolysis
2. Chronic exertional rhabdomyolysis

Sporadic (acute) exertional rhabdomyolysis

Sporadic episodes include occasional episodes or a single tying up episode. Horses that occasionally have a generalized tying-up episode are affected by this. Excessive physical activity above a horse's regular level of training or fitness, or forcing a horse to exercise beyond its normal capacity, may result in sporadic ER.

Horses with no underlying tendency to muscular problems and otherwise in good health are frequently observed in this condition. Such horses do not have any underlying or intrinsic condition that causes the muscle tissue to break down abnormally. Rather, extrinsic causes like strenuous exercise or environmental stressors that trigger muscle cell injury are the source of tying up episode. Periods of normal muscle function may occur in between these episodes, which may not always follow a pattern (Wilberger et al., 2015).

Examples of external factors that can trigger sporadic ER include**:** (Valberg 2022; Virginia Equine Imaging 2024**)**

Overtraining and muscle strain*:* This is particularly common when there is a sudden rise in training intensity after a prolonged period of rest. Muscle stiffness, changes in gait, and elevated muscle enzyme activity are some of the symptoms. Horses who compete or exercise on hot, muggy days lose fluid and electrolytes through sweating, which depletes their muscle energy stores.

Nutritional deficiencies: Some horses may experience ER as a result of electrolyte or antioxidant (vitamin E and selenium) deficiencies. When horses exercise in hot conditions for extended periods of time, they may experience electrolyte imbalances. Additionally, dietary imbalances—specifically, deficiencies in calcium, potassium, and sodium—have been connected to ER episodes.

Exercising while ill*:* Horses who exercise vigorously while battling herpes, flu, or other diseases may be more susceptible to sporadic ER episodes.

Chronic exertional rhabdomyolysis

Chronic ER is defined as recurrent bouts of tying up and elevated muscle enzyme activity. Horses may be more susceptible to chronic forms of ER if they have certain intrinsic genetic abnormalities in muscle function (Velberg, 2016). Using genetic testing or muscle biopsies, four types of persistent tying-up have been identified:

a. Type 1 Polysaccharide storage myopathy (PSSM)
b. Type 2 Polysaccharide storage myopathy (PSSM)
c. Malignant hyperthermia
d. Recurrent exertional rhabdomyolysis (RER)

Type 1 Polysaccharide storage myopathy (PSSM)

Horses with PSSM are unable to properly use sugar in their muscles, which causes the muscles to starve and sustain significant damage while exercising (Ulman, 2000), The muscle cells of affected horses contain up to 1.5 times as much glycogen as those of healthy horses. A genetic mutation in the glycogen synthase-1 (GYS1) gene causes an enzyme to excessively convert sugar into its storage form, glycogen, in horses with Type I PSSM. The horse has difficulty when converting to burning glycogen for energy during exercise because of the constant synthesis of glycogen in its muscles (Valberg, 2016) This prevents sugar from being used to meet the energy needs of the muscle (Wilberger, 2015; Norton, 2016). The mutation that causes Type 1 PSSM is a dominant trait that can be passed to a foal from an affected mare or stallion. This is commonly found in Quarter horses, draft horses, and some warmblood breeds. (Williams et al., 2018). Their muscles are unable to generate as much energy, hence the affected horses may experience stiffness, cramping, and pain after light exercise. Increased insulin sensitivity in certain horses with this illness adds to the muscles' accumulation of glycogen and increases the risk of ER after exercise.

Type II Polysaccharide storage myopathy

Another muscle condition that causes abnormal glycogen storage in horses is Type 2 Polysaccharide Storage Myopathy (PSSM 2), which may be a factor in chronic ER. Horses do not have the genetic mutation, but they nevertheless have abnormal muscle sugar storage that prevents them from using it as energy (Liburt and William, 2017). In PSSM1, glycogen might be normal or increased and found in unusual locations. Warmbloods' varying reactions to diets intended to reduce glycogen suggested that PSSM2 might possibly be a combination of several distinct illnesses (Williams et al., 2018). Myofibrillar myopathy has been identified as one of those conditions (Young, 2020). Instead of ER, warmbloods with PSSM2 may exhibit topline atrophy, back pain, and aberrant gait.

