Feature Article

Neurologic conditions in the sport horse

Daniela Bedenice,[†,*] and Amy L. Johnson[‡]

[†]Department of Clinical Sciences, Cummings School of Veterinary Medicine at Tufts University, 200 Westboro Road, North Grafton, MA 01536, USA

[‡]Department of Clinical Studies, School of Veterinary Medicine, University of Pennsylvania, New Bolton Center, 382 W Street Rd, Kennett Square, PA 19348, USA

Implications

- Cervical vertebral stenotic myelopathy (CVSM), equine protozoal myeloencephalitis (EPM), and equine degenerative myeloencephalopathy (EDM) are three of the most common, non-contagious neurologic diseases in U.S. horses.
- Horses with mild or early clinical signs of neurologic gait abnormalities often present for performance-related concerns that can be difficult to distinguish from a lameness condition. Horses with unspecific gait changes should therefore undergo a complete neurological examination.

Key words: cervical vertebral stenotic myelopathy, equine degenerative myeloencephalopathy, equine protozoal myeloencephalitis, wobbler disease

Introduction

Neurologic disease can often mimic or be mistaken for a lameness, especially when horses present for performance problems. A careful history, clinical examination, and appropriate diagnostic testing are thus essential for an accurate diagnosis. The diagnosis of neurologic disease always starts with a detailed clinical examination and should not be based on diagnostic imaging (such as radiographs and ultrasound) or antibody testing for common infections (such as equine protozoal myeloencephalitis) alone, since many horses have had exposure to infectious disease without clinical illness. There is generally little disagreement between veterinarians when assessing the presence or absence of neurologic signs in moderately to severely affected horses. However, considerable differences in opinion can exist when grading neurologic abnormalities or assessing horses with more subtle clinical signs (Olsen et al., 2014; Saville et al., 2017). Athletes, such as hunters, jumpers, and dressage horses, with mild neurologic disease can often meet performance expectations to a certain point, or complete their existing job quite well (until their disease progresses or confounding conditions such as lameness develop). The true onset of their neurologic signs can thus be difficult to determine.

The current review focuses on the recognition, diagnosis, and management of the three most commonly reported non-contagious neurologic conditions in U.S. horses (cervical vertebral stenotic myelopathy [CVSM], equine protozoal myeloencephalitis [EPM], and equine degenerative myeloencephalopathy [EDM]) (Bedenice and Johnson, 2018). Many additional neurologic disorders exist that may result in gait deficits or performance problems, but are beyond the scope of this review.

Wobbler Disease or Cervical Vertebral Stenotic Myelopathy

CVSM, quite often referred to by the catch-all term "Wobbler Disease," is one of the most common causes of incoordination in young sport horses. Its cause and manifestation are complicated, and CVSM is widely considered to be a developmental abnormality affected by genetic (inherited) traits and environmental influences, including diet, rate of growth, workload, and injury. The development of the disease involves spinal cord compression due to structural abnormalities of the neck bones and joint spaces, joint or ligament instability, and soft tissue or bony changes of the neck. Simplistically, the deformed or unstable vertebrae press against the spinal cord, mixing up the signals from the brain to the limbs or vice versa. In general, CVSM is often divided into two broad categories: one affecting young horses with neck instability (type I), and the other affecting older horses with arthritic joint changes in the neck bones (type II) (Van Biervliet, 2007; Oswald et al., 2010). There is substantial overlap between types, and older horses can have developmental abnormalities despite a late onset of clinical disease, while very young horses can have bone remodeling that contributes to their clinical signs. Additionally, older horses frequently develop bony changes in the neck without damaging the spinal cord or leading to neurological signs.

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Clinical signs

CVSM primarily manifests as general incoordination or stiffness when the horse moves. Affected patients may trip, appear to lurch at the canter, have difficulty halting smoothly, and may swing out or collide their limbs while turning. Walking up and down hills can also be difficult for the horse. Most commonly, all four limbs are affected, but horses with milder disease can appear unaffected in the forelimbs, with mild signs in the hind limbs. Additionally, it is common for hind limb abnormalities to be more obvious than those in the front. A long-strided stiff gait can be quite characteristic of the condition, but lower neck problems can also manifest as weakness in the front limbs. These signs include a short-strided, choppy forelimb gait, limb buckling at rest or during movement, and muscle mass loss (atrophy). Signs are often symmetric or mildly asymmetric, with the left and right side usually being similarly affected.

