Horse, Vet, & Farrier™

THE ONLINE MAGAZINE OF THE NAEP

Spring 2024

EXPANDING THERAPIES

IMAGING OF THE CERVICAL SPINE

EQUINE GASTRIC DISEASE

EQUINE ORAL EXAMINATION

THERAPEUTIC FARRIERY

STEM CELLS AND STEM CELL-LESS THERAPIES

EQUINE INFECTIOUS DISEASES

NAEP™

Together For The Horse™

Horse, Vet, & Farrier™ THE ONLINE MAGAZINE OF THE NAEP

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ABOUT THE COVER: Spring has arrived and brings with it a new crop of foals that will benefit from the care of equine professionals.

contents

PRESIDENT'S MESSAGE

NAEP™ Together For The Horse™

together for the horse

Welcome

DEAR NAEP MEMBERS,

What an incredibly busy and productive Spring the National Alliance of Equine Practitioners has had! We have traveled across the country for three of our four regional wet labs to bring farriers, veterinarians, technicians and students together for hands-on learning in Arizona, California and Pennsylvania. The response has been tremendously positive by attendees, and truly inspiring. This is exactly what the NAEP represents, and what we intend to continue to share with all practitioners who are curious and strive to improve.

We have one more wet lab coming in May, in Alberta, Canada. This will represent our first ever international wet lab with the NAEP! Our speakers are Dr. Scott Fleming of Rood & Riddle, KY, and Dr. Jaret Pullen of JP Hoofworks, who is also a current member of our board of directors. They will be discussing 'The High-Low Horse', a topic that all of us deal with on a daily basis and sure to get all attendees minds thinking. We hope to see you in Canada soon!

The sponsorship for the 2024 regional wet labs has been phenomenal. I would be remiss if I did not mention our incredible sponsors; Cargill, Choice Medical Systems, Creative Equine Solutions, Dechra Veterinary Products, Mustad, Platinum Performance, Sound/Mars Companies, Vet Ray Technology, & Zoetis. Thanks to each of you for understanding the NAEP mission, of providing some of the best education possible to bring practitioners together in a place of mutual respect and learning for the horse. Thank you!

The planning for the 2024 Saratoga Equine Practitioners Conference is well underway, and what a line up of educators we have! Some of our speakers are; Dr. Jean-Marie Denoix, Dr. Jenny Hagen, Mr. Mike Savoldi, and Dr. Ben Sykes to name a few. Our speakers are coming to Saratoga, NY in September, from around the world, to share their insights and research with all of you! The Saratoga Wet Lab on Saturday, will include these speakers, as clinicians, as a culmination of the week's learning. It will allow attendees to apply the concepts and practical application from the lectures with some of the very best in the world. This is one of the many reasons to attend the Saratoga Equine Practitioners Conference!

Our Spring edition of the Horse, Vet, Farrier magazine is filled with some incredible articles for you this quarter. From practical application of how to take cervical neck radiographs and dentistry exams to an extensive look at therapeutic shoeing, you're sure to find an article that will provide some helpful tips, or stimulate some thought in your day. To assist with your education, the new NAEP website is very user friendly on tablets or cell phones, making it easy to look at information while on the go.

As the workload of Spring transitions to the steady sprint of Summer, please take care, and manage yourself as well as you do your horses.

Together for the Horse.
Sasha Hill, DVM
NAEP President

Imaging of the **Cervical Spine**

By Myra Barrett DVM, MS, DACVR, DACVR-Equine Diagnostic Imaging

RADIOGRAPHY

TECHNIQUE

Prior to image acquisition:

A complete study of the cervical spine includes the caudal skull through the first thoracic vertebra. Lateral radiographs are often obtained in the field with a portable X-ray generator and detector. Unlike the distal extremities, the radiographer cannot see the X-ray detector (plate) on the opposite side of the neck. This creates positioning problems and often results in images with one vertebral body or facet joint that is not centered on the plate. Furthermore, obliquity of the articular process joints on the lateral radiographs can lead to interpretation errors. Image acquisition and quality can be optimized by aligning the anatomy prior to acquiring the radiographs. Prior to acquisition, palpate the transverse processes and apply a marker such as white tape to these sites, which will serve as a guide to detector placement and X-ray generator focus.

The addition of individually distinct metallic markers (such as bbs or even coins or paperclips) in the jugular furrow with overlapping x-ray images will also allow for improved localization of the vertebrae. This is particularly important to include when imaging a large horse or using a smaller plate when fewer vertebra fit on an image. The vertebrae of the mid cervical spine have very similar appearances and anatomic differences are not a viable source of localization. Even in the caudal cervical spine, anatomic variants can lead to confusion of which vertebra is which.

Labeling is particularly crucial for the oblique radiographs. A digital label naming the view (RDLVO, LDRVO) and/or a left and right marker denoting the highlighted side (both are optimal) are crucial for accurate localization and interpretation.

Image acquisition:

Individual radiograph systems will have variable suggested X-ray technique and using the vendor recommendation is a good starting place. Technique will need to be adjusted depending on the size of the horse and the location on the neck, with higher technique required in larger horses and in the caudal cervical spine.

Centering just dorsal to the transverse process will provide well positioned radiographs, when the horse's poll is in line with the withers. The resultant images should have the articular processes superimposed centrally. Towards the periphery of the x-ray image the articular facets may be slightly oblique/off set in a craniocaudal fashion due to X-ray beam divergence

Oblique radiographic projections to better visualize the facet joints individually have been described and can be utilized to more completely assess the pathologic changes within the cervical spine. Oblique radiographs project the dorsolateral and ventrolateral aspects of the cervical vertebra

Figure 1: Left 55°dorsal-right ventral oblique radiographic technique

on both the right at left sides. This aids in the separation of symmetrical anatomy and allows for lateralization of bone pathologic change. To accurately evaluate both sides, orthogonal oblique (both left and right) images must be obtained. Oblique radiographs can be obtained from ventral to dorsal or dorsal to ventral. The choice of position will depend on the height of the horse and the height of the person acquiring the images. The dorsal approach requires holding the x-ray generator up high, which can be more physically difficult and risk more motion artifact in smaller people or with big horses.

Regardless of orientation, the images are typically obtained from a right/left dorsolateral to left/right ventrolateral fashion at approximately 50 to 60°. These are often more easily obtained while the neck is in a neutral position.

Dorso-ventral approach:

The X-ray generator light is approximately 6 to 8 cm dorsal to the tape marking the transverse processes, while the plate is placed slightly ventral to the neck to accommodate the angle of the beam. (Figure 1)

Ventro-dorsal approach:

The X-ray generator is centered at the jugular furrow and the plate is placed with the transverse process centered at the bottom 1/3 of the plate.

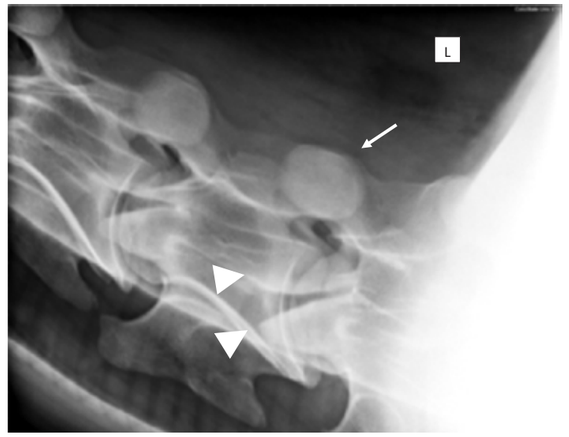

Figure 2: Well positioned RDLVO of the caudal cervical spine. The left articular process joint is dorsally displaced (white arrow) and the right articular process joint is ventral (arrowheads). Note that the cranial aspect of the joint is wider, which is normal.

Obtaining a right dorsal to left ventral oblique will highlight the left articular facets dorsally, and the right transverse process ventrally (Figure 2) and vice versa with the opposite oblique. A common error is to only take oblique images from a single side rather than both left and right, which, for example, would be akin to taking a DMPLO but not a DLPMO of fetlock.

Figure 3: The transverse processes of C4 and C5 are closely superimposed with minimal articular process joint obliquity. There is more separation of the transverse processes at C6 and double lines of the left and right C6-C7 articular process joints (arrows). This is a common occurrence due to beam divergence as well as often slight tilt or curvature to the patient's neck.

ASSESSING IMAGE QUALITY

Unfortunately, it takes only a small amount of obliquity of the lateral image to alter the appearance of the articular process joints, making them appear larger than normal and potentially leading to incorrect diagnosis of pathology. Obliquity also makes it difficult to accurately assess cervical canal diameter and obtain intra-vertebral minimum sagittal ratio measurements. For that reason it is important to try have as truly straight of a lateral image as possible. Internal references can be used to help determine if positioning is good. Assess if the left and right transverse processes and articular facet contours are directly superimposed *(Figure 3)*. If there are double lines, it means that the medial and lateral sides are separated by obliquity. In some cases if the horse is standing with a slight tilt or bend in the neck, the transverse processes may be superimposed while the articular process joints are still offset, which is why both internal markers should be used to assess position.

Although a perfect lateral radiograph is the goal, reality dictates that it is not always achievable. In such cases, a careful assessment of the image can help the evaluator estimate to what degree obliquity may be influencing the appearance of the anatomy, particularly the articular process joints. For a trained interpreter, mild obliquity can often be overcome, but when obliquity increases the diagnostic value of the images is diminished.

The most common error of oblique radiographs is insufficient beam angle resulting in only partial separation of the left and right articular process joints. If each articular process joint cannot be traced individually, the images are not sufficiently separated. Another common error is an absence of labels. If metal left and right markers are used for labeling, ensure that they are included in the image and/or apply a digital label *(Figure 4)*

Underexposure is common, particularly of the caudal cervical spine, and results in a grainy appearance of the digital radiographs. This may be overcome in the field by using a shorter distance to the plate and ensuring that the X-ray tube setting is high enough. Often a portable X-ray tube is at the maxed-out setting for the caudal cervical region. Image quality of the caudal cervical spine can also be improved by separating the forelimbs, thereby decreasing the amount of superimposed musculature. Collimation to the area of interest (particularly limiting the dorsal-ventral beam width) decreases scatter radiation and can markedly improve image quality as well. Limiting the number of repeat radiographs is always optimal to reduce exposure to patient and personnel; however, it can be helpful to obtain an initial image with collimation open to better capture the anatomy and be sure the beam is centered appropriately and then repeat the view with collimation to the area of interest. While this does require two images at the same site, it still often reduces overall exposure that occurs with multiple retake images due to poor positioning or underexposure artifact.