Malignant hyperthermia

An autosomal dominant mutation in the skeletal muscle ryanodine receptor gene (RYR1) results in malignant hyperthermia. Both anesthesia-related and non-anesthesia-related causes of rhabdomyolysis in Quarter horses are caused by the mutation (Valberg, 2016). Malignant hyperthermia is a potentially lethal stress-induced condition that primarily affects Quarter horses or related breeds and is characterized by muscle rigidity, elevated body temperature, and other complications.

Recurrent exertional rhabdomyolysis (RER)

Horses in this case have recurrent bouts of ERM, the first of which happens when they are young. Frequent tying-up periods may result in permanent muscle injury (Velberg, 2005). RER may be brought on by an irregular control of calcium levels within the muscle cell. The contraction and relaxation of muscles are significantly influenced by calcium. The muscle's energy reserves may be depleted, leading to over-contraction and delayed reuptake as a result of an excessive release of calcium ions (Ca^{2+}). This dysregulation may lead to prolonged or uncontrollable contractions of the muscles, which could cause injury to the muscle tissue and the typical tying-up symptoms seen in ER. It is thought that stress makes the problems with aberrant calcium regulation worse, interfering with muscle cells' regular functions and resulting in bouts of muscle injury (Valberg, 2020). Muscle spasms and soreness during and after activity are frequent symptoms of the illness.

Among the suggested reasons for tying up are: (Singh, 2020; Carson and Rickettes, 2022).

1. When the horse is exposed to work following a period of rest and the concentrate ration is not lowered.
2. A shift in the horse's metabolism of carbohydrates or an excess of non-structural carbohydrates.
3. Hormonal imbalance, including thyroid hormones in horses with hypothyroidism and reproductive hormones in nervous fillies and mares.
4. Weather that is windy, wet, or cold.
5. Electrolyte abnormalities which are frequently observed in horses after exercise.
6. Increase in lactate
7. Ca, Mg, P, and K deficiencies
8. Muscle hypoxia
9. Insufficiencies in vitamin E or selenium
10. Dehydration
11. Imbalance in the calcium:phosphorus ratio.
12. RER is most likely inherited as an autosomal dominant trait, according to genetic studies.

II. EPIDEMIOLOGY

Numerous athletic horse breeds are known to suffer from exercise-induced rhabdomyolysis syndrome (Isgren et al., 2010), A survey conducted in the United Kingdom revealed that this disease is more common in females than in males, primarily in age groups ranging from 2 to 6 years (Harris, 1991). Temperament may have a role in increase expression of RER in Thoroughbred females and younger horses. The racetrack environment may be stressful for young horses, and trainers are more likely to describe fillies as having an anxious temperament (MacLeay et al., 1999). While at rest, draft horses with mild injuries are frequently kept on a full work ration and suffer when put to work (Deben Valley Equine, 2018).

III. PATHOPHYSIOLOGY

The accumulation of muscle glycogen during the rest time and the subsequent production of excessive lactic acid when the horse resumes activity are hypothesized to be related to carbohydrate overloading (Singh, 2020). ER may develop as a result of potassium deficit, thiamine shortage, hypocalcemia, enzyme abnormalities, or impaired metabolism (Equimed, 2014; Valberg, 2016). Potassium is released to the extracellular fluid when muscle cells contract normally. This is the main way to increase blood flow to the working muscles (Waldro-Mease et al., 1982). If the potassium level in the muscles is low, there will be a decrease in perfusion. Reduced

oxygenation and the requirement for anaerobic glycogen utilization are the outcomes of reduced perfusion. Additionally, there is a mechanism for the buildup of lactic acid in the muscle due to a decrease in waste clearance. Thiamine (vitamin B) aids in the metabolism of waste products from muscle activity; if it is lacking, waste products may accumulate producing lactic acid (Valberg, 2016). The hydrophilic nature of lactic acid causes muscle degeneration, myoglobin release, and muscular swelling as lactic acid builds up (Kenney, 2022). Elevated blood myoglobin level causes kidney dysfunction and renal failure due to its precipitation and formation of solid deposits on renal tubules.

