AN IN-DEPTH LOOK AT NEUROLOGIC DISORDERS

MARCH 2016 | TheHorse.com/AAEP2015

the HORSE

YOUR GUIDE TO EQUINE HEALTH CARE

YOUR GUIDE TO THE

2015 AAEP CONVENTION

FEATURING

WOUND CARE

EQUITARIAN PROJECTS

DIAGNOSING LAMENESS

AND MUCH MORE ...

Never Stop Learning

STEPHANIE L. CHURCH, *Editor-in-Chief*

My poor veterinarians. Each winter/early spring for the past 16 years—even the horseless ones—I've become hyperaware of horse health conditions. And now, because I have my own horse, Happy, to worry about, I know a couple of practitioners who might get the odd phone call or text here or there because of this para- … wait, no, *conscientiousness*.

Happy loves the mud, and he has a pond in his field. How high is his risk for contracting leptospirosis, and should I get him vaccinated? Did he hang on to that longish hair last spring because he began growing his winter coat in February, or could there be something endocrine-related at play? Is his wound taking forever to heal because he's playing too rough in the pasture, or because he has a biofilm?

Why the questions? Well, for the past two months, since early December, my team and I have been listening to, taking notes on, summarizing, and reading about every equine condition under the sun that could infect, debilitate, or otherwise affect our horses. Each year at the American Association of Equine Practitioners' Annual (AAEP) Convention, we have the wonderful privilege of getting to hear some of the greatest minds in equine veterinary medicine share what they're learning about horse health both at the research bench and in their daily practice.

The 2015 convention, held Dec. 5-9 in Las Vegas, was no exception. We burned up the Mandalay Bay Convention Center's hallways to attend the presentations we thought you'd find most interesting or applicable in managing your own horses. We sat in the sessions, tweeted snippets of information, visited with the speakers and other veterinarians, and then returned home to distill the information into take-homes for you, our readers.

As in the past, all of the discoveries, reviews, and steps toward new understanding of the horse were inspiring. A few highlights for me included the amazing work equitarians are doing around the world to improve life for working horses and donkeys, clinicians' growing understanding of the equine liver and its diseases (and the new ones they're just discovering), and some of what we're learning about treating age-old conditions such as melanoma.

Finally, kudos to the AAEP program committee for selecting an increasingly important topic for the keynote address—self-care for veterinarians in the face of empathy fatigue. Indeed, our horses' doctors have an incredibly important and also emotionally taxing job. We didn't have room to cover it here, but I encourage you and your veterinarian to read the summary at TheHorse.com/37070.

We hope you enjoy the information we have curated from the convention and that you keep it around for future reference.

the HORSE
YOUR GUIDE TO EQUINE HEALTH CARE

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COVER PHOTO DUSTY PERIN

ISTOCK.COM

BY the NUMBERS

7,394

veterinary professionals, students, exhibitors, and guests from 33 countries converged in Las Vegas for the convention

84% U.S.

7.5% Canada

8.5% Other

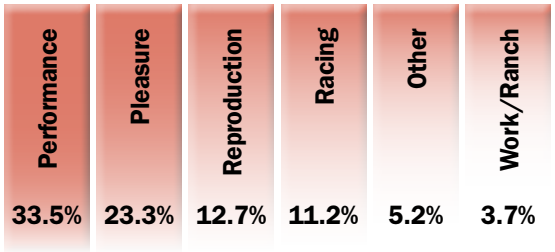
135 HOURS of Continuing Education

350 STUDENT MEMBERS Attended

The **2nd largest** convention in the association's history

$91,350 donated in support of the AAEP Foundation's mission to improve the welfare of the horse

Attendees' **PRACTICE FOCUS**



Neuropsychiatrist and best-selling author **Dr. Daniel J. Siegel** described the "Art and Science of Resiliency" during the keynote address.

TheHorse.com/37070

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The 62nd Annual Convention will take place December 3-7, 2016, in Orlando, Florida

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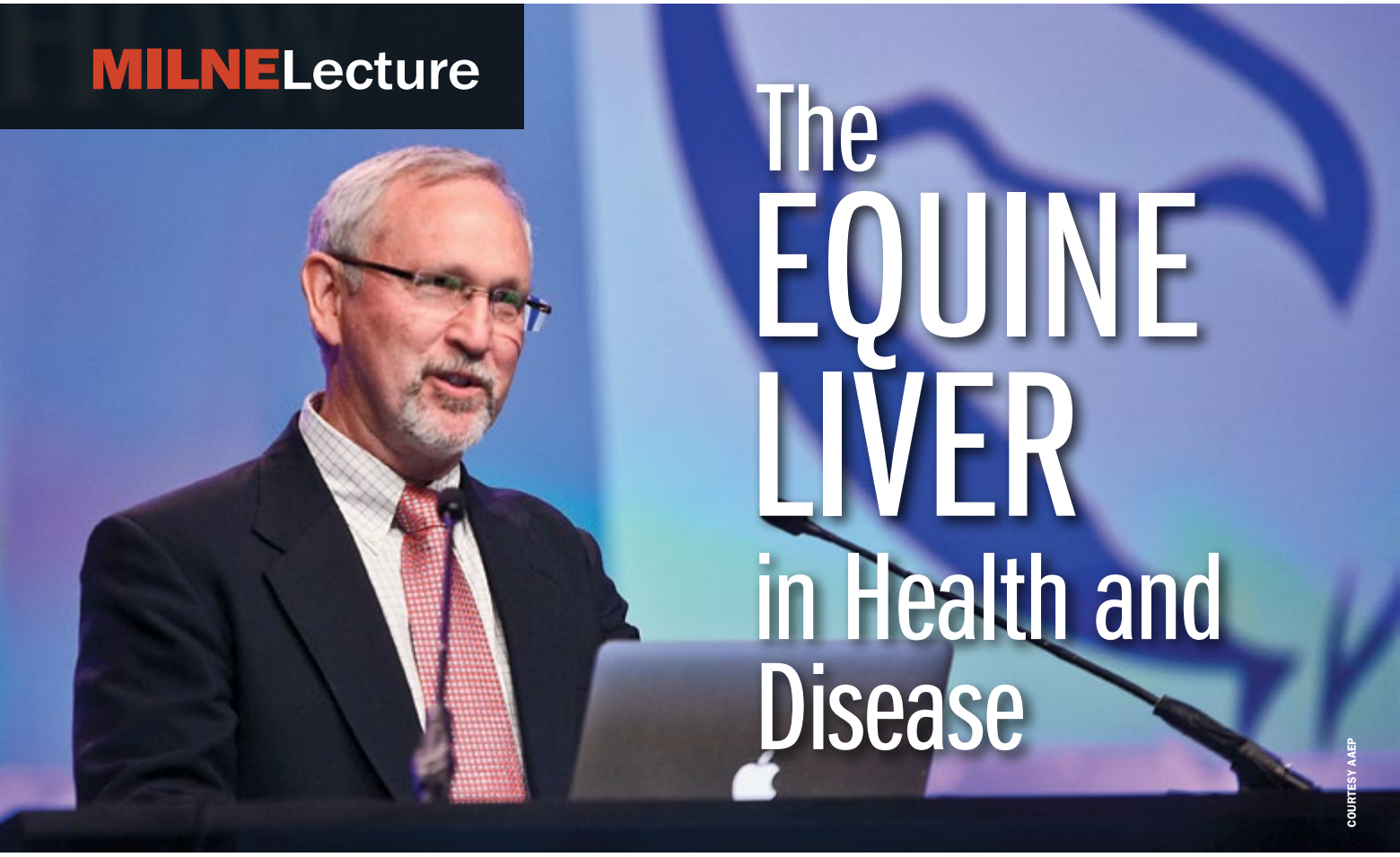
The EQUINE LIVER in Health and Disease


COURTESY AAEP

NANCY S. LOVING, DVM

The liver might not get as much airtime as, say, the horse's lungs or intestines, but it is an essential organ for life. It accounts for at least 1.6% of an adult horse's body weight and performs many vital functions: processing nutrients from food; making proteins and bile; storing glucose, vitamins, and minerals; maintaining immune function; and removing toxins from the blood.

Thomas Divers, DVM, Dipl. ACVIM, ACVECC, professor of veterinary medicine at Cornell University's College of Veterinary Medicine, described the liver in great detail during the Frank J. Milne State-of-the-Art Lecture.

Liver Function and Tests

The liver is unique in many ways, one of which is how blood flows through it. Normally, oxygen-rich arterial blood circulates to an organ, then oxygen-depleted venous blood returns to the heart and through the lungs to pick up more oxygen to send back through circulation. But with the liver, the relatively deoxygenated hepatic portal vein provides the organ with a large amount of oxygen. Because 10% of a horse's blood resides in the liver, any disease can have serious consequences.

Equine liver failure is relatively rare, in part because at least 70% must be affected before functional biochemical changes and signs of liver disease occur. Liver disease is common, though, and often associated with filtering and detoxification.

"While enzymatic tests are useful for detection of disease, they don't reliably attest to function," said Divers. Specific enzymes point toward problems with the biliary tract (ducts that make and transport bile—horses don't have gall bladders)

> "While enzymatic tests are useful for detection of disease, they don't reliably attest to function."
> DR. THOMAS DIVERS

while others track injury to the liver cells (hepatocytes). Bilirubin concentrations are another measure of liver health.

Veterinarians can also test bile acids to determine liver function; these values are excellent prognostic indicators of chronic disease, said Divers. Other useful measures are globulins and iron: High globulin levels often indicate an inflammation response, and high iron levels are unique to a horse with hepatic disease.

Horses with liver failure commonly have neurologic signs and jaundice and can become blind and ataxic (uncoordinated). Other signs include edema (fluid swelling) along the midline of the belly, weight loss, dermatitis, colic, stomach impaction, and laryngeal paralysis.

Divers suggested taking a liver biopsy if unsure of the cause of disease and/or to pursue bacterial culture. This helps distinguish acute from chronic disease, localize the most severely affected zone, identify disease, and determine whether the main problem is in the biliary tract or liver tissue. Using ultrasound to guide the biopsy also yields information about the case.

Causes of Liver Failure

Cholangiohepatitis is a common cause of equine liver disease, typically starting as bile duct obstruction with concurrent liver cell inflammation. It might begin as an ascending bacterial infection from the small intestine that, when chronic, forms sludge that eventually turns to calcium bilirubinate stones, or cholelithiasis. Affected horses usually have fever and abdominal pain. Other signs are icterus, photosensitivity (to sunlight), weight loss, and, rarely, central nervous issues.

Cholelithiasis isn't always visible on ultrasound. Ideally, treat the horse early before stones form. Long-term antibiotic therapy helps eliminate bacteria, fluid therapy dilutes the sludge, and anti-inflammatory medications improve comfort. Ursodiol (used to dissolve human gallstones) might help decrease inflammation and ease bile excretion. If medical treatment isn't effective, the veterinarian might clear the obstruction surgically.

Theiler's disease is an important, but sporadic, cause of liver failure in adult horses occuring when tetanus antitoxin, plasma, or serum products cause serum-associated hepatitis. It can occur with a rapid onset of hepatocellular necrosis (cell death) and neurologic signs four to 10 weeks after giving equine-origin blood products. Disease lasts six hours to three days; signs include jaundice, sweating, discolored urine, and neurologic signs. The horse might experience gastric impaction from impaired intestinal motility.

An identical disease can occur without use of equine-origin blood products. This nonbiologic Theiler's form develops only in adult horses, sometimes as small outbreaks and usually in the fall. "The reason for neurologic signs subsequent to liver failure is primarily because of ammonia-induced toxicity," said Divers. Nerve cells called astrocytes process ammonia into a substance called glutamine; excess ammonia and, therefore, glutamine causes fluid increases in the astrocytes, resulting in cerebral edema and brain dysfunction.

Aggressive treatment is important. "If treatment can keep the horse alive for four days, it may have complete recovery, as the liver can regenerate quickly," he said.

He listed crystalloid intravenous fluids, glucose, pH balancing, antibiotics, and nutritional supplementation as important measures for managing hepatoencephalopathy, along with strategies to prevent injury from neurologic signs. He suggested using lactulose and oral antibiotics and keeping the bowel active to reduce intestinal ammonia production.

CONVENTIONTWEET

AAEP
@AAEPHorseDocs

Horses with Theilers disease are usually dead within hours. Keep them alive for a few days and they usually recover fine.

Liver viruses could have a role in serum-related and non-serum-associated Theiler's cases, scientists suspect, due to incubation times (from infection to sickness) and pathology similarities to human viral hepatitis. In fact, they have found four new hepatitis viruses in horses since 2012: nonprimate hepatitis virus (NPHV), equine pegivirus (EPgV), Theiler's disease-associated virus (TDAV), and a fourth virus associated with recent Theiler's cases.

They first saw NPHV when screening healthy horses for equine infectious anemia. More than 2% of adult horses have NPHV in their blood and might be chronically infected. Up to 44% have serum antibodies, indicating broad exposure. How it's transmitted is unknown, but the high seroprevalence suggests avenues besides blood products. After infection, NPHV replicates in the liver, causing transient disease but rarely, if ever, liver failure.

Veterinarians first found EPgV in 12 of 74 adult horses tested in Alabama. It doesn't seem to cause clinical disease.

Theiler's disease-associated virus is similar to hepatitis C virus in humans. In one outbreak, eight of 17 horses receiving an equine biologic product developed biochemical liver changes; four showed clinical signs and had abnormal lab findings associated with hepatic failure. All horses recovered, but four remained viremic (virus in the blood) for up to a year.

In 2014 scientists found another virus that Divers and others are eyeing to unravel the mystery of what causes Theiler's. The yet-to-be-reported hepatotropic virus was consistently linked with Theiler's cases in 2014 and 2015 but can also be seen in a small percentage of normal horses.

Hyperammonemia (excess ammonia in the blood) without liver disease is more common in horses than other species, occuring mostly in adults of any breed. "Most are on pasture," Divers said. "It is possibly related to changes in the intestinal microbiome (microbial communities), resulting in an increase in urease-producing bacteria. Or there may be both an increase of intestinal ammonia production along with increased intestinal permeability of ammonia, which overwhelm the liver's ability to metabolize ammonia."

Horses often have mild GI disease just prior to hyperammonemia onset and severe signs in one to two days. He reported a 50% mortality rate in affected horses.

Liver disease from toxic plants is usually caused by pyrrolizidine alkaloids (PA). Plants containing PA are most toxic when growing and about to bloom. "A horse needs to eat about 2% of its body weight of the toxic plant to develop liver failure," he said. "Normally, PA-containing plants tend to be bitter, and horses will avoid them." Such plants include fiddleneck, groundsel, ragwort, and hounds tongue.

The liver metabolizes PA to its toxin, which kills liver cells and/or exerts antimitotic (cell-dividing) effects on them, causing widespread liver fibrosis (scarring). It also causes ongoing damage until the horse has acute neurologic signs. First he might lose weight and have a reduced appetite, jaundice, and photosensitization.

The PA toxin is associated with a high mortality rate in affected horses. "Attempts at treatment include the same supportive care for many other causes of fulminant liver failure," said Divers.

Alsike clover poisoning occurs mostly in Canada and the Northeastern United States. This knee-high clover causes "big liver disease," with the liver weighing as much as 5% of a horse's body weight due to extensive bile duct proliferation. Researchers suspect that mycotoxin growing on the clover is the inciting cause.

Veterinarians identified another toxic plant, ***Panicum dichotomiflorum***, in equine cases in Maryland and Virginia. Most horses recovered in 34 days once taken off the contaminated hay. The toxin might be due to a saponin (a foaming compound) that damages the hepatocytes.

Potential equine liver problems are many and varied. Timely recognition of mild clinical signs, then biochemical tests, ultrasound, and biopsy, can help a veterinarian determine the nature of the problem and begin therapy.

Top Equine Studies of 2015

COURTESY AAEP

ALEXANDRA BECKSTETT, ERICA LARSON, AND NANCY LOVING, DVM

Each year at the AAEP convention, a panel of three veterinarians presents research highlights to attendees during the ever-popular Kester News Hour.

This year featured Elizabeth Santschi, DVM, Dipl. ACVS, professor of equine surgery at Kansas State University, on surgery-related studies; Terry Blanchard, DVM, MS, Dipl. ACT, theriogenology professor at Texas A&M University, on reproduction papers; and Carol Clark, DVM, Dipl. ACVIM, Peterson & Smith Equine Hospital partner, on medicine topics.

Cryptorchidectomy Complications

In the first study Santschi described, researchers reviewed 604 cryptorchidectomies to remove a retained testicle. Fifteen percent of the horses had undergone previous castration attempts, which made locating the hidden testicle difficult. Because the dropped testicle had been removed, it wasn't clear where the retained one was; scarring made the approach even more difficult. Further, in 60% of horses retained testicles were in the abdomen, while the remainder were in the inguinal (groin) region. The team determined that surgical technique had no impact on success or complication rates.

Mild postoperative complications, such as short-term fevers, were more common (43% of horses) than major (3%). Fatal complications were very rare (0.05%).

Pastern Arthrodesis Outcomes

Next, Santschi described a retrospective study in which researchers evaluated outcomes of proximal interphalangeal joint arthrodesis, or surgical fusion of the pastern joint, in 82 horses. Surgeons used one of three methods: three transarticular cortical bone screws (screws that stabilize or compress a joint), a dynamic compression plate (a standard bone plate that compresses the fracture) with two transarticular screws, or a locking compression plate (with threaded holes so screws lock into plate and bone) with two transarticular screws. The team found:

- Osteoarthritis was the most common reason for the surgery;
- 45% of horses returned to competition, while 37% were sound at a lower level;
- The surgical technique used had no effect on the outcome;
- Horses with osteoarthritis were less likely to be sound post-surgery; and
- Horses undergoing hind limb arthrodesis were significantly more likely to return to competition (73%) than those with forelimb arthrodesis (25%).

In sum, this procedure results in a favorable outcome—more so in hind limbs.

Contamination Post-Joint Injections

With injections for intra-articular (within the joint) injury comes the risk of

joint contamination with tissue and hair, which can lead to problems potentially more serious than the issue being treated. Santschi described a study in which researchers took a closer look at whether needle brand, bevel grind, and silicone lubrication impact contamination risk.

They found 19-gauge nonlubricated needles were more likely to lead to joint contamination than 19-gauge lubricated needles, and that both types were more likely to result in contamination than 20-gauge needles. All other types tested posed similar contamination risks.

Santschi said to consider these results with perspective: Post-injection septic arthritis is rare, with reports suggesting a 0.078% prevalence. However, a septic joint is serious, and it's important to provide veterinarians relevant, valuable information to help avoid infection.

Reviewing an Arthrodesis Technique

One research team looked at the long-term effects of a surgical procedure they'd developed years prior: a three-drill-tract arthrodesis technique for treating carpometacarpal (the lower joint space in the horse's knee) osteoarthritis. This surgery is designed to advance joint fusion and decrease pain and lameness. Using a more invasive technique, researchers had found a long-term 83% success rate, but significant postoperative lameness, and so they developed the three-drill-tract technique to reduce postoperative pain.

In the study, the team evaluated nine procedures done on six horses. Two horses had mild postoperative pain, three had moderate, and one had severe. Three did not have long-term pain relief, while the other three reported improvement.

With a 50% success rate with no significant reduction in postoperative pain, the three-drill-tract technique is not useful for advancing joint fusion in horses with carpometacarpal osteoarthritis.

Short-Term Colic Complications in Senior vs. Mature Horses

Santschi also described a retrospective study in which scientists compared colic surgery complications and short-term outcomes in 78 geriatric (20+ years old) and 156 mature (4-15 years old) horses.

The team found that older horses were more likely to have strangulating lesions than mature horses. Santschi added that a higher proportion of geriatric horses had postoperative reflux and inappetence, but there was no difference in the proportion of geriatric and mature horses with both small intestinal strangulating lesions and reflux. Further, short-term outcomes were similar between the two age groups.

These results reinforce the fact that age should not be the sole deciding factor in determining prognoses or treatment options for colic, Santschi said.

CONVENTIONTWEET

Michelle Anderson
@TH_MNAnderson

Acorn toxicity: 6 of 9 horses in retrospective study died. "This can happen."

Uterine Blood Flow and Infertility

A mare's uterine blood flow changes frequently throughout her estrous cycle. Blanchard described a study in which researchers compared uterine blood flow and perfusion in young, healthy mares to those of older, subfertile mares with vascular degeneration—when the uterine wall vessels have degenerative changes in surrounding elastic fibers (called elastosis). This vascular elastosis could be associated with infertility. The team found decreased uterine blood flow and perfusion in older subfertile mares, compared to the young fertile mares, regardless of estrous cycle stage. They also noted no increase in uterine blood flow during estrus in the subfertile mares, which should have occurred.