COMMON RADIOGRAPHIC ABNORMALITIES

Cervical vertebral malformation (CVM aka wobblers) is a common differential for horses with neurologic deficits. Radiographs can be helpful for screening, and can often accurately diagnose cervical vertebral malformation but cannot definitively allow for diagnosis of spinal cord compression. Myelography is needed to further evaluate the sites of suspicion for evidence of spinal cord compression, although even it can produce ambiguous results. Increasingly we are recognizing the role of developmental enlargement or osteoarthropathy of the articular process joints in spinal cord compression. While standard radiographic myelography helps identify compression that occurs in the dorsal-ventral plane, the increasing use of CT has allowed us to better identify lateralized spinal cord from enlarged articular process joints[1]. If a horse presents for neurologic deficits and radiographically has a normal dorsal-ventral spinal canal parameter but abnormal articular process joints, lateralized impingement should be considered as a differential diagnoses. In such cases, if referral for a CT myelogram is an option, it is more likely to identify a lateralized lesion than a standard radiographic myelogram. This can occur both in young horses due to articular process joint enlargement as part of developmental CVM or in older horses due to osteoarthritis and remodeling.

Enlargement or malformation of the cervical articular process joints can result in various clinical signs, including neck pain, poor performance, neurologic deficits and forelimb lameness. Enlargement can be developmental or occur secondary to multiple pathologic processes, including osteochondrosis, osteoarthritis and previous trauma. Classic signs of osteoarthritis that are frequently seen in other joints, such as osteophyte formation and subchondral bone sclerosis are less commonly identified radiographically in the cervical facet joints. More common signs of degenerative change include enlargement, periarticular bone production and joint capsule enthesopathy.

Enlarged articular process joints will cause the intervertebral foramina to appear narrow and less distinct radiographically (Figure 5), which can help be a radiographic indicator of severity (the larger the articular process joint, the more difficult it is to see the foramen). Stenosis of the intervertebral foramen may cause pain or lameness due to spinal nerve root impingement.

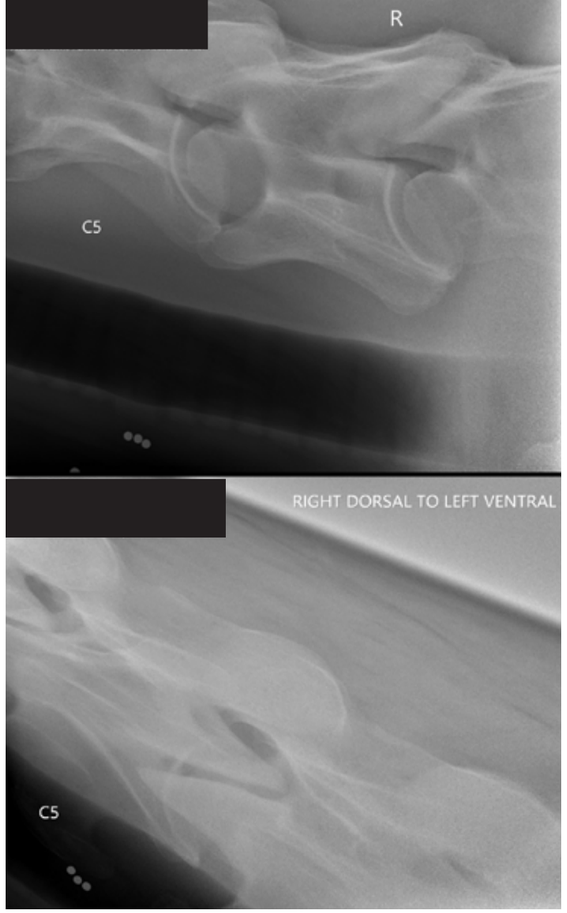

Figure 4: Well labeled lateral and oblique radiographs. Note the metallic markers in the jugular furrow. The 3 bbs are seen between the characteristic anatomy of C5 and C6 on the lateral image. Even though the vertebral bodies are cut off in the oblique view, the interpreter is still localized by the bbs. Also, the digital label of the projection informs the viewer of how the image was acquired, thereby differentiating left and right sides.

Although articular process joint pathology can cause significant performance limiting problems, it is important to recognize that enlargement can also be found as incidental remodeling with no associated clinical signs[2,3] Therefore, as with so many radiographic findings, clinical correlation is crucial. This variability also makes interpreting risk on screening radiographs difficult and requires compiling clinical history and exam, severity of the changes, intended use, owner risk tolerance and resale considerations to best prognosticate the

Figure 5: Enlargement of C6-C7 articular process joint resulting in intervertebral foramina narrowing radiographically

significance of articular process joint changes.

The spinal canal should be assessed for malalignment, including a "step" between vertebrae or angulation such as kyphosis. Mild dorsal angulation can be found incidentally, particularly at C3-C4 and be clinically insignificant. If there is concern for dynamic instability, it can be useful to acquire images with the neck in extended, neutral and flexed position to see if that changes the angulation. Clinically significant angulation can occur due to dynamic instability, often secondary to trauma. Malalignment can also be due to developmental abnormalities. Spinal cord compression due to malalignment or instability will result in neurologic deficits (Figure 6). C2-C3 is somewhat more forgiving of mild-moderate subluxation due to the wider spinal canal at this level.

Intervertebral disk disease has received much less attention in horses than small animals, but recent work has shown that it may be more prevalent than previously thought[4,5]. Radiographic indications of intervertebral disk disease can include disk space narrowing, endplate sclerosis, endplate lysis and spondylosis. The disk space width should be assessed on the images centered at that space – when the disk is on the periphery of the image, beam divergence can make it artifactually look narrow. A radiographically normal disk space does not rule out intervertebral disk disease.

Figure 6: Severe malalignment and spinal cord narrowing at C3-C4 with marked kyphosis and cervical vertebral malformation. Subluxation of the articular process joints at C2-C3 and C3-C4.

CONCLUSION

Imaging of the cervical spine is complex not only due to the anatomy, but also the degree of extrapolation required given the portions of the anatomy not readily visible with standard imaging, such as the spinal cord and nerve roots. Evaluation of pathologic changes must take into account possible artifact as well as the variable clinical significance of the findings.

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Equine Gastric Disease: What causes it and what can we do to prevent it ?

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THE TERM equine gastric ulcer syndrome (EGUS) was previously used to describe squamous gastric disease (ESGD) and glandular gastric disease[1] (EGGD). More recently however, there has been a growing appreciation of the differences between both these diseases with a realisation that the pathophysiology, risk factors, treatment and management of ESGD cannot be extrapolated to EGGD. Whilst both conditions may occur concurrently, it does not necessarily mean there is an association between them.

Acid suppressive therapy remains the cornerstone of treatment for both ESGD and EGGD with additional strategies often employed in EGGD. Implementing management changes to reduce risk factors is essential to maximise healing rates and to prevent recurrence when disease has been identified. Ideally horses would be managed in such a way that the risk of gastric disease was minimised but this can be challenging where recommendations conflict with traditional training practices. There is also a high prevalence of disease in feral horses, broodmares and other groups that do not have the accepted risk factors, therefore it is unrealistic to think we can prevent gastric disease through management alone. This also raises questions as to whether gastric disease is "normal" and makes it difficult to know when treatment is indicated. A recent study provided further evidence for the potential of ESGD to limit performance, although no such association was found with EGGD [2].

EQUINE SQUAMOUS GASTRIC DISEASE

Squamous gastric disease primarily occurs as a result of acid injury to a tissue that has limited defence against a low pH environment. Any disruption to the normal stratification of gastric pH will therefore increase the risk of ESGD. Excessive exposure to acid causes the stratified squamous epithelium to become thickened and hyperkeratotic. Continued acid exposure leads to sloughing of the superficial epithelium which can progress to deeper lesions and areas of erosion and ulceration[3]. Grading of lesions within the squamous mucosa should follow the Equine Gastric Ulcer Council 0-4 scoring system[1].

Diet and exercise have consistently been shown to play a major role in the development of ESGD[4–8]. In horses prone to squamous disease, grain feeding should be eliminated from the diet to reduce the production of volatile fatty acids [4]. For horses in heavy work, or those that require additional calories, oils provide a safer alternative to cereals. In a study conducted in ponies, corn oil supplementation (45ml/day for 5 weeks) was beneficial to gastric health and was shown to decrease gastric acid production and increase prostaglandin production[9]. Maize (corn), vegetable or canola oil can all be used at up to 1 ml/kg bwt per day. Oil should be gradually introduced over a few weeks to allow the horse's metabolism to adapt. Horses should receive supplementation with vitamin E (2000 iu/day) when feeding oil, to mitigate the potential for oxidative injury as a result of increased free radical production.

Feed deprivation has also been shown to cause an increase in gastric acidity, a reduction in intraluminal pH and the development of squamous disease[8]. A study conducted on racehorses in Australia demonstrated that those with free access to pasture were 3 times less likely to have ESGD[10]. A 2015 consensus statement [1] also recommended free access to good quality grass pasture or frequent feeding of hay (4-6 meals/day) to help restore the normal stratification of gastric pH. In one study feeding straw as the sole roughage source increased the prevalence of ESGD [4].

Exercise causes gastric compression, disruption to the stratification of gastric pH and 'splashing' of acidic fluid onto the squamous mucosa [11]. Feeding a small amount (2-3L) of roughage prior to exercise to prevent this acid 'splash' would therefore seem logical to reduce the risk of ESGD. As the duration of acid exposure also parallels the risk for development of squamous disease [12], horses prone to ESGD should ideally be trained with short duration, high intensity exercise programs.

Environmental factors have also been demonstrated to play a role in the development of ESGD. Horses are herd animals and direct contact with others and a rural environment reduced the risk of ESGD in a large study of Thoroughbred racehorses; individual trainer, lack of contact with other horses, solid partitions and playing talk radio were found to increase the risk [10]. Other risk factors specific for ESGD include being owned for a shorter period, an increased time in work, travelling, current training or recent racing and stereotypies.

In cases where risk factors are persistent (e.g. racehorses in training), the prophylactic use of oral omeprazole should be considered. A 2019 meta-analysis demonstrated that omeprazole prevented ESGD in horses in training with only 23% of treated horses developing squamous disease, compared to 77% which were given no omeprazole prophylaxis[13].

GLANDULAR DISEASE

Glandular gastric disease likely represents a multifactorial syndrome with different underlying aetiologies. Unlike the squamous mucosa, the glandular epithelium has several mechanisms to protect it from injury by hydrochloric acid. These include the secretion of mucus and bicarbonate, good mucosal blood flow, epidermal growth factors and prostaglandin secretion[14]. The pathogenesis of EGGD is poorly understood but it has been hypothesised that failure of normal defence mechanisms may predispose the glandular mucosa to injury[15]. We now know that how we manage squamous disease cannot simply be applied to the management of glandular disease.