IV. CLINICAL SIGNS

The severity of the disease and the speed of onset may influence the signs of tying up. The horse becomes reluctant to walk and its gait gradually stiffens in mild cases (Valberg, 2016). Although the triceps muscles above the elbow of the fore limbs may also seem stiff and painful, the main affected muscles are the large, heavy muscles of the hind limbs (Horse Sport, 2019). There is profuse sweating, the horse's heart and respiratory rate may also rise (KER, 2024). The large muscles of the hind legs may even seem to bulge in extreme tying-up cases. The horse's urine turns dark or reddish-brown if there is sufficient muscle injury because the damaged muscle fibers release myoglobin, which is subsequently excreted in the urine (Valberg, 2016). Horses with severe kidney failure may collapse and die (Ulman, 2000; El-Ashker, 2012).

V. DIAGNOSIS

Mild cases of ER can manifest as a nonspecific lameness or impaired performance that starts in the back or hind end (Quist et al., 2011). In order to diagnose ER, blood tests can assess particular enzymes found in a horse's tissues that serve as markers of muscle injury (Piercy et al., 2004). Blood test performed to check for moderate to high levels in muscle enzyme levels include:

Creatine Kinase (CK)

The enzyme creatine kinase contributes to the horse's muscle cells' ability to produce energy. Skeletal, smooth, and cardiac muscles contain large levels of CK, which helps convert creatine phosphate and ADP (adenosine diphosphate) into creatine and ATP (adenosine triphosphate) (Volek et al., 2008). ATP supplies the energy required for cellular functions such as muscular contractions. Muscle cells that have been damaged by intense exercise may have more permeable cell membranes. As a result, CK is released into the bloodstream, raising plasma CK levels, which peak four to six hours after exercise. When a blood sample is obtained during an ER episode, CK is a useful measure of the degree of muscle damage sustained during the exercise.

Aspartate aminotransferase (*AST)*

Aspartate aminotransferase is an important enzyme in the metabolism of amino acids, which is necessary for many cellular functions. The horse's skeletal, liver and cardiac muscles are among the tissues that contain AST (Valberg, 2008). When muscle cells are strained or injured, as occurs after prolonged or vigorous activity, AST is released into the bloodstream, much like creatine kinase. An ER diagnosis may be supported by a horse's elevated AST values. El-Ashker (2012) states that after gradual increase in AST, it can remain elevated for seven to ten days. Previous ER episodes may be indicated by a persistent rise in AST (Carson and Ricketts, 2022).

Lactate dehydrogenase (LDH)

Another enzyme that is present in many bodily tissues, such as the liver and muscles, is lactate dehydrogenase, or LDH. Anaerobic energy metabolism depends on LDH, especially when lactate is converted to pyruvate. (Valberg, 2006), Since LDH is released into the blood when muscles are injured, elevated levels of LDH in blood tests are indicative of muscle damage or injury.

Urinalysis

One useful diagnostic method for detecting ER is urinalysis. In order to determine kidney function, this test analyzes the urine for a number of characteristics, including color (Sanderson, 2022). Numerous cellular components are released into the bloodstream as a result of ER-induced muscle injury; some of them are filtered by the kidneys and eliminated in the urine.

In horses, the term "myoglobinuria" describes the presence of the muscle protein myoglobin in the urine. Myoglobin is released into the bloodstream by damaged muscle cells (Knoepfli, 2020). The dark reddish-brown color of urine is caused by the presence of myoglobin. The kidneys' renal tubules which process and filter urine may precipitate and form solid deposits as a result of elevated blood myoglobin levels. Significant myoglobin excretion in the urine by horses with severe ER could result in tubular degeneration, kidney dysfunction and, in extreme situations, acute renal failure. In moderate to severe rhabdomyolysis, myoglobinuria could be detected by urine stick tests as Hb-positive even when there is no hemolysis or red blood cells in the urine (Holmgren and Valberg, 1993).