Signs of neck pain are inconsistent. Young horses with malformations frequently do not appear uncomfortable, whereas older horses with lower neck arthritis (Figure 1) can show mild to severe signs of discomfort. These signs include abnormal head and neck posture, most commonly carrying the head lower than normal, or decreased range of motion when asked to bend to the side or raise and lower the head. More severely affected horses rarely bend their necks, even when asked to circle, and display a rigid "weathervane" posture when moving. If nerve root compression is occurring, the horse might show a front limb lameness that cannot be localized by a lameness examination and become occasionally "stuck" with the head and neck held in an abnormal, usually lowered, position. Abnormal muscling might be evident; some horses have poorly developed neck muscles, while others seem to have poor topline muscling that extends to their rumps.

Not every horse with CVSM shows overt signs of neurologic disease or neck pain. In some cases, the first sign of the problem is a behavior change under saddle, such as bucking, bolting, rearing, or stopping at fences. The horse might be resistant when working in one direction, reluctant to move forward, reluctant to bring its head and neck up into a frame, or just lose enthusiasm for its job. Difficulty with bending or lateral work, often worse in one direction, and mild front limb lameness can be observed. The rider might notice an occasional stumble, or the horse might have fallen under circumstances where it was not expected. Some horses have difficulty traversing hills but work well in other situations. The rider might comment that the horse feels lame, or different, but no apparent lameness is present. Obviously, many other orthopedic or even systemic problems can cause similar signs and poor performance. In summary, many performance problems that are noted by the rider could stem from CVSM, and horses without an obvious lameness or other explanation should be assessed carefully for neurologic disease and neck pain.

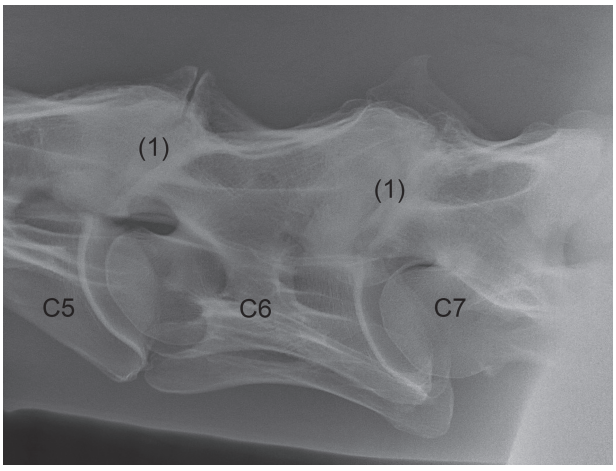

Figure 1. Lateral (side-view) radiograph of the lower neck of a 17-year-old gelding with neck pain. Marked arthritis is associated with the joint spaces (articular facets – 1), especially between the fifth (C5) and sixth (C6), as well as sixth and seventh (C7) vertebrae.

Diagnosis and differential diagnosis

The basis for diagnosis should be a comprehensive history and neurologic evaluation, followed by appropriate imaging.

History. Clinical signs as described above can become apparent at any age, depending on the severity of spinal cord compression and demands placed upon the horse. Many cases are recognized when training or competitions begin or when workload and demands increase. The recognized problem might have a sudden onset, such as occurs after a fall or other injury, or the clients might have noticed more subtle abnormalities over a prolonged period of time. Adequate or even superior performance results, particularly at lower levels, do not exclude the possibility of CVSM; horses can frequently compensate for mild neurologic deficits.

Clinical examination. Thorough neurologic evaluation, with special focus on the gait examination, is essential for diagnosis. The horse should be observed for signs of incoordination, and weakness while moving in hand at the walk and trot, both in a straight line and circling. Additional maneuvers performed at the walk can include moving in a serpentine, walking with the head elevated, walking tail pull, tight circles, backing, and walking up and down hills with the head in a neutral and elevated position (Figure 2). The horse is asked to bend to each side for a food reward and touch its nose to its flank; normal horses accomplish this easily and bend fairly evenly throughout the length of their neck, while abnormal horses cannot or will not reach back to their flank. They might try to reach the food reward by twisting their head and bending only the front of their neck. The horse is also asked to reach up in the air and down to the ground for food or can be observed grazing. Hesitation in lowering the head or abnormal limb position while grazing with forelimbs widely spread can be observed in horses with neck pain. Ridden examination is not performed if neurologic abnormalities are clearly identified while the horse is in hand. However, evaluation under saddle can be informative for horses with very subtle or equivocal abnormalities;