Whilst acid injury is not thought to initiate EGGD, a low pH may perpetuate mucosal injury and prevent healing[1]. Recent work also indicates that unlike ESGD, the lamina propria is rarely damaged in EGGD which represents more of an inflammatory gastritis rather than an ulcerative condition. A validated hierarchical grading system for EGGD is yet to be developed, and lesions are typically described according to their anatomical location, distribution and appearance[15].

In recent years, a growing body of evidence has indicated that both physiological and psychological stress may play a role in the development of EGGD [15–19]. Frequency of exercise has been demonstrated to be an important risk factor; the risk of EGGD was shown to increase 10-fold in Thoroughbreds exercised more than 5 days per week [18]. Another study in Canadian showjumpers found a 5-fold increase in risk of disease in horses exercised more than 6 times per week [19]. It has been postulated that the frequency of exercise may negatively impact gastric blood flow, thereby impairing the normal protective mechanisms of the gastric mucosa. There is

evidence that limiting exercise to up to 5 days per week may reduce the risk of EGGD [15]. Warmbloods appear predisposed and in this breed number of days in work and active competition further increase risk [20]. In endurance horses risk increases in horses that are competing [21].

Trainer has been identified as a risk factor for the development of EGGD in Thoroughbreds [18] and in a riding horse population having a greater number of handlers and riders was associated with a greater risk of disease [22]. Horses with EGGD have also been shown to have greater increases in endogenous cortisol in response to novel stimuli as well as exogenous ACTH, suggesting that they may be more sensitive to stress[16,17]. Measures to minimise stress should be tailored to each individual as the effectiveness of specific interventions will vary widely between horses. Number of human riders/carers has been shown to be a risk factor for EGGD [23]and in a recent study of Quarter Horses pet horses and horses with greater human contact were more likely to suffer from the condition [24]!

Associations between diet and EGGD have not been identified consistently despite investigation in a number of studies. A recent study of Standardbreds did show as association between dietary sugars and risk of EGGD and a reduction in EGGD in horses subsequently fed alfalfa [25]. Mucosal protectants such as pectin and lecithin complexes may be beneficial in the prevention of EGGD[15,26]. Lecithin is a phospholipid and pectins are highly viscous substances which may aid to stabilise the protective mucus layer[26] of the glandular mucosa, however robust clinical trials to prove their efficacy are lacking.

CONCLUSION

Optimising diet and management are fundamental to the prevention of gastric disease. Careful consideration should be given to the constituents of the diet as well as the timing and frequency of feeding. Exercise routines should be developed such that exercise follows the provision of some roughage and shorter bursts of higher intensity exercise are preferred over longer lower duration exercise. Management should be as consistent as possible, and stressors minimised. Where diet and management are insufficient, omeprazole is effective in preventing squamous disease and mucosal protectants such as oil, pectin and lecithin may reduce the risk of glandular disease.

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How to Perform an **Equine Oral Examination**

By Jeff Reiswig DVM, PhD, Dipl. AVDC/Eq

INTRODUCTION

Many of us were taught in veterinary school to float teeth, never giving a thought to a proper oral examination. Clients call requesting a dental float without even considering the importance of examination. We now realize how important it is to perform a dental exam prior to any treatment, even floating.

An oral evaluation can be broken down into four main components:

- The orthodontic examination to determine if the teeth are in proper alignment and find the dental overgrowths caused by misalignment.
- The periodontal examination to determine pathology of the periodontal ligament, gingiva and alveolar bone.
- The endodontic exam to detect pathology of the dental pulp and tooth structure.
- The oral soft tissue exam is performed to determine pathology of the cheek, palate and tongue including trauma and neoplasia.

These examinations can occur individually or concurrently but should be performed in a consistent order to minimize pathology being overlooked.

Using minimal, inexpensive equipment and simple examination techniques, the equine practitioner can recognize dental disease and inform owners of treatment options. The oral exam should be performed in a safe environment for the horse and practitioner. This may be in a stall, wash stall or stock. The footing should be level and not slippery. Backlight should be minimized because it makes it difficult to illuminate the oral cavity with a headlamp.

The equipment needed for a proper dental exam in the horse includes:

- a full mouth speculum
- bright light source (headlamp)
- dental mirror
- dental explorer (Shepherd's Hook)
- periodontal probe *(Figure 1).*

Each instrument should have a handle long enough, usually 19 inches, for the working end to reach the third molar. Standard-sized, pet animal, periodontal probes and explorers may be used for the incisors and canine teeth. The working end of periodontal probes should be thin and have grooved markings for measuring pocket depth. For a more complete

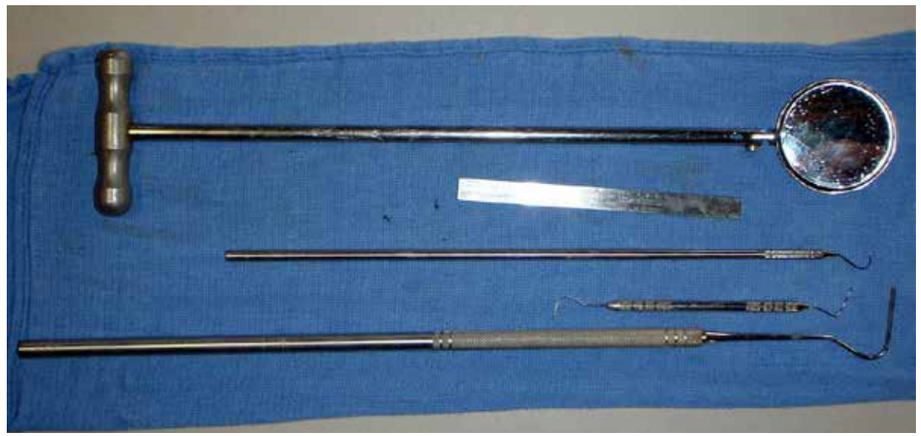

Figure 1. Basic equine examination equipment from top to bottom includes a dental mirror, measuring device, Shepherd's hook dental explorer, 6-inch combination dental explorer and periodontal probe, and a long handled periodontal probe for examination of pocketing around cheek teeth.

diagnosis of endodontic and periodontal abnormalities, dental radiography is necessary.

Prior to sedation, perform a general health exam to ensure there are no cardiovascular conditions that would make the patient unfit for sedation. Next, perform an extra-oral exam of the patient's head. This portion of the exam includes palpating the temporomandibular joint, the upper and lower jaws and just ventral to the facial crest along the buccal surface of the upper cheek teeth. Swellings, draining tracts or areas that are painful should be noted for further investigation.

To perform the oral exam, sedate the patient using methods for standing restraint and rest the patient's head in a dental halter or head stand. The incisors are examined prior to the placement of a full mouth speculum. Part the lips and observe the upper and lower incisors as well as the canines on the labial, lingual, proximal and occlusal surfaces. Normal alignment of the incisors is when they are in contact with the midline of the upper incisors directly opposing the midline of the lower incisors and are level on the horizontal plane. Note any deviations from the normal alignment as well as diagonal, ventral or dorsal curvatures of the incisors. These misalignments are often due to uneven jaw growth during development and may or may not require therapy. When the incisors are observed from the lateral view the upper incisors should be in occlusal contact with the lower incisors. A misalignment in which the lower jaw is shorter than the upper jaw causing the upper incisors to rest rostral to the lower incisors is called a Class II Malocclusion. This can be caused by either mandibular brachygnathism or maxillary prognathism. The opposite misalignment in which the upper jaw is shorter than the lower jaw is a Class III Malocclusion. This can be caused by either mandibular prognathism or maxillary brachygnathism. The number and location of incisors are noted as well as their color, mobility and surface texture. The gingiva, mucosa and adjacent soft tissues should also be examined. The gingiva surrounding the incisors should be light pink, smooth and even along the vestibular margin. A periodontal probe is gently introduced into the gingival sulcus at multiple locations around each tooth to identify periodontal pockets. Gingival sulcal depths of 1 to 2 mm are considered normal.

Inspect the occlusal surfaces of the upper and lower incisors both visually and with the dental explorer. Use a 6-inch dental explorer to examine the incisors and canines. The explorer is designed to be used above the gingival margin by drawing the point of the instrument over the tooth surface. Normal dental tissues should be hard and smooth and the explorer will glide across the surface of the tooth. Defects in the cementum, enamel or dentin may be seen visually or felt as soft, "sticky" areas when a dental explorer is drawn over the defect. Special attention should be employed with the dental explorer to the brown stained area (the dental star) that sits labial to the infundibulum. The dental star is stained secondary dentin that has filled the pulp cavity to prevent pulp exposure during the eruption and wear of the dental crown. This is where a pulp defect will be found. If the explorer sticks into the dentin or drops into the pulp cavity, this is an indication of endodontic disease. All incisor and canine crown fractures should be examined with a dental explorer to determine if a pulp exposure has occurred. A discolored tooth (excluding stained cementum) may have suffered pulp injury. Tooth fractures, pulp defects and discolored teeth should be radiographed to make a diagnosis and offer a treatment plan.

Figure 2. A cheek retractor and bright light source are used to view the point of cheek teeth occlusion and to determine cheek teeth overgrowths that may cause premature contact during mastication.

Examine the gingiva surrounding the incisors for gingival recession and draining tracts. Draining tracts from abscessed incisor teeth appear like papules or draining tracts at the mucogingival margin. When an incisor or canine tooth abscesses, the tract typically drains intraorally, either at the mucogingival margin near the infected tooth appearing like a small papule or along the periodontal ligament.

Before using the oral speculum to look at the cheek teeth, place a cheek retractor in the commissure of the lip and look in the vestibule on the left and right side alongside the cheek teeth to observe the space between the upper and lower cheek teeth called the free space *(Figure 2).* Shift the mandibular incisors left and right and observe the point of molar contact of the cheek teeth. This view along the space between the cheek teeth reveals overgrown teeth and the potential for premature contact during the chewing cycle. Lateral excursion of the mandible can be examined by moving the lower jaw to the left and right to the point where the cheek teeth contact and separate the upper and lower incisors while the head is resting in a dental halter or stand. The excursion to molar contact can be measured by comparing the location of midline of the lower incisors in relation to the upper incisors when the cheek teeth come in contact and cause the upper and lower incisors to part. Observing the point of cheek teeth contact identifies the cheek tooth overgrowths that are making premature occlusal contact and should be reduced.