Muscle Biopsy

Muscle biopsy is done by taking a tiny sample of the affected horse's muscle tissue for examination under a microscope. Under local anesthetic, the gluteal or hamstring muscles are usually used for this procedure (Valberg,

2016). The muscle sample is examined under a microscope to assess the fiber structure, look for indications of inflammation, degeneration, or necrosis, and find any unusual glycogen buildup. A myofibrillar protein called desmin, which is a defining feature of myofibrillar myopathy, may also be detected in samples (Nakano et al., 1996). It is crucial to use muscle biopsies to differentiate between chronic ER, sporadic ER and other myositis disorders (Valberg, 2008). More mature muscle fibers with centrally displaced nuclei, higher subsarcolemmal staining for glycogen, and varying degrees of muscle necrosis are frequently observed in skeletal muscle biopsies from Thoroughbred and Standardbred horses exhibiting active RER (Valberg et al., 1993).

Genetic Testing

Horses that have repeated ER episodes might be tested for PSSM1 genetically. This disorder is brought on by a mutation in the glycogen synthase-1 gene, which causes abnormal muscle cell glycogen storage (Young, 2020). To do genetic testing, a sample of entire blood or hair with roots still in place is taken (Rice, 2022). The glycogen synthase-1 gene is analyzed to determine whether a mutation is present or absent (Liburt and Williams, 2022).

Differential diagnosis

The symptoms of an ER episode in horses can resemble those of the following conditions: (Singh, 2020; Rice, 2022; Valberg , 2022).

Colic: Horses with ER may exhibit symptoms like colic, such as restlessness, discomfort, and distress. Symptoms like pawing, sweating, and elevated heart rate can mimic the abdominal discomfort that is frequently observed in cases of colic. The big muscles in the hind limbs are stiff or extremely hard, and the affected horse will paw the ground or want to lie down. These characteristics allow ER to be distinguished from colic, even though the affected horse may exhibit signs of colic.

Laminitis*:* Because of the stiff and painful muscles, horses with ER may show signs of lameness or a reluctance to move. Laminitis, which similarly manifests as lameness and altered gait, may be mistaken for these symptoms.

Lameness: Horses with ER exhibit symptoms of lameness which include soreness, stiffness, discomfort, and a reluctance to carry weight.

***Hyperhidrosis* (excessive sweating)**: In mild cases of ER, horses may exhibit excessive sweating after exercise. If other symptoms are not immediately noticeable, this could be mistaken for a typical reaction to physical activity.

***Acute neurological disease*:** Distress and a reluctance to move are also symptoms of severe neurological disease with acute onset resembling ER.

VI. TREATMENT AND MANAGEMENT

For affected horses, a short walk could exacerbate muscular injury. The best way to reduce the long-term effects of an ER episode is to trailer the horse back to its stall. Stall rest for 12 to 48 hours until the horse is able to move freely is the first line of treatment for an ER episode. Different treatments may be used, such as:

Pain Management Non-steroidal anti-inflammatory drugs such flunixine meglumine (1.1 mg/kg), phenylbutazone (2.2–4.4 mg/kg), or ketoprofen (2.2 mg/kg) (Ulman, 2000), but they should be used carefully in dehydrated animals. Dantrolene, a drug mostly used to treat diseases involving muscle rigidity or spasticity, may be useful for persistent ER situations. It functions by delaying the release of calcium from the storage sites of muscle cells and aid relax muscles thereby preventing tying-up episodes (Valberg, 2022). The recommended dose for dantrolene is 4 mg/kg body weight.

Maintenance of Hydration and Electrolyte Balance*:* It may be necessary to give horses with mild dehydration free-choice electrolytes and water or to administer fluids via a nasogastric tube (Rawson, 2017). Myoglobulin and other byproducts of muscle breakdown should be flushed from the kidneys by maintaining proper hydration. It is necessary to rectify electrolyte imbalances, which are common in rhabdomyolysis and include potassium, calcium, and phosphate. Depending on the particular imbalances, either supplements or drugs may be needed. Administering balanced polyionic electrolyte solutions intravenously is necessary for horses with moderate to severe dehydration (Singh, 2020). Severe rhabdomyolysis may result in hyperkalemia, which calls for the administration of isotonic sodium chloride. It is advised to supplement with 100–200 ml of 24% calcium borogluconate intravenously if hypocalcemia is detected (Turner, 1992).