"Decreased uterine perfusion in mares with vascular degeneration may play a role in subfertility or infertility and (they) postulated that it could contribute to post-mating-induced endometritis (uterine lining inflammation), delayed uterine clearance (of semen and inflammatory debris), and possibly even early embryonic or fetal death," said Blanchard.

NSAID Administration and Ovulation

Veterinarians use non-steroidal anti-inflammatory drugs (NSAIDs) to treat a variety of conditions. But study results show that they can negatively affect a mare's reproductive activity. In the next study Blanchard described, Brazilian researchers evaluated how two NSAIDs affected pre-ovulatory follicle development. They studied 11 mares over three consecutive estrous cycles: the first cycle served as the control, on the second cycle mares received a standard dose of phenylbutazone (Bute), and in the third a standard dose of meloxicam (Metacam, a COX-2 inhibitor available for equine use in Europe). The researchers found that all mares ovulated as expected during the control cycle, while only one and two mares ovulated during the meloxicam and phenylbutazone cycles, respectively. With both NSAIDs the researchers saw hemorrhagic anovulatory follicles (follicles that didn't release eggs) on ultrasound. In conclusion, "administration of NSAIDs may lead to formation of these hemorrhagic anovulatory follicles," said Blanchard.

Prostaglandin Might Counter Flunixin Meglumine's Impact on Ovulation

Prostaglandin is important for preparing follicles to ovulate, but NSAIDs can reduce its production. In the next study, scientists sought to determine whether giving synthetic prostaglandin could reverse NSAID effects. The team administered flunixin meglumine (Banamine) to five mares over two estrous cycles. In the treatment cycle they administered the NSAID every 12 hours after giving human chorionic gonadotrophin (used to induce ovulation) for 36 hours.

At Hour 32, the researchers administered prostaglandins into the follicle. For the control cycle, they injected water. They inseminated mares in three control and three treatment cycles. All prostaglandin-treated mares ovulated on schedule, while only one in five control mares did. Only prostaglandin-treated mares conceived. The team concluded that intrafollicular treatment with prostaglandins overcame Banamine's anovulatory effects.

Cloprostenol Administration, Follicle Size's Effect on Ovulation

Objectives were twofold in a on cloprostenol (a prostaglandin analog): to assess the effect of follicle size at cloprostenol administration on the interval until ovulation, and to determine the incidence of hemorrhagic anovulatory follicle formation after administration. No ovulatory agents were administered. Researchers found that giving cloprostenol to mares with large (at least 35 mm in diameter) follicles resulted in ovulation after 48 hours accompanied by uterine

edema (fluid swelling, 73.1%), with 13.4% ovulating within 48 hours with variable edema and 13.4% of the large follicles regressing. There was a very low (2.5%) incidence of hemorrhagic anovulatory follicle formation.

"Three-fourths of mares with large follicles present at prostaglandin administration did develop edema and ovulate more than two days later," Blanchard said. "Whether the uterine edema indicates that the follicle was therefore competent and capable of producing a viable pregnancy remains to be determined." He added that because competent follicles produce more estrogen, veterinarians might be able to use edema to predict successful breeding.

Low-Stress Settings and Foaling Rates

Blanchard described a study on whether management strategies improve foaling rates. Researchers evaluated 1,206 barren and in-foal Thoroughbred mares over 10 breeding seasons that were divided into "stressed" and "relaxed" groups. The relaxed mares lived in consistent (i.e., mares weren't removed or added) small groups outside and were not teased prior to breeding. Stressed mares were kept in stalls at night, lived in larger groups on pasture, and were teased daily. Barren mares in the relaxed group had significantly higher pregnancy rates than barren mares in the stressed group; in-foal mares in the relaxed group had higher pregnancy rates per cycle; and both barren and in-foal mares in the relaxed groups had a lower incidence of early embryonic death.

"Reducing social stress can increase reproductive efficiency and decrease early pregnancy loss," he said.

Pregnancy Rates and Uterine Fluid When Using Frozen-Thawed Semen

It's been reported that breeding with frozen-thawed semen can result in increased incidence of post-breeding intrauterine fluid (IUF) accumulation and decreased pregnancy rates compared with fresh or chilled semen, said the authors of another study. They evaluated pregnancy rate and IUF's association with frozen semen breeding in a retrospective study of 1,023 fresh, chilled, or frozen-thawed inseminations. "All mares, including old mares, had similar pregnancy rates between frozen and chilled semen breeding," Blanchard said. "Even the older maiden mares did quite well with frozen semen breeding and had less intrauterine fluid accumulation following frozen semen breeding than with chilled or fresh semen.

"Frozen breeding can be suitable for older mares … and might not require the increased post-breeding management we sometimes expect to be necessary," he said.

Stallion Sperm Viable After Death

Italian researchers evaluated whether severe illness—in this case colic—would affect epididymal semen quality and freezability. They compared epididymal sperm of five stallions that died within 12 to 36 hours after colic surgery and compared it to that of healthy stallions post-castration. Deceased stallions' sperm motility parameters were initially lower than healthy stallions', but sperm membrane integrity values were essentially the same. After processing for freezing, or after freezing and thawing, semen quality parameters did not differ between groups. So frozen epididymal semen can still be good-quality after severe illness resulting in death.

MATHEA KELLEY

Broodmares living 24/7 in small, consistent herds might have higher pregnancy rates than those teased frequently and living in large groups with only daytime turnout.

> "Reducing social stress can increase reproductive efficiency and decrease early pregnancy loss."
> DR. TERRY BLANCHARD

Diagnosing Keratomycosis

In the first paper Clark described, scientists retrospectively looked at 22 cases of keratomycosis (fungal infection of the cornea). They found 100% of the cases' scraping samples contained fungal hyphae (there should be no fungi in healthy scrapings). Only 60% grew fungi on culture, indicating that corneal cytology (cellular swab exam) was more sensitive than culture for diagnosis.

The veterinarians treated 91% of the horses with at least one antifungal and an antibiotic eye medication and treated all horses for secondary uveitis (pupillary tissue inflammation). Also, 91% underwent a keratectomy (trimming away the corneal plaque). This promoted blood vessel migration into the defect and epithelial cell growth to repair tissue. Treatment took, on average, 6 ½ weeks, and 73% of the cases regained vision in eight weeks. Clark said cytology is important for accurately diagnosing eye infections to implement appropriate treatment.

The Case of the Fading Iris

Next Clark reviewed the newly recognized ocular inflammatory disease heterochromic iridocyclitis—in which the iris loses pigment and gets inflamed, along with the ciliary body (which produces liquid in the eye)—with secondary keratitis (corneal inflammation). In the retrospective study scientists examined 21 affected eyes in 16 horses. All horses had iris pigment dispersion on the corneal

lining. Initially, many affected horses have corneal edema but no pain, and it looks like glaucoma. This is a progressive disease, and in 24% of cases a fibrous membrane develops behind the cornea that can impair vision. Researchers believe an immune-mediated uveitis attacks the iris' melanin pigment, causing the dispersion and secondary dysfunction of corneal endothelial cells (the layer of cells on the inner corneal surface). About 50% of treated horses had retained vision on short-term follow-up. The best treatment was a combination of immunosuppressive cyclosporine implants placed beneath the conjunctiva and a topical NSAID. Clark reported that treatment is long-term and cases don't seem to go into remission.

ISTOCKCOM

Horses living and grazing in areas with an abundance of oak trees could be at risk of acorn toxicity.

Buscopan for Ileal Impactions

Ileal impactions in the small intestine can lead to colic associated with smooth muscle contractions. Researchers evaluated the *in vitro* (in the lab) use of Buscopan (butylscopolamine, an anti-spasmodic drug) for its effect on ileal smooth muscle and found that it inhibited spontaneous contractions, regardless of whether it was administered pre- or post-treatment with medications that cause contraction.

"This study was done in tissue baths with normal intestine harvested from healthy horses," Clark said. "When Buscopan was added either before or after the contraction drug, the tissue relaxed."

Clark noted that this drug might be useful to administer with impaction colic, and because its half-life is short (it takes less than 25 minutes for its blood levels to reduce by half, an indication of clearance), it's not likely to adversely affect colic cases.

Acorn Toxicity a Real Risk

Clark then described a study evaluating acorn toxicity. Study horses had to meet three of four criteria: acorn access, acorns in their gastrointestinal (GI) tract, clinical signs of GI and kidney illness, and if there was a necropsy, acorn toxicity findings. The researchers examined nine cases from 2004-2013 that occurred in autumn, but only in two of the 10 years studied. They hypothesized that these cases probably correlated with bumper acorn crops. Affected horses presented with colic or diarrhea. Horses initially having just colic developed bloody diarrhea within 36 hours; most had hemorrhagic diarrhea. Six horses died or were euthanized within 36 hours. The three survivors had a slower onset and progression of signs; they improved after 72 hours. Acorn toxicity induces acute tubular necrosis (cells of the kidney's renal tubules are damaged or die) and edema of the intestinal lining. Horses with rapid onset had a poorer outcome.

Tramadol for Chronic Laminitis Pain

Clark described a study in which researchers evaluated the use of tramadol (an opioid analgesic) at two doses—5 mg/kg vs. 10 mg/kg twice a day for a week—in chronic laminitis cases. In four horses, the higher dose reduced weight-shifting and offloading of the feet by 40%, whereas the lower dose only reduced it by 9%. This treatment is inexpensive and can be used with NSAIDs or for those horses that cannot tolerate NSAIDs. The researchers said tramadol should be safe if administered no longer than seven to 10 days, as it was in this study.

Butorphanol Administration Routes

Next, Clark said researchers compared the effects of the opioid butorphanol when administered both intravenously (IV) and subcutaneously (under the skin) at a high dose of 5 mL for a 1,100-lb adult horse. When given IV, the drug becomes 100% bioavailable (the horse can absorb and use it); subcutaneously it was 87% bioavailable. With the subcutaneous form, analgesic (pain-relieving) levels occurred within five minutes, and maximal concentrations occurred at 20 minutes and lasted two hours, slightly longer than what's seen with IV administration of that dose. Horses experienced fewer physiological and behavioral side effects with the subcutaneous route than with IV. The authors decided subcutaneous butorphanol administration is an acceptable alternative to the IV route.

Pain Written All Over His Face?

In the last study Clark described, the researchers aimed to develop a face pain scale for horses. They used two pain inducers: ischemic (reduced oxygen) pain via a tourniquet on the forelimb; and neuropathic pain by applying capsaicin on the skin. In horses, facial pain expressions can manifest as:

- Low or asymmetric ears and outwardly rotated ears;
- Angled appearance of the eyes;
- Withdrawn and intense stare;
- Dilated nostrils; and
- Tension of certain facial muscles.

This universal face pain scale might improve pain recognition in horses and help improve equine welfare.

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[1] UC Davis (Nicola Pusterla) & Merck Animal Health. Infectious Upper Respiratory Surveillance Program. Ongoing Research 2008-present.
[2] Townsend HGG. Onset of protection against live-virus equine influenza challenge following vaccination naive horses with a modified-live vaccine. Unpublished data.

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Diagnosing and Managing LAMENESS

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STEPHANIE L. CHURCH, ERICA LARSON, AND NANCY LOVING, DVM

Man vs. Machine on Post-Nerve-Block Lameness Evaluation

Which limb is lame? Even practitioners who handle lameness cases day in and day out second-guess each other's assessments (and even their own) when pinpointing a mild lameness. While developments of tools such as inertial sensor systems (ISS) have enabled more objective lameness measurements, veterinarians are still determining if they can use them effectively in the field and combine them with subjective assessment and, if so, how.

Indeed, agreement among clinicians about where a mild lameness is tends to be poor (only 50-60%). So Josh Donnell, DVM, equine sports medicine and rehabilitation resident at Colorado State University's (CSU) Orthopaedic Research Center, in Fort Collins, was curious if an ISS would improve lameness assessment post-blocking and could be used outside the confines of a veterinary clinic. He presented the results from research he and professor of equine surgery and advisor David D. Frisbie, DVM, PhD, Dipl. ACVS, ACVSMR, completed.

"Regionalization of pain 'blocking' is the gold standard (for lameness diagnosis), but there is fair to poor agreement between clinicians," Donnell said. "There are some objective devices that are being used and sought after, but currently there's a lack of repeatable methods."

> **"The correlation between ISS and the blinded clinician is strong for estimating lameness change post nerve-block."**
>
> DR. JOSH DONNELL

In the experiment he dubbed "man vs. machine," experienced lameness clinicians evaluated 36 horses 181 times (about five exams per horse) in the field.

"Every horse had a baseline exam … simultaneously, ISS data was collected when horses were moving in a straight line," he said. Next, "diagnostic regional anesthesia was performed … and then the (blinded) clinician reported what they thought their percent improvement was.

"Sixty percent of the time the blinded clinician and the ISS agreed on which was the primary lame limb" in the baseline exam, he said, and they found an 81% agreement when the clinician was unblinded in later exams. Agreement of blinded clinician and the ISS was similar to reports of agreement between clinicians on the presence of mild lameness.

When they combined unblinded clinician opinion with ISS, they saw an 80% agreement, potentially suggesting an improvement in choosing the primary limb.

"The correlation between ISS and the blinded clinician is strong for estimating lameness change post-nerve-block," he added. "This information could benefit all clinicians," regardless of experience level.

He added that the clinician has the advantage of clinical experience, a complete musculoskeletal exam, and a case history. But because subjective viewpoint and bias do affect their assessments, the input of the ISS could be helpful.

Finally, Donnell and Frisbie reported that while the horse cannot speak up, telling us what hurts, and a true gold standard for lameness diagnosis remains elusive, certainly the ISS can be a useful tool to help diagnose mild lameness.

Is Ultrasound Useful for Diagnosing Hind-Limb PSD?

Hind-limb proximal suspensory desmopathy (PSD) is as challenging to diagnose as it is to say. But researchers are making progress in telling what methods are most effective for pinpointing it.

Sue Dyson, MA, Vet MB, PhD, DEO, FRCVS, head of clinical orthopaedics at the Animal Health Trust Centre for Equine Studies, in Newmarket, England, evaluated whether ultrasonography is a reliable method for diagnosing PSD.

Horses with PSD have inflammation and tissue damage in the upper part of the suspensory ligament, which connects to the top back of the cannon bone, divides into two branches that attach to the proximal sesamoid bones, and lies under the superficial and deep digital flexor tendons and the check ligament. Traditional treatment approaches generally involve an extended period of confinement. Further, researchers have determined that the prognosis for hind-limb PSD after conservative therapy alone (generally, rest, with or without shock wave therapy and treatment with drugs such as corticosteroids) is poor, with only 14% of horses resuming full work without lameness for more than a year. Surgeons also treat PSD with procedures such as cutting the deep branch of the lateral plantar nerve and fasciotomy (ligament splitting) or desmoplasty (creating small longitudinal stab incisions in the ligament).

Dyson said an earlier study's results suggested that diagnostic ultrasound is unreliable for detecting hind-limb PSD and that MRI is vastly superior and should be the diagnostic gold standard.

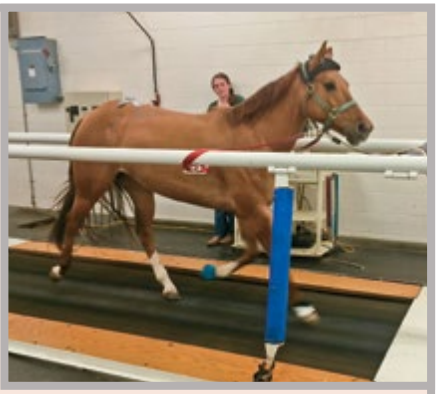
But MRI is considerably more expensive, and not every veterinarian has access to it. So she and colleagues compared ultrasound with post-mortem gross dissection and histology (cell structure) findings.

In the first part of their two-part study, the team evaluated 19 horses diagnosed with hind-limb PSD, euthanized for reasons unrelated to the study. Based on ultrasound before euthanasia, the team graded PSD as mild, moderate, or severe. After horses were euthanized, the team examined 37 limbs grossly and 36 suspensory ligaments histologically. They graded the suspensories on a four-point scale (0 being normal and 3 being severe). They also examined suspensories of 10 control horses with no PSD evident post-mortem.

Key findings included:

- Lameness was detectable in 47% of horses in hand and in 68% of horses when longed; all the horses were lame under saddle or in harness;
- Most lamenesses were characterized by a lack of hind-end impulsion;
- Ultrasound revealed moderate PSD in 31 limbs, severe PSD in seven;
- Ultrasound predicted the presence of

Gait Analysis Sensor Placement Crucial



COURTESY DR. VALERIE MOORMAN

Inertial sensor systems give veterinarians a way to collect objective lameness data when they're conducting research and to record subtle movement abnormalities when they're assessing difficult-to-pinpoint and/or multiple-limb lamenesses in patients. Ideally, veterinarians and assistants place wireless sensors consistently in specified locations. But, because humans are not machines, there can be some slight variation in that application. One research group wanted to see if the system remained accurate when sensor locations were altered.

Valerie Moorman, DVM, PhD, Dipl. ACVS, and colleagues at Colorado State University's Orthopaedic Research Center, in the College of Veterinary Medicine and Biomedical Sciences' Department of Clinical Sciences, looked at the effects of changing two sensor placements ever so slightly.

The team hypothesized that shifting the position of the right fore pastern sensor would not significantly affect the system's output, but that moving the pelvic sensor would. They examined 12 horses trotting on a high-speed treadmill, which, while it does not exactly mimic a horse trotting over ground, does help ensure consistent speed and data collection between trials. On each horse the team tested the right forelimb sensor in its recommended spot (dorsal midline) and then 2 cm medially (toward the center of the horse's body) and 2 cm laterally (toward the outside). In another session, they tested the pelvic sensor in five locations: in its recommended midline position, 2 cm to the right and left of midline, 2 cm cranially (toward the head), and 2 cm caudally (toward the tail).

Moorman said the researchers saw lameness in 11 forelimbs: nine in the right, two in the left, with a median lameness of 1 out of 5, with 5 being most severe. They saw lameness in 20 hind limbs, with a median lameness 1.25 out of 5. They didn't notice any significant differences with the right forelimb sensor measurements, but pelvic sensor location significantly affected their measurements.

In the end, the team found a sensor position change of 2 cm could result in the sensor inaccurately diagnosing hind-limb lameness, so placement of this sensor must be anatomically accurate. Moorman expressed that repeating the pelvic sensor testing with a 1-cm difference might yield different results.—*Stephanie L. Church*

CONVENTIONTWEET

Erica Larson
@TH_EricaLarson

Fraley: The sky's the limit with hoof boots. If you can imagine it, you can glue or bolt it to a hoof boot.

adhesions (bands of scar tissue) in four;
- On gross necropsy, veterinarians did not identify adhesions in the controls;
- Gross exam revealed adhesions between the suspensory and adjacent soft tissue structures in 27% of lame limbs, despite ultrasound only predicting them in four;
- Further, they found that tough adhesions had formed between the suspensory and cannon in 10 limbs, which ultrasound exams had not predicted;
- Histology on control limbs without PSD revealed no abnormalities;
- But the team noted numerous abnormalities in PSD limbs: Abnormalities in collagenous tissue in 69%, muscle tissue 97%, adipose (fat) tissue 44%, neural 64%, and vascular changes (changes in blood supply) 8%.

Dyson said one lame limb had no histologic abnormalities at any sampled sites; but the horse had tough adhesions between the suspensory and the deep digital flexor tendon in several locations.

In the second part of the study, the team evaluated seven other horses with PSD; three had recurrent lameness following previous PSD surgery, and four had suspected adhesions between the upper suspensory and cannon bone, based on ultrasound. Those horses were euthanized for reasons unrelated to the study, and the team completed gross necropsies without histology. They found that while ultrasound accurately predicted some adhesions, others were only seen on necropsy.

Dyson said that quality ultrasonography is reasonably reliable for detecting PSD when judged against necropsy findings as the ultimate gold standard, but it underestimates adhesion presence.

COURTESY DR. JOHN JANICEK

Foot casts can immobilize joints, maintain hoof angles, and decrease recovery time.

Pelvis or Femur Fracture? Check Both

Horses can suffer pelvic and upper-hind-limb trauma—even fractures—in falls. One veterinarian reported that detecting these injuries and telling them apart can be tricky and offered tips on how to do so.