A second objective measurement of mandibular motion during occlusion is the rostral-caudal mobility (RCM). During the chewing cycle the lateral pterygoid muscle contracts, causing a slight rostral-to-caudal motion of the mandible. This range of motion can be duplicated passively in the sedated horse by comparing the relative positions of the upper and lower incisors when the head is held in a horizontal plane to when the head is held vertically. When the neck is flexed 90 degrees at the poll, the mandible will move rostral in relation to the maxilla. A measurement is made comparing the difference between the labial surface of the upper and lower first incisors when the head is held in a horizontal plane versus the difference when the head is flexed 90 degrees at the poll. Failure of the mandible to move rostrally may indicate dental interlock, which is occlusal interference due to overgrown cheek teeth that prevents normal range of mandibular motion during mastication. RCM has been found to increase after floating and occlusal correction of dental overgrowths.

To examine the cheek teeth, place a full mouth speculum in the horse's mouth. Examine the cheek teeth in a systematic fashion, looking for sharp enamel points that may be lacerating the cheeks or tongue. Examine the occlusal surface for dental overgrowths such as hooks, waves, steps and excessive transverse ridges. Overgrowths occur due to misalignment of cheek teeth or to pathology of teeth in the opposing arcade; for example, a fractured tooth, a dysplastic tooth that did not develop normally, an aged tooth with no infundibular enamel, a missing tooth or a widened interproximal space. These pathologic conditions will lead to steps or excessive transverse ridges in the opposite arcade. The elongated tooth is a normal tooth that is not sufficiently worn by the opposing "pathologic tooth" during mastication.

The interproximal spaces between teeth are examined for separations called pathologic diastema where foodstuffs lodge and cause periodontal disease. Food must be cleaned from the space with long handled Gracey-curettes and lavage. After cleaning the interproximal space of food material, tartar and plaque use a periodontal probe to measure gingival recession and depth of pocketing to determine the amount of periodontal attachment loss. Examine the occlusal surface of each maxillary and mandibular cheek tooth using a dental mirror and dental explorer. Look for fractures, pulp exposures and cavities. Feel for defects in the occlusal surface by pulling the sharp point of a long equine dental explorer over the occlusal surface of the tooth. The brown stained areas on the occlusal surface are secondary dentin that was laid down in each of the retreating pulp horns. A clinician should carefully explore these areas for pulp defects *(Figure 3*). Infundibula should be assessed for decay and care must be taken not to mistake the vascular channels in the center of the two maxillary cheek teeth infundibula as pulp defects. The practitioner should note if the decay involves the central cementum only (Grade 1), cementum and enamel (Grade 2), or if it extends past the infundibular enamel into the dentin (Grade 3). Additional signs of endodontic disease in the maxillary cheek teeth are draining tracts or nasal discharge that is typically unilateral. Swellings or draining tracts that develop along the ventral border of the mandible may be an indication of dental disease in the mandibular cheek teeth. After examining all the cheek teeth and the interproximal spaces with a dental mirror, periodontal probe and dental explorer, also examine the oral soft tissues. Use a dental mirror and cheek teeth retractor to examine the cheek and hard palate. Move the tongue

Figure 3. Using a mirror to examine tooth 407, a pulp defect of the second pulp horn is observed. When a dental explorer was drawn across this area it stuck into the defect. Observation of a pulp defect is an indication for dental radiographs.

side to side to examine the sublingual portion of the oral cavity. Look for lacerations caused by sharp enamel points, foreign bodies embedded in the cheek or tongue and soft tissue lumps and growths that may need biopsied. Dental endoscopy is becoming more affordable and common and provides a more detailed examination of the oral cavity and teeth. Record all of the examination findings, radiographic interpretations, treatments and prognoses in a dental record or medical chart.

Proper diagnosis and treatment of dental disease necessitates a complete oral examination and the identification of pathology such as elongated teeth, discolored teeth, draining tracts, pulp defects, cavities, fractures, feed impactions, periodontal pocketing and soft tissue lesions. A thorough oral examination with ancillary testing such as dental endoscopy and radiography leads to a complete diagnosis so that a treatment plan and a prognosis can be established. Treatment will decrease patient pain and improve the health of our equine patients.

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Principles of **Therapeutic Farriery**

By Mr. Shane Westman

THE EQUINE FOOT is the source of most lameness.[1] Other problems in the musculoskeletal system may be initiated by hoof injury or improper trimming or shoeing. Application of therapeutic hoof orthotics beyond a basic horseshoe are often utilized in treatment of lameness. The term therapeutic farriery is not well defined within the industry. Dr. Harry Werner defined therapeutic farriery, "the treatment of diseases or disorders of the equine limb by application of remedial methods and/or appliances to the digit."[2] Werner went on to state "Therapeutic farriery employs a broad range of treatments that extend from the simple removal of an inappropriate shoe to the use of sophisticated diagnostic imaging and construction of a custom appliance." Dr. Andrew Parks wrote, "the application of therapeutic farriery would follow a linear or algorithmic approach in which a definitive diagnosis determines which tissues are injured, and with this knowledge an optimal farriery solution can be applied... The goals of therapeutic farriery should be considered as concepts that are applied to achieve the desired effect regardless of the manner in which they are achieved."[3] This author has a similar view and believes a harmonious relationship between veterinarian and farrier can exist for soundness and performance of the horse.

A definitive diagnosis must exist to then develop a prescription for application of an orthotic device. Expertise, diagnostic equipment, and license possessed by a qualified veterinarian are required to create a diagnosis.[4] A deep understanding of how farriery interventions can affect function of the structures involved are required to develop an effective treatment protocol.[2-4] Farriers do not have license to diagnose lameness. Veterinarians and non-specialized farriers often have gaps in their knowledge in advanced farriery concepts and modern tools available in hoof care. These two practitioners and their differing but complimentary tools, skills, and abilities should optimally work together for the highest chance of successful outcome in lameness work. For successful communication, each practitioner should learn the basic language and concepts for the other and learn to develop a working relationship based on mutual trust, professional respect for the skills and knowledge the other possess.

Farriery continues to be largely based on practice-based evidence, handed down generation to generation. Though hoof care is generally considered to play a key role in maintaining soundness and performance of the horse, robust peer-reviewed research in the field of farriery has historically been lacking.[5] 'Normal' or 'ideal' structure or conformation is largely based on anecdotal information printed in textbooks without research-based evidence.[5] In recent years, farriery related research has been increasing with a focus on the interaction between the foot and ground surface. Farriery choices can influence hoof impact, load, pressure, leverage, hoof flight, and traction. This article explains basic concepts related to therapeutic farriery used by the author in a clinical setting based on scientific studies and information available.

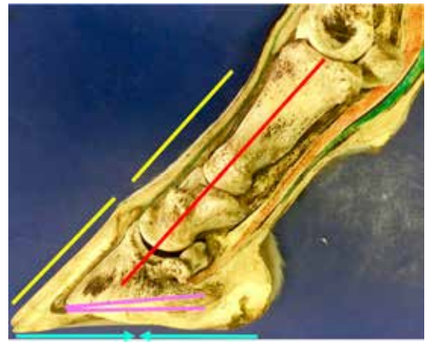
IT STARTS WITH THE TRIM

Dr. Hans Castelijns, veterinarian and certified farrier, wrote "if for therapeutic or performance reasons we want to modify the hoof-shoe combination, there is a not a lot of leeway in the trim of a particular foot, while the applied shoe type, placement and adjustments give us endless possibilities."[6] Outside of extreme circumstances such as severe laminitis, the goals in trimming the hoof remain consistent.[7] A short internet search brings up numerous named or labeled trimming methods theorizing the most ideal way to achieve 'balance' for the foot and limb for function and health. The term balance in trimming is not well defined in literature and continues to be widely debated. Examples of sound trimming are based on creating symmetry on an ideal hoof on a digit with ideal conformation.[9] The ideal hoof is symmetric and aligned directly under the limb when standing. The ideal foot lifts straight, travels in line when moving, and lands flat.[10-11] Most horses are not ideal in conformation, however, and have some deviation in symmetry or mechanics which may be congenital or acquired through injury. The correct trim may be adjusted to compensate for these deviations to enhance biomechanical efficiency. Though the technique or finish to achieve static 'balance' may be different for these trimming systems, the overall goals are generally similar for biomechanical efficiency.[8-12]

HOOF ASSESSMENT

The author follows general guidelines for assessment based on anatomical landmarks.

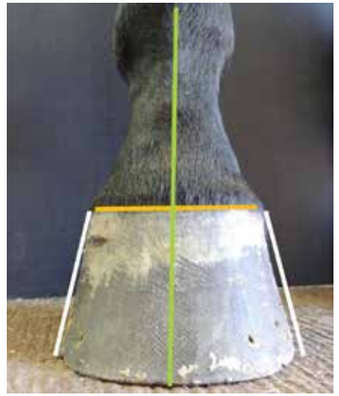
VIEWING FROM LATERAL (FIG. 1)



- Hoof-pastern alignment – a straight line from the fetlock to the ground along the dorsal surface on the healthy foot.
- Straight or gently curved hairline – absence of proximal or distal deviations along the hairline.
- Consistent growth rings – rings follow angle of hairline and are spaced evenly with each other without divergence.
- Dorsal hoof wall length – dorsal wall length is in proportion to the size of the horse allowing adequate depth to allow protection for the structures of the foot and proper biomechanical function.
- Heel length and angle– heel length is in proportion to the size of the horse and angled similarly to the dorsal surface.
- Digital alignment – similar to the hoof-pastern alignment but measured as a straight line through the center of the phalanx bones.
- Best viewed radiographically.
- Digital alignment may differ than hoof-pastern alignment in cases of laminitic associated displacement of the distal phalanx.
- Palmar/Plantar angle – Positive angle in relation to ground surface of the hoof.
- Dorso-palmar/plantar symmetry – length from center of rotation to termination of the toe is similar to the termination of the heel.

VIEWING FROM DORSAL (FIG. 2)

- Medial-lateral symmetry – similar length of medial and lateral wall.
- Foot centered under limb – ideally a line bisecting the limb also bisects the hoof.

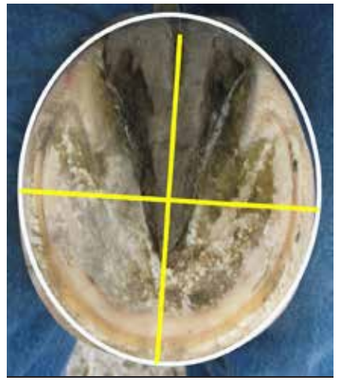


Discretion due to conformation must be used.

- Straight hairline – no areas of displacement proximally or distally.
- Consistent rings – rings follow angle of hairline and are spaced evenly with each other without divergence.