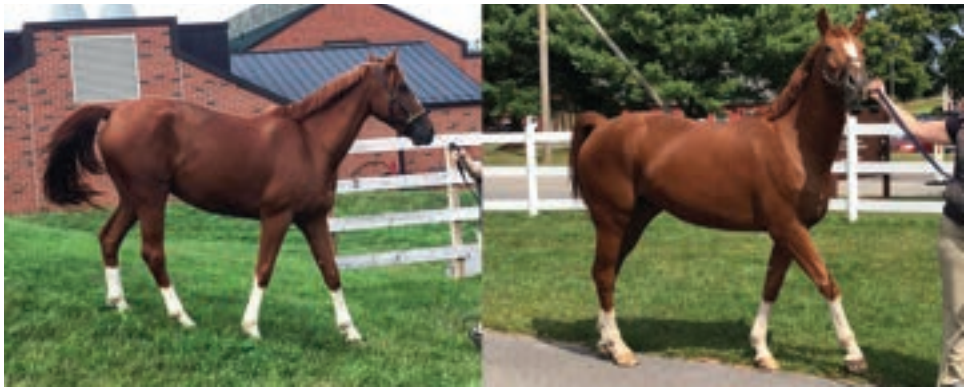

Figure 2. Walking a horse downhill (left image) or with the head elevated (right image) to exacerbate clinical evidence of neurological gait abnormalities, especially in the forelimbs.

some horses show a marked change in gait when ridden with their head and neck in a tighter (upright, flexed) frame compared to a lower, more relaxed position or when ridden in one direction compared to the other.

Imaging. Complete radiographs ("X-rays") of the neck are usually the first imaging method pursued and should include side views from the first neck bone (C1) to the first vertebra of the chest (T1). When indicated, oblique (angled) views of the joint spaces of the neck can allow for more accurate assessment of asymmetric abnormalities. Some practitioners also use ultrasound to evaluate the neck, particularly the neck joints. Depending on findings, more advanced imaging, such as myelography, computed tomography (CT), or magnetic resonance imaging (MRI) might be warranted.

After a subjective assessment of the spinal column, more objective assessments are undertaken using measurement software. For example, the intravertebral minimum sagittal diameter (MSD) ratio can be measured by dividing the smallest height of the vertebral canal by the largest height of the corresponding vertebral body in the front aspect of each neck bone. A low MSD ratio puts the horse at risk of being a wobbler. More subjective radiographic indicators include subluxation (malalignment) of the joints, growth plate enlargement, and arthritis or bony proliferation (irregular bone formation) associated with the joint spaces of the neck bones (Figure 1).

However, plain (regular) radiographs are generally insufficient for confirming spinal cord compression because they do not show the spinal cord itself. Myelography, which is a contrast study performed under general anesthesia to outline the spinal cord on radiographs, is often considered the most accurate test for CVSM in the live horse, but will likely be superseded by CT myelography or MRI in the future. One of the primary limitations of radiography and myelography in horses is that only side views are typically obtained, while cross-sectional imaging obtained with CT or MRI is the standard for spinal cord evaluation in smaller species. For decades, CT and MRI size limitations precluded imaging of the lower neck of the horse. However, the availability of large-bore and robotic CTs for clinical use will revolutionize our understanding of the equine spinal column and its disease. Major advantages of these systems include the ability to image the neck in multiple planes, detection of spinal cord compression from side to side (rather than top to bottom), and, with some systems, the ability to perform studies in the standing horse. Many people prefer to avoid anesthesia when possible but there are safety concerns with performing myelograms in non-anesthetized horses using standing systems. Additionally, dynamic views (with the neck in flexion and extension) are more difficult to obtain in the standing horse.

Nuclear scintigraphy does not allow for a specific diagnosis but might serve to exclude other potential causes of poor performance. Likewise, a spinal tap generally yields normal or nonspecific results but can allow the exclusion of other potential diseases, such as EPM.