Georgette Shields, DVM, a resident at CSU's Veterinary Teaching Hospital, described a horse with an unresolved lameness six weeks after a fall. An earlier ultrasound of his pelvis and his lumbosacral and sacroiliac joints of the spine and pelvis revealed no abnormalities. But nuclear scintigraphy (bone scan) showed radioactive marker uptake—inflammation and injury—in the third trochanter of the femur.

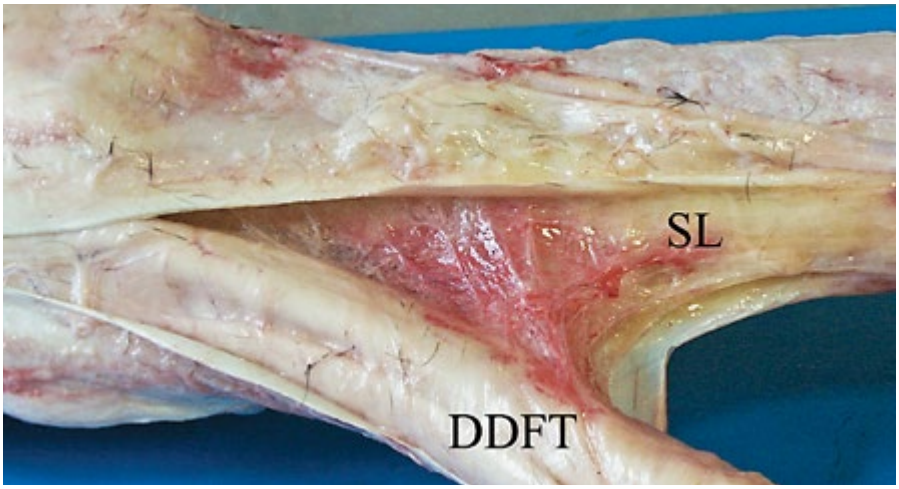
The third trochanter protrudes from the femur about halfway between the hip and the stifle. It is difficult to radiograph due to large overlying muscles and more conducive to ultrasound, which in this case—once clinicians knew where to look based on bone scan—revealed a large fracture fragment where the gluteal muscle tendon and tensor fascia muscle insert. The protrusion doesn't bear weight and isn't involved with the stifle, so a horse can use the leg even though quite lame.

Shields reviewed abnormal imaging findings of the femoral third trochanter in 20 horses seen at the University of California, Davis, Veterinary Teaching Hospital, from December 2004 to June 2014. Veterinarians used ultrasound to diagnose 14 horses with acute lameness due to third trochanter fractures. They also saw focal fluid (blood or serum) accumulation, muscle tearing, and/or hemorrhage around the fracture. The majority of the horses were Grade 3 (out of 5) lame.

"Nuclear scintigraphy prompted a focused ultrasound exam in nine of the 14 positive fracture cases," Shields said. "Pelvic and third trochanter fractures can present similarly; therefore, it is important to ultrasound both areas."

Three-quarters of horses with third trochanter injuries needed at least two imaging modalities to confirm it. Stall rest was the treatment of choice followed by slow and progressive increases in hand walking and light activity over many months.

Third trochanter fractures generally produce more lameness than what one would expect with sacroiliac injury—a common rule-out when a horse has an upper-hind-limb lameness. Anytime a veterinarian suspects an upper limb fracture, Shields recommends performing an ultrasound of both the pelvis and femur.



COURTESY DR. SUE DYSON

Researchers found extensive adhesions between the suspensory ligament (SL) and the adjacent soft tissues (such as the deep digital flexor tendon, DDFT) in the metatarsal region of this lame horse.

Foot Casts for Lower Limb Injuries

It's one thing for a doctor to tell a patient to rest and keep an injured lower leg immobilized and unloaded. It's another thing, however, when a veterinarian treats an injured horse, which lacks the ability to kick back and rest the limb until it heals.

Fortunately, veterinarians have options

for managing equine distal (lower) limb injuries. One of those is foot casts. John Janicek, DVM, MS, Dipl. ACVS, reviewed how to use foot casts in clinical practice. He is a practitioner at Brazos Valley Equine Hospital, in Salado, Texas.

Janicek said foot casts can help veterinarians treat a variety of conditions, including heel bulb and pastern lacerations, hoof wall avulsions (where pieces have been torn away or surgically removed), collateral ligament (which stabilizes various lower limb joints) injuries, and coffin bone fractures. Casts incorporate the entire hoof and extend to the upper pastern. Advantages they offer include decreased recovery time, coffin and pastern joint immobilization, maintainance of the hoof-pastern axis (alignment of the front of the hoof wall with the pastern; if parallel, the hoof has a proper hoof-pastern axis), and reduction of the time and cost associated with frequent bandage changes.

Prior to applying a hoof cast on a standing sedated horse, the veterinarian should determine if any synovial structures (i.e., joints, tendon sheaths, bursa) the cast will cover are infected. If so, he or she must address the infection and not apply the cast until it's cleared.

Also before applying the cast, the veterinarian must prepare the horse's hoof and surrounding structures. This includes removing the horse's shoe (if applicable) and trimming the hoof to prevent pressure points along the outside edge of the cast. If the horse has any lacerations that will be covered with the cast, treat and lightly bandage those, as well.

Keep a cast on for two to three weeks; Janicek said most ailments heal or improve enough to be managed without a cast in that time. He also said to keep casted horses in clean, dry stalls to minimize complications, including cast sores; fluid discharge; broken casts; excessive wear around the toe; and lameness.

Janicek said clinicians should modify or remove the cast if any complications arise.

For a step-by-step review on how to apply a hoof cast, see TheHorse.com/37076.

Boots for Managing Chronic Laminitis

Despite extensive research into the painful hoof disease laminitis, one thing is unchanged: There's little scientific proof that one treatment method works better than another. So veterinarians and farriers must do the best they can with the options available, one of which is the hoof boot.

COURTESY DR. BRYAN FRALEY

A new hoof boot with an interchangeable base might benefit horses with chronic laminitis.

Bryan Fraley, DVM, of Fraley Equine Podiatry, a Hagyard Equine Medical Institute affiliate in Lexington, Kentucky, shared how veterinarians can use boots to manage chronically laminitic horses.

> "It's not uncommon for a horse with chronic laminitis to get more comfortable in boots, but deteriorate radiographically."
> DR. BRYAN FRALEY

Laminitis—the separation or failure of laminae, which connect the hoof wall to the coffin bone within—can cause permanent structural changes in a foot, leading to repeated bouts of disease and lameness. In severe cases the coffin bone sinks or rotates downward, sometimes even puncturing the sole. Laminitis can cause such severe pain and structural change that euthanasia might be warranted.

One of the main reasons veterinarians, farriers, and owners alike use hoof boots is to improve the comfort of horses suffering from painful conditions such as laminitis. Fraley cautioned, however, that comfort is only part of the bigger picture.

"It's not uncommon for a horse with chronic laminitis to get more comfortable in boots, but deteriorate radiographically," he said. Essentially, though the horse might appear more comfortable, the structural changes can ultimately lead to more severe problems and pain.

Hoof boots have other limitations, as well. Not all horses wear the same size or benefit from the same style, meaning veterinarians and farriers need a large inventory, Fraley said. Further, boots can cause rubs, sores, and inflammation, and they must be removed, reset, and checked for damage regularly. They're high-maintenance and not for all owners. Fraley said he views boots as a temporary treatment for chronic laminitis, mainly because of the need for intensive management.

He added that there are a number of benefits to using hoof boots—and modifying them to benefit each individual patient. Some modifications include adding inserts, insoles, or hoof packing to provide comfort and improve the health of the compromised hoof.

Fraley also encouraged attendees to take radiographs after placing the horse in hoof boots to see how the internal structures look: "It's surprising how bad the mechanics can be radiographically," even in some properly applied boots.

He also shared a new hoof boot with an interchangeable base that he and three other professionals recently developed. He said the idea came from a ladies' shoe that can be converted from a high heel to a flat. The first prototype they developed had five sole options, ranging from heel wedges to clogs, which can be switched out with a screwdriver to meet a horse's changing needs. The patent-pending boot is commercially available as the EasyBoot Rx Click System.

Boots aren't a permanent solution for chronic laminitis, but they provide customized support and pain relief until underlying causes of disease are addressed, the horse is transitioned to shoes, or a decision is made regarding his future.

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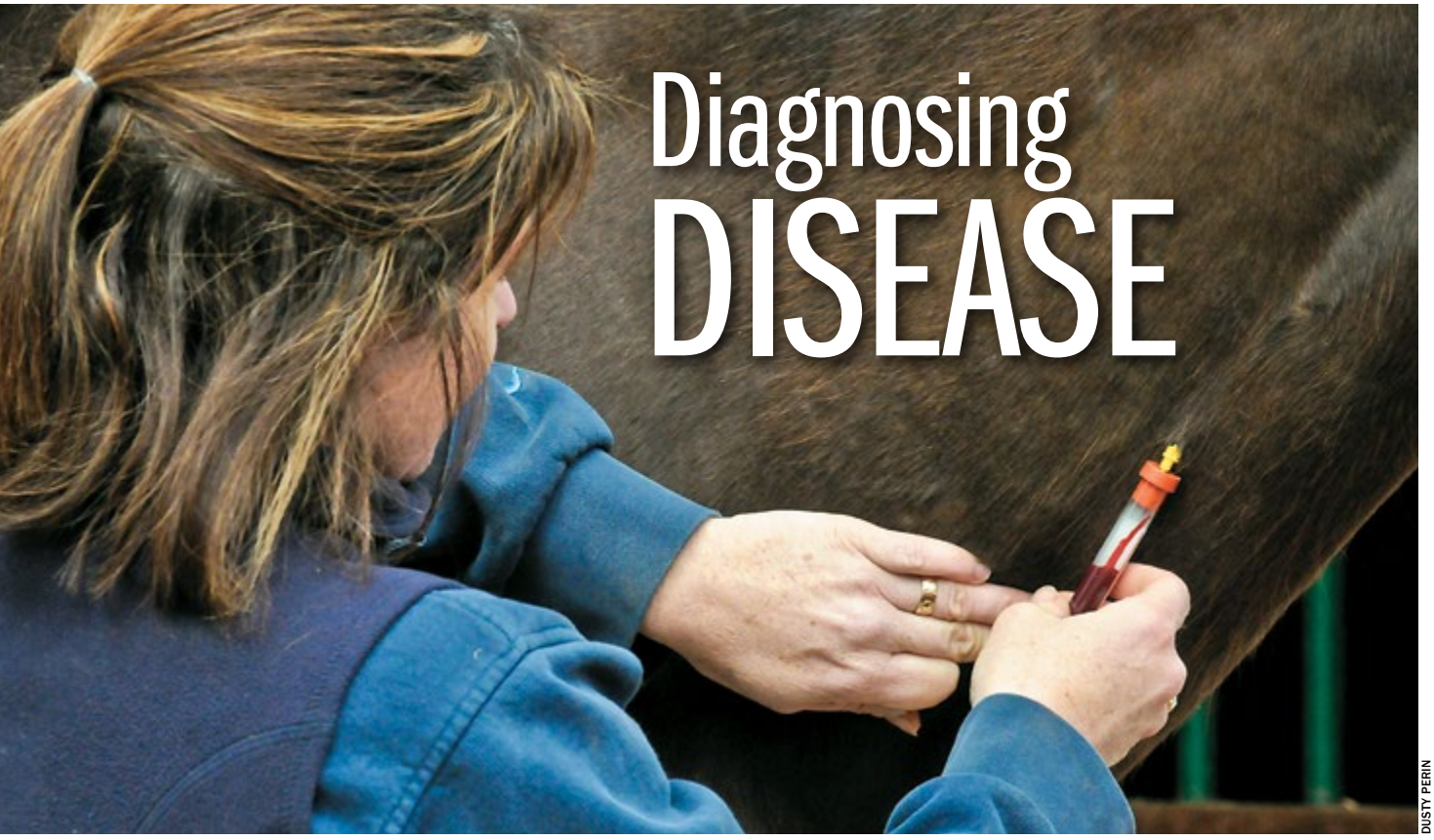

Diagnosing DISEASE

DUSTY PERIN

ALEXANDRA BECKSTETT AND STEPHANIE L. CHURCH

Measuring SAA Can Help Identify Health Issues Early

In the early stages of infection or inflammation, it might be apparent that something isn't quite right with your horse, but for all intents and purposes, he's clinically normal. Such vague signs can delay diagnosis and treatment, as the veterinarian opts for a "wait-and-see" approach, leaning on blood tests for clues.

Fortunately, an accurate and reliable indicator for infection is gaining traction in equine practice: serum amyloid A (SAA) concentration. Rose Nolen-Walston, DVM, Dipl. ACVIM, associate professor of large animal internal medicine at the University of Pennsylvania School of Veterinary Medicine's New Bolton Center, described its uses.

Nolen-Walston explained that SAA is an inflammatory marker that the liver produces as part of the body's response to inflammation. Veterinarians can use it to differentiate between systemic inflammation and noninflammatory disease.

Historically, veterinarians have relied on another inflammatory marker, the protein fibrinogen, to identify infections. All horses have a baseline level of fibrinogen in their bloodstream that rises slightly with inflammation. In contrast, SAA isn't present without inflammation, but levels rise into the thousands when infection sets in, Nolen-Walston said. Additionally, SAA levels rise and normalize faster than fibrinogen, which allows veterinarians to track the course of disease more closely.

Overall, fibrinogen's diagnostic accuracy is 62%, compared to SAA's accuracy of 75%. Hence, Nolen-Walston has dubbed SAA "a souped-up fibrinogen."

"It's not going to change your life, but it's going to make it arguably better," she said.

She described how SAA concentrations can help identify particular health issues.

> **"Surgical colics are less likely to have high SAA levels, so this finding should make a veterinarian think twice before exploring the abdomen."**
>
> DR. ROSE NOLEN-WALSTON

Gastrointestinal disease and colic While SAA measurements can't necessarily help veterinarians distinguish whether a colic is one that can be resolved medically or surgically, SAA can help them diagnose colitis, enteritis, and other inflammatory colics, said Nolen-Walston. "Surgical colics are less likely to have high SAA levels, so this finding should make a veterinarian think twice before exploring the abdomen," she said.

Respiratory disease Veterinarians should expect to see very high SAA concentrations if a horse has an infectious respiratory condition, such as bacterial pneumonia, and some elevation with viral lung disease. They should only see minimal SAA concentrations in horses with recurrent airway obstruction (heaves). "Probably the main use of SAA in horses with recurrent airway obstruction is distinguishing them from pneumonia cases, in which the SAA is likely to be much higher," Nolen-Walston said.

Surgery She said SAA levels are worth looking at after surgery to identify postoperative complications. In animals with postoperative infections, veterinarians will notice a high SAA peak and a slow fall.

Joint disease While SAA concentrations aren't apparent with typical osteoarthritis,

they are a sensitive marker for septic (infected) joints, said Nolen-Walston.

Laminitis "The question of how SAA changes in laminitis is complicated by its myriad inflammatory as well as noninflammatory etiologies (causes)," she said. But, in a nutshell, SAA isn't going to tell you much. "If the SAA is increased in a foundered horse, look for a source of infection or inflammation."

Exercise Researchers have been examining how SAA concentrations respond to exercise in race and endurance horses. In these studies, said Nolen-Walston, SAA levels were unchanged post-racing but slightly elevated post-endurance ride. So while SAA might eventually help endurance trainers determine a horse's preparedness for advanced competition, there's still a lot of research to be done.

Reproductive disease As can be expected, SAA levels rise with inflammatory reproductive diseases such as placentitis, and Nolen-Walston said they increased steadily until placentitis-related abortion occurred in study mares. "It is also normal for SAA to increase slightly in the few days after foaling (in normal mares), but very high levels probably indicate uterine inflammation or infection," she added.

Parasites Veterinarians do not detect SAA in heavily parasitized horses, or in these horses after deworming.

In summary, Nolen-Walston said SAA is a sensitive predictor of early inflammation and infection that outperforms fibrinogen. She cautioned, however, that SAA should not replace the veterinarian's physical exam and disease diagnosis.

"In a general sense, SAA can be used in most situations to obtain early identification of an inflammatory process, to assess the effectiveness of a chosen antimicrobial or other treatment, to monitor the rate of improvement, and to mark resolution of disease," she said.

How to Differentiate Between Cushing's and Equine Metabolic Syndrome

Pituitary pars intermedia dysfunction (PPID, or equine Cushing's disease) and equine metabolic syndrome (EMS) are by far the most common equine endocrine disorders. Recent study results suggest that up to 30% of some breeds suffer from one of these conditions in their lifetimes.

While these potentially career- and life-ending diseases are distinctly different in the damage they cause, they do share some similarities; laminitis, for instance, is associated with both. This can make distinguishing them and selecting appropriate treatment challenging.

Kelsey Hart, DVM, PhD, Dipl. ACVIM, assistant professor of large animal internal medicine at the University of Georgia's Department of College of Veterinary Medicine, reviewed current recommendations for PPID and EMS testing.

Here's how each disease works:

- ***PPID*** occurs most commonly in horses older than 12. Factors related to aging inhibit function of the horse's pars intermedia, located in the pituitary gland. This results in an overproduction of hormones, such as adrenocorticotropic hormone (ACTH) and cortisol, that leads to clinical signs such as abnormal hair coat and failure to shed, abnormal sweating, loss of muscle mass, and increased water intake and urination, etc.

> "Differentiating between (PPID and EMS) is still an art."
> DR. KELSEY HART

- ***EMS*** can develop in horses of any age. Researchers believe adipose (fat) tissue abnormalities alter the metabolism of affected horses, leading to characteristic signs that include regional fat deposits, insulin resistance, and laminitis.

"Differentiating between the two diseases is still an art," said Hart. Practitioners must use clinical signs, screening tests, and dynamic testing (which involves comparing samples at specific time intervals) to make an accurate diagnosis.

"The classic presentation of PPID is an older (late teens and upward) animal that presents with pasture-associated or seasonal laminitis, generalized muscle wasting/weight loss, and hair coat abnormalities," she explained. "The classic presentation for EMS is also an animal that presents with pasture-associated laminitis, but in contrast this is a younger to middle-aged animal with a normal hair coat that has always been an easy keeper and is clearly obese with obvious fat deposits in the crest of the neck and tailhead."

She cautioned, however, that these signs are really only helpful in advanced stages of disease. Further, the two conditions can appear concurrently in some horses. Thus, she recommended

Classic Clinical Signs of PPID and EMS

PPID	EMS
Laminitis, often seasonal (spring/autumn) and/or pasture-associated	Laminitis, often seasonal (spring/autumn) and/or pasture-associated. Onset may be gradual, with abnormal growth rings on hooves or chronic laminitic changes noted on radiographs but no clinical signs.
Middle-aged and older, almost always older than 12	Any age
Predisposed breeds/types: Ponies, Morgans	Predisposed breeds/types: Ponies, Morgans, Paso Finos, Arabians, Saddlebreds, Quarter Horses, Tennessee Walking Horses
Abnormal hair coat: early or late shedding/hair growth, retention of guard hairs, failure to shed out completely or at all, a long curly coat	Normal hair coat and shedding pattern
Muscle wasting/weight loss, ranging from difficulty maintaining condition to topline muscle loss to severe emaciation	Normal to increased body condition, often has been an "easy keeper" or obese since a young age
Abnormal fat distribution: Regional adiposity, or fat deposits in the crest of the neck, tailhead, prepuce, and flanks. Can make muscle wasting/weight loss harder to detect.	Abnormal fat distribution: Regional adiposity, or fat deposits in the crest of the neck, tailhead, prepuce, and flanks. Can occur with or without generalized obesity.
Decreased immunity/delayed healing	No apparent changes in immunity or healing
Polyuria/polydipsia (excessive urination/drinking)	No changes in urination or water consumption

COURTESY DR. KELSEY HART

veterinarians run hormonal tests to accurately differentiate between the two.

To screen for PPID, she said veterinarians start by measuring baseline resting ACTH concentrations. Keep in mind, however, that season affects both healthy and Cushing's horses' ACTH concentrations, with levels naturally increasing during fall months.

"We used to say don't test in the fall because you can get false positives," said Hart. "But it's possible to test in the fall with seasonally correct ranges for the fall (ACTH) spike."