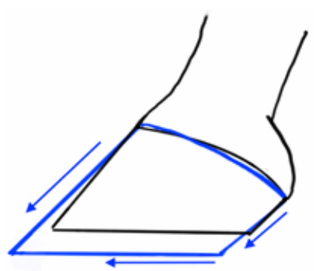
VIEWED FROM SOLAR (FIG. 3)

- Hoof capsule symmetry – Ideally equal area of hoof medially, laterally, dorsally, and palmarly/plantar around the center of the foot. Discretion due to conformation must be used.



- Hoof wall thickness – consistent thickness around perimeter of hoof.
- Frog – Straight, thick, and wedge-shaped frog.
- Bar health – thick, upright, straight, or gently sloping bars.
- Sole Depth – adequate sole depth for protection of bone and sensitive structures in proportion to body size.

When assessing the digit for therapeutic farriery, knowledge of where the hoof growth is in the trimming cycle is important. Assessing a hoof that was trimmed/shod 8 weeks prior will require different judgement than the same hoof just trimmed/shod due to the effects of normal growth.[13-15] Normal hoof growth is demonstrated to decrease the hoof angle during the trim cycle *(Fig. 4)*. Growth creates a palmer shift with the center of pressure, increasing load on more acutely inclined heels, altering distal interphalangeal joint (DIPJ) angulation, and increases load on structures such as the deep digital flexor tendon (DDFT). Medial-lateral variable asymmetries are created due to repeated landing and unrollment patterns during the trim cycle.[15] Hoof growth and length effects are similar on the front and hind feet. A short, regular trimming cycle of 4-6 weeks to prevent excessive loading of structures is recommended for most horses.[15]



BEYOND THE TRIM: CONSIDERATIONS FOR A THERAPEUTIC FARRIERY PRESCRIPTION

- Forces of load and leverage can be moved around the foot, but cannot be removed from the foot. 3, 16
- Evaluate the possible negative consequences of shoe selection.
- Consider the effect of additional shoe weight and distribution of weight's effect on foot flight during the stride.17
- Is the injury to soft or bony tissue, proximal or distal?
- Is the injury acute or chronic?
- Will the horse be rested or worked?
- Footing during rest, rehab, and work: Firm vs deformable
- What is the horse's living situation? Paddock/stall/pasture
- Don't ignore the support leg/legs!

BASIC BIOMECHANICS TERMINOLOGY

The hoof care provider has the power to manipulate certain forces acting on the limb. A basic understanding of these biomechanical principles and terminology helps to develop and communicate a more effective shoeing prescription for specific injury while paying attention to the side effects of altering the forces acting on the limb.

GROUND REACTION FORCES (GRF)

Sir Isaac Newton's laws of motion form the basis for classic mechanics. Newton's third law of motion states that when two bodies interact, they apply forces to one another that are equal in magnitude and opposite in direction.[18]

Applied to the standing equine, the forces of magnitude and direction exerted by the body are matched equally but opposite by the ground.[3, 16, 19]

- GRF is represented as a vector that represents the sum of all individual forces on the surface of the body in consideration.
- Newton's second law of motion states that the time rate of change of the momentum of a body is equal in both magnitude and direction to the force imposed on it.18
- Muscle forces move the equine limb and the GRFs are adjusted allowing the horse to move in different gaits, speed, and direction.[19]
- Landing or impact is the most critical part of stance phase for musculoskeletal injury.
- Impact force is a result the grounds reaction to impact on the limb on landing during motion.[16,19]
- Magnitude of GRF dependent on horse's weight, speed of movement, and surface footing.[16]
- Farriery can manipulate GRFs by changes to trimming, shoe length, shoe position, toe area, shoe toe or heel height, or shoe contact area with the ground surface.[16]

CENTER OF PRESSURE (COP)

- CoP is the term given to the point of application of the GRF vector.[3,19]
- CoP represents the sum of all forces acting between a physical object and its supporting surface.[3,19]
- CoP is not a static outcome measure, but dynamic.[3,19]
- Whether CoP increases or decreases the stress within a structure depends on how the structure functions and in which direction the center of pressure is moved.[3]
- Deviation from straight limb conformation will affect the CoP. For example, on a toed-in horse CoP will be lateral to that of a straight limb. On a base wide horse, the CoP will be medial to that of a straight horse.
- The manner in which the ground surface of the hoof interacts with different footing affect pressure force distribution.[20]
- Horseshoe selection influence how horses' hooves interact with different ground surfaces, during the impact, loading and push-off phases of a stride cycle.[21]

MOMENT ARM OR LEVER ARM

- The Moment of a force is a measure of its tendency to cause a body to rotate about a specific point or axis.[22]
- A moment arm is the perpendicular distance between the line of action of the force and the center of moments.[22]
- Various moments act to flex and extend joints.
- Manipulating shoe placement, length, width, and placement of point of breakover can affect moment force and torque on the joints of the distal limb.[16]

THERAPEUTIC HORSESHOE SELECTION

DEFINE "SHOE"

To most, the mention of horseshoe conjures an image of a length of steel covering the perimeter of the hoof that is nailed on. The historic alternative to shoe is to be barefoot, and debate has raged for hundreds of years which is better for the horse. The scope of this report is not do debate which is the best choice for the horse, or even which shoe may be best, but to highlight the many options available to the hoof care practitioner for any specific mechanical goal. The


Oxford Languages defines shoe: "*Noun* 1. a covering for the foot, typically made of leather, having a sturdy sole, and not reaching above the ankle. 2. something resembling a shoe in shape or use. *Verb* fit (a horse) with a shoe or shoes." In context of the farriery, the author considers a shoe to be any material covering the foot, attached in any matter for the purposes of protection, force manipulation, traction, or therapeutic reasons. A shoe may be fabricated with steel, aluminum, synthetics, composites, textiles, adhesives, or a combination of these materials. A shoe may be attached to the foot an any manner including nails, adhesives, screws, cast, or tape.

EFFECTS OF SHOE MODIFICATIONS

WIDE BRANCH SHOE OR ASYMMETRIC SHOE

- The branch on one side of the shoe is wider than the opposite branch. The larger the difference, the larger the effect.
- In deformable footing the wide branch creates 'floatation,' or will not penetrate into the footing while allowing the narrower side to penetrate further into the footing.[23]
- Pressure moves toward wider side during loading.[23]
- Characteristics of breakover may be affected.

The narrower branch side will have reduced concussion and load, but more motion, relieving bony structures of the same side and more tension on soft tissue.

The wider branch will protect the soft tissue above by hindering movement of the joint but creating more compression on bony tissue.

Effects are not consistent and may be affected by the conformation of the horse.[23]

An asymmetric shoe may be bought off-the-shelf pre-manufactured or fabricated with forged modification, added with welded inserts, or built with composites adhered to the hoof or shoe *(Figs. 5, 6, 7)*.

LENGTH

- Length is ground bearing surface area added beyond the normal length or width of the hoof.
- Length can be added to:
  - Support the deviant limb.
  - Move center of pressure.
  - Influence motion about the distal interphalangeal joint.
  - Change stance, and change direction of travel.
- Adding length may lead to hoof capsule distortion or stresses similar to the asymmetric shoe due to changes in GRFs.



- Length may be added with off-the-shelf shoes, changing shoe placement, selection of a larger shoe, forging modification, welded insert, synthetics, or built with composites adhered to the hoof *(Figs. 8, 9, 10)*.

POINT OF BREAKOVER (POB)

- PoB is the fulcrum at the most dorsal point of ground contact that the foot rotates around.[3,24]
- Moving PoB more dorsal by leaving toe length or trimming to a more acute angle has not been shown to have any effect on stride length.[3,24]
- Breakover duration is significantly prolonged with a longer toe.[3]
- Moving PoB more palmar reduces dorsal lever arm.[3,16,23]
- Shortens the moment arm of the GRF on the DIP joint.16
- Does not alter the duration of breakover or the force exerted on the navicular bone.26
- It may smoothen hoof unrollment.26
- It may cause breakover to occur slightly earlier.[24, 26]
- Placing the breakover in relation to the dorso-distal border of the distal phalanx is a more dependable location than placing breakover guided only by the outer hoof capsule.24
- PoB may be manipulated with shoe placement, rolled toe, rocker toe, square toe, welded inserts, or off-the-shelf options *(Figs. 11, 12)*.


- Effect may be magnified by adding width or depth to the shoe *(Fig. 13)*.



ELEVATION

- Elevating an area displaces pressure toward the elevated side.[3,16,28]
- Decreases strain in the DDFT.[27]
- May increase strain in the Suspensory Ligament. Effect on the superficial digital flexor tendon remains disputed.[27]
- The opposite effects are achieved when a wedge is applied to the toe.[28]
- Reduces force exerted by the DDFT on the navicular bone due to decrease in the tension of the DDFT and a shortening of the extensor moment arm. [3,16,28]
- Effects of elevation may affect the hind limb differently than the front limb.[28]
- Stance duration is not affected by application of a wedge.[16]
- Change to the pattern of hoof impact.16
- Delays unloading of the heel.[16]
- Induces flexion of the DIP and PIP joints and increases intra-articular pressure of the DIP joint.[3,16,27,28]
- Elevation may be added with the use of forging modification, pads, welded inserts, composites, or off-the-shelf options *(Figs. 14, 15, 16)*

SIDE ELEVATION

- Application of a lateral or medial wedge shifts the CoP toward the wedged side.
- On penetrable ground, this effect is minimized due to the sink in of the medial side of the hoof.[29]
- A 4° elevation of the lateral side with a side wedge did not alter the footing pattern constantly. [29]
- Not the whole 4° was transmitted directly to the distal phalanx. [29]
- Application of the side wedge shoe caused a constant unilateral narrowing of the lateral aspect of the DIPJ on the elevated side on firm ground. [29]
- Was not possible to alter the alignment of the middle and proximal phalanx by using the side wedge horseshoes. [29]
- Side elevation may be added with the use of forging modification, pads, welded inserts, or composites.

DYNAMIC ELEVATION

- Utilization of a widened section of shoe, increasing the surface area to decrease penetration of the widened section into deformable footing.
- Induces more progressive elongation of tendon.[30]
- May improve deformability of scar tissue.[30]
- May avoid tendon contraction.[30]
- Dynamic elevation such as onion heels, straight bar, egg bar, heart bar, wide toe, asymmetric shoes may be added with off-the-shelf shoes, forging modifications, weld in inserts, or narrowing or removing sections of the shoe by grinding or cutting *(Figs. 17, 18, 19)*.