Treatment

Horses with CVSM can be treated medically or surgically. The mainstays of medical treatment involve rest or reduction in exercise and systemic or local anti-inflammatory treatment. Young horses are also sometimes treated with dietary modifications to reduce the rate of growth (Donawick et al., 1989; Kronfeld et al., 1990). There are no controlled studies to evaluate the efficacy of the "paced growth" diet or any anti-inflammatory protocol. Horses with arthritis of the neck joints are frequently treated with joint injections of corticosteroids, hyaluronan, or autologous protein solution. Theoretically, these injections might reduce inflammatory mediators and pain, reduce soft tissue swelling, and stabilize new-bone proliferation (arthritis).

Surgical treatment generally entails fusion of the neck bones with the goal of eliminating movement at the affected joint spaces. If the horse has a dynamic spinal compression that is exacerbated during extension or flexion (bending) of the neck, the fixation of the affected joint(s) will immediately reduce damage to the spinal cord. If the horse has a static compression with spinal cord compression in all neck positions, the surgical stabilization can lead to clinical improvement due to gradual decompression that happens when bones and tissue atrophy (shrink). Sequential radiographs as well as postmortem evaluations performed months to years

after neck fixation will demonstrate reduction (atrophy) and remodeling of the soft tissue and bony structures around the affected neck joint, generally causing enlargement of the spinal canal.

The most common surgical technique uses a partially or fully threaded cylindrical implant (Kerf cut cylinder) and bone graft placed into the body of two adjacent neck bones (vertebrae). The implant markedly reduces but does not totally eliminate movement of the vertebrae, although subsequent bone fusion should lead to complete fixation. This procedure is performed by a limited number of surgeons at a limited number of facilities within the United States. Although critical evaluations of surgical outcome are limited within the scientific literature, experts estimate that the procedure has been performed in more than 2,000 horses and long-term survival is greater than 80% (Johnson and Reed, 2015).

Prognosis

Factors that influence prognosis include age of the horse, severity of neurologic deficits, duration of neurologic signs, and owner expectations for performance. Most horses with CVSM do not have life-threatening ataxia, although some horses become unable to rise or demonstrate such severe incoordination that safety concerns warrant euthanasia. Without treatment, prognosis for substantial improvement in neurologic function is generally poor as the underlying malformation, instability, or bony proliferation will continue to damage the spinal cord. Additionally, sudden deterioration in neurologic status can occur following trauma, as a horse with a narrowed spinal canal has little ability to compensate or avoid further injury to the cord when trauma occurs.

Medical treatment alone is unlikely to lead to long-term improvement in incoordination, although improvement in comfort can be observed in response to systemic or localized anti-inflammatory treatment. If recent spinal cord damage has occurred, initial response to medical therapy with anti-inflammatory drugs is often good. However, without removing the inciting cause of spinal cord damage, neurologic deficits are likely to remain or reoccur in the future. If arthritis is present, neck-joint injections with corticosteroids or other anti-inflammatory substances might relieve discomfort or reduce soft tissue impingement on nervous structures. However, improvement is often transient and repeated injections might be necessary (Birmingham et al., 2010).

Surgical stabilization provides the best long-term prognosis despite the short-term risk. If owners are willing to consider surgical stabilization, this course should be pursued as soon as feasible after diagnosis to reduce cumulative injury to the spinal cord. Published studies estimate that approximately 75% of horses improved, and 45–60% achieved athletic function (Walmsley, 2005). Anecdotally (S. Reed, personal communication), current success rates have slightly improved, with clinical improvement in about 80% of horses and 63% of horses returning to athletic function. Subjectively, sport horses undergoing surgery can often be ridden at equivalent or lower levels but rarely, if ever, continue to progress in their training so that they successfully compete at higher levels after surgery. Additionally, riding a horse with ongoing neurological abnormalities increases the risk of stumbling or falling and thus injury to both rider and horse.

Equine Protozoal Myeloencephalitis

EPM is one of the most common infectious neurological conditions in horses of North America. The protozoan parasites *Sarcocystis neurona* and *Neospora hughesi* are known causes of EPM, although the majority of cases are associated with nervous system infection by *S. neurona* (Reed et al., 2016). The definitive host of *S. neurona* is the opossum *Didelphis virginiana* in North America, while several mammalian intermediate hosts exist (i.e., warm-blood vertebrate animals that support the immature forms of the parasite), including skunks, raccoons, armadillos, and cats. Horses are infected with *S. neurona* through the consumption of food or water contaminated with opossum feces. The disease cannot be transmitted between individual horses (it is not a contagious condition), nor can it be transmitted to horses from the intermediate hosts.