Testing for EMS can be more complicated. While the fasted insulin concentration test (in which the veterinarian measures insulin in a blood sample taken after the horse has fasted overnight) is the most straightforward, Hart said that other factors, such as stress, diet, and pregnancy, can affect a horse's insulin regulation.

If these PPID and EMS test results come back borderline or negative, as they often do in early stage disease, your veterinarian might want to proceed with dynamic testing, said Hart.

For PPID, the overnight dexamethasone suppression test (where the veterinarian administers the steroid dexamethasone, which in healthy horses will cause a decrease in ACTH) has long been the gold standard. However, Hart suggested that the thyrotropin-releasing hormone stimulation test (where TRH administration causes an exaggerated ACTH response in PPID horses) might be a more useful method for early disease diagnosis.

CONVENTIONTWEET

AAEP
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EMS pathophysiology poorly understood. We do know that it's not the same as PPID and hypothyroidism.

Hart said she thinks the simplest and most useful dynamic field test for EMS is the oral sugar test, which assesses the horse's insulin response to dietary carbohydrates—in this case, corn syrup.

In summary, there is no ideal, one-size-fits-all testing method to differentiate between these two diseases, said Hart. "It is unlikely that a single diagnostic testing approach will ever be applicable to or useful in all presentations of these diseases," she said. "It is important to remember that all of the tests described can have false positives and false negatives," particularly in the early stages of both diseases.

ONLINE extras

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- Is Equine Coronavirus Prevalent is Nasal Secretions? TheHorse.com/37097
- MRI Can Help Diagnose Early Stage PPID, TheHorse.com/37098

EQUITARIAN Issues

COURTESY DR. JENNIFER LANE

ALEXANDRA BECKSTETT

Don't Forget About Working Equids

Out of sight, out of mind. This is often the harsh reality for working equids, while people in developed countries are busy caring for their own horses. But, argues Derek Knottenbelt, DVM&S, Dipl. ECEIM, MRCVS, these animals serve a very important role across the world and need our attention.

A longtime equitarian (volunteer veterinarian on trips to developing countries) and professor of Equine Medicine at Scotland's University of Glasgow School of Veterinary Science, Knottenbelt described working equids' plight and importance.

His philosophy, he said, is that by improving working animals' welfare, we are in turn relieving human burden.

More than 100 million families in rural communities worldwide depend on working equids for transportation, farming, economic value, and social value. "They play a fundamental role in individual family prosperity and in the local and national economics," Knottenbelt said. "Indeed, it could be said that if the working horse or donkey were to be removed from society, the economy of the world would collapse."

Unlike in the Western world, however, where equids enjoy quality veterinary care and legislative protection, working equids aren't always blessed with trained veterinarians, well-educated owners, or government support. They're victim to ill-fitting harnesses, malnutrition, and preventable diseases, such as tetanus and rabies.

This is not, however, because their owners don't care about them. "A donkey can increase a family's income by up to 500%," Knottenbelt said, so it's in a family's best interest to keep it healthy. It's because they're caring for these animals the only way they know how, while doing all they can to care for themselves.

> **"Indeed, it could be said that if the working horse or donkey were to be removed from society, the economy of the world would collapse."**
>
> PROF. DEREK KNOTTENBELT

So what can veterinarians from developed countries do to help?

Due to financial, practical, and geographical constraints, he said, we need to focus on the most effective efforts.

"Simply offering advice will not bring sustainable change," he said, adding that "primary first aid" won't in itself make much of an impact either. What's the long-term advantage, for instance, of deworming a donkey who lives in a worm-riddled environment? But primary care does provide a window of opportunity for educating and advising owners.

Knottenbelt instead puts the focus on controlling epidemic or fatal diseases. "Vaccination programs for tetanus, rabies, and African horse sickness will make a significant difference in the horse population," he said.

And in countries like Ethiopia, where the contagious fungal infection epizootic lymphangitis contributes to massive loss of use in working equids, Knottenbelt said government-supported euthanasia programs can and have significantly reduced case numbers. This is challenging, he added, due to cultural and religious aversions to euthanasia.

Lastly, "education is probably the most basic requirement," he said. Things as simple as teaching a farmer how to properly harness his donkey can go a long way toward keeping that donkey in work.

Overall, "We need to identify specific local needs and encourage government support and development of equine veterinarians," he said.

Working Equids' Influence on Human Health and Livelihood

The U.N. Food and Agriculture Organization estimates that there are at least 112 million working horses, donkeys, and mules in the world today. And not coincidentally, you can find most of these equids living and working in areas where people live on less than $2 a day.

Jennifer Lane, DVM, MPH, Leland International Hunger Fellow at the Congressional Hunger Center, recently confirmed that equid health is intrinsically linked to human health in these areas.

"Many families in disadvantaged, marginalized communities are heavily dependent on the income provided by the power and work of their working equids," said Lane, who's based with Land O'Lakes International Development in Malawi,

quoting the African proverb, "A woman who has no donkey is a donkey."

Indeed, working equids are particularly important for reducing the burden of work on women and children.

"If the animal is unable to work, then the labor is frequently performed by a woman or child in the family, thereby removing them from ... wage-earning or attending school," she said.

To put more evidence behind working equids' effects on human health, Lane conducted a study in 2014 during an annual mobile veterinary clinic event organized by the Equitarian Initiative in rural Nicaragua. Of the 70 owners she surveyed, 31 (22%) lived on less than $1.25 a day. They used their equids primarily to haul agricultural goods throughout the mountainous region. Seventy-four percent strongly agreed that their equids' health affected their family's health.

As part of the study, Lane evaluated the growth indicators of 20 children between the ages of 6 and 14. She calculated each one's weight-for-age and height-for-age scores—measures of past or present malnutrition. Lane found that two children were underweight, one had stunted growth, and seven others had scores indicative of some degree of malnutrition.

She then scored the 132 equids in the study using a 25-point health scale and found a significant association between working equid and human health scores.

While Lane's sample size was fairly small and limited to only one part of the world, she said her study opens the door for more questions and supports causes providing humane treatment, owner education, and policy advocacy for working equids and their owners worldwide.

Poor Body Condition in Nicaragua

One of the most obvious signs of welfare issues in working equids is emaciation. We might be quick to judge that these animals are not being fed enough, but the reality is dental issues, parasites, or other conditions might be contributing.

During an Equitarian Workshop in Nicaragua in 2014, Sara Gomez-Ibanez, DVM, of Sustainable Veterinarians International, investigated how infectious and parasitic conditions correlated with body condition scores (BCS) in working equids.

"I wondered why some horses looked so much better than others in the same area," she said. "I started asking (owners) questions and got recurring complaints: lethargy, inappetence, and ill thrift."

She said she immediately wondered whether these horses might be suffering from tick-borne diseases, equine infectious anemia (EIA), or parasite infections.

In her study, Gomez-Ibanez selected 35 working horses at random from four of the Equitarian Initiative-organized veterinary clinics. She conducted full physical exams on the horses and took blood and fecal samples for laboratory analysis.

Based on her observations and the lab results, Gomez-Ibanez determined that:

- The horses' average age was 8.4 years;
- The average body condition score was 2.9 (on the 1 to 9 scale);
- 33 horses (94%) were anemic;
- 34 (97%) were seropositive for the causative organisms (*Theileria equi* or *Babesia caballi*) of the tick-borne disease piroplasmosis;
- Four (11%) were positive for EIA; and
- 24 (83%) of 29 for which fecal samples were available had strongyles; 19 of those were moderate or high shedders.

She said her ability to draw correlations between these conditions and BCS was limited by the small study size and the uniformly low body condition scores (all were 5 or lower).

But two factors did suggest a possible correlation with low BCS: seropositivity for EIA and a positive PCR (polymerase chain reaction test, which finds pathogen DNA) result for *T. equi*.

"In the case of EIA, confirming this correlation would provide more evidence in favor of enhanced control and surveillance programs," Gomez-Ibanez said. "In the case of *T. equi*, confirming this correlation could in turn generate two different hypotheses: 1. that the active form of the disease causes poor body condition, and/or 2. that the horse's ability to control *T. equi* parasitemia is dependent upon having adequate overall body condition."

In a nutshell, poor body condition in working equids is multifactorial, she said, and it's nearly impossible to separate simple malnutrition from other diseases. She hopes other equitarians will take blood samples to test for these diseases.

CONVENTIONTWEET

Alexandra Beckstett
@TH_ABeckstett

Knottenbelt: Working equid situation in developing countries: It's a cruel life out there, but it's not cruelty.

The Equitwister: A Simplified Way to Castrate Working Equids

One of the most common (and some might say important) surgical procedures veterinarians perform on working equids is castration. While it's generally

COURTESY DR. JENNIFER LANE

Many families in developing countries depend heavily on the income provided by the work of their horses or donkeys.

considered a quick, easy, and inexpensive procedure in developed countries, it can be cost-prohibitive and/or lead to complications in rural developing communities.

So Tracy Turner, DVM, MS, Dipl. ACVS, ACVSMR, of Turner Wilson Equine Consulting, in Elk River, Minnesota, developed a simple, inexpensive castration tool for use in equitarian work: the Equitwister.

Castration is important in developing countries, he said, for improved equine behavior and handler safety; to prevent pregnancies in working mares; and to promote selective breeding for better animals.

So why the need for a new tool?

"In equitarian work, castration is typically done on a single day in a community during a yearly visit," Turner said. "Due to the lack of ability to follow up on these patients, it is imperative that reliable techniques with few complications be used. In addition, these techniques are often simultaneously taught to local veterinarians or veterinary students. Ideally, the techniques should be simple, easily repeatable, and use equipment that is affordable."

Common castration complications that know no socioeconomic bounds include hemorrhage, swelling, infection, and evisceration (protrusion of the intestines through the surgical site). In addition to the impracticality of veterinary follow-up, these occur more frequently in developing countries because of the logistical challenges of keeping wounds clean.

In the past, equitarians have relied on the Henderson castration tool, which clamps around the spermatic cord, attaches to a power drill, and twists off the testicle. This twisting technique helps prevent hemorrhage.

But because sustainability—in this case, the locals' ability to continue veterinary work after equitarians leave—is an important part of equitarian work, the Henderson tool is impractical if for no other reason than cost, said Turner.

"The clamp is expensive, the power drill is expensive, and castrations may be performed in areas without (electrical) access to recharge batteries, making the tool unusable," he said. Each tool costs $200-400, which is impractical in a country where average annual income is $1,600-6,800.

Enter the Equitwister. Made of stainless steel rod, PVC pipe, and a crank, it uses a similar approach to the Henderson tool in how it twists the spermatic cord,

COURTESY DR. TRACY TURNER

The Equitwister is safe, easy to use, and very inexpensive.

and though it's manual, it requires little effort. It also costs less than $5 to make.

"The Equitwister is easier to use, much less expensive, and as effective as any castration technique today," said Turner, who has been using prototypes since 2014 and continues to make improvements.

He said the procedure results in hardly any hemorrhage and, after the horse undergoes general anesthesia, can be performed in under a minute. Turner said he's performed more than 200 Equitwister castrations and encountered only one hemorrhage and one evisceration.

Hoof Care in Developing Countries

Because a working equid's cargo might be his owner's sole source of income, soundness is especially crucial. Most owners, however, don't have access to quality farriery (if they can find any at all). And the challenges of trying to provide them with hoof care and education are many.

Stephen O'Grady, DVM, MRCVS, of Virginia Therapeutic Farriery, in Keswick, has been involved with equitarian projects worldwide. He listed inherent challenges of teaching proper hoof trimming and shoeing to owners of working equids:

- ***The language barrier*** Many of these owners must learn by observation.
- ***Limited supplies*** Farrier tools typically aren't available in rural communities. "We have addressed this in many instances by having farrier supply companies donate shoes, nails, and tools," he said. "Lately, we have even asked farriers to donate used tools that could be used by the local farriers while we are there and then left for them to continue what they have been taught."
- ***Limited time*** Visiting farriers and equitarians have only a day or two to teach trimming and shoeing techniques.
- ***Noncompliant animals*** Many of the equids simply won't allow their feet to be worked on without sedation.
- ***Environment*** Farriers must work in less-than-ideal conditions. In Ethiopia, for instance, it's so dry that they can't even cut through the toughened, brittle feet to trim them, said O'Grady.

Nevertheless, hoof protection is important for these animals because most are working on hard surfaces. Excessive hoof growth and distortion can lead to abscesses, cracks, and abnormal forces on the foot—all issues that can put an equid temporarily out of work.

On his equitarian trips, O'Grady said he teaches the locals a very basic trim technique using whatever tools are available to them: Find the frog and the widest part of the foot, trim the hoof wall at the heels to the base of the frog, and remove excess toe until the hoof is fairly proportional.

O'Grady then described his week working with owners in Ethiopia, a poor country with rampant animal welfare issues.

He said this project was particularly challenging because the only materials and tools on-hand were rubber tire scraps, round carpenter nails, hammers, and hoof knives. When O'Grady and his team arrived, they noted that abscesses were widely prevalent in these horses because the local farriers placed the nails inside the hoof's white line and drove them through the sole and out the hoof wall. So they taught the farriers the bare basics of trimming and how to remove flares from the outer hoof wall using the toeing knife.

"By the second day we started to see results," he said. "The farriers would look at the foot, start to trim the heels/remove the flares, and cut out (rubber) shoes that actually fit the foot."

With proper education, equid owners in developing countries can sustainably improve their animals' hoof health. Beyond improving standard of welfare for these horses and donkeys, keeping them sound can mean preserving owners' sole source of income.

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[1] UC Davis (Nicola Pusterla) & Merck Animal Health. Infectious Upper Respiratory Surveillance Program. Ongoing Research 2008-present.
[2] Townsend HGG. Onset of protection against live-virus equine influenza challenge following vaccination naive horses with a modified-live vaccine. Unpublished data.

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MERCK Animal Health

Wound Care


PAULA DA SILVA

ALEXANDRA BECKSTETT

Managing Chronic Infected Wounds

Wounds that remain infected long-term are challenging for veterinarians to manage, not to mention distressing and costly for the horse owner. With the increase in multiple antibiotic resistance, handling these wounds isn't as clear-cut as it used to be. Today veterinarians can't just reach for the nearest antibiotic; they must consider the wound's entire ecology, the patient's immune health, and the pathogens involved.

James Orsini, DVM, Dipl. ACVS, associate professor of surgery at the University of Pennsylvania School of Veterinary Medicine's New Bolton Center, described how to manage these wounds accordingly.

He said the most common modes of contamination include contact with fecal matter, particularly in stalled horses; sustaining a penetrating wound to the oral cavity, pharynx, esophagus, or upper airway, which have extensive resident microflora populations; and exposure to dirt, plant debris, and flies.

The first step, when faced with a contaminated wound, is to lavage it. Your veterinarian should thoroughly but gently cleanse every part of the wound with a sterile saline solution.

If the wound is heavily contaminated or the tissue irreparably damaged, the veterinarian should also debride, or surgically remove, all compromised tissue. He suggested turning to medical maggots when surgical debridement is difficult, such as with foot injuries and deep-tract wounds.

Drainage is very important to healing. "As infection accumulates, it overwhelms the body's ability to clear," Orsini said. "This bacteria-laden, inflammatory exudate must have an egress for the immune system to effectively control the infection and orchestrate wound repair."

> **"We don't always think about the potential for human infection and vice versa, where we become the source of bacteria for these wounds."**
>
> DR. JAMES ORSINI

While gravity and implanted drains can encourage drainage, movement also helps. Controlled exercise, such as hand-walking, increases drainage and blood circulation, helps prevent gastrointestinal and musculoskeletal issues that can result from inactivity, and helps alleviate stress from confinement and isolation.

Another crucial consideration is biosecurity. "We don't always think about the potential for human infection and vice versa, where we become the source of bacteria for these wounds," Orsini said. Anyone handling open wounds should wear gloves, wash hands before and after, and dispose of dressings properly.

One reason wounds become chronic or unresponsive to antibiotics is a concept called bacterial refugia, or "anything that's protecting the bacteria from the host's defenses, enabling the infection to persist," said Orsini.

These might include foreign bodies, surgical implants (e.g., orthopedic screws), devitalized tissues, or mucoid

biofilms produced by the bacteria themselves. Biofilms are gel-like bacteria that form around a structure—it's what you clean from your teeth when you brush, he said. While veterinarians can remove foreign bodies or surgical implants and debride tissues, these biofilms are a bit trickier to infiltrate. They are highly resistant to antibiotics and impervious to antiseptics, bleach, alcohol, and hydrogen peroxide, to name a few.

PHOTOS COURTESY DR. DEAN HENDRICKSON

Effective cleaning agents can help wounds go from infected to indiscernible.

Orsini described a three-step approach to treating biofilm-infected wounds:

1. ***Physically degrade the biofilm*** The veterinarian should vigorously debride the wound to remove as much of the biofilm as possible and expose bacteria to biocides (agents that kill living organisms). He suggested using mildly abrasive gauze sponges, lavage, low-frequency ultrasound, and scalpels.
2. ***Prevent re-formation of the biofilm*** "Immediately after debridement, the bacteria become susceptible to biocides again," said Orsini. At this point, the veterinarian should administer proper topical and systemic antibiotics based on culture and sensitivity results.
3. ***Repeat frequently*** Biofilms can re-form within 24 hours, so he advised repeating Steps 1 and 2 daily. Frequent debridement trims treatment duration and overall cost. Reduce treatment intensity as the wound begins to heal.

Above all, when treating infected wounds, veterinarians should identify the principal pathogen, determine antibiotic sensitivities, and achieve an effective antibiotic concentration at the infection site. After geting a handle on the infection, he or she can proceed with other therapies such as sutures or skin grafting.

(Learn how Orsini treats wounds in immunocompromised horses and those with poor perfusion: TheHorse.com/37068.)

Things You Should and Should Not Put on a Horse's Wound

Over the centuries, veterinarians and horse owners have tried many wound ointments and salves, cleansers and dressings, but not all of them have been backed by evidence of safety and/or efficacy.

So Dean Hendrickson, DVM, MS, Dipl. ACVS, professor of equine surgery at Colorado State University, in Fort Collins, went back to basics, describing effective and ineffective wound-cleaning agents.

Although our intentions are good, "most wound-cleaning agents and techniques will cause chemical or mechanical trauma to the wound bed," he said. "Weigh the benefits of cleaning the wound against the trauma that agent will cause."

But before applying anything, clip the hair around the wound to prevent it from contaminating the area. Then, use sterile gauze to very gently scrub the wound; if that doesn't work, use another technique, he said. "Don't scrub harder."

Hendrickson then listed the common topical treatments we apply to wounds and which ones are safe to use.

Saline is one of the most simple, yet effective, wound-cleaning agents. Hypertonic saline, in particular, is very effective for debriding while lavaging and for reducing wound bacteria. It can damage normal cells, so use it only in infected wounds.

Povidone iodine has been used extensively, but he cited several studies showing it causes tissue necrosis, impairs healing, and leads to increased infection. Only use it around the wound over intact skin and never in the wound itself.

Chlorhexidine has low systemic toxicity, but studies have shown little evidence of its safety and efficacy reducing bacterial numbers without causing wound trauma. It also causes tissue necrosis and bacteria regrowth, he said.

Hydrogen peroxide is popular for its effervescent activity, which can convince the user it's working, but has few beneficial or negative effects, said Hendrickson.

Acetic acid (vinegar) has a low pH that "is not compatible with certain bacteria like *Pseudomonas*," he said, meaning it can be effective against this common disease-causing pathogen.

Surfactant-based cleansers are minimally toxic and irritating but not necessarily nontoxic, he said. "They are very effective on minimally contaminated wounds and should be applied, allowed to sit for 1 to 2 minutes, rinsed off, and reapplied as necessary."

Topical antibiotics are effective at reducing bacterial numbers, but their overuse contributes to antibiotic-resistant microbes. Thus, Hendrickson suggested using them for only one to two weeks and choosing one you have confirmed the infecting pathogen has sensitivity to. Common options for wound care include:

- **Silver** has been proven effective as an antimicrobial agent in several studies. He said it contributes to less exuberant granulation tissue than other ointments.
- **Nitrofurazone**, a common topical antibiotic, is not helpful and might even retard healing. He emphasized that there's not a single positive study on it.
- **Triple antibiotic ointment** has good bacterial susceptibility, and many studies (although primarily in humans) have confirmed its efficacy. "Along with silver, it's one of the best topical agents available to use in a wound," he said.

Honey derived from plants like the Manuka bush have an antimicrobial effect. Just remember that not all honeys are created equal and to only apply ones that have antimicrobial benefits.