IMPACT FORCES

- Impact part of the stance phase is associated with high magnitude and frequency vibrations.[32,33]
- Shoeing with steel alters the concussion dampening mechanism of the distal limb on a firm surface.[32]
- Steel increases the magnitude and frequency of shock waves experienced by the foot as it decelerates during the landing phase of the stride compared with an unshod foot.[32]
- This does not seem to transmit to the upper limb.[32,33]
- Most dampening happens between the hoof wall and distal phalanx.[32]
- Deceleration force (the rate at which the force decreases at impact) is not significantly different when steel shoes are compared with the unshod condition.[32]
- Evidence indicates that specific shoes and shoe-pad combinations can reduce the magnitude and frequency of impact vibrations.[34]
- Viscoelastic pads with or without sole filling may further enhance this effect.[34]
- Shoes of different materials present differences in shock absorption.[21,34,35]
- Footing surface has a larger effect than shoe selection on impact.[21]
- Impact forces may be mitigated by the use of pads, pour in urethanes, silicone sole packing, aluminum shoes, or synthetic shoes *(Fig. 20, 21, 22)*.



Hoof care knowledge has increased at an increasingly accelerated rate in the last few decades. The tools, techniques, and materials used in farriery have evolved a great deal with new products arriving to the market or borrowed from other industries. With all of the options available, decisions while building a prescription after a diagnosis can be difficult for the veterinary clinician and should consider the farrier involved in the application. An understanding of mechanical principles that can be addressed with farriery by veterinarian and farrier is paramount. Mechanical goals should be decided upon first, then an orthotic shoe package built to satisfy those goals keeping in mind the variables such as living environment, cost, and farrier's skill set. Understand no one shoe is perfect for any situation, and any one situation will have a number of shoes that may fill the prescription. A horse may not respond positively to a shoe package, or not respond at all. It is important for the practitioner to be flexible and have another solution available. Incorrect decisions and trial and error are part of the learning process in learning what is best for the horse. There is so much more we still need to learn, the evidence in our industry is only still catching up.

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Stem Cells and Stem Cell-less Therapies for Tendon and Ligament Injuries

By Stacey Oke, DVM, MSc

RESEARCHERS AND PRACTITIONERS are finding more protocols for stem cell and stem cell-less therapies for tendons and ligaments.

Musculoskeletal injuries continue to plague the equine industry, remaining a leading cause of lost training days and attrition. Of the available therapies veterinarians use to expedite quality healing, stem cells have opened a whole new world for repairing and regenerating these finicky tissues. There are, however, a surprising number of roadblocks to using stem cells that limit either their use or effectiveness. A new technology is emerging that holds promise for alleviating many of the issues with using stem cells. It is called stem cell-derived extracellular vesicles (EVs).

"EVs are essentially intracellular 'sacs' that contain tons of information in the form of proteins and genetic material. EVs remove the hassle of dealing with live cells and potentially avoid the recipient's immune system," said Aimee Colbath, VMD, MS, DACVS (large animal), an assistant professor in the Department of Clinical Sciences at Cornell University's College of Veterinary Medicine.

This article briefly reviews tendon and ligament injuries and their "natural" healing phases. It relays our current knowledge of the role stem cells play in altering that "natural," yet inefficient, repair process. The exciting world of EVs will then be introduced with suggestions on how this technology could drive advancements from repair to regeneration.

TROUBLESOME TENDONS AND LANGUISHING LIGAMENTS

Tendon and ligament injuries pose major economic and welfare burdens on the industry due to injury frequency and poor healing capacity. The superficial digital flexor tendon (SDFT), for example, is a common site of injury in many disciplines, including racing, eventing and show jumping. The deep digital flexor tendon is often injured in elite show jumpers, and dressage horses are prone to hind limb suspensory desmitis.

"SDFT lesions are overstrain injuries," said Christopher Elliott, BVSc (hons), MANZCVS, DACVSMR, Palm Beach Equine Clinic, Wellington, Florida.

He added, "You can think of the SDFT as an acute on chronic strain or accumulation of microdamage over a period of time … a superphysiological load on top of a cumulative stress or strain."

When injured, tendons and ligaments go through a defined series of healing phases: inflammation, proliferation and remodeling. The inflammatory phase begins immediately after an acute injury. A clot forms among the damaged tissue, and resident cells within this clot release a host of cytokines that cause local inflammation. The clot then serves as a scaffold for recruiting cells that participate in the healing process. Then the proliferative phase begins, characterized by the influx of fibroblasts that begin creating a scar. Angiogenesis is also initiated, as well as cellular proliferation—all orchestrated by a variety of cellular mediators. After about two weeks, the remodeling phase begins. This is where the scar undergoes remodeling and tenocytes and collagen fibers become aligned and cross-link in an attempt to create a tissue with tensile strength.

"The reason why horses' tendons and ligaments are predisposed to reinjury is because the 'natural' healing process results in the production of type III collagen rather than the stronger, more elastic, type I collagen," Elliott explained.

In reality, all three phases overlap, and the remodeling phase can last months to years following injury. Regardless of how efficiently these phases of healing occur, the new tissue will always lack the same biochemical and biomechanical properties as the native tendon.

Thus, the "natural" healing process for these tendon and ligament injuries isn't exactly natural.

Regenerative therapies have the potential to restore tissue function, and stem cells are particularly promising for tendon and ligament injuries.

"Another reason why tendons and ligaments heal poorly and are prone to reinjury is because they have poor vasculature, and it is typically the vessels that transport the elements that cause healing," explained Colbath.

MOVING FROM HEALING TO REGENERATION

As mentioned above, the remodeling phase can last months to years, and the resultant tissue isn't as good as the original tendon and ligament tissue.

"We want to promote healing with as much type I collagen as possible and minimize type III," Elliott emphasized. "Therapies that promote type I will encourage more robust healing and reduce the likelihood of re-injury. We want to increase the quality of healing—not the speed of healing—to have horses successfully return to performance with a low rate of re-injury."

Therapies designed to support maximal tendon and ligament healing include one, or preferably several, of the following:

- Rest
- Anti-inflammatory therapies
- Physical therapy/rehabilitation
- Cryotherapy
- Laser therapy
- Extracorporeal shockwave therapy
- Magnetic fields
- Therapeutic ultrasound

It is unclear based on the evidence we have to date which of these therapies—alone or in various combinations—best supports healing.

"What we can say is that they appear to have benefits, but science is limited regarding what exactly those benefits are and how exactly they help repair and regeneration," explained Elliott.

The lack of "ideal" therapeutic plans and the continued high rate of reinjury at least partly explains why the equine industry met the introduction of regenerative (biological) therapies with open arms, eagerly embracing stem cells in particular for improving tendon and ligament healing.

The term "regenerative therapies" describes a collection of therapies that replace, regenerate or restore tissue or organ function. This field includes tissue engineering as well as cell-based and cell-free stimulation of self-repair mechanisms. Examples include mesenchymal stem cells (MSCs), platelet-rich plasma, autologous conditioned serum and autologous protein solution.

Colbath and colleagues surveyed 423 board-certified equine specialists regarding the types of biologic (regenerative) therapies they used in clinical practice for the treatment of musculoskeletal disease (Knott, et al. 2022). Information regarding primary reason for use, route of administration, preferred protocols, perceived efficacy, adverse effects and limitations was collected.

Key findings from that survey included the following points:

- Bone-marrow-derived MSCs (BM-MSCs) were the third-most-common biologic therapy, slightly less popular than platelet-rich plasma and autologous conditioned serum. In total, 111 of 154 (72.1%) survey respondents reported using BM-MSCs.
- Adipose-derived MSCs (AD-MSCs) were far less popular, with only 30 out of 154 (19.5%) survey respondents indicating they used this therapy.
- MSCs were primarily used intralesionally in tendon and ligament injuries.
- Most practitioners (80%) did not repeat intralesional MSC injections. When those MSC injections were repeated, they were most often repeated 1-2 months after the initial injection.
- Expense was the most common limiting factor for using regenerative therapies.
- "Stem cell therapy is not inexpensive. It costs about $2,000-$4,000 for each round," noted Elliott.

While some attest that the widespread use of regenerative medicine in equine practice currently exceeds the science supporting its use, others feel the available data are promising.

THERAPY	NUMBER OF HORSES	RETURN TO RACING	RACED FIVE OR MORE TIMES
All horses	213	95 (44.6%)	57 (26.8%)
CERP only	130	51 (39.2%)	26 (20%)
BM-MSC and CERP	66	39 (59%)	26 (39%)
A-MSC and CERP	17	5 (29.4%)	5 (29.4%)

Show jumpers often sustain costly SDFT and DDFT injuries.

Indeed, many studies do show encouraging results for stem cell therapy in tendon and ligament injury rehabilitation.

In early 2023, Elliott and colleagues published a study in the Equine Veterinary Journal comparing stem cell treatments to controlled exercise rehabilitation for racehorses with SDFT injuries.

The study included a cohort of client-owned Thoroughbred racehorses in Australia diagnosed with a novel, acute, unilateral overstrain injury of the SDFT. Core lesions were graded from II-IV ultrasonographically. Lesion length and cross-sectional area were measured. The veterinarian and owner then chose their preferred treatment plan: cultured BM-MSCs, allogenic mesenchymal stem cells (A-MSCs), or a controlled exercise rehabilitation program (CERP) alone.

The BM-MSCs collected from the patient were sent to a commercial laboratory for cell isolation and expansion. The lesions were therefore injected three weeks after bone marrow aspiration. The commercially available allogenic MSCs were injected intralesionally approximately 7 days after ultrasonographic diagnosis.

All horses in the study participated in the CERP. The 52-week CERP graduated slowly from strict stall rest to hand walking, small yard rest and working under saddle, to large paddock turnout and light to moderate work. Horses were followed for 2 years after treatment, and race records were analyzed to compare racing success.

In total, 213 horses were included. One hundred thirty were subjected to the CERP alone, 66 were treated with BM-MSCs, and 17 were treated with A-MSCs.

In total, only 95 (44.6%) horses returned to racing and only 57 (26.8%) raced five or more times post-injury.

"Racing five or more times is the marker for 'success' in racing Thoroughbreds," explained Elliott.

Of the 130 horses with CERP-only treatment, more than one-third returned to racing, but only one-fifth raced five or more times. More horses treated with BM-MSCs successfully returned to racing (59%) compared to CERP alone. Moreover, one-third of the BM-MSC-treated horses raced five or more times. Few horses were included in the A-MSC group but the same five horses (29.4%) that returned to racing also raced five or more times after treatment.