Horses of all breeds appear to be affected by EPM and there is no apparent gender bias. Standardbred, Thoroughbred, and Quarter Horses have been overrepresented in some EPM studies (Fayer et al., 1990; Pusterla et al., 2014), but this likely reflects a selection bias that is further influenced by breed prevalence, breed-specific uses, or management factors which increase infection risk. It has been shown that stressful events (including high-intensity training, heavy exercise, transport, or injury) or advanced age may predispose to the development of EPM through immune suppression. However, most studies suggest that EPM is more common in young to middle-aged horses.

Clinical signs

This protozoal infection may affect any part of the central nervous system (CNS), leading to highly variable signs involving the brain, brainstem (base of the brain), or spinal cord. Spinal cord symptoms often predominate, leading to general incoordination, weakness, or muscle mass loss that is often unevenly distributed (asymmetric). Early signs of gait abnormalities may be noted under saddle as an uneven stride, stumbling, tripping, interference between limbs or difficulties changing leads, and can initially be confused with lameness. Clinical signs vary from a sudden to slow onset and may progress slowly or rapidly. EPM infection can thus mimic a variety of other neurological diseases and can rarely be discounted based on clinical signs alone. However, infected horses are typically not painful or febrile unless other concurrent conditions exist. Dullness or abnormalities in cranial nerve function (nerves originating from the base of the brain) may be seen in horses with brainstem involvement. These more commonly manifest in swallowing abnormalities, leaning, or falling to the side (vestibular dysfunction), muscle wasting of the face, upper

airway dysfunction, or lack of normal facial movement (facial palsy) (Furr and Rowe, 2015; Johnson, 2011).

Diagnosis and differential diagnosis

Despite decades of research, a definitive diagnosis of EPM remains diagnostically challenging. Almost all clinical signs found in other equine neurologic conditions can also be present in EPM-affected horses. Therefore, a presumptive diagnosis of EPM is considered most accurate if all of the following three criteria are fulfilled: Compatible clinical signs consistent with neurological disease, exclusion of other likely diseases, and confirmation of exposure to *S. neurona* or *N. hughesi* by antibody testing (Johnson, 2011; Reed et al., 2016). In areas where *S. neurona* and opossums are common, there is extensive exposure of horses to the protozoa. Therefore, antibodies may be found in the blood of up to 89% of horses, depending on the region (Reed et al., 2016). Since EPM occurs only in a small percentage of horses infected with *S. neurona*, it is extremely important that an EPM diagnosis is not merely based on serum antibody testing, as many horses would be falsely diagnosed. Certain viral, tick-borne, parasitic, developmental, and even traumatic neurological conditions can mimic aspects of the clinical presentation of EPM, which thus requires a strategic assessment by the veterinarian. Ancillary diagnostic evaluations, such as spinal fluid cytology, vitamin E analysis, infectious disease testing, and advanced diagnostic imaging, may be indicated to rule out conditions that mimic EPM.

Diagnostic testing

A variety of antibody tests are currently used for the diagnosis of EPM, including two quantitative tests to measure antibody titers in serum and spinal fluid (Figure 3: standing spinal tap in a horse). A definitive diagnosis is most likely reached by assessing the relationship between antibody titers in the spinal fluid to those in blood, using either the indirect fluorescent antibody test (IFAT) or surface antigen (SAG) ELISAs. Serum (blood) IFAT titers have been used to predict the likelihood of EPM, with higher titers suggesting a greater probability of disease. However, these predictions are likely less accurate in geographical regions with high EPM exposure and should be interpreted with caution. Similarly, two independent studies of a commercial *S. neurona* SAG2, 4/3 ELISA showed that testing serum (blood) alone yielded less accurate results than cerebrospinal fluid (CSF) testing alone, or comparing serum antibody titers to spinal fluid titers (serum:CSF titer ratio). As such, blood testing alone will lead to a high number of false-positive tests, and thus a potentially false diagnosis of EPM. In contrast, both studies demonstrated the highest overall accuracy for the SAG2, 4/3 ELISA serum-to-CSF titer ratio, as compared to any other diagnostic test (Western Blot, IFAT, and SAG-1 ELISA). The reported test sensitivity ranged between 88% and 93% (i.e., showing a low likelihood of missing the diagnosis), with a specificity of 83–100% (leading to a low likelihood of inadvertent overdiagnosis of the disease) when using a serum:CSF ratio of ≤100 as the cutoff for a positive test result (Johnson et al., 2013; Reed et al., 2013). The available evidence, therefore, suggests that measuring specific antibodies in both serum and CSF to allow calculation of a serum-to-CSF ratio is the most accurate means of diagnosis. In general, antibodies are partitioned between blood and CSF at a relatively constant ratio (>100:1), due to a tight blood-brain barrier. Infection of the CNS, however, leads to antibody production within the nervous system and a decrease in this ratio, which is useful in the clinical diagnosis of EPM (Furr et al., 2011; Johnson, 2011).