Dressings serve different purposes that range from removing bacteria and necrotic tissue and providing moisture in dry wounds to encouraging proper wound healing and contraction and finishing off the healing process.

CONVENTIONTWEET

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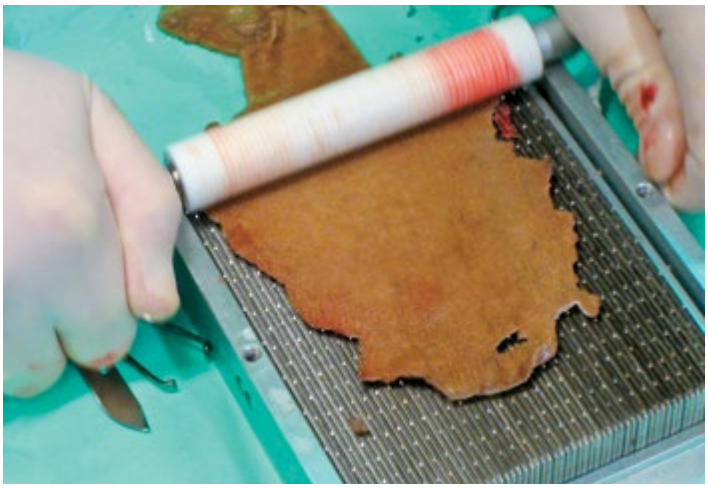
Don't do to a wound what you wouldn't do to your own eye.

In summary, Hendrickson said to forget what we've heard about "magical cleansers" purported to heal wounds. Saline, surfactant-based wound cleansers, silver, and triple antibiotic ointment are the few things we should put in wounds, he said.



PHOTOS COURTESY DR. JIM SCHUMACHER

Veterinarians can remove a split-thickness sheet of skin (left) from part of the horse's body, "mesh" it, and apply it to the wound to aid healing.

Skin Grafting Options

Small wounds typically heal quickly and easily without major veterinary intervention. Large insults that can't heal on their own, however, might require skin grafts. Because not all grafts are created equal, and some are better-suited for certain areas of the body than others, Jim Schumacher, DVM, MS, Dipl. ACVS, described the different techniques.

Shumacher, a professor in the University of Tennessee's Department of Large Animal Clinical Sciences, in Knoxville, said the most common reasons veterinarians perform skin grafts are to treat wounds so large they can't heal by other means, to speed healing, and to avoid time and expense associated with lengthy periods of bandaging.

A skin graft involves the removal and transfer of a healthy piece of skin from a donor site on the horse's body to the wound. The graft attaches to the wound bed naturally with the help of fibrin—a protein involved in blood clotting. In successful procedures, within 48 hours capillaries connect the pieces of skin, by Day 4 or 5 the graft has a blood supply, and by Day 10 it's attached firmly to the wound. Not all grafts are accepted this effortlessly; fluid accumulation, movement, and infection can lead to failure, he said.

Schumacher described three types of free (meaning the skin has been detached completely from the donor site) skin grafts used on horses: Island grafts, which are implanted into the wound, and full-thickness (containing all skin layers) or split-thickness (just the epidermis and a portion of the dermis) sheet grafts, which are applied to the wound surface.

Island grafts "The simplest method of skin grafting is island grafting, a technique in which small pieces of full- or partial-thickness skin are implanted into a granulating (filling with healthy red tissue) wound for the purpose of increasing the area of skin from which epithelial cells can migrate to cover the wound," Schumacher said, adding that wounds healed with these grafts do not have very cosmetically appealing outcomes. Island grafts are subdivided into punch, pinch, and tunnel grafts (for details about each type, see TheHorse.com/37069).

"Island grafting requires little expertise and no expensive equipment and can nearly always be performed without anesthetizing the horse," he said. "Because island grafting is tedious, it is usually reserved for small wounds." Another downside is scarring at the donor site.

> **"Because island grafting is tedious, it is usually reserved for small wounds."**
>
> DR. JIM SCHUMACHER

Full-thickness sheet grafting This graft is one of the most practical, said Schumacher. It doesn't require sophisticated equipment, can be harvested from the standing horse, and offers the best resulting appearance. He suggested removing these grafts from the relatively mobile skin of the horse's pectoral region, which heals quickly and cosmetically after suturing. The veterinarian attaches the graft to the wound using staples, sutures, or glue.

Schumacher said one of this method's downsides is it's usually reserved for fresh, clean wounds (e.g., surgical wounds that can't be sutured) because full-thickness grafts "require more nourishment than do split-thickness grafts and have fewer exposed blood vessels … for revascularization (restoration of blood flow)."

Split-thickness sheet grafting This method is ideal for wounds too large to be covered by an island or full-thickness graft, said Schumacher. Because the sheet of skin harvested is large (up to 4 inches wide), the veterinarian should choose an inconspicuous donor site, such as the underside of the abdomen or thorax, and use a specialized power-driven or free-hand knife to harvest the graft. This procedure requires more equipment and skill than the other methods, said Schumacher.

The split-thickness sheet graft covers the wound more completely and offers a more cosmetic result than island grafting, yet it's less cosmetic than full-thickness grafting. Other downsides include scarring at the donor site and the need for general anesthesia.

"Although a split- or full-thickness sheet graft can be applied to a wound as a solid or meshed sheet, most are meshed (staggered, parallel rows of openings cut in the skin) before being applied to a horse," said Schumacher. "Meshing allows you to cover an area much larger than the graft itself, and it tolerates motion better than does a nonmeshed graft."

Regardless the type of skin graft your veterinarian applies, your horse's wound dressing and bandage need to be changed periodically until the graft is nearly healed. "The graft can be considered accepted when it has revascularized, and this usually occurs by approximately Day 5," said Schumacher.

If your horse suffers a large wound, discuss with your veterinarian which grafting approach is best, considering the wound's size and location, need for cosmetic outcome, available equipment, and finances.

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Tackling TUMORS

Veterinarians can remove sarcoids from a horse, cut them into pieces, and implant them back into the horse as part of a treatment called autologous vaccination.

PHOTOS COURTESY DR. DAVID LEVINE

ALEXANDRA BECKSTETT, STEPHANIE L. CHURCH, AND NANCY LOVING, DVM

Autologous Vaccination a Safe, Affordable Sarcoid Treatment

A circular wartlike nodule appears at the base of your horse's ear. Maybe it's just one, maybe it's an entire cluster. Maybe your veterinarian has already removed it once and, guess what, it's back! These common tumors—called sarcoids—are rarely more than cosmetic blemishes, but treating them is extremely challenging. There's no one effective treatment that works very well.

Recently, however, veterinarians explored the efficacy of autologous vaccination, in which the practitioner removes a sarcoid lesion from the horse and implants pieces of it back into the horse's neck, with some success. David Levine, DVM, Dipl. ACVS, assistant professor of Clinical Large Animal Surgery at the University of Pennsylvania School of Veterinary Medicine's New Bolton Center, described his experience with this method.

Historically, said Levine, veterinarians have used many modalities to treat equine sarcoids, including:

- Most commonly, surgical excision, with a 50-64% recurrence rate (a 36-50% success rate);
- Cryotherapy (freezing), with a 60% success rate;
- Interstitial brachytherapy (radiation), with anywhere from 50-100% success;
- Chemotherapy (cisplatin), which researchers performed with 96% success in one study;
- Imiquimod anti-tumor medication, resulting in about 56% remission; and
- Xxterra herbal paste, with a 56% response rate.

While some practitioners have dabbled in autologous vaccination to treat sarcoids, no published studies on the topic existed. So Levine and colleagues assessed its safety and efficacy in treating both single and multiple sarcoid lesions.

They evaluated 18 horses with sarcoids that underwent an autologous vaccination procedure at New Bolton from 2009 to 2014. During the procedure, Levine removed the sarcoid and sectioned it into several 3-mm cubes. He placed these cubes into liquid nitrogen for 10 minutes to kill any bacteria, along with the sarcoid cells. Here, Levine noted, he also changed instruments and gloves. He then stabbed two to four of the thawed sarcoid fragments into various sites along the nuchal ligament in the horse's neck.

Sixteen of these horses were available for follow-up, on average, 10.5 months later. Levine determined that:

- 12 (75%) cases experienced a decrease in the number of sarcoids;
- 15 (93.8%) had a decrease in the size of the sarcoids;
- 11 (68.8%) cases resolved completely;
- 7 (43.8%) experienced complications (mainly swelling around the incisions);
- 75% of owners were satisfied with the results; and
- 25% of owners were satisfied with the procedure, but not with the complications.

Though Levine and his team don't know exactly how the autologous vaccination works, they "suspect the tissue

acts as an immunomodulatory agent to stimulate a host response not only against the debulked lesion, but on other lesions on the body," Levine said, noting that this therapy is a safe, quick, and inexpensive method for treating sarcoids.

It does take a long time for the sarcoids to regress, he added, suggesting that veterinarians treat the remaining tissue post-vaccination with imiquimod or cisplatin while the immune system does its job.

What's a Pheochromocytoma, and How Does a Vet Know a Horse Has it?

There's a hormone-secreting tumor that can form in horses' adrenal glands, potentially causing damaging high blood pressure, but it's so incredibly rare that only a handful of cases have ever been described in studies. Veterinarians don't normally notice the tumor until the horse is on the post-mortem table, at which time it's difficult to determine its significance (Did it kill the horse, or was it just an incidental finding?). But if veterinarians knew what signs to look for, they could conceivably recognize the tumor—called a pheochromocytoma—and intervene.

Daniela Luethy, DVM, a large animal internal medicine resident at New Bolton, and colleagues at Penn Vet and the University of California, Davis, reviewed records for 37 horses diagnosed with pheochromocytoma on post-mortem exam from 2007 to 2014 at both schools to identify common signs that might lead to a higher clinical suspicion of the tumors.

"Pheochromocytoma is the most common adrenal medullary neoplasm of domestic animals," she said. "It has been described in horses, dogs, cattle, and humans, and this tumor arises from the chromaffin cells of the adrenal medulla. These cells are responsible for release of catecholamines."

The tumor can secrete high amounts of these catecholamines, which are hormones that can cause a number of side effects in the horse's body. In people, high levels of catecholamines associated with this tumor can lead to high blood pressure, headaches, and sweating.

In their study, veterinarians had identified pheochromocytoma in 37 of 4,094 horses on post-mortem exams. In seven cases, Luethy said, clinicians had observed possibly associated clinical signs in the live patient. "Colic was the most common presenting complaint (35%), and tachycardia (a rapid heartbeat) was noted in 95% of cases," she said.

The most common blood work abnormalities they saw in the seven horses were hyperlactatemia (high blood lactate concentration), which could be associated with poor blood flow to tissues and hyperglycemia (high blood sugar). In four horses, veterinarians noted hemoperitoneum (blood within the abdominal cavity) after the tumor ruptured.

Luethy noted 27 of the 37 horses had concurrent endocrine tumors, and eight had lesions similar to what is seen with a genetic condition in humans called multiple endocrine neoplasia syndrome.

In the end, Luethy and her colleagues noted pheochromocytoma in 0.95% of cases undergoing necropsy, that most of them were incidental findings, but that clinicians thought the tumors contributed to disease in seven of the cases (19%).

A specific type of scintigraphy might help pinpoint and diagnose pheochromocytomas in horses, as would blood and urine analysis for particular compounds associated with high catecholamine levels. For now, Luethy said veterinarians should consider the possibility of pheochromocytoma in horses presenting with colic, tachycardia, and hemoperitoneum.

Canine Melanoma Vaccine Testing in Horses Underway

If you own a gray horse and melanomas aren't already on your horse health radar, they should be. Eighty percent of grays older than 15 develop this skin tumor, and while some horses have just a few benign lesions, others have highly invasive, performance-limiting, or even life-threatening melanomas. Few effective treatment options exist, but researchers are looking into how a canine melanoma vaccine, shown to be effective in extending the life span of dogs with oral melanomas, works for treating horses.

In 2009 the canine vaccine came on the market. Recently, the Morris Animal Foundation awarded a grant to explore use of the canine vaccine (called Oncept) in horses. Researchers are actively working to get this vaccine USDA-approved and labeled for use in horses. Jeffrey Phillips, DVM, MSpVM, PhD, Dipl. ACVIM, of Lincoln Memorial University, led a question-and-answer session about the study at the convention.

The trial to establish the vaccine's efficacy involved 15 horses with confirmed melanoma. Veterinarians saw a favorable result from the vaccine protocol in 13, but not in the other two. There were no adverse reactions. Manufacturers developed the targeted DNA vaccine by inserting the human gene for tyrosinase, a protein found on melanoma cells, into a DNA ring to stimulate an immune response. It's adjuvant-free, meaning the component often charged with triggering vaccine reactions has been omitted. The veterinarian uses a specific applicator to inject the vaccine through the skin into the pectoral muscle. In some horses, resecting (cutting away) the bulk of the tumor might help improve vaccine efficacy to control tumor growth.

Dogs undergoing the vaccine protocol receive four injections—one injection every two weeks—and then a booster every six months, indefinitely. Researchers recommend the same protocol for horses. The vaccine is not considered a cure in dogs, but it has been shown to extend their life expectancy from two to 24 weeks after diagnosis to 18 months to five years.

In horses there is not enough data to know how long favorable effects will last. While the researchers have yet to see full resolution of cancer in the study horses, all tumors became smaller or stopped growing. Slow-growing melanomas seem to respond best and, so far, the vaccine has demonstrated good short-term efficacy. Again, at this time, the vaccine is not yet approved in horses, and its use is considered extra-label. Owners of affected horses should have a conversation with their veterinarian that explores all available treatment options.

This vaccine is not without cost. A horse owner might expect to pay $2,200-$3,000 for the initial series of four injections and then a quarter of that for each booster.

—Nancy Loving, DVM

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COLIC Types & Treatments

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Nephrosplenic Entrapment Treatment, Recurrence, and Survival

Recently, a team from Colorado State University took a closer look at the treatments, survival rates, preventive measures, and recurrence rates for one type of colic—nephrosplenic entrapment (NSE). PhD candidate Brad Nelson, DVM, MS, Dipl. ACVS, presented the results.

Nephrosplenic entrapment occurs when the large colon migrates between the spleen and the abdominal wall and becomes trapped over the nephrosplenic ligament (which attaches the spleen to the left kidney). Affected horses generally display mild to moderate colic signs, and veterinarians diagnose NSE using rectal palpation, abdominal ultrasound, laparoscopy, or celiotomy (exploratory abdominal surgery).

Nelson said veterinarians can treat the condition medically or surgically. Medical options include fluid therapy, phenylephrine administration (to induce contraction of the spleen, making room for the colon to dislodge from the nephrosplenic space), longeing, and/or rolling under general anesthesia. Veterinarians believe the positional movement that longeing and rolling provide helps relieve the entrapment.

Surgical options include celiotomy, flank laparotomy, and laparoscopy. Veterinarians can also conduct a nephrosplenic space ablation, which involves placing sutures or a mesh in the nephrosplenic space to induce fibrosis; this collapses the space and prevents future NSE colics.

Nelson said researchers have found that recurrence rates range from 3 to 8% and were as high as 21% in one European study.

He and colleagues evaluated 231 NSE cases from 2002 to 2014 in their retrospective study. They reviewed the horses' signalment (age, sex, breed, etc.), physical exam findings, laboratory results, diagnostic imaging results, treatments, and survival rates and learned that:

- Thoroughbreds, Warmbloods, and geldings appeared to be predisposed;
- 91.8% of horses survived to hospital discharge;
- Of the 136 hospital cases with at least two years of follow-up information available, 83% survived for at least one

year following colic, and 82% survived for at least two years following colic;
- There was a 23% recurrence rate;
- Veterinarians treated the majority of cases with rolling and/or longeing and fluid therapy;
- Horses were less likely to survive to discharge if their packed cell volume (PCV, percentage of red blood cells in whole blood) increased after treatment; this can be indicative of dehydration and/or poor blood supply;
- Horses that underwent nephrosplenic space ablation were less likely to colic after NSE;
- 86% of owners reported fewer colics following NSE treatment, while the remaining 14% saw no change or more colic; 93% of owners reported being satisfied with the treatment outcome; and
- Older horses were less likely to survive long-term than younger ones.

Nelson cautioned that nephrosplenic space ablation will only prevent future NSE episodes; it won't help reduce the likelihood of other types of colic.

"Survival is high following NSE correction," he said, adding that decreased colic frequency following ablation suggests that it's a successful NSE preventive measure in horses prone to this type of colic.

Strangulating Intestinal Lesions Compared

When a colicking horse arrives at a referral hospital for treatment, clinicians immediately begin making notes that could help them identify the cause. For instance, based on what veterinarians know about risk factors for different types of colic, a big 15-year-old gelding that cribs is a candidate for epiploic foramen entrapment, or EFE.

But physical signs of some conditions resemble others, complicating diagnosis. Such is the case with EFE and a similar type of colic—gastrosplenic ligament entrapment (or GLE)—so researchers conducted a study in which they compared the two to find ways to tell them apart during diagnostic workup and to know more about GLE outcomes. Isabelle Kilcoyne, MVB, Dipl. ACVS, an equine surgeon at the University of California, Davis (UC Davis), School of Veterinary Medicine, described what they learned.

A horse suffers an EFE when a section of small intestine gets trapped in the epiploic foramen, a narrow opening in the cranial (forward part of the) abdomen. A GLE occurs when part of the small intestine becomes trapped in a tear in the gastrosplenic ligament, which extends from the spleen to the stomach.

Kilcoyne said researchers know that EFE is the second most common strangulating small intestinal lesion and that geldings, middle-aged horses, large-breed horses, and horses with a history of colic, stall rest, and cribbing are most likely to be affected. However, she said, "few studies regarding the prevalence, predisposing factors, and clinical findings of horses presenting with entrapment of the small intestine within the gastrosplenic ligament have been reported."

She and colleagues conducted a retrospective study of colic cases treated at UC Davis from 1994 to 2012, including horses with a definitive diagnosis of GLE (43 horses) or EFE (73). While the colic types had similar clinical presentations, horses with EFE appeared to be in worse condition. Geldings were overrepresented in both groups.

"Overall, ultrasound can provide substantial diagnostic information about both conditions," Kilcoyne said. "Both groups had similar postoperative complication rates. Ultimately, there are similar favorable short-term survival rates (survival to discharge) for GLE and EFE if appropriate surgical intervention is performed."

CONVENTIONTWEET

Michelle Anderson
@TH_MNAnderson

Colic surgery complications in geriatric vs mature horses: similar results.

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ALEXANDRA BECKSTETT AND ERICA LARSON

Foal and Adult Horse Blood Samples: What's the Difference?

Blood and serum testing can provide a wealth of information about a horse's current health status. Is he battling an infection or an immune-mediated disease? Does he have metabolic issues? Liver or kidney damage?

These levels are quite different in a neonatal foal, whose body is still adapting to life outside the uterus. Therefore, it's important that veterinarians become familiar with what's normal and what's not on a foal's blood sample test results.

"Most labs only report reference ranges for adult horses, which can lead to foal samples being incorrectly flagged as abnormal," said Michelle Barton, DVM, PhD, Dipl. ACVIM, director of clinical academic affairs and the Fuller E. Callaway endowed professor of large animal medicine at the University of Georgia College of Veterinary Medicine. She described some of these differences.

Red blood cells Immediately after birth, a foal's red blood cell count is about the same or slightly higher than an adult's, thanks to the last little bit of blood the placenta transfers, said Barton. Within 48 hours, as the foal begins consuming colostrum, or first milk, the count drops and continues to decrease gradually over the next few months due to milk's low iron content as well as reduced signaling to the bone marrow to replace old red blood cells. "Therefore, foals look anemic compared to adults," she said.

> **"Most labs only report reference ranges for adult horses, which can lead to foal samples being incorrectly flagged as abnormal."**
> DR. MICHELLE BARTON

White blood cells These are involved in the body's immune defenses and include neutrophils and lymphocytes. Neutrophil counts in neonates tend to be similar to or higher than those in adult horses. Lymphocyte counts, on the other hand, are typically the same or lower.

Coagulation It's important to use age-controlled references when looking at platelet levels, said Barton, as coagulopathy—a reduced ability to clot—is common in critically ill foals. Here's why: During the first few days of life, neonate platelet counts are the same as or higher than adult counts; prothrombin and activated partial thromboplastin times (how long it takes for blood to clot) are the same or longer; and fibrinogen (a protein vital to clotting) concentrations are the same or lower. Antithrombin

(another clotting protein) activity is significantly lower in the first month of life—almost half that of adults, she added.