Muscle Damage Regulation: Sedation and analgesia can be obtained with tranquilizers like acepromazine (0.04–0.07 mg/kg), xylazine (0.2–0.5 mg/kg), or detomidine (0.02–0.04 mcg/kg) in combination with butorphanol (0.01–0.04 mg/kg) (Valberg, 2006). When horses are in the acute stage and lying down, methyl prednisolone succinate (2–4 mg/kg, IV) can be used to promote blood flow and muscular activity while preventing more muscle injury. The effects of muscle relaxants, like methocarbamol (5–22 mg/kg, IV, slowly), appear to vary, probably based on the dosage. An anticonvulsant drug called phenytoin is used to treat epilepsy and seizures in people. It aids in controlling seizure symptoms by regulating electrical activity in the brain. Phenytoin can alter the function of sodium and calcium channels in muscle and nerve tissues, it has been investigated as a possible treatment for ER in horses (Valberg and Dyson, 2011). Electrical signal transmission and the control of cellular processes, including muscle contraction, depend on these channels.

VII. PREVENTION AND CONTROL OF EXERTIONAL RHABDOMYOLYSIS

Exercise Management

Ensuring the horse receives a lot of turn-out and, if the horse has had a day off, giving them calm exercise can help prevent ER (Gowland, 2019). Avoid pushing the horse past its conditioning level by exercising too quickly or too hard, particularly during extremely hot and muggy weather (Kósa and colleagues, 2018). In chilly weather, keep the horse warm with an exercise blanket and refrain from short squirts of fast work. A horse's fitness should be increased gradually to lower the chance of muscle strain and repeated ER episodes. Good conditioning reduces damage from stress and promotes muscle function (Valberg, 2016). Prior to exercise, a horse's muscles, tendons, and ligaments are better prepared when they are warmed up. The risk of muscular damage is decreased by a proper warm-up, which increases blood flow to the muscles and makes them more sensitive and flexible. In order to prevent muscular damage and heat intolerance, a comprehensive cool-down procedure after exercise helps the horse's body temperature and heart rate return to normal. Moreover, a cool-down phase promotes relaxation and the removal of metabolic waste products from the muscles, which lessens stiffness, soreness, and the risk of ER. Additionally, using a hot walker before and after exercise is advised. (Valberg, 2016). Hot walker is a mechanical device which exercises the horse by walking it in a circle. It is particularly helpful for conditioning and sustaining fitness levels and for warming or cooling horses before or after training sessions. Exercise should be avoided until the symptoms of a respiratory infection in a horse have subsided (Global Herbs, 2022).

Avoid Days off Exercise

Due to the sudden change from relaxation to intense activity following a weekend of inactivity, ER episodes usually happen on Mondays. To keep horses with chronic ER active, they should be taken out every day in spacious paddocks. Regular exercise keeps muscles toned and conditioned, increasing their ability to withstand physical stress. Regular exercise also enhances metabolic function and lowers the risk of imbalances that may lead to ER by regulating blood sugar levels (Young, 2020)

Minimize Stress

Overexertion, being separated from stablemates, or traveling are examples of stressful situations or events that frequently lead to tying-up incidents. Stalling horses in a peaceful barn is crucial to creating a comfortable living environment for them (Valberg, 2016). According to research, horses who are stressed or exhibit "hot" behavior are more likely to experience ER episodes (Owen and Marcella, 2025). Maintaining regular routines, limiting exposure to stressors like loud noises or strange environments, and giving horses enough of outdoor time in a suitable social grouping can all help to lower their stress levels.

Feeding Program

Horses with chronic ER do well on diets of mid-maturity grass hay and little to no grain. Commercial feeds that are heavy in sugar and starch should be avoided because they can quickly raise blood glucose levels, which makes many horses more agitated and anxious (Valberg, 2016). To promote healthy digestion, the bulk of the diet should consist of forage. A mature horse should eat 2% of its body weight in hay per day on average. Less than 12% of the diet should consist of hydrolyzable carbohydrates (HC) in order to avoid tying up episodes (Young, 2020). Vulnerable horses, consuming a diet with greater HC levels raises the chance of ER episodes (Young, 2020). The skeletal muscle of horses with PSSM is better able to store glucose, and they are more sensitive to insulin than usual. According to Valberg (2005), starch and sugar should not account for more than 10–15% of the diet of PSSM horses and 20% of the diet of RER horses. Up to 1 to 2 cups of oil are typically advised for horses with PSSM1 in order to meet their energy needs. This may also help Thoroughbreds experience fewer RER episodes. Cool calories and long-lasting energy release are provided by fat, which also lowers the danger of muscle dysfunction brought on by grain-based diets. Horses that are active benefit greatly from fat supplements like flax oil and rice bran (Baldwin, 2022). To prevent dehydration, plenty of fresh water should be available both indoors and outside. A healthy diet that includes high-bioavailability mineral supplements, such as chelated minerals, is crucial.