When testing only blood, the probability that neurologic horses with antibodies against *N. hughesi* truly have EPM is higher than if testing blood for *S. neurona*, due to decreased likelihood of incidental exposure (low seroprevalence) to

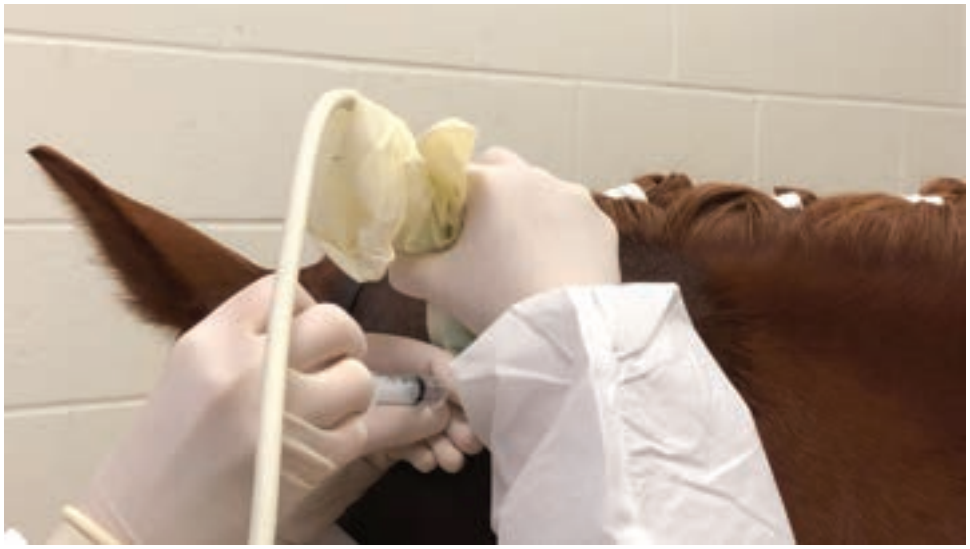

Figure 3. Ultrasound-guided spinal tap performed in the standing horse.

N. hughesi in horses; with some geographic differences (Reed et al., 2016). However, CSF testing and ideally calculation of a serum:CSF titer ratio is still recommended for most accurate diagnosis of EPM due to *N. hughesi*.

Treatment

Three treatments are currently approved by the U.S. Food and Drug Administration (FDA) for EPM and available on the U.S. market (December 2021): a combination of sulfadiazine and pyrimethamine, ponazuril, and diclazuril; with apparently similar efficacy across therapies.

ReBalance (PRN Pharmacal, Pensacola, FL) is an approved combined EPM treatment of sulfadiazine at 20 mg/kg and pyrimethamine at 1 mg/kg daily given by mouth for a minimum of 90 days. A field study performed during the approval process of *ReBalance* resulted in successful outcomes in 61.5% (16/26) of horses, based on two or more improvement grades in the overall neurologic function or reversion to antibody-negative CSF fluid (Animal Health Pharmaceuticals, 2004). Side effects of the drug are usually mild with bone marrow suppression (mildly low red blood cells, white cells, and platelets) most commonly observed. Sometimes, intestinal complications (low appetite, dullness, or diarrhea) and reproductive problems (abortions and birth defects) are also reported (Johnson, 2011).