Serum protein Because dams do not pass infection-fighting antibodies to the fetus, foals are born with very low immunoglobulin (an antibody type) levels that make their total serum protein concentrations lower than adults'. After foals have nursed properly and absorbed antibodies from the colostrum, their total protein concentration increases to the low end of normal adult concentration.

Electrolytes Neonatal electrolyte levels are fairly stable and similar to those of adult horses. The only exception, said Barton, is increased phosphorus values during the first year of life, due to osteoblastic (bone-forming) activity as the foal grows.

Renal (kidney) values During the first 48 hours of life, neonate serum creatinine levels will often be higher than normal adult levels. This is because the foal's body is accustomed to the placenta removing this waste product while in utero and must adjust to the kidneys clearing it, she said. Further, neonates typically don't urinate for the first six to 12 hours after birth, also delaying creatinine clearance.

Hepatic (liver) values Neonate bilirubin (a waste product from clearing dead red blood cells) concentrations are significantly higher than adult levels for the first few weeks of life, making foals appear jaundiced, said Barton.

Liver enzyme concentrations are often greater in neonates than in adults, and serum bile acids concentration (indicating liver function) might be greater in the first few weeks of life. Collectively, these values can throw veterinarians off and lead to an inaccurate liver disease diagnosis.

Metabolic values Milk contains fat and lactose that the body breaks down into the sugars glucose and galactose. This is why a neonate's glucose levels are typically the same or two to three times higher than an adult's for the first month. Triglyceride (fat) concentrations are also higher than adult levels for the first several months.

In closing, said Barton, "There are some very unique differences in clinical pathologic parameters between neonates and mature horses. We really need to use age-related lab references; failure to do so can result in erroneous interpretations."

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Healthy foals can be hyperlipidemic relative to adults and can have a wide range.

Using Ultrasonography to Monitor Ascarid Burdens in Foals

Researchers recently determined that veterinarians can essentially kill two birds with one stone when they monitor foals for a couple of common health problems: *Rhodococcus equi* pneumonia and lung abscesses and heavy ascarid worm burdens. All it takes is moving the ultrasound probe a little farther back. Martin Nielsen, DVM, PhD. Dipl. EVPC, ACVM, described how to do just this.

Foals in Central Kentucky routinely undergo ultrasound examinations to detect lung lesions caused by *R. equi*, said Nielsen, who is an assistant professor at the University of Kentucky's Gluck Equine Research Center, in Lexington. Recently, he said, a fellow practitioner questioned whether the same technique could be used to monitor foals for ascarid burdens.

Nielsen explained that ascarids, or roundworms, are ubiquitous in foals and put them at risk for potentially fatal small intestinal impaction. "Ascarids infect foals very early in life, but it takes a while before they can be identified on fecal egg count," he said. And even if veterinarians could determine ascarid egg count with this method, it isn't very useful for determining the extent of the worm burden.

In other words, we need more diagnostic options. So Nielsen and colleagues sought to see if they could, in fact, use ultrasound to identify foal worm burdens.

Through two studies—one of 10 naturally infected foals and a second of 15 naturally infected foals—the team determined that ultrasonography is an effective approach for detecting ascarids in foals' abdomens, consistent with equine fecal egg counts when those were positive. The team also created a four-point scoring system, where Grade 1 reflects low to no evidence of ascarids and Grade 4 reflects evidence of a high roundworm burden.

In the first study, the team determined that, when using Grade 2 as a cutoff value, ultrasonography was 100% predictive and specific for identifying roundworm burdens. They also learned that foals' fecal egg counts peaked at 4 to 5 months of age. While the ultrasound exam results followed the same trend, worms were still visible as fecal egg counts dropped.

In the second study, the team tested the efficacy of ivermectin and oxibendazole in eliminating ascarids. Nielsen said an untreated control group's ultrasound scores stayed stable, while the scores of both the ivermectin and the oxibendazole groups declined.

COURTESY DR. MARTIN NIELSEN

Transabdominal ultrasonography is useful in foals for diagnosing not only *R. equi* pneumonia, but also heavy ascard worm burdens (the double parallel white lines at top left).

Finally, the team evaluated the intra-observer (the same observer evaluating the same specimens) and inter-observer (different observers evaluating the same specimens) agreement in the dewormed foals—basically, determining how repeatable this approach is and with what precision—and found that most practitioners came to similar results.

Nielsen said, based on training sessions for Central Kentucky practitioners, feedback has been positive and includes:

- The parasite-focused ultrasound takes only five to 10 minutes to complete;
- Clipping and sedation isn't needed; and
- The worms were easy to spot.

Ultimately, Nielsen said he's proven transabdominal ultrasonography useful for reliably identifying burdens of more than 10 ascarids. As an added perk, it's a simple add-on to the *R. equi* foal ultrasound exams that are already happening.

"The decision to use this technique will have to depend on a cost-benefit assessment, where the cost of the procedure is considered relative to the risk of ascarid-associated disease in a given population of foals," Nielsen said. "Horse owners who have experienced a small-intestinal ascarid impaction in one of their foals may be particularly motivated for setting up this kind of monitoring for a period of time to evaluate if chosen interventions have worked satisfactorily."

> **"Ascarids infect foals very early in life, but it takes a while before they can be identified on fecal egg count."**
>
> DR. MARTIN NIELSEN

Mare Thyroid Condition Might be Linked to Foal Deaths

Periodically since its discovery in 1979, an ailment called congenital hypothyroidism dysmaturity syndrome (CHDS) has caused newborn foal deaths in Western Canada and the northwestern United States. Since then, around 75% of foals born in affected herds have died, and the condition's cause remains unclear.

Now researchers in Canada are making strides in understanding what could trigger CHDS. Mariana Diel de Amorim, DVM, DVSc, Dipl. ACT, and colleagues recently became the first to identify primary hypothyroidism in a herd of mares with a history of producing CHDS foals.

COURTESY DR. CLAIRE CARD/WCVM

Foals with CHDS can have improper bone formation, as seen in this cross section of the knee.

Diel de Amorim is an associate professor of theriogenology at the University of Prince Edward Island's Atlantic Veterinary College, in Charlottetown. She worked on the study with senior investigator Claire Card, DVM, PhD, Dipl. ACT, at the University of Saskatchewan's Western College of Veterinary Medicine, in Saskatoon.

Foals with CHDS are born to mares that appear healthy, but after a prolonged gestation and sometimes dystocia (difficult birth). Affected foals can have umbilical hernias, contracted front legs and other flexural deformities, cubital bone dysgenesis (inappropriate bone formation), mandibular prognathism (their lower jaw sticks out beyond their upper), and poor muscling. Diel de Amorim said researchers believe contributing factors include a mare's excessive consumption of nitrates, endophytes, and goitrogens (goiter-causing substances), along with a deficiency in trace minerals, such as selenium.

Wondering if a condition in dams could be causing CHDS, Diel de Amorim took a closer look at primary hypothyroidism—a rare condition in horses in which the thyroid gland fails to respond to thyrotropin-releasing hormone (TRH). "Reported clinical signs of hypothyroidism include lethargy, exercise intolerance, weight gain, and a poor hair coat," she said.

Veterinarians diagnose hypothyroidism using a TRH stimulation test. In their study, Diel de Amorim and colleagues evaluated thyroid levels in a herd of 16 mares with a history of having CHDS foals. Key study findings included:

- The majority, if not all, of the mares and foals were selenium-deficient;
- The mean gestation length for mares with CHDS foals was 332 days, while for mares with healthy foals it was 325 days;
- Six of the 16 foals had CHDS clinical signs; three of them died or were euthanized;
- Most mares' baseline thyroid levels were excessively low or undetectable; and
- Four of seven mares that underwent a second TRH stimulation test and blood testing were considered positive for primary hypothyroidism.

Diel de Amorim noted that some hypothyroid mares did deliver apparently healthy foals. "However, the majority of those foals did not respond to the TRH stimulation test either," she added.

She said mares' age, the presence of toxins in the system, trace mineral deficiencies, and other factors likely influence their thyroid function.

"We don't really know exactly how and what levels of hypothyroidism may affect mares' fertility at this point," she explained. "I believe that breeders should investigate if the mare is really hypothyroid by performing a TRH stimulation test, if possible, and if this (comes back positive) they need to investigate the cause for the hypothyroid.

"Good management in terms of appropriate feeding practices and additional mineral supplementation in pregnant mares and/or animals that are in areas known to be deficient in trace minerals is crucial," she added. "If mares are out in pasture, investigating if the pasture contains common goitrogenic plants like mustard plants should be important."

Sleep Apnea Tool Could Help Foals Breathe Better

Several hours into life, a foal is still trying to catch his breath. The veterinarian can only do so much on the farm to support this tiny patient and, alas, the closest equine hospital with a ventilator and around-the-clock monitoring is hours away. Veterinarians and broodmare owners living far from a large referral center are no strangers to such logistical challenges. So one research group has been working finding a way to support neonatal respiratory cases on the farm by

Veterinarians: Always Perform Post-Mortem Exams on Aborted Fetuses

Studies report that 8-19% of equine pregnancies result in abortion. While not pleasant to think about, a post-mortem examination is crucial to determine what caused the abortion; confirming disease (If there is one to blame) is the catalyst for taking appropriate biosecurity measures to halt its spread.

Luke Bass, DVM, MS, Dipl. ABVP, a field service veterinarian at Colorado State University's Veterinary Teaching Hospital, in Fort Collins, reviewed the steps practitioners should take when performing a post-mortem exam on an aborted fetus.

"There are many causes of abortion, and identifying them could aid in further prevention of subsequent abortions," said Bass.

He described some of the common causes based on four retrospective studies of 7,800 cases:

- The majority (58.5-67.3%, depending on the study) were infectious;
- Noninfectious causes included twinning (5%), placental insufficiencies, umbilical cord problems (torsions making up 5-60%), congenital abnormalities, and fetal resorption;
- The cause of 17% of abortions was unknown;
- Bacterial placentitis (inflammation of the placenta) was the most common cause of infectious abortion at 21%;
- Viral causes of abortion included equine herpesvirus (EHV)-1 and -4 and equine viral arteritis, with EHV-1 being most common (4%); and
- 13% of bacterial cases were due to leptospirosis.

When the veterinarian arrives to examine an aborted fetus, he or she must decide whether to perform the necropsy on the farm, collect tissue samples and send them to a laboratory, or send the entire fetus to a laboratory. If the veterinarian opts to perform the exam on the farm, he or she should find a well-lit large, flat surface to work on, said Bass, and practice biosecurity measures, wearing protective outerwear until infectious disease has been ruled out.

The veterinarian should first clean, weigh, and examine the placenta for tears, missing sections, inconsistent coloring, exudate (pus), or other abnormalities. Then evaluate the amnion that surrounds the embryo and the umbilical cord, as leptospirosis and mare reproductive loss syndrome, for instance, cause umbilical cord disease, he said.

COURTESY DR. LUKE BASS

Umbilical cord torsions make up 5-60% of noninfectious abortions.

The practitioner can then move onto the fetus itself, noting its weight, length, body condition, and physical abnormalities. He or she should sample the spleen and stomach contents and collect any tissue for culture, said Bass, remembering to use clean gloves and instruments to avoid contamination and ensure accurate results. Most state diagnostic labs offer an abortion panel, which includes tests for a variety of tissues. After finishing the necropsy, the veterinarian should clean the area and dispose of the body properly.

"Performing a necropsy to diagnose the cause of abortion is very important as well as a relatively simple and straightforward procedure," Bass said. It's worth the $250-300 cost of the procedure and lab submission to make a diagnosis that might help the veterinarian and farm manager prevent further pregnancy losses.

Also, "Necropsies are an educational opportunity for the horse owner to get involved and see certain disease processes that can affect their horse population," he added.—*Alexandra Beckstett*

adapting a tool borrowed from human medicine.

While it's not yet commercially available, Australian veterinarians recently constructed and tested a CPAP, or continuous positive airway pressure, machine to help equine neonates breathe better. Rosemary McKean, BVetBio/BVSc (Hons. 1), described how she and colleagues created the system using a human sleep apnea mask. McKean is a veterinarian at Moorong Veterinary Clinic, in Wagga Wagga, New South Wales.

Simply put, CPAP uses mild air pressure to keep the airways open. McKean said it can help prevent airway collapse, decrease breathing effort, increase oxygenation, reduce lung inflammation, and eliminate the risk of complications from intubation (which isn't required with CPAP). She said veterinarians might be able to use CPAP to treat foals with conditions such as respiratory failure, increased breathing effort, respiratory distress at birth, and more.

McKean and team built and tested a prototype CPAP system (it cost about AU$1,000, or US$700, to construct) for foals using a human sleep apnea system attached to an equine anesthesia mask. She said such a device could be an effective, practical means of providing respiratory support in the field. They tested their device on five foals ages 5 to 8 weeks with pharmacologically induced respiratory insufficiency and determined that:

- The system was effective and had no adverse effects on the foals' heart rates, blood pressure, or other measurements;
- Treatment improved oxygen extraction and increased oxygen usage; and
- Foals' respiratory rates remained lower when treated with CPAP compared to traditional nasal oxygen.

"The CPAP system provided an improved method of clinical respiratory support for foals without ventilator-assisted respiratory therapy," she said, noting that further studies are needed to optimize CPAP delivery and determine efficacy in sick newborns. "We are not advocating a 'DIY' approach to respiratory care of foals, rather taking the first steps in researching what may prove to be a lifesaving respiratory support system that could be used by veterinarians in the field."

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REPRODUCTION Breakthroughs

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ALEXANDRA BECKSTETT AND STACEY OKE, DVM, MSC

In-House Epididymal Semen Collection Can Be Practical, Cost-Effective

Veterinarians and breeders have benefited from the use of epididymal semen—located in a duct behind the testes—in equine breeding programs dating as far back as the late 1950s. Cryopreserved (frozen) epididymal sperm is a valuable commodity if a stallion will be castrated or if he unexpectedly dies or must be euthanized.

However, the process of referring the horse to a facility that's equipped to collect, process, and cryopreserve epididymal sperm is expensive and typically reserved for only the most valuable of stallions.

So Robert J. Stawicki, MS, DVM, Dipl. ACT, from the Department of Large Animal Medicine at the University of Georgia's College of Veterinary Medicine, developed a practical, cost-effective in-house method, making it available to a larger population of stallion owners. "The technique for collecting epididymal semen has been sufficiently refined and can now result in the recovery of high numbers of sperm and up to 100 insemination doses in a cost-effective manner," he said. "Practices that already collect and cryopreserve ejaculated semen require very little additional equipment to collect the semen from the tail of the epididymis, where the semen is the most mature."

Processing and freezing epididymal semen after collection is no different than methods for ejaculated semen.

To date, Stawicki has collected data on processed epididymal sperm from 15 testicle pairs. Of those cryopreserved samples, 13 had acceptable post-thaw motility, and seven of 13 inseminated mares (53.8%) conceived. This pregnancy rate is acceptable, especially considering that previous studies report pregnancy rates ranging from only 7-30%, he said. More recently, researchers on two studies that used a novel semen freezing extender reported pregnancy rates of 61-92%, which either equal or exceed benchmark rates reported for cryopreserved ejaculated sperm.

> **"Practices that already collect and cryopreserve ejaculated semen require very little additional equipment to collect the semen from the tail of the epididymis."**
>
> DR. ROBERT J. STAWICKI

Stawicki said, "It is comforting to know that clients who invest the money to preserve their stallions' genetics by cryopreservation of epididymal sperm may be able to expect higher pregnancy rates than previously thought possible." For more collection tips, see TheHorse.com/37084.

Fine-Tuning Embryo Freezing Methods

Equine reproduction researchers know that a specialized embryo freezing process called vitrification results in higher mare pregnancy rates than traditional slow-cooling cryopreservation techniques. But not every veterinarian has access to specialized vitrification equipment, so they must opt for the less successful approach or ship embryos to be vitrified elsewhere.

Handling these tiny structures with care becomes an issue in the meantime, so Louisiana State University (LSU) researchers investigated the best approach.

"When large embryos are subject to slow-cooling cryopreservation, pregnancy rates are less than 30%," said Fabian A. Diaz, MS, a graduate research assistant in LSU's School of Animal Science. "Embryos frozen via embryo micromanipulation and vitrification, however, result in pregnancy rates greater than or equal to 65%." So, to make this preferred method more available to the masses, he examined the toll of temporarily cooling young embryos—called blastocysts—to low temperatures (7-10°C, or 44-50°F) before vitrification on pregnancy rates.

Embryo transfer involves breeding a mare, with live cover or artificial insemination, and then transferring the blastocyst to a donor (or recipient) mare for gestation. Mare owners have embryos frozen for use when a recipient is ready for implantation, or simply to preserve for future transfer.

Ice crystals form during the traditional freezing process that damage embryo cells during thawing. But vitrification involves replacing some of the water in a cell with cryoprotectants that minimize ice crystal formation and replacing the cryoprotectant with water during thawing.

The team collected Day 7 and Day 8 blastocysts, vitrifying them either immediately or after 12 or 24 hours of storage at temperatures cold enough to preserve the structures but not form ice crystals. They measured pregnancy rates 17 and 18 days (equivalent to 25 days post-ovulation) after transfer for thawed blastocysts.

Diaz's key findings:

Blastocyst cooling treatment before vitrification	Pregnancy rate
Day 8, noncooled (vitrified immediately)	83.3%
Day 8, cooled 12 hours	0%
Day 8, cooled 24 hours	20%
Day 7, cooled 12 hours	60%
Day 7, cooled 24 hours	80%

"These data show that pregnancies can be achieved following a 12- to 24-hour low-temperature storage prior to the vitrification of blastocysts," said Diaz.

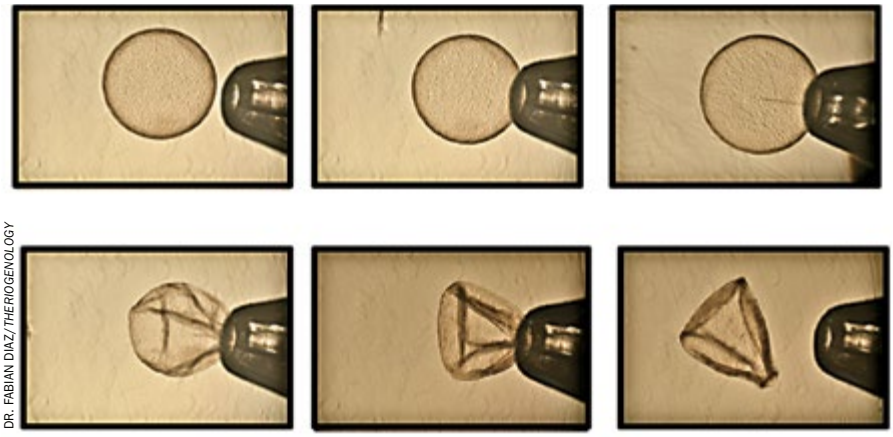
Pregnancy rates are typically 60-75% after transfer of fresh embryos to recipient mares, so these rates are encouraging.

"Day 7 blastocysts were better able to tolerate low-temperature storage than Day 8 blastocysts prior to vitrification," he said. "Thus, it appears that Day 7 embryos can be cooled for up to 24 hours and transferred from a collection facility to laboratory for vitrification without worry."

At this point, embryo transfer facilities do not widely perform vitrification of Day 7 and 8 equine embryos because this is a relatively new technique, and collapsing the blastocyst prior to vitrification requires special equipment and training.

Diaz is hoping his data will help make vitrification a more popular breeding tool.

"Cooling embryos for 24 hours prior to vitrification without negatively affecting … rates allows practitioners to recover their embryos wherever they are, place the embryos in a holding solution, and ship them in a slow-cooling device like an Equitainer to a specialized facility where vitrification can be properly performed."



DR. FABIAN DIAZ/*THERIOGENOLOGY*

Prior to vitrification, the veterinarian punctures the embryo and extracts the fluid to prevent ice crystal formation, which damages the cells upon thawing.

Laser Safety for Uterine Cyst Removal

Uterine cysts are one of many conditions tied to mare infertility. Veterinarians can remove cysts to try to improve a mare's ability to carry a foal to term, but they hadn't sized up the efficacy of the most current technique until recently.

Because practitioners have had some success using a method called laser photoablation (which involves cutting the cyst away with a laser), Nicole Scherrer, DVM, of the University of Pennsylvania's New Bolton Center, in Kennett Square, studied its efficacy in a group of broodmares treated at Rood & Riddle Equine Hospital, in Lexington, Kentucky.