"Looking at the odds ratios, horses treated with BM-MSCs in combination with CERP were more than three times more likely to return to racing than horses participating in the CERP alone," noted Elliott. "Similarly, horses treated with BM-MSC and CERP were more than twice as likely to complete five or more races than horses treated with CERP alone."

He added, "There are two main take-away messages from this study. First, it justifies the use of autologous BM-MSCs as a worthy treatment of core lesions in tendons in racehorses.

It shows return on investment because these horses are significantly more likely to race and race five or more times. Second, the data helps relay the importance of CERP. It is the cake that all other treatments are built on. Anything you do on top of the CERP is icing with a cherry. If you don't have the CERP, stem cells or any therapy are a waste of money and time."

HOW STEM CELLS "WORK"

Of all the regenerative therapies, stem cells are widely considered promising for equine musculoskeletal injuries, particularly for ligaments and tendons. In this setting, the goal of stem cells—like any regenerative therapy—is to restore the normal function of damaged tissues. This is in stark contrast to what the "normal" tendon and ligament healing phases currently achieve.

MSCs are multipotent progenitor cells that are able to self-replicate and also differentiate into different cell types. And while cell "replacement" was initially thought to be the main function of stem cells, we now know that is not true.

"Gone are the days where we believe that stem cells grew more tendon or ligament. That is not the up-to-date science of how stem cells work. That was the original thought, but it doesn't happen. Instead, stem cells have potent anti-inflammatory and cell-signaling effects. They signal to the body where the injury is and are a kick start to expedite quality healing," Elliott explains.

Colbath added that, "The primary mechanism of action of stem cells is to orchestrate healing. They direct other cells to come to the site of healing using paracrine factors, such as growth factors, chemokines, cytokines, etc. They tell the body, 'Come here and fix this.' "

MSCs can, theoretically, be isolated from almost every tissue in the horse's body, but in clinical practice, BM- and AD-MSCs are the most common.

For tendon and ligament injuries, stem cells—regardless of their source and post-collection processing—are most often injected directly into the injured region of the tendon or ligament (i.e., intralesionally) using ultrasound guidance, but some studies show that they can be injected intravenously or via regional limb perfusion.

BM-MSCs have helped racehorses that sustained SDFT injuries return to racing, with some racing five or more times following treatment.

What happens to those cells once they're injected?

While one might think that because they're the directors of tissue regeneration they would stay where they're injected, that is not true.

According to Colbath, "There are some studies that have used nuclear scintigraphy, green fluorescence protein (GFP) or labels detectable by MRI to follow the fate of stem cells once they're injected.

These studies indicate that cells are present at the lesion site following injection for days to weeks. In horses, though, we still don't know exactly how long stem cells live. This may vary with cell type and lesion type."

DETRIMENTS OF STEM CELLS

Despite the positive data associated with stem cell therapy, many disadvantages also need to be addressed.

Collecting bone marrow is not completely innocuous. The procedure might be associated with risks such as infection, hemorrhage, pneumothorax and pneumoperitoneum.

"Really, both are easy to obtain," said Colbath. "Adipose tissue is easier to access, but it leaves a scar. Bone marrow is still relatively easy to obtain from the sternum."

A study by Watts, et al. (2018) found that horses tolerate bone marrow aspiration well, and that aspiration of bone marrow from the sternum does not appear more painful than a sham procedure.

It takes approximately three weeks to generate stem cell cultures from bone marrow aspirates, leaving a delay between injury and implantation. To circumvent the delays associated with cultured MSCs, autologous stem cells can be used. These cells are banked, making them a ready-to-use product. Still, research by Watts, et al. (2017) suggested that allogenic stem cells are not immunologically privileged, bringing into question whether this is truly a viable approach.

Sometimes, the patient is not an ideal donor for stem cells. For example, Bagge, et al. (2022) found that the chondrogenic and osteogenic differentiation performance of both bone marrow-derived and adipose tissue-derived stem cells declined with increasing age.

They demonstrated this after collecting stem cells from bone marrow and adipose tissue (as well as dermal fibroblasts to serve as a control) from neonatal foals, yearlings, adults, middle-aged horses and geriatric horses. The chondrogenic differentiation of BM-MSCs was already declining in yearlings compared to foals.

Data are lacking regarding the ideal dose, timing or number of treatments. In Colbath, et al.'s survey of board-certified equine specialists, they noted that there is not a current consensus regarding the timing of the first injection or optimal treatment intervals.

"In fact, our study identified a large disparity in current treatment intervals for all biologic therapies," Colbath said. "Additional clinical studies are needed in this field to determine optimal treatment intervals and even dose."

In terms of timing, Colbath said she injects BM-MSCs intralesionally while there is a 'black hole' in the tendon or ligament to fill as seen on ultrasound.

"I do not re-inject if there is already fiber alignment appreciated on the ultrasound because I don't want to add

volume and disrupt those delicate fibers," Colbath added. "At six weeks, if there is still a black hole [as seen on ultrasound], then I will go ahead and re-inject."

EXTRACELLULAR VESICLES: A STEM CELL-LESS REGENERATIVE THERAPY

As an alternative to using actual cells — either autologous or allogenic—researchers instead have started looking at the stem cell "secretome."

As described by Rhatomy, et al. (2020), the secretome is the medium where stem cells are cultured that contains soluble proteins, lipids, nucleic acids and extracellular vesicles (EVs). Those researchers suggested that the secretome could be used in place of stem cells for improved safety (e.g., to avoid transmission of infections for allogenic stem cells), removing the concerns for immune incompatibility, and for providing a readily available regenerative therapy at much-reduced costs than cell-based therapies.

Taking this technology one step further, some researchers are focusing on the EVs themselves.

Angela M. Gaesser, DVM, DACVS, is a veterinary surgeon and PhD student at the University of Pennsylvania School of Veterinary Medicine's New Bolton Center. In reference to EVs, she said, "There are three categories of EVs: exosomes, microvesicles and apoptotic bodies. Exosomes are thought to be more bioactive and come from the endocytic pathway. Microvesicles are created by outward budding of the cell's plasma membrane, and apoptotic bodies are formed by cells undergoing apoptosis (dying cells)."

These microscopic membrane-bound particles measure anywhere from 40-1000 nm.

"EVs can be isolated from the medium via ultracentrifugation, which is a special type of centrifuge that is not typically used in most laboratories," noted Colbrath.

These EVs contain proteins, lipids and nucleic acids that, according to Po Yee Lui (2020), reflect the cellular origin and metabolic state of the cell from which they are generated. That precious cargo is shuttled to neighboring or distant cells, "actively regulating gene transcription and functions of the recipient cell," noted Lui.

In essence, EVs appear to be the functional unit of stem cells, providing all the benefits of stem cells without having to work directly with the cells themselves. They appear to possess anti-inflammatory and pro-regenerative effects (Mocchi, et al. 2020).

Gaesser added, "I think of EVs as being the signals that cells send to other cells. So, if we are talking about stem cells, EVs are the signals that help stem cells enact change in other cells. Many of these signals are anti-inflammatory and anabolic in nature to 'turn on' healing mechanisms within the tissue that they are injected into. I think about this technology as harnessing the bioactive properties of stem cells while reducing the immunogenicity associated with the cells themselves."

"The question remains, though, how much cell-to-cell cell contact do you need when using stem cells versus how much is simply the paracrine effect? When using EVs, we're assuming that it's what the cells are producing that is important," Colbath pointed out.

Gaesser concurred, adding, "I think it's probable that some of the actions of stem cells are direct cell-to-cell interactions that don't involve EVs. The question is whether this is a large or small proportion of how stem cells work that would be lost when just EVs are used."

Colbath suggested that EVs could be used in a similar fashion as stem cells in a clinical setting by injecting the product intralesionally.

"The goal would still be to get those paracrine messages to the area of concern," she said.

One potential detriment to EVs is that once injected, they are not able to adapt to their environment or tailor their responses like stem cells might do.

"So, stem cells still have some advantages over EVs," Colbath noted.

She added, "Sick horses, older horses, horses on medications ... all these animals could have sub-par stem cells and could therefore benefit from allogeneic EVs instead. That's especially true if those EVs were collected from young, healthy horses and cryopreserved so they are immediately available. EVs, because they are a cell-less therapy, will also likely avoid the immune system."

Gasser noted that "because of the reduction in immunogenicity, we think they have a better potential to be used as an allogeneic treatment, whereas in the horse we typically use autologous stem cells to reduce the immune response. The benefit of having an allogeneic treatment is that it can be produced as an 'off-the-shelf' product. You wouldn't need to wait two to three weeks for stem cell expansion like you do when using autologous cells."

Although exciting, this research is still in its infancy. Much work needs to be performed to reliably produce standardized products.

"In our laboratory, we are working toward using them in an in vivo model for treating osteoarthritis, but we first need to validate them in vitro," said Gaesser.

TAKE-HOME MESSAGE

Stem cell therapy appears safe, and it effectively allows horses to return to competition with lower rates of reinjury than horses not treated with stem cells.

According to Elliott, a multimodal approach, extending beyond just stem cells, is most likely to provide maximal effect.

"For example, the last tendon I treated, I used platelet-rich plasma on Day 7, purely for natural anti-inflammatory effects and to 'dull' the collagenases," said Elliott. "I injected autologous stem cells on Day 22 and began lasering that tendon. Based on studies conducted in Germany, laser therapy appears to promote appropriate healing and collagen development and alignment of the tendon fibers."

Elliott added, "This is what I believe is the 'diamond-encrusted' treatment plan for horses with tendon and ligament injuries, which is better than a gold standard. But we are always looking to see how we can improve and are seeking the best way to make these horses heal."

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Show-Stopping Equine Infectious Diseases

By Holly J Helbig, DVM, Equine Technical Services Veterinarian, Zoetis

ONE NIGHT IN FEBRUARY a few years ago, I received a call from a concerned trainer that her Welsh pony was dull, standing in the back of the stall with a fever of 102 F. She asked in a restless tone, "Can you bring your thermometer because mine might be broken. It's really old and I haven't used it recently."

As an official horse show veterinarian, the word "fever" always sends shivers down my spine. I was the only attending veterinarian at this horse show and was just beginning to respond to a variety of emergencies in the wee hours of the night. To say the facility was large would be an understatement. Enormous was more like it. It was fully enclosed, temperature-regulated and housed up to 1,500 horses.

I always hope as a veterinarian that the cause of any horse's elevated temperature is obvious, like cellulitis or a history of traveling 20 hours on a trailer. When it comes to my personal life, family and friends, I tend to have an optimistic view of the world. When it comes to medicine, I tend to fear the worst. This 3 a.m. call didn't turn out to be an ordinary case of "give NSAIDs and antibiotics q12h." Indeed, the Welsh pony gelding had an elevated 102 F temperature. And so did the trainer's gray Warmblood mare stalled next to the pony, munching away on her hay as if nothing in her world was abnormal. Typical, isn't it?