Marquis (Merial, Duluth, GA) is a 15% w/w ponazuril paste (an antiprotozoal drug) that is labeled for use at a loading dose of 15 mg/kg orally on day 1 (in an effort to achieve therapeutic concentrations more quickly), followed by 5 mg/kg given daily by mouth for the following 27 days. A field study performed during the drug approval process described a 60% (28/47) success rate, based on an improvement in neurologic score by at least one grade (on a 0 to 5 scale) or CSF conversion to negative status on Western blot for *S. neurona* antibodies, after 28 days of treatment (Furr et al., 2001). No adverse effects were noted. A recent study showed that the concurrent administration of vegetable oil (1/2 cup) may increase the bioavailability (overall absorption) of the FDA-approved ponazuril product up to 15% (Reed et al., 2016; Furr and Kennedy, 2020). In the clinical setting, ponazuril is frequently used at higher dosages than listed on the product label or for a longer duration, depending on the horse's clinical response (Johnson, 2011; Pusterla and Tobin, 2017). Antibody re-testing in blood, CSF, or both is currently not recommended to guide duration of drug treatment (Reed et al., 2016).

Protazil (Merck Animal Health, Kansas City, KS) is marketed as a pelleted (alfalfa-based) oral antiprotozoal medication, containing 1.56% diclazuril and administered as a daily top-dress at 1.0 mg/kg for 28 days. A field study performed during the approval process described a similar efficacy to the other products, with 67% (28/42) of horses being considered treatment successes after 28 days of drug therapy, based on an improvement in neurologic score by at least one grade or CSF conversion to negative status on Western blot. No important adverse reactions were reported (Schering-Plough Animal Health Corporation, 2007). Based on unpublished data, a loading dose for this product is not required and the use of vegetable oil has not been shown to increase drug uptake (Reed et al., 2016).

Ancillary treatments for EPM may include a short course of non-steroidal anti-inflammatory medications or corticosteroids (and/or dimethyl sulfoxide) in an attempt to control the inflammatory response, and prevent potential worsening of neurologic signs during the early antiprotozoal treatment phase in moderately to severely affected horses. Additionally, natural vitamin E formulations (e.g., 10–20 IU/kg orally per day) are often supplemented as an adjunct antioxidant treatment. Immunomodulators (Equimune, Zylexis, Eqstim, and/or levamisole) have also been used anecdotally by some, based on the assumption that horses develop EPM in association with immune compromise. Owners should be aware that levamisole can be metabolized to aminorex, a CNS stimulant that is banned in performance horses. The use of levamisole in performance horses may thus give rise to the possibility of regulatory concerns if subjected to drug testing (Gutierrez et al., 2010; Pusterla and Tobin, 2017).

Prognosis

Approximately 60% of EPM-affected horses are expected to improve at least one grade with treatment regardless of type, while a smaller percentage (10–20%) may return to normal athletic performance (recover completely). However, it is reasonable to estimate that 10–20% of successfully treated horses will suffer at least one relapse within 1 to 3 years after discontinuation of treatment. The outlook for mildly affected horses (grade 1) may be considerably better, and early recognition and treatment will likely result in the best outcome (MacKay, 2006).

Equine Degenerative Myeloencephalopathy

EDM is a degenerative condition affecting the nervous system (brainstem and spinal cord) in young horses that is predominantly characterized by symmetric generalized incoordination. It is clinically indistinguishable from a related condition called equine neuroaxonal dystrophy (eNAD). Both familial (genetic) and environmental factors are believed to play a role in the development of EDM. As such, low dietary vitamin E (α-tocopherol) levels with resultant oxidative damage to selected neurons contribute to disease development. In a retrospective case–control study, the reported risk factors for EDM included housing on dirt lots and exposure of young foals to insecticides and wood preservatives, whereas housing in green pasture (as a source of natural vitamin E) was considered protective (Dill et al., 1990). EDM has been recognized in most sporthorse breeds with reports of familial disease in Appaloosas, Morgans, Standardbreds, Mongolian wild horses, Quarter Horses, and Lusitano Horses (Finno et al., 2011; Carr and Maher, 2014).

Clinical signs

Affected horses classically show symmetric incoordination (proprioceptive deficits and weakness), where the forelimbs can be equally or less severely affected than the hindlimbs. Horses may also appear "clumsy," show a two-beat "pacing" gait at walking speed, a body sway, base-wide stance, or notable spasticity (stiffness) in the affected limbs. Muscle wasting (atrophy) is usually not seen in horses with EDM. Clinical symptoms can thus be similar to those of CVSM.