About 22.4% of producing broodmares have these cysts; however, 55% of subfertile mares have them, said Scherrer. Veterinarians typically see a significant increase in cyst numbers as mares age.

So how can growths this small have such a detrimental effect on fertility? Scherrer said researchers have two theories: They cause the mare's body to not recognize pregnancy, and/or they cause inadequate placental exchange of blood and nutrients necessary for fetal growth.

Researchers have shown that mares with more than five cysts or cysts larger than 1 cm have lower pregnancy rates.

Historically, treatment has included manual removal, aspiration, and uterine lavage. Manual removal, while inexpensive, is only effective on large cysts, said Scherrer, and lavage has poor efficacy. Aspiration of the cystic fluid leaves the capsule behind, which is likely to fill up again in the future. Veterinarians have also performed laser photoablation with standing sedation, which allows the veterinarian to see and accurately remove the cyst, but researchers had not evaluated its effect on future foaling rates.

Scherrer looked at records for 42 Thoroughbred mares (45 cysts) that had undergone laser ablation at Rood & Riddle from 1992 to 2011. She found that one and two years after the procedure, their foaling rates were 74% and 65%, respectively.

Mares younger than 17 were more likely to produce a foal than older mares (96% foaling rate vs. 58%), and cyst number and location had no significant effect. Overall, she said, "diode laser photoablation is a safe, effective procedure for cyst removal and future foaling."

She said to remember that the

average age among study mares was 17—significantly older than the average broodmare. Also, the laser is a major investment that requires training, so large, multispecialty clinics are more likely to offer the procedure than smaller ones.

Acyline to Curb Testosterone Levels

For some breeders, lowering a breeding stallion's testosterone concentrations in the off-season is, among other uses, a solution for undesirable behavior. They administer a substance that suppresses the horse's hypothalamic-pituitary-gonadal (HPG) axis, which regulates testosterone.

Gabriel M. Davolli, DVM, MS, a theriogenology resident at LSU's School of Veterinary Medicine, studied one gonadotropin-releasing hormone (GnRH) antagonist's effects on suppressing the HPG axis. Essentially, GnRH tells the stallion's body to produce testosterone. The appropriate antagonist would block this function. He described several reasons why you'd want to do this:

- Stallions infected with the respiratory and reproductive disease-causing equine arteritis virus (EAV) can become carriers, constantly shedding virus in semen. Because the infection is testosterone-dependent, suppressing testosterone might help prevent disease spread.
- Lower testosterone levels could help curb sexual and aggressive behavior during training and competition.
- It provides an alternative to castration and its potential complications.

ARND BRONKHORST

Lower testosterone levels could curb sexual and aggressive behavior in stallions in training.

Historically, some veterinarians have used the progestin altrenogest (designed for manipulating mares' estrous cycles) off-label for behavior modification in stallions. Others have "vaccinated" against GnRH, as is done in some mares to stop cycling. But both methods have variable effects on behavior, said Davolli, and not all stallions regain reproductive function.

So he and colleagues evaluated whether the GnRH antagonist acyline could effectively suppress the HPG axis without having detrimental effects on the stallion's future fertility. There is currently no FDA-approved veterinary acyline product, so the team used a compounded version.

Davolli's team used four treatment stallions and four controls, paired based on sperm count and testicle size. They administered intramuscular acyline to the treatment group for eight weeks, followed by nine weeks of "recovery," evaluating endocrine levels, semen characteristics, and testicular measurements during and up to 72 days after treatment. They also assessed sexual behavior.

"Treatment induced a decline in testosterone to gelding levels," Davolli said. Testosterone returned to control values within nine days after the last dose.

Treated stallions' sperm count, motility, and volume decreased, but quickly regained normal levels by 72 days post-treatment, he said. The only behavioral difference was that the treatment stallions took longer to ejaculate than the controls.

Therefore, Davolli concluded that acyline can effectively and safely suppress the HPG axis, and its effects are reversible. Perhaps most importantly, testosterone concentrations as low as that of geldings might be sufficient to clear EAV virus in carrier stallions, he added. Acyline did not, however, have a significant effect on stallion behavior, and this treatment is currently cost-prohibitive for owners.

Which Agents Disrupt Biofilm in Endometritis Cases?

Chronic bacterial endometritis (uterine lining inflammation) in mares is a major source of economic loss to the breeding industry. This condition can be difficult to treat because many times the bacteria form a protective biofilm that antibiotics have trouble penetrating. Colorado State University (CSU) researchers wondered if antibiotic alternatives would do a better job getting through, so they pitted them against various uterine pathogens. Kristen Loncar, DVM, of CSU's Equine Reproduction Laboratory, in Fort Collins, presented their results.

She and colleagues produced an *in vitro* (in the lab) biofilm from *Streptococcus equi* subspecies *zooepidemicus, Escherichia coli, Pseudomonas aeruginosa*, and *Klebsiella pneumonia* isolates of mares with endometritis. They tested nine agents' ability to disrupt each species at recommended doses when challenged for six hours and found that:

- **Chelating agent Tris-EDTA, hydrogen peroxide, N-acetylcysteine, dimethyl sulfoxide (DMSO), and the antimicrobial peptide mimic Ceragyn** significantly degraded *E. coli* biofilm and also significantly reduced bacterial load.
- **Ceragyn and DMSO** reduced *K. pneumonia* biofilm mass. These agents and hydrogen peroxide significantly reduced bacterial load.
- **Hydrogen peroxide and Ceragyn** significantly reduced half of the *P. aeruginosa* isolates' biofilm. N-acetylcysteine significantly reduced its bacterial load.
- **All agents except ozone** significantly disrupted and reduced bacterial load of *S. zooepidemicus*.
- **Hypochlorous agents Vetricyn and OmniPhase** were only effective against *S. zooepidemicus*.

"No single nonantibiotic agent reliably disrupts biofilm in all bacteria species tested," Loncar said, adding that Ceragyn and DMSO were the most effective.

Therefore, she said, "It's very important to test and identify the bacteria species prior to treatment to determine which treatments will be most effective."—*Alexandra Beckstett*

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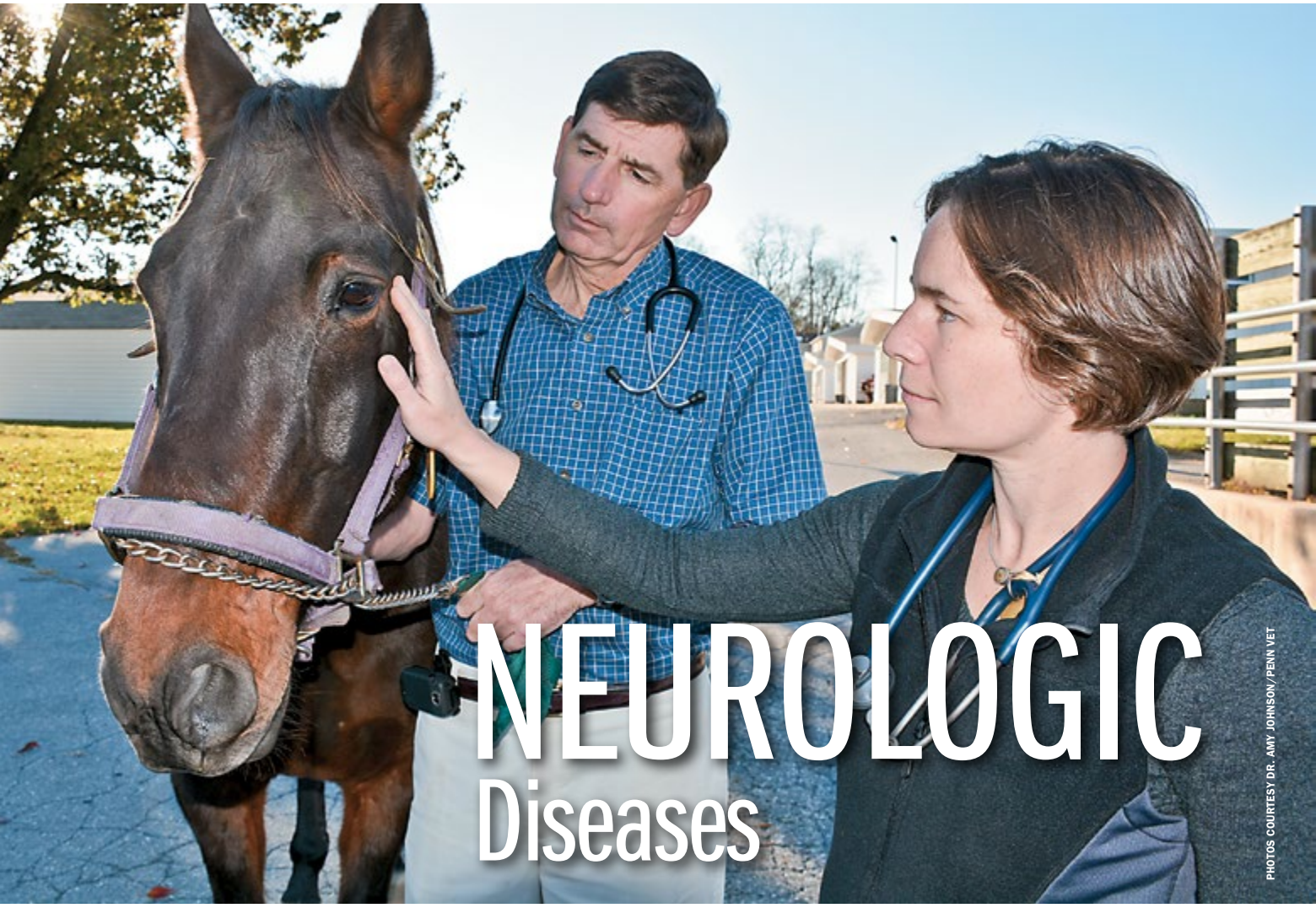

NEUROLOGIC Diseases

PHOTOS COURTESY DR. AMY JOHNSON/PENN VET

STEPHANIE L. CHURCH AND NANCY LOVING, DVM

Lab Testing for EPM, Lyme, and Other Equine Neurologic Diseases

Amy L. Johnson, DVM, Dipl. ACVIM, an assistant professor of Large Animal Medicine and Neurology at the University of Pennsylvania School of Veterinary Medicine's New Bolton Center, admits that much of what she has learned about neurologic diseases has been from examining horses that have died from them. After all, many can only be definitively diagnosed on post-mortem. She's applying what she's learned to keep horses out of necropsy and presented tips to help veterinarians navigate the landscape of lab tests for these diseases in live horses.

"If you know the best sample to collect, as well as the best test to request, it should improve your ability to diagnose neurologic diseases," she said. "Not only is choosing the test important, but you need to know how to interpret the test, and that's not necessarily as easy as it sounds.

"A neurologic workup should never start by pulling blood and sending it off to a lab," she said. "You need to start with your clinical examination, and figure out if the horse really does have signs of neurologic disease."

If so, localize the lesion and form a list of rule-outs fitting for the horse's age, breed, sex, location, and history. "Only then do you figure out which ancillary lab tests are appropriate to submit," she said.

> **"Remember that the diagnosis of EPM is always presumptive without a post-mortem exam."**
>
> DR. AMY JOHNSON

Equine protozoal myeloencephalitis (EPM) "We all know that EPM diagnosis is challenging, because there is extensive equine exposure to the protozoa (*Sarcocystis neurona*), and … it can mimic anything," Johnson said. Though *Neospora hughesi* also causes EPM, she detailed *S. neurona*, the most common cause and what she sees in the Mid-Atlantic region.

She bases EPM diagnosis in the antemortem (live) horse on three principles:

1. **Presence of neurologic disease:** "Compatible clinical signs that are referable to the central nervous system," she said.
2. **Rule-outs of other likely causes:** "That's why cervical radiographs might be so important, make sure there's no evidence of neck trauma, or some sort of stenotic or compressive myelopathy."
3. **Confirmation of *S. neurona* (or *N. hughesi*)-specific antibodies** in CSF, serum, or both. "Only then do we look for proof of exposure to the causative organism, and usually that's through

immunodiagnostics, by documentation of antibody production in the horse."

"Your index of suspicion should be very, very high if you have a combination of ataxia, atrophy, and asymmetry," she added. "Also remember that the diagnosis of EPM is always presumptive without a post-mortem exam," she said.

Commonly used antemortem tests that can be run on blood, cerebrospinal fluid (CSF), or both, and none of which are considered a gold standard, include:

- Western blot (Standard, sWB, and Modified mWB)
- Indirect fluorescent antibody test (IFAT)
- Surface antigen (SAG) ELISAS (enzyme-linked immunoassays, SAG 2, 4/3, and SAG 1, 5, 6, named for antigens they detect antibody production against)

A positive blood test simply indicates the horse has been exposed to *S. neurona*, but it doesn't necessarily mean he is infected and has central nervous system disease. As for looking at titers, Johnson doesn't find their magnitude to be helpful in her region for indicating likelihood of active infection vs. exposure. However, a negative blood test generally means no *S. neurona* exposure and, therefore, no EPM.

There's an exception to every rule, of course, and in this case it is a recently infected horse that might not show up positive for more than a week.

"If the horse 'smells' like an EPM case," she said, "and you get a negative blood result back, and you still think the horse has EPM, test again in 10 to 14 days, and if that horse … goes from negative to positive—that's really strong evidence." It also can happen with CSF, with *S. neurona* antibodies not yet being measurable.

False positives are common with CSF because of blood contamination and because antibodies diffuse over into the CSF in normal horses. She encouraged vets to test both blood and spinal fluid.

She said that a diagnostic test based on the titer ratio between serum and CSF antibodies provides the best answers.

Lyme disease Then there's Lyme neuroborreliosis, which is caused by *Borrelia burgdorferi* infection, carried by *Ixodes* ticks. It causes variable clinical signs.

"We think infection and seroconversion are very common, but true Lyme neuroborreliosis is likely rare," she said. "Maybe my definition of Lyme neuroborreliosis is too stringent, and that's why I think I only see a few cases. But I do think this is even more challenging than EPM."

X rays help clinicans rule out trauma and stenotic or compressive myelopathy in neurologic cases.

Potential criteria for testing include:

1. Possible exposure;
2. As with EPM, neurologic signs;
3. Abnormal CSF;
4. Evidence of nervous system infection on polymerase chain reaction test (PCR, for pathogen DNA) or intrathecal (in the spinal cord) antibodies; and
5. A positive blood test or isolation of *B. burgdorferi* from other sites.

Antemortem tests for Lyme are Western blot, ELISA, IFAT, stall-side SNAP tests, and the Multiplex assay. The Multiplex assay shows if the horse has produced antibodies against outer surface proteins that can indicate different stages of infection.

"I don't know, quite frankly, how important it is to know whether you have early infection or chronic infection," she said. "Also, it's complicated because a lot of horses have more than one exposure. What if you have a horse that has 12 ticks on it that are infected with *Borrelia* over the course of a year, and it's getting reinfected or re-exposed? What do its antibodies do, and how does that correlate with what you see on the Multiplex?"

But she can say with confidence that interpreting Lyme test results is similar to EPM. Positive blood? The horse has been infected at some point with *B. burgdorferi* and could have disease, but that might not be true at test time. Also, if the horse was vaccinated against Lyme, the veterinarian must know what antigens the vaccine contained before interpreting test results.

A negative blood result usually means no exposure or no infection and no disease, but not always, she said. Some horses "have local antibody production such that they truly have infections with *Borrelia* but are negative on blood tests. As with EPM, is it better to used paired blood and CSF? I think it is, but this is not even as straightforward as EPM."

A few other things (yes, more) can complicate Lyme diagnosis. Horses with Lyme neuroborreliosis have a leaky blood-brain barrier, so there will be more antibodies in CSF than usual. But the Multiplex test runs on an undiluted CSF sample, whereas blood testing is on a diluted sample.

For this reason, she said, the CSF titers will be about twice what you see in the blood of an exposed but unaffected horse, while they'll be at least four times what you see in blood in a sample that has evidence of intrathecal *B. burgdorferi* antibody production. But she cautions that this approach to analysis is unvalidated. Also, some horses negative on blood are positive on CSF, and vice versa, so a

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With EPM, best to test blood and spinal fluid. It's harder but better practice. #AAEPVegas

paired test isn't a bad idea.

Lastly, Johnson mentioned a few take-homes about other viral diseases:

- If a veterinarian is concerned about EHV-1 infection, "for any individual neurologic case we recommend that you submit both blood and nasal swabs for PCR testing … you can have a horse that is infected with EHV-1 that is positive on blood and not nasal swabs, or vice versa, even though a lot of horses are positive on both," she said.
- There is no advantage to testing CSF for West Nile virus.
- Always pay close attention to vaccination history in light of the signs.

Summing up, Johnson said, "Lab tests are helpful in the diagnosis of neurologic disease but are an adjunct, not the be-all and end-all!" Vets must stay up-to-date on available tests and how to interpret results, as two patients with the same results could have two very different diseases.

Recognizing Neurologic Syndromes

Robert MacKay, BVSC, PhD, Dipl. ACVIM, professor of Large Animal Clinical Sciences at the University of Florida College of Veterinary Medicine, described some confusing neurologic findings.

Consciousness is a life-sustaining operation based in the brain's reticular formation that runs the cardiovascular system, breathing, and swallowing. Part of this formation, called the ascending reticular activating system, is responsible for wakefulness and transitions in and out of it. Injury location determines wakefulness impact. For instance, midbrain injury (the uppermost part of the brainstem, involved in basic, unconscious body function) results in dulled alertness; cerebral injury (concerned with conscious thought, perceptions, and learned skills) might have no effect to a serious effect on consciousness; and widespread forebrain (the forwardmost part) injury, is necessary to moderately affect consciousness.

Behavioral changes can also be caused by brain injury. Examples include:

- Loss of learned behaviors (e.g., no longer knowing how to be led);
- Altered inherent behavior (e.g., a foal no longer bonding to its dam);
- Bizarre postures;
- Repetitive compulsive motor activity, such as circling;
- Teeth grinding;

COURTESY DR. ROBERT MACKAY

Head-pressing is a neurologic behavior often associated with brain injury.

- Head-pressing, often seen as pushing into a corner with the head lowered;
- Compulsive yawning;
- Self-mutilation, as seen in rabies; and
- Seizures, which might be classified as a form of dementia and can occur with eastern equine encephalitis.

Compulsive circling could indicate asymmetric vestibular (pertaining to the horse's balance mechanism) injury or a forebrain lesion. Vestibular signs include:

- Head tilt and small, incomplete circles;
- Signs of cranial nerve dysfunction, (i.e. facial paralysis); and
- Staggering and falling toward the inside of the circle.

A forebrain lesion, as seen with moldy corn poisoning, causes the horse to:

- Hold its head vertically;
- Complete large circles without staggering, though it results from compulsive behavior (dementia); and
- Suffer from central blindness or diminished touch perception, usually of the eye or face on the outside of the circle.

Altered menace response and pupillary light reflexes are evident when a horse fails to blink when you wave a hand in his face. "For clinical purposes to localize which part of the brain might be affected, (the menace) response appears to be generated by the brain cortex on the side opposite to the tested eye," he said. "In contrast, pupillary light reflexes use specific nerve pathways that go both directly and cross over the midbrain to cause constriction of the pupils."

Damaged facial nerves "Injury external to the skull only affects one of the three branches (the somatic branch) of the facial nerve," he said. There might be loss of blink reflexes, but the eye still retracts, and the third eyelid still functions to spread the tear film across the cornea, although not as well, so mild corneal ulcers might develop from dryness. In contrast, injury to the greater petrosal branch leads to dry eye and rapid corneal damage due to loss of functions that deliver tear film.

Nystagmus, or repetitive uncontrollable eye movement, can be caused by neurologic lesions: a lesion in the vestibular system referred to as peripheral nerve dysfunction; a lesion in the central nervous system medulla (the spinal cord, as with EPM); or a central lesion within the cerebellum (which controls motor control and cognitive function), in which case the head tilts the direction opposite the lesion. Typically, peripheral and medullary lesions cause horizontal (side-to-side) nystagmus, while central lesions usually change orientation to other patterns.

Specific signs can help the skilled, carefully observant clinician pin down or rule out lesion location to define cause and, when possible, implement treatment.

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Best Practices for Choosing NSAIDs

One of the most important tools in a practitioner's kit is his or her collection of anti-inflammatory medications to reduce pain, swelling, and fever. Non-steroidal anti-inflammatory drugs (NSAIDs) come in many forms, but usually as intravenous or oral. These medications are relatively inexpensive and very effective within hours of administration.