Antioxidant Supplements

Free radicals can cause oxidative damage to cells, which antioxidants help prevent. The two most crucial antioxidants for horses' diets are vitamin E and selenium (Lindinger, 2022). These antioxidants are crucial for preserving the integrity of muscle cell membranes in exercising horses. It has been discovered that taking 5,000 IU of vitamin E daily can effectively reduce the amount of muscle enzymes that leak out of cells (Wyganowska et al., 2017). For horses with severe symptoms, intragastric dimethyl sulfoxide (as a <20% solution) or IV is also utilized as an osmotic diuretic, antioxidant, and anti-inflammatory (Valberg, 2006).

Electrolyte Balance

Studies indicate that electrolyte imbalances are associated with equine ER episodes (Valberg, 2022). Electrolytes assist neuron function, maintain appropriate pH levels, control fluid balance, and ease muscular contractions. Supplementing with electrolytes can benefit high-performance horses who are in danger. Electrolytes, including calcium, potassium, and sodium, are essential for healthy muscle function and should be given to horses, particularly when they are exerting themselves and sweating excessively to avoid electrolyte imbalance, muscle cramps, exercise intolerance, and dehydration (Liburt and William, 2022). For proper hydration, horses also require unrestricted access to fresh water and loose salt (Lindinger, 2022).

Medications

RER horses that are prone to excitation have been treated with low dosages of tranquillizers, such as acepromazine before exercise (Carson and Ricketts, 2022). Dantrium sodium is used to treat malignant hyperthermia by inhibiting the release of calcium from the skeletal muscle's calcium-release channel (Valberg, 2020). Another drug that has shown to be successful in a reducing rhabdomyolysis in horses with RER is phenytoin (1.4 – 2.7 mg/kg, q 12 h, PO) (Biles, 2015; Valberg and Dyson 2011; Kenney, 2022), which affects several ion channels in muscles and nerves, such as sodium and calcium channels. Horses with RER have been administered a variety of hormones, including progesterone, testosterone, and thyroxine. Progesterone injections may be useful in suppressing estrous behavior in mares that appear to display symptoms of rhabdomyolysis during estrus (Valberg, 2016).

VIII. PROGNOSIS

The severity of the condition, the underlying causes, and the effectiveness of management affect the prognosis for equine ER. If the horse returns to normal within 24 hours, the prognosis stance is better. It is also possible that a horse may exhibit lameness and/or permanent damage to muscles. The result becomes fatal if the horse is not treated for myoglobinuria and it goes into renal failure (Bile, 2015). With the right management techniques in place, horses with moderate cases can frequently recover completely and return to their regular activities as soon as therapy is started. After a single acute ER episode, muscles in horses usually recover in 3–4 weeks with no noticeable long-term damage. (Rivero, 2002) Horses can typically return to their regular activities after an acute episode has passed, with modifications made to their feed, exercise, and management to avoid recurrence. With the right care, severe tying-up episodes can result in muscular atrophy, necessitating a prolonged recovery period of two to four months. The success of controlling PSSM1 is demonstrated by the fact that very few or no ER episodes occur in about 90% of horses kept on a rigorous exercise and diet regimen (Young, 2020).

IX. CONCLUSION

Equine exertional rhabdomyolysis is a syndrome commonly seen when a horse on a high-energy diet abruptly cuts back on exercise. The buildup of muscle glycogen during period of rest and the subsequent production of excessive lactic acid when the horse resumes activity are cause of symptoms including stiffness, cramping and pain observed. The condition can be managed by providing stall rest, maintaining of hydration and electrolyte balance, administering analgesics and sedation, minimizing grain intake and then gradually returning the horse to exercise.

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