The clinical signs of EDM typically develop between 1 and 12 months of age and can remain unchanged, or progress for days to months before stabilizing. Mild cases may therefore present for performance-related concerns and can be difficult to discern from a lameness condition. EDM sometimes remains undetected for years unless the horse specifically undergoes a neurological examination (Carr and Maher, 2014; MacKay, 2015). Personal experience (unpublished results) has shown that late-onset EDM may also be recognized in older horses (often 5- to 15-year-old warmbloods or less frequently other breeds) that initially present with behavior changes (altered personality, spooking, bolting, refusing fences) and subsequent ataxia, where a diagnosis of EDM can ultimately be confirmed on necropsy.

Diagnosis and differential diagnosis

A definitive antemortem diagnosis of EDM is not possible but is clinically suspected based on patient signalment, suggestive clinical findings, and exclusion of alternate diagnoses in young horses. Early onset (<2 years) of symmetric limb incoordination, coupled with confirmed EDM in the bloodlines of affected horses, a low or marginal serum vitamin E level (≤2.0 µg/ml), or deficient dietary vitamin E is strongly suggestive of the disease. However, since dietary and serum vitamin E levels are not always abnormal, a deficiency in the metabolism or function of vitamin E cannot be ruled out in affected horses (Carr and Maher, 2014).

A commercial biomarker test to evaluate nerve cell (axon) damage by measuring concentrations of a phosphorylated neurofilament heavy subunit (pNF-H) in serum and/or spinal fluid in horses, was recently developed at UC Davis, to aid in the diagnosis of EDM. Unfortunately, this test has a low sensitivity, and many horses with a confirmed diagnosis of EDM do not have increased pNF-H results.

Treatment

Vitamin E supplementation is the treatment of choice but is unlikely to result in significant improvement of clinically affected horses. However, in susceptible families, vitamin E supplementation of breeding stock and young horses can decrease the incidence and severity of developing disease (Finno et al., 2011). Natural vitamin E (RRR-α-tocopherol) has a notably higher bioavailability and potency than synthetic vitamin E (all rac-α-tocopherol acetate or DL-α-tocopherol) (Finno and Valberg, 2012) and is commonly supplemented at 10–20 IU/kg orally per day in deficient horses (5,000–10,000 IU per horse). Dietary fat is required for intestinal absorption, so Vitamin E should be given with feed or vegetable oil (MacKay, 2015).

Prognosis

The prognosis for recovery is poor in affected horses, which generally stabilize over time without improvement in their neurological signs or performance, despite treatment. Rare reports of clinical improvement exist following supplementation with natural vitamin E (Carr and Maher, 2014).

Synopsis

EPM, CVSM, and EDM are currently recognized as the three of the most common neurologic diseases in U.S. horses, with the latter two conditions being most prevalent in young animals. A clinical diagnosis of any neurologic disease should be based on a careful history, complete neurologic examination, and appropriate diagnostic testing and interpretation. However, mild or early neurologic signs can often mimic or be mistaken for a lameness condition, when horses present for performance-related concerns.

Conflict of interest statement. None declared.

About the Authors

Daniela Bedenice, Dr. med. vet., DACVIM (LAIM) and DACVECC (Eq) graduated from the Free University of Berlin (Germany) and underwent specialized training in large animal critical care and respiratory medicine before joining the Tufts Cummings School of Veterinary Medicine faculty. She is currently an Associate Professor, who is dual board-certified in the specialties of large animal internal medicine and equine emergency and critical care. Additionally, she is a principal research investigator for the Dorothy Russel Havemeyer Foundation. Her special interests lie in the field of neurologic and respiratory disease management, clinical pharmacology, and development of novel treatment approaches in both horses and camelids. **Corresponding author:** daniela.bedenice@tufts.edu

Amy L. Johnson, DVM, DACVIM (LAIM and Neurology) is currently an associate professor of Large Animal Medicine and Neurology at the University of Pennsylvania School of Veterinary Medicine's New Bolton Center. She received her DVM from Cornell University and completed an equine internship at B.W. Furlong and Associates in New Jersey. She became board-certified in large animal internal medicine after completing a residency at Cornell University, and she subsequently became board-certified in neurology after completing a residency at the University of Pennsylvania. Her research interests focus on improving the ability to diagnose the cause of neurologic disease in horses using clinical examination, laboratory testing, and advanced imaging techniques.

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