Alastair Cribb, DVM, PhD, dean and professor of pharmacology at the University of Calgary, in Alberta, reviewed NSAID options for use in horses.

He explained how NSAIDs work primarily through blocking cyclooxygenase (COX) enzymes—basically, the process responsible for inflammatory response. There are two forms of NSAIDs:

- Those that are nonselective and inhibit production of all prostaglandins (hormonelike products the body produces), including COX-1, which is important for maintaining health of the intestinal lining and blood flow through the kidneys; and
- The newer selective inhibitors, including firocoxib and meloxicam, which only target inflammation-causing COX-2 prostaglandins.

Cribb listed the NSAIDs currently approved for use in horses: flunixin meglumine (Banamine), phenylbutazone (PBZ, Bute), ketoprofen, firocoxib, aspirin, and topical diclofenac cream. He added meloxicam to his discussion because, while it is not labeled for use in horses in North America, doctors use it to treat rheumatoid arthritis and osteoarthritis, and veterinarians have access for off-label use "only for cases in which there is insufficient response from other approved NSAID choices," he said.

> **"For laminitis, because neuropathic pain is part of the syndrome, nonselective NSAIDs may be preferable with acute onset."**
>
> DR. ALASTAIR CRIBB

NSAIDs for musculoskeletal pain One of the primary reasons veterinarians reach for NSAIDs is to treat musculoskeletal disorders. Cribb reported that Bute was more effective than ketoprofen and Banamine in reducing inflammatory pain in experimental synovitis (inflammation of the synovial membrane, in this case in the joint) cases. Meloxicam and Bute were similarly effective in reducing joint temperature, but meloxicam improved both objective and subjective lameness scores better than Bute.

In one study, when researchers induced mechanical pain in horses, flunixin, Bute, and a high dose of firocoxib decreased heart rate (an indicator of pain level) and lameness similarly, whereas low-dose firocoxib was ineffective. In a study of naturally occurring osteoarthritis, firocoxib

and Bute had comparable effects.

"For laminitis, because neuropathic pain (which arises when damaged, dysfunctional, or injured nerve fibers send incorrect signals to pain centers) is part of the syndrome, nonselective NSAIDs may be preferable with acute onset, whereas for longer-term treatment, firocoxib is better at minimizing gastrointestinal (GI) side effects," says Cribb.

NSAIDs for GI disorders and endotoxemia Colic is a painful abdominal condition that generally necessitates NSAID use. With this and other GI disorders flunixin was shown to impair healing of the colon, whereas firocoxib and meloxicam don't impair healing of the intestinal lining following an event (e.g., colic surgery) that resulted in reduced blood flow to the intestinal tract.

A horse suffering from endotoxemia-associated laminitis might benefit from aspirin therapy early on, because it inhibits thromboxane (a substance that causes blood vessel constriction). When treating horses with colic, veterinarians typically prefer Banamine over Bute because, when used at a lower dose, it decreases thromboxane production and blood lactate without masking certain signs that could interfere with clinical monitoring.

Foals Veterinarians should avoid using NSAIDs in foals, particularly those that are dehydrated, premature, or younger than 30 days old. Foals have different pharmacokinetics than adults and appear to be more susceptible to NSAID toxicity.

One important point that Cribb stressed is that a horse's disease state affects his NSAID response, and it is worth trying a different NSAID if the current one is ineffective. Further, there is not a good correlation between pain-relieving and anti-inflammatory effects.

Pain Management Options for Laminitis and More

During the conversation-style Medical Pain Management Table Topic, practitioners relayed their pain management experiences and discussed the pros and cons of various drugs. Lori Bidwell, DVM, Dipl. ACVAA, a certified veterinary acupuncturist from Kentucky-based East West Equine Sports Medicine, and Debra Sellon, DVM, PhD, Dipl. ACVIM, director of Washington State University's Veterinary Teaching Hospital, facilitated the session.

In particular, they focused on laminitis. Some of the drugs they said they use most commonly to treat pain in laminitic horses include gabapentin, tramadol, acepromazine, acetaminophen, and NSAIDs such as phenylbutazone (Bute).

Attendees discussed ketamine bolus administration, but the risk of laminitic horses falling down had many veterinarians nervous about trying this drug. Bidwell and Sellon encouraged veterinarians to consider morphine. Subcutaneous administration of butorphanol (a k-agonist opioid) is another option, and a new study shows that subcutaneous butorphanol administered at 0.1 mg/kg body weight lasts longer than intravenous or intramuscular administration, said Sellon.

The panel strongly dissuaded the practice of "stacking NSAIDs," in which veterinarians administer more than one NSAID at the same time. And attendees universally voted dimethyl sulfoxide (DMSO) "off the island" and deemed it ineffective in laminitis patients.

The conversation quickly moved forward to address methadone, a μ-agonist like morphine, as an economical analgesic option, particularly for laminitic pregnant mares.

Lidocaine patches taped or glued to horses' fetlocks also earned accolades. Wrapping up, Bidwell and Sellon broached topical ketamine's potential benefits for laminitic horses that underwent hoof wall resection.

They also briefly discussed other painful conditions, such as septic (infected) joints in foals, back pain, osteoarthritis, and castration. To read about the entire discussion, see TheHorse.com/37088.—*Stacey Oke, DVM, MSc*

Antibiotic-Anesthetic Combo an Effective Lower Limb Treatment

If a horse has a severe lower limb infection, the veterinarian must treat it immediately and aggressively, using the appropriate antibiotics. Some use a technique called regional limb perfusion (RLP), in which the practitioner places a tourniquet above the injury site, isolating blood flow to the lower limb before injecting antibiotics into the vein below the tourniquet. This localizes high concentrations of antibiotics at the site of infection.

Using an anesthetic during this procedure is important, but some antibiotics become ineffective when combined with other drugs. So Aimee Colbath, VMD, of Colorado State University's Orthopaedic Research Center, evaluated a combination of the antibiotic amikacin with the anesthetic mepivacaine.

She noted that because mepivacaine is an effective anesthetic, this combination could be very useful for repairing wounds or flushing synovial structures in the sedated standing horse without resorting to general anesthesia. Historically, researchers have shown that combining amikacin with another antibiotic (ticarcillin) reduced amikacin levels and efficacy, so Colbath wanted to take a closer look at mepivacaine, amikacin, and RLP.

Colbath used this combination on nine horses. Her team administered one of two RLP treatments—amikacin only, or an amikacin/mepivacaine combination—in 14 limbs, using the middle carpal (knee) joint as the test area and the top of the cannon bone to evaluate sensation. The researchers then sampled synovial fluid from the joint to assess amikacin concentration and antimicrobial activity based on bacterial culture and sensitivity testing.

The researchers found that 30 minutes post-treatment, horses receiving the combination had decreased limb sensation compared to horses treated with amikacin alone. Amikacin concentration in the synovial fluid did not differ significantly between treatment groups at 30 or 60 minutes. Similarly, when mepivacaine was combined with amikacin, the amikacin exerted the same antibacterial inhibition on media plates cultured with *Staphylococcus aureus* and *Escherichia coli* as it did without mepivacaine.

Veterinarians can use this combination to safely and effectively treat lower limb injuries in standing, sedated horses, Colbath concluded.

CONVENTIONTWEET

Michelle Anderson
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Oral tramadol use for laminitis: don't forget it as an option for pain management.

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[1] UC Davis (Nicola Pusterla) & Merck Animal Health. Infectious Upper Respiratory Surveillance Program. Ongoing Research 2008-present.
[2] Townsend HGG. Onset of protection against live-virus equine influenza challenge following vaccination naive horses with a modified-live vaccine. Unpublished data.

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Examining Horse Fatalities in Long-Distance Endurance Competitions

Endurance is an aptly named riding discipline. The sport requires horse and rider to complete more than 50 to 100 miles of trail in a single day. Because of the nature of the sport, dehydration, electrolyte imbalances, and heat stress can arise, sometimes leading to fatalities.

To investigate causes of fatality in endurance horses, Olin Balch, DVM, MS, PhD, of North Fork Veterinary Service, in Cascade, Idaho, and Hal Schott II, DVM, PhD, Dipl. ACVIM, professor of large animal medicine at Michigan State University, reviewed results from American Endurance Ride Conference post-ride surveys and veterinary reports from 2002 to 2014. During this time there were 96 fatalities out of 270,070 horses entered in competition—that's 0.32 fatalities per 1,000 starts.

Balch and Schott's study included all fatalities that occurred over the four-day period from check-in the day before the race to two days following the competition. If a problem developed at the ride, then they investigated that horse's outcome beyond those four days. "An increase in ride distance often leads to gastrointestinal problems and metabolic compromise," Schott explained.

They determined that 26 deaths (30%) in competing horses were not fatigue-related. There were 61 fatalities (70%) attributed to the demands of endurance exercise, including consequences of severe muscle cramping and exhaustion.

> **"An increase in ride distance often leads to gastrointestinal problems and metabolic compromise."**
>
> DR. HAL SCHOTT II

"Exhaustion was commonly associated with decreased intestinal function due to a long period of decreased blood flow to the intestinal tract, as blood was diverted to the exercising muscles during exercise," Schott explained. "Affected horses showed a poor appetite and colic signs attributable to ileus (poor intestinal motility). A disastrous consequence was stomach rupture in several horses, with no apparent relation to stomach ulcers, while others developed renal failure and/or laminitis."

Another important finding, he said, was that 20 of these 61 horses actually finished the ride and received completion awards, yet developed signs of exhaustion after the ride with fatalities occurring over the next couple of days.

"This finding emphasizes that riders must monitor their horses closely after the ride and seek veterinary attention when any concern over recovery arises," he said.

"Finally, it warrants mention that owners of 19 horses that ultimately died or were euthanized declined fluid therapy and/or referral to a hospital for further care when recommended by veterinarians at the ride site," Schott added.

Armed with this information, Schott said there are several steps owners and riders can take to help prevent endurance-related fatalities.

"The best way a rider can reduce the risk of fatality, or for that matter elimination from competition, is to be in tune with their horse and voluntarily withdraw when their horse is not performing as expected," he relayed. "Despite close examination, ride veterinarians cannot identify all at-risk horses and, ultimately, riders are their horses' voices and are responsible for their health. This includes following veterinarians' recommendations for treatment and/or referral for more intensive care."

Unfortunately, said Schott, fatalities are a consequence of athletic events and are an inherent risk of all types of equine competition. "When compared to data for horse mortality rates from all causes compiled by the USDA, horses competing in limited distance rides had no greater risk of fatality than horses at home in a stall or pasture," he said. "However, horses that compete in 50-mile competitions are twice as likely to suffer a fatality and horses competing in 100-mile rides have a tenfold greater risk of fatality."

IDDSP Surgerical Approaches Go Head to Head

Ever since researchers developed a novel way to correct intermittent dorsal displacement of the soft palate (IDDSP), a condition that can limit or end a horse's racing career, there hasn't been much argument over the surgical method to use. The procedure, called "tie-forward," has a proven success rate. But a new study casts doubt on whether this method is truly superior to older techniques.

Scientists had not compared like-to-like racing results to see if one IDDSP surgical approach gave better success rates than another and, ultimately, the competitive edge. So James Carmalt, MA, VetMB, MVetSc, FRCVS, Dipl. ABVP, AVDC, ACVS, a professor of surgery at the University of Saskatchewan (U of S), in Canada, and a colleague from U of S and Halland Animal Hospital, in Sweden, compared race speed of Swedish Standardbred trotting horses that had undergone either a staphylectomy or a "tie-forward" procedure.

The staphylectomy, in which surgeons remove a small amount of the back edge of the soft palate, is designed to scar and, thus, stiffen the soft palate, potentially reducing the size of the hole through which the epiglottis could displace. The tie-forward surgery involves pulling the larynx forward and upward by suturing it to the hyoid apparatus. This wishbone-shaped combination of short bones joins the larynx to the base of the skull, ultimately allowing controlled movement of the larynx during head and neck position changes, vocalization, swallowing, and movement. The surgical technique drives the larynx into the soft palate and reduces the chance of displacement. Surgeons developed this technique after the advent of overground endoscopy, which allowed them to see the successful results of the procedure in the working horse.

Carmalt and his team compared race records of 56 Standardbreds with endoscopically confirmed IDDSP to those of 48 horses with no abnormality on upper airway endoscopy and 90 matched controls. They used statistical methods to control for possible differences between horses and compared their pre- and post-surgery speed. They also evaluated the effect of the surgical procedure type on likelihood to return to racing and on post-surgery speed, career race starts, and earnings.

Results showed that all the horses got faster, but it was a function of experience—number of races under the horses' proverbial belts. "Horses are not slowing down before surgery day," he said. "Horses with IDDSP that went to surgery did not speed up post-surgery. There was also no effect of (surgical) technique."

Bottom line, there was no difference between the IDDSP and control horses, before or after surgery.

"Trainers and owners have a significant amount of input into how their horses are cared for, so veterinarians must pay special attention to the research and communicate with their clients clearly and carefully about it before recommending a surgical approach," he summed up. "Similarly, trainers and owners have to keep an open mind about different treatment options and carefully weigh up the pros and cons of everything, including cost and benefit before proceeding."

Rodenticide Causes Sudden Death in Exercising Horses

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A secure rat bait box.

Veterinarians with the California racing necropsy program have recently discovered a less obvious cause of sudden death among race horses: rat poison.

Rick Arthur, DVM, the equine medical director at the University of California, Davis, School of Veterinary Medicine, and colleagues took a closer look at sudden death incidents caused by rodenticide and at racehorses' risk of exposure to the poison.

Over 22 months of racing, from 2012 through 2014, six out of 374 sudden deaths on four California racetracks were due to idiopathic (having no obvious cause) hemorrhage. Necropsy results revealed traces of anticoagulant rodenticide in all six horses' liver tissue. These substances inhibit the horses' blood from clotting, causing massive internal bleeding.

The levels of anticoagulant rodenticide found upon necropsy, however, were well below what's considered toxic in horses, Arthur said. Thus, he hypothesized, "strenuous exercise might alter the toxic threshold for anticoagulant rodenticide in these horses."

These post-mortem discoveries prompted the California Horse Racing Board (CHRB) to launch extensive investigations into understanding the poison's source. They evaluated each track's pest control program and found that three out of the four racetracks used commercial vendors to set bait out in sealed and secure stations, away from horse's stalls. The fourth offered mechanical traps to trainers as needed.

The CHRB also interviewed barn personnel, some of whom admitted to commonly distributing anticoagulant rodenticide around the barns. "From statements made to investigators, unauthorized anticoagulant rodenticide use occurs because barn personnel considered rodent control efforts inadequate and believed it was necessary to take matters into their own hands," said Arthur.

At the end of the investigation the CHRB established that rats are clearly a frustrating problem at the barns they investigated and that the most likely source of equine exposure is from barn personnel doing their own rat control.

Because toxicity thresholds are so low in horses, Arthur recommended strictly monitoring anticoagulant rodenticide use at racetracks and other locations that are stabling strenuously exercising horses. And "anticoagulant rodenticide toxicity should be considered in sudden death cases with idiopathic hemorrhage," he said.—*Alexandra Beckstett*

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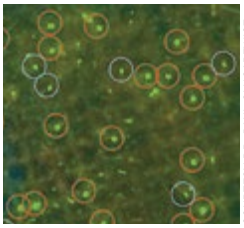
Sesamoiditis Associated With Suspensory Branch Changes

Severe sesamoiditis (inflammation of the sesamoid bones at the back of the fetlock) can predispose a horse to suspensory ligament injuries. Sarah Plevin, BVMS, MRCVS, CVA, Dipl. ABVP, ACVSMR, (Florida Equine Veterinary Associates) wondered if early detection of significant sesamoiditis and suspensory ligament branch changes could indicate likelihood of suspensory ligament injury. She performed X ray and ultrasound exams on 50 yearlings at a Thoroughbred training facility prior to the start of their racing careers and observed them for signs of suspensory branch injury as training progressed. She found a significant relationship between severe sesamoiditis and suspensory branch changes, Plevin said, adding that veterinarians can use this information to identify at-risk horses and manage them appropriately.

Scientists Can Count Equine Parasites With a Cell Phone



COURTESY DR. PAUL SLUSAREWICZ

Researchers have developed a fast, easy, and on-site way to perform fecal egg counts for deworming programs: Collect the sample and let your cell phone do the counting. Paul Slusarewicz, PhD, (MEP Equine Solutions) said he and colleagues identified a universal egg marker present on all parasite eggs that would allow software to detect eggs amidst the rest of the debris in a sample. They also determined that the software can distinguish between different types of parasite eggs. The team is carrying out full validation studies and finalizing the system—Parasight—before it becomes commercially available in late 2016.

A Stall-Side Test for Confirming Infection in Synovial Structures

Confirming joint infection (which comes with a mortality rate of 10-50%) can be costly and time-consuming. Veterinarians have been exploring a speedier approach, looking at serum amyloid A (SAA) levels the body produces in response to pro-inflammatory mediators. Florent David, DVM, MSc, Dipl. ACVS, ECVS, ACVSMR, ECVDI, (Mid-Atlantic Equine Medical Center) recently tested synovial fluid samples from both inflamed, septic (infected) joints and inflamed, nonseptic joints using an SAA stall-side test (EquiCheck) and the laboratory ELISA test for comparison. He found that both tests were very reliable for detecting synovial structure infection. David said the stall-side test can help practitioners start treatment while awaiting definitive laboratory results, or it can serve to initiate immediate referral to a facility for treatment.

Researchers Review *Klebsiella* Pneumonia

Klebsiella spp are a common cause of bacterial pneumonia, but cases are not well-described in the literature. Krista Estell, DVM, Dipl. ACVIM, (University of California, Davis) and colleagues conducted a retrospective study of 46 horses diagnosed with *Klebsiella* pneumonia over 20 years. They found that 47% of the isolates were multidrug resistant, but that the antibiotic amikacin was effective in killing the bacteria. The survival rate was 70%, and horses that developed laminitis and/or hemorrhagic nasal discharge were more likely to die. Ultimately, the team determined that veterinarians should consider pneumonia caused by *Klebsiella* spp as a differential diagnosis for horses with hemorrhagic nasal discharge. Because they observed multidrug resistance, they urged practitioners to determine which medications the bacteria are sensitive to prior to beginning treatment.

Preemies' Performance Prognosis

Some premature foals are born with incomplete ossification (cartilage hasn't completely hardened into bone) of their cuboidal bones. Lillian M.B. Haywood, VMD, (Rood & Riddle Equine Hospital) sought to determine whether these foals could become successful racehorses. Based on her results, foals with a shorter gestation length and incomplete cuboidal bone ossification were less likely to race and earned less than their maternal siblings. However, she said, with proper management and radiographs to monitor ossification, these foals can still have successful athletic careers.

Is Equine Coronavirus Prevalent in Nasal Secretions?

Nicola Pusterla, DVM, PhD, Dipl. ACVIM, (University of California, Davis) and colleagues evaluated whether equine coronavirus (ECoV, a pathogen that causes gastrointestinal illness), which can be detected in infected horses' feces, can colonize horses' respiratory tracts and be isolated from their nasal secretions. They found low detection rates in nasal secretions from horses with fever and signs of respiratory disease. "The testing for ECoV should be restricted to feces from horses with fever, lethargy, anorexia, colic and diarrhea and not necessarily include horses with upper respiratory tract signs," he said.

Accuracy of Lower Hock Injections

Veterinarians use joint injections to diagnose and/or treat osteoarthritis, but the injection is only effective if accurate. Kathryn Seabaugh, DVM, MS, Dipl. ACVS, ACVSMR, (University of Georgia) recently evaluated practitioners' accuracy when injecting lower hock joints and found that they successfully injected the tarsometatarsal (TMT) joint nearly 100% of the time, whereas they hit their target 46% of the time in the distal intertarsal (DIT) joint. As a result, she recommended veterinarians use radiographs to ensure proper needle placement before injecting the DIT joint.

EPM-Causing Parasites Ubiquitous in U.S. Horses

Researchers at UC Davis recently looked at the seroprevalence (confirms presence of antibodies) of EPM-causing parasites *Sarcocystis neurona* and *Neospora hughesi* among 5,250 horses in 18 states. Of those, 79% tested positive for *S. neurona*; 34% tested positive for *N. hughesi*; 31% tested positive for both; and 18% tested negative for both. While seroprevalence was slightly less likely among horses in the Western region, distribution was evenly spread across the United States.