Given how difficult it is to the stop the spread of certain infectious diseases, prevention needs to be our top priority. Prevention is in the textbooks we read, and equine vet conferences always seem to have a good panel of speakers on biosecurity.

I calmly asked the trainer to continue temping her other horses while I anxiously waited for the serum amyloid A (SAA) reader to render results. I was already planning the worst-case scenario. The results came in…Elevated SAA ➳➳ quarantine ➳➳ nasal swab ➳➳ communicate ➳➳ supportive care ➳➳ wait for PCR results, in that order. Please don't be herpesvirus!

It was 5 a.m. when I received a phone call from another trainer in another isle, stating her horse seemed "off." (TPR: 101.7, 44, 24, SAA – 450). There were now three infected horses in close proximity in two different barns. It wasn't a coincidence — it was the early signs of a biosecurity event.

And so it began. The innate but also learned skills/experiences that no one can truly prepare you for in school: communication, leadership, poise, setting boundaries, the hours of anxiously waiting for lab results to come in. The juggling of phone calls between owners, trainers, owners' home veterinarians, show officials, show management, the governing body of the horse show, state veterinarians, even managers of other shows and their official show veterinarians. Can someone please turn off my phone?

No one prepares you for this. This equine influenza virus (EIV) strain, a highly transmissible but not very virulent pathogen, had a disturbing impact on the horse show and affected numerous training operations. Many horses were ill, but no lives were lost. Horses were quarantined, vaccination records checked, bloodwork run and care rendered until SAA was at 0 or a negative PCR result came in.

Some trainers took their horses home and self-quarantined; others ran SAAs on all their horses and left horses at the show if levels were above 50ug/mL, indicating early signs of infection. Several trainers stayed and continued to show healthy animals. Because EIV is a non-reportable disease, there were no mandated restrictions on horse movement. As you can imagine, there were a lot of opinions on how to handle the situation.

I often reflect and ask myself, what did we do well? What could we have improved? How do we prevent infectious disease outbreaks with so many horses moving from one event to the next? What principles should be in place to minimize future outbreaks moving forward? What did we learn from Covid-19 that can influence preventive measures in the equine community?

PREVENTION IS PRIORITY

Given how difficult it is to the stop the spread of certain infectious diseases, prevention needs to be our top priority. Prevention is in the textbooks we read, and equine vet conferences always seem to have a good panel of speakers on biosecurity. Of course, as veterinarians we advocate for prevention with our clients because we care about it and it's our duty.

We remind clients that their horses are particularly vulnerable at shows, races and events. We emphasize a 2-week quarantine for new horses welcomed at barns and after transport with horses outside their normal population. But how often does this happen? As a barn owner, I know I'm guilty of committing this crime. It's additional work when so many operations are already short-staffed. How do we do a better job as equine veterinarians of emphasizing and educating on the importance of preventive measures?

Frankly, my firsthand experience of this outbreak absolutely changed the tone with which I discuss preventive measures with clients. I have a lot more urgency in my voice. Conversations around recent outbreaks, such as vesicular stomatitis in California this year, usually gets their attention. One gift the pandemic gave us was heightened awareness of contagious diseases. It's a relatable conversation with horse owners.

Considering the 'not fun' factor of an outbreak, one 'fun fact' I loved sharing during this particular outbreak was, "Did you know a horse can sneeze and shed a virus reaching half the length a football field?"[1] That's 50 yards (150 feet) according to the Equine Disease Communication Center (EDCC).

Let's not wait to prioritize biosecurity measures until it's too late. Let's focus on prevention first.

TRUST THE SCIENCE AND VACCINATE

Routine preventive care and vaccination is critical for all horses at all stages of life. No matter if the horse travels, lives at a facility where others travel or simply is exposed to other horses across the fence line, the end game is the same—healthy, happy and protected.

Although vaccinating doesn't guarantee prevention of disease, science has shown that it significantly reduces the risk of clinical signs as well as the duration of disease. The AAEP divides vaccinations into core and risk-based. Core diseases are those that are endemic, pose risk of significant harm to a horse and are potentially significant to public health. Core diseases include Eastern equine encephalomyelitis, Western equine encephalomyelitis, tetanus, rabies and West Nile virus. Core EQ Innovator® is the only approved vaccine for horses that covers all five core diseases in a single injection.

Risk-based vaccines that target diseases such as equine rhinopneumonitis (EHV-4/1) and EIV are often chosen based on the nature of commingling, travel and geographic location. Because respiratory viruses are the most common risk-based viruses, most organizations overseeing performance horse events require horses to be vaccinated for EHV-1 and -4 and EIV every 6 months.

In studies, Fluvac Innovator® EHV-4/1 was shown to be highly immunogenic in stimulating a cross-protective titer against all 14 circulating strains of EIV in 2022 and all 66 other influenza strains between 2017 and 2021. These strains were isolated and tested by the World Organization for Animal Health's reference lab[2,3,4,5,6,7]

Important note: The AAEP recommends that all horses get vaccinated 2 to 3 weeks prior to traveling.

IMPROVING BIOSECURITY THROUGH HEIGHTENED COMMUNICATION

The transmission of information is essential for effective outcomes. The governing bodies regulating horse shows and large equine events, along with the veterinarians involved, need to have an action plan in place before potential biosecurity events occur. Like COVID-19, social and economic impacts are at risk. Alternating perspectives of all parties involved can often make a plan of action difficult to execute.

On the management side, show owners may not want to lose entry money or make it publicly known that there may be a biosecurity threat at their show. It's not good for business. Trainers and owners may be hesitant to inform others of their sick horses out of fear that they'll be blamed as the source of disease transmission. Many febrile horses are treated by trainers, sometimes for days before getting a veterinarian involved. Veterinarians may feel obligated to protect their clients and have a mindset that if a horse is already shedding a virus, he's already shed to neighboring horses at this point. All these mindsets are a recipe for disaster.

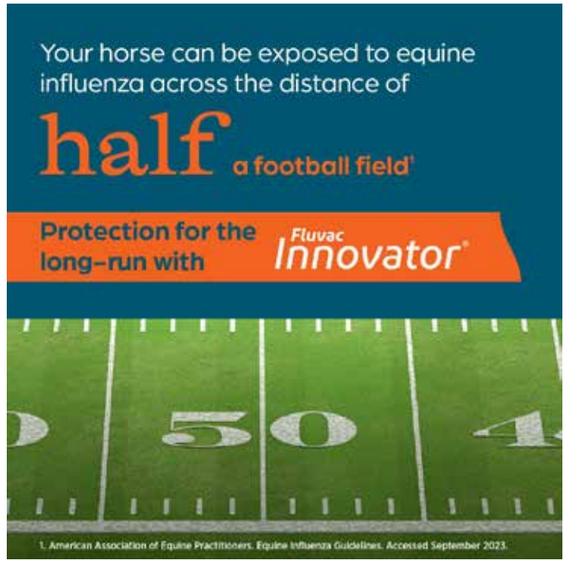
As veterinarians, professionals and experts in the equine field, it's our duty not only to treat these horses but also to communicate potential threats to the community. It's our responsibility to have these difficult conversations. Sometimes I think we don't give our little horse world enough credit. I saw firsthand, as many of you would probably agree, a quick moment of panic followed by a huge support network around the outbreak. Let's applaud the horse show for releasing a public statement and being forthcoming. Let's applaud the staff who rallied together to create a safe and healthy quarantine. Let's create a mindset that applauds individuals openly communicating and proactively working to contain outbreaks!

Let's also give a huge shoutout to the EDCC, whose sole purpose is to help track equine outbreaks and improve the welfare of horses by communicating real-time alerts across the country. Click on their link above to sign up for notifications.

HORSES THAT TRAVEL: SPREAD THE WORD, NOT THE DISEASE

Most horse owners travel with their horses at some point during the year. After all, most horses are part of the family, and for equestrian enthusiasts, some of the best vacations are spent at events accompanied by their horse. The following are simple guidelines you can share with your clients when traveling:

- Be up to date on all core and risk-based vaccinations
- Provide proof of a negative Coggins test within the last year (6 months for some states/events)
- Have a current certificate of veterinary inspection, required for interstate travel
- Run a Stablelab® EQ-1 Handheld Reader SAA stall-side test to assess whether there are no early indicators of infection (before and after the show)



- Ensure manure is removed and the stall is cleaned and disinfected prior to unloading a horse from his trailer to enter the show barns
- Take your horse's temperature upon arrival at an event, twice daily during an event and at departure
- Do not share tack, cleaning or grooming equipment
- Minimize nose-to-nose contact, including avoiding sharing rags to wipe horses' faces
- Isolate your horse for 2 to 3 weeks when returning from an event and monitor for any signs of disease
- If a horse is coming from a previously infected farm or event, a nasopharyngeal swab and culture may be warranted
- Communicate with your veterinarian if your horse(s) show any signs of infectious disease or if other horses at the event are reported febrile

IN THE FACE OF AN OUTBREAK

Shut down a horse show or training barn for a week? Wait, what?!

In the event you're faced with a potential outbreak, setting up proper isolation depends on the capabilities of the property. Most farms and events have the ability to isolate horses. For those that can't, implementing things such foot baths, personnel protocols, proper ventilation and human hygiene when working with horses is imperative. Some events have a biosecurity and outbreak plan in place that can be found by contacting show management. Open communication with event staff, show officials and other veterinarians from the beginning of a potential outbreak helps reduce the number of horses exposed and disease transmission.

The AAEP has an extensive and resourceful link on its recommended biosecurity guidelines. Many governing bodies of horse shows also offer informative guidelines on biosecurity.

THE NEED TO RETHINK POTENTIAL IMPACT

No one around the world grasped just how large the impact of Covid-19 would be. Beyond the enormous human and economic impact, the pandemic exposed the weaknesses of organizations, lack of preparedness and poor response of health care systems. The virus inflicted carnage across the world, as did EIV at the large horse show I was officiating at, with dozens of horses, trainers, owners and businesses affected.

Currently, outbreaks of more devastating diseases such as equine herpesvirus, equine herpes myeloencephalitis and strangles continue to populate our newsfeeds and social media. In the future, the equine community may be confronted with other viruses whose combination of virulence, transmissibility and other characteristics pose even greater danger.

Sometimes biosecurity measures get neglected. We underestimate the potential impact to our horses' health, along with the economic impacts to owners and the industry. The necessary measures continue to require leadership, time, education, routine preventive care and public awareness